Attracting Tomorrow

TDK

Innovative Capacitor Solutions Transforming Energy Storage, Solar Inverters & EV Charging

TDK Electronics Inc
Sept 2023

The history of TDK

Our innovations and diversification

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TDK

DIVERSIFICATION

- **1986** SAE Magnetics: **HDD head**
- **2000** Headway Technologies Inc: **HDD head**
- **2005** Amperex Technology Limited: **Lithium polymer battery**
- **2005** Lambda Group: **Power supply**
- **2008** EPCOS AG: **Passive components**
- **2016** Tronics Microsystems SA: **Sensors**
- **2016** Hutchinson Technology Inc.: **HDD Suspension**
- **2016** Micronas AG: **Magnetic sensors**
- **2017** ICsense NV: **ASICs**
- **2017** InvenSense, Inc.: **Sensors**
- **2018** Chirp, Inc.: **Sensors**
- **2018** Relyon: **Cold plasma technology**
- **2018** Faraday Semi: **3D embedded power solutions**
- **2019** TDK Ventures, Inc.: **Corporate venture capital (CVC)**

INNOVATIONS

1935

TDK's starting point was the first ever commercialization of ferrite

The world's first ferrite core

1968

Magnetic tape technology revolutionized music life

The first Synchro Cassette Tape, made in Japan

1980

Fine multilayering technology promoted the miniaturization of electronic equipment

The structure of a multilayer chip inductor

1987

Magnetic head technology achieved awesome recording density

The internal structure of an HDD and magnetic heads

TDK Corporation
Product categories

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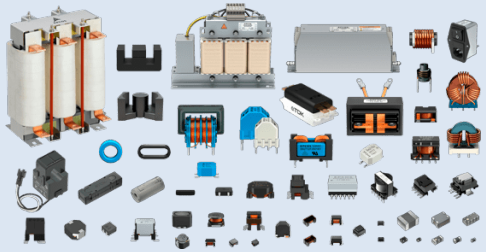
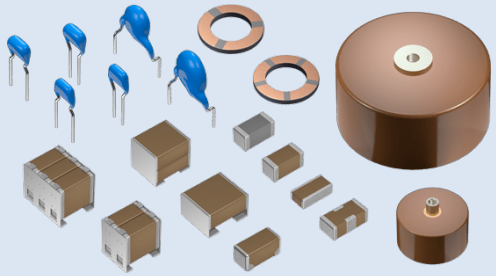
Passive Components


Magnetics


Communication Devices


Ceramic Capacitors

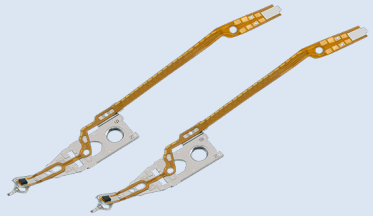

Aluminum and Film Capacitors

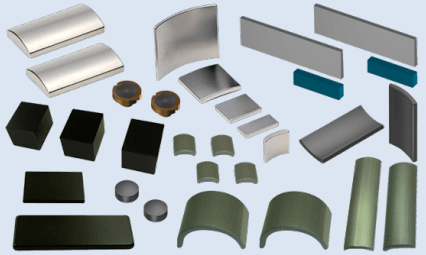

Piezo and Protection Devices

Sensor Application Products

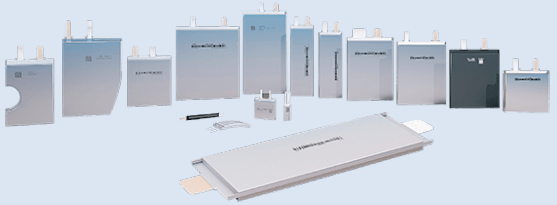

Sensors/MEMS

Magnetic Application Products


HDD Heads & Components


Magnet Products

Energy Application Products


Energy Devices

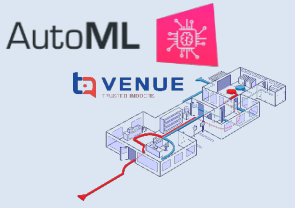

Power Supplies

Others


Flash Memory Applied Devices


EMC & RF Engineering


Micro-actuator Solutions & Others



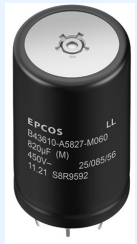
Software

Global presence around the globe

More than 250 factories, R&D & sales offices in more than 30 countries

Capacitor Technology guideline

Aluminum capacitors

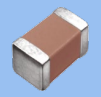


- Higher ripple current capabilities
- Higher frequencies
- Longer lifetime

Film capacitors

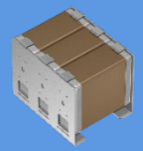
- Smaller
- Higher operating temperature
- Higher frequency
- SMD

MLCC chips



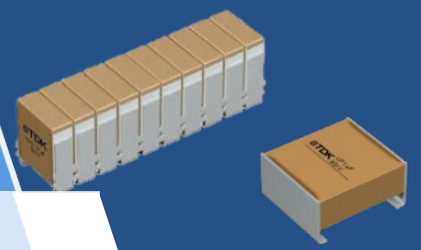
- Lower ESL
- Mechanically more robust
- Smaller footprint

Stacked MLCC



- Higher frequencies
- Higher operating temperature
- Higher ripple current ratings

CeraLink



Si IGBT → SiC / GaN

We provide a comprehensive aluminum electrolytic and film capacitors portfolio

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Aluminum electrolytic capacitors

- ¬ Screw terminals
- ¬ Snap-in / Solder pins / Large size
- ¬ Axial-lead / Soldering star
- ¬ Single-ended
- Hybrid polymer aluminum electrolytic capacitors
  - ¬ Axial-lead / Soldering star
  - ¬ SMD

Film capacitors for Industrial and for Automotive

- DC capacitors
- AC capacitors
- Power capacitor chips for low power

Film capacitors for Energy Solutions

- Power electronic capacitors for high power
- Power electronic capacitors for low power
- Power factor correction capacitors and key components for low and medium voltage
- Power quality solutions

Our Aluminum & Film Capacitors Business Group has a global manufacturing presence

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Aluminum Capacitors – Characteristics & functions

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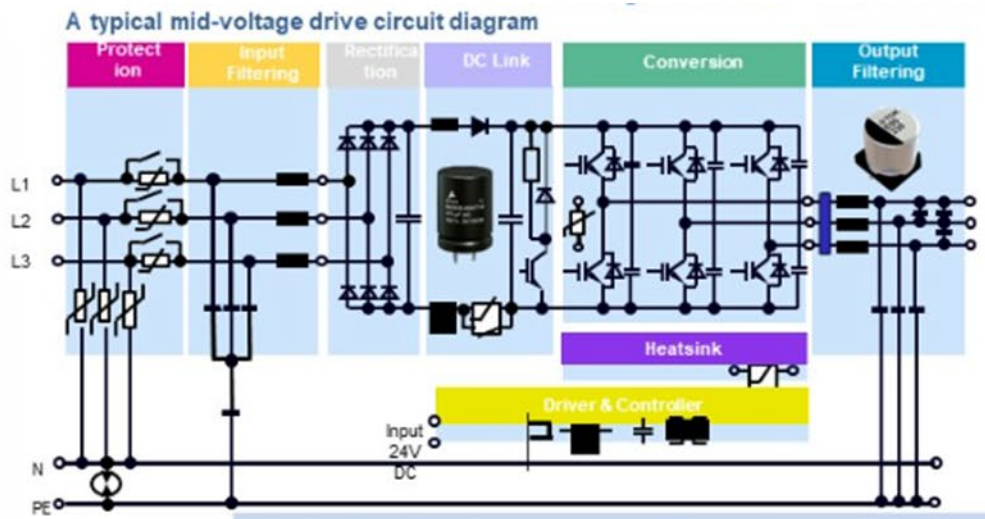
Characteristics	Capacitance	Voltage	Ripple current	Temperature	Main functions
Aluminum Electrolytic Capacitors	> 100.000 µF	≤ 600 V DC	Up to 70A	Up to 150 °C	DC-Link, Output filtering

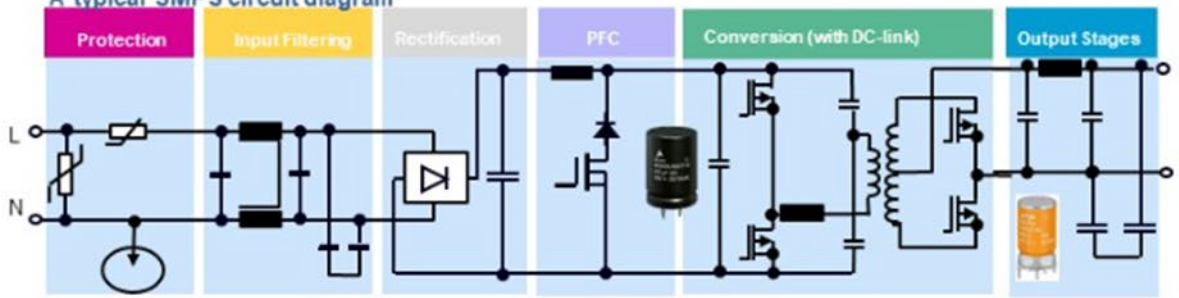
DC-Link capacitor (or capacitor bank) is responsible for smoothing the ripple voltage left over from the rectification stage. To avoid unnecessary inductance, the capacitor should be mounted as close as possible to the switching semiconductors so compact size & high temperature perfomance are needed too.

➔**Here high capacitance is needed**
(*Aluminum electrolytic cap can provide with comparatively small size & low cost)
➔**Motor drive needs high ripple current**
➔**Automotive applicaton needs also high anti-vibration capability**

A typical mid-voltage drive circuit diagram



A typical SMPS circuit diagram



Output Filtering: Key elements of the output stage are the magnetic components and capacitors to store energy and to remove ripple from the switching semiconductors.

➔**Here high ripple current & low ESR is needed**
➔**Automotive applicaton needs high anti-vibration capability**
(*Hybrid polymer cap here can offer times better performance of ripple current & ESR in high frequency comparing traditional aluminum cap as well as wider temperature range)

ALU caps for industrial & energy applications

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Product design & application

Snap-in / Multi-pin & Screw terminal capacitors

Hybrid Polymer Capacitors

Focus applications:

- EV Charging
- Energy Storage
- Solar Inverters
- SMPS
- Drives
- UPS

Product
Snap-in capacitors: Design highlights

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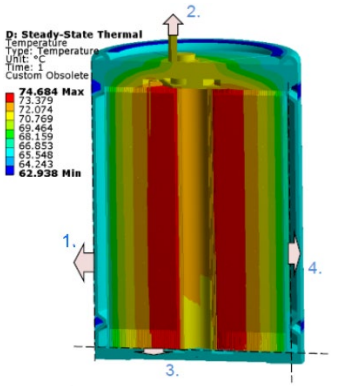
For DC link application in frequency converters, inverters for solar power and professional power supplies **with very high ripple current load per capacitance**

+85 °C	+105 °C			
B43541	**B43544**	**B43548**	**B43545**	**B43547**
200 … 600 V 8000 h	200 … 550 V 3000 h	400 … 500 V 3000 h	400 … 500 V 5000 h	200 … 500 V 8000 h



Significantly **reduced ESR** and extremely **low inner thermal resistance**

- Outstanding ripple current capability at operating conditions, especially at high frequencies
- Low costs per ampere of ripple current
- **Size** and **cost reduction** in capacitor banks where the design is driven by the **ripple current capability**

Snap-in capacitors for high demanding application

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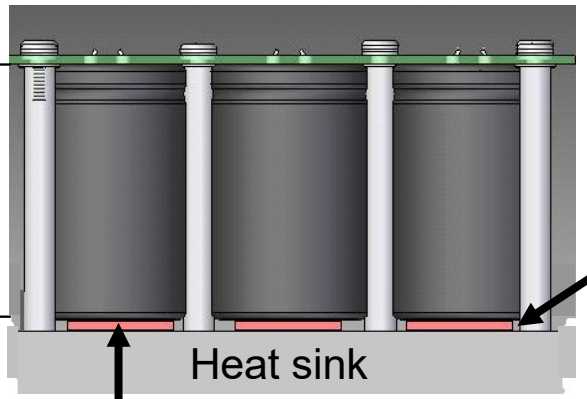
DC links **with ultra high ripple current load, extra long useful life** or **superior reliability requirements**

Reduced overall length tolerance **(±0.2 mm)** for effective heat sink mounting of capacitor banks



- PET-sleeve as standard insulation
- Base-cooling feature on request
- Suited for use of thin thermal pads (optional: mounted thermal pads)

Reinforced can with long-term rigidity

Characteristics:

- **Outstanding low ESR** at operating conditions above +50 ˚C
- **Low thermal resistance** between base and winding
- Optional for B43541, B43544, B43545, B43547, B43548

Ultra-high ripple current capability (up to +50 %) and **very long lifetime**

ALU Snap-in capacitors new series

B43657 series – Ultra compact

V_R – 450 V & 475V
+105 °C operating temperature

Product features / advantages

- High CxV product – e.g. 910 µF / 450 V / dim 30 x 60 mm
- High ripple current capability – up to 7.68 A @ 100 Hz, 60 °C
- Further compactness option based on selected anode foil selection upon request

B43548 series – Higher ripple current

V_R – 400 to 500 V
+105 °C operating temperature

Product features / advantages

- Highest ripple current capability – up to 9.8 A @ 100 Hz, 60 °C
- Faster charging/discharging cycles design
- Base cooling version available for Ø 30 & 35 mm

Target applications

- EV Charging
- Solar inverters
- Frequency converters
- UPS

ALU Multi-pin capacitors new series

B43610 series – Compact
V_R – 400 to 450 V
+85 °C operating temperature

Product features / advantages

- High CxV product – e.g. 1500 µF / 400 V / dim 35 x 80 mm
- High ripple current capability – up to 18.7 A @ 100 Hz, 60 °C
- Overload protection by pressure relief vent on the base
- Up to 3 case steps shorter with increased current density

B43612 series – High ripple current
V_R – 400 to 450 V
+85 °C operating temperature

Product features / advantages

- Highest ripple current capability – up to 21.3 A @ 100 Hz, 60 °C
- Useful life up to 10,000h, 85 °C , Vrated, Iacr @ 100Hz
- Overload protection by pressure relief vent on the base

Target applications

- EV Charging
- Solar inverters
- Frequency converters
- UPS

Hybrid polymer capacitors
TDK portfolio for industrial applications

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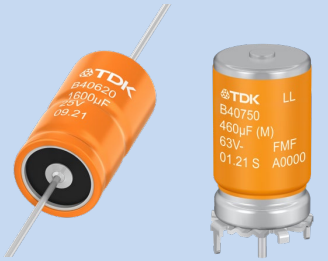
Features	
Rated voltage	25 → 63 V (80 V coming soon)
Rated capacitance	Up to 2200 µF
Operating temperature	-40 up to +135 °C
Ripple current capability	Up to 20 A/105 °C
Useful life	Up to 10,000 h / 105 °C
Dimensions (d x h)	10 x 10.2 → 10 x 12.5 mm (10 x 16 mm coming soon) 14 x 25 → 18 x 30 mm
Construction	Radial SMD Axial and soldering star



B40921
25 to 35 V

B40940
63 V

B40600/700
25 to 35 V

B40650/750
63 V

Under development for industrial applications

B40950
25 to 80 V

B40650/750
25 to 80 V

Hybrid polymer capacitors for high ripple current

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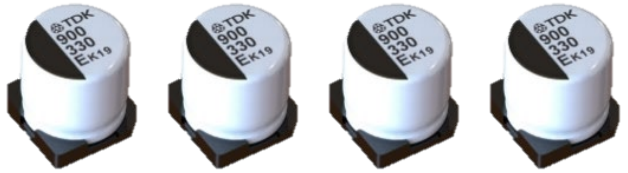
Equivalent ripple current performance

6x standard radial al caps	Only 1x soldering star HP cap	4x SMD HP caps

or

NEW

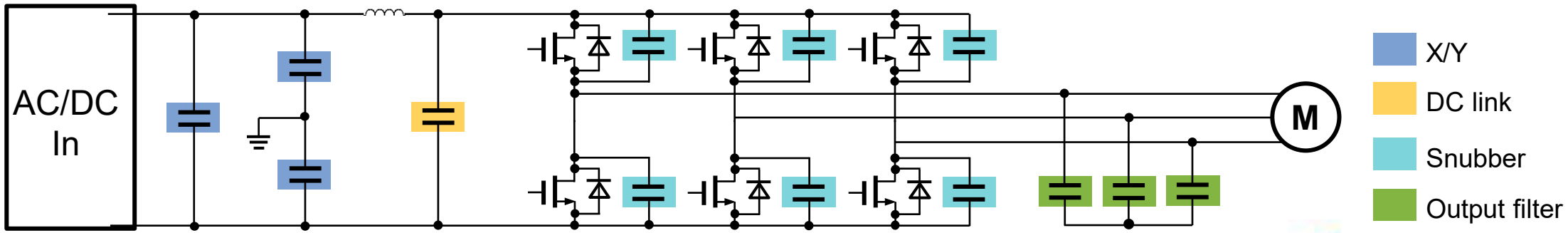
or



Advantages

- ✓ Replaces multiple components with a single, smaller capacitor
- ✓ Smaller footprint, volume and weight
- ✓ Over dimensioning of capacitance not necessary

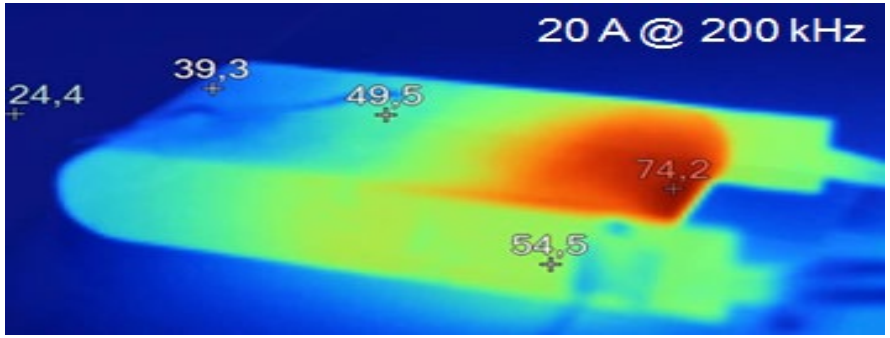
Film Capacitors characteristics and function

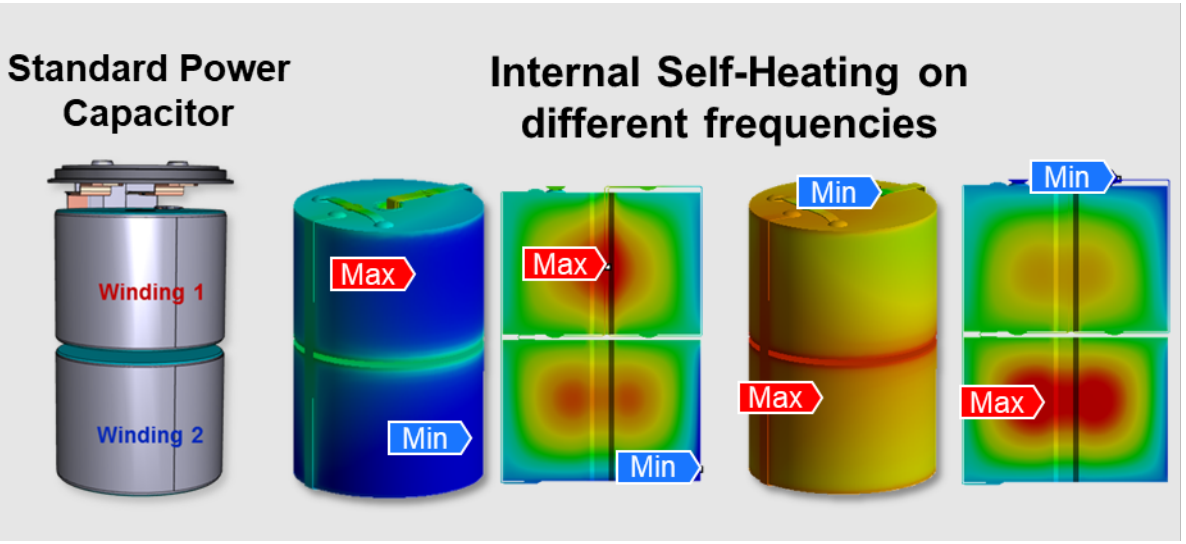


- **Film caps can be used in DC or AC (Non-polarized)**
- **Voltage ratings can go over 3kV for PCB and Busbar mount, and over 10kV for Power Distribution types.**
- **Many mechanical variations, from PCB mount to screw terminal types and**
- **Very high reliability, featuring “Self-Healing” Properties**
- **Designs with very low ESL, making possible usage with Wide Band Gap semiconductors**

Film Capacitor Characteristics

- Due to termal and mechanical characteristics associated with the plastic dielectric used, most Film capacitors have their usage limited to 125°C.
- Thermal management requires detailed analysis to avoid problems with useful life and termal runaways for these types.
- Electric load and environmental conditions are importante aspects to be considered.





Key Capacitor Series in xEV

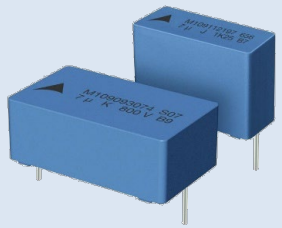
Position	Series	Voltage and Capacitance	Temperature	Biased Humidity
EMI X2	**B3292*P/Q**	305Vac/630Vdc 0.033…5.6uF	Maximum operating temperature **125°C**	40°C/93%RH/305Vac/1000h **85°C/85%RH/240Vac/500h**
EMI Y2	**B3202*H/J**	300Vac/1500Vdc 0.001…1uF	Maximum operating temperature **125°C**	40°C/93%RH/300Vac/1000h
DC-Link	**B3271*H**	500…1600V DC 0.47…170uF	Maximum operating temperature 105°C	**60°C/95%RH/Vr/1000h**
Resonant	**B3264*B**	400…2000V DC 2.2…560nF	Maximum operating temperature **125°C**	**60°C/95%RH/Vr/1000h**

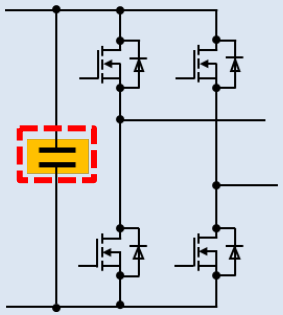
Stocking package with 41 additional P/N‘s being prepared
Sample Kits recommended

NPI in Q3 2023

B3271#H- New DC link

- Voltage up to 1600Vdc
- Capacitance up to 170µF
- Small size and Low ESR
- THB
  - 60°C/95%RH/Vr/1000H
- Compliant with AECQ200
- Pitch : LS27.5mm to 52.5mm

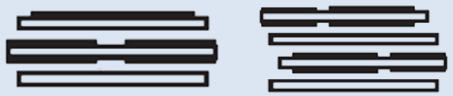




Series	B3271*H	B3277* D/G (old)	B3277*H
Vr @85°C	500Vdc - 1600Vdc	450Vdc - 1100Vdc	450Vdc - 1600Vdc
THB	60°C/95%RH/Vr/1000H	40°C/93%RH/1344H	60°C/95%RH/Vr/1000H **85°C/85%RH/Vr/500H**
AECQ 200	**Yes**	No	**Yes**
Example	B32716H1166	B32776G1166	B32776H1156
	1100V@85°C	1100V@85°C	1100V@85°C
	4.0mΩ	6mΩ	5.2mΩ
	30x45x42mm	33x48x42mm	33x48x42mm

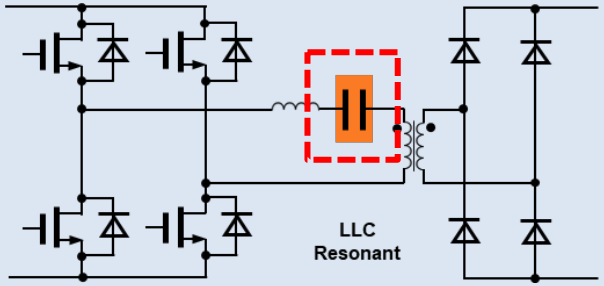
B3264#H - MMKP2.0

- Tmax :125°C
- Rated voltage at 105°C
- High AC voltage : up to 700Vac
- Low ESR
- High Irms
- Better THB performance
  - 85°C/85%RH/Vr/1000H
- Compliant with AECQ200
- Pitch : LS10 mm to 22.5mm



MMKP type

Series	B3264#H	B3264#B (old)
DC Voltage	630Vdc - 2000Vdc	400Vdc - 2000Vdc
AC Voltage	400Vac - **700Vac**	250Vac - 500Vac
pitch	10mm - 22.5mm	10mm - 22.5mm
capacitance	2.2nF - 470nF	2.2nF - 560nF
Tg limited	**0.0003** @ 1kHz **0.0010** @ 100kHz	0.0006 @ 1kHz 0.0015 @ 100kHz
THB	**85°C/85%RH/Vr**/1000H	60°C/95%RH/Vr/1000H



B3264#H and B3271#H Focus Applications Industrial

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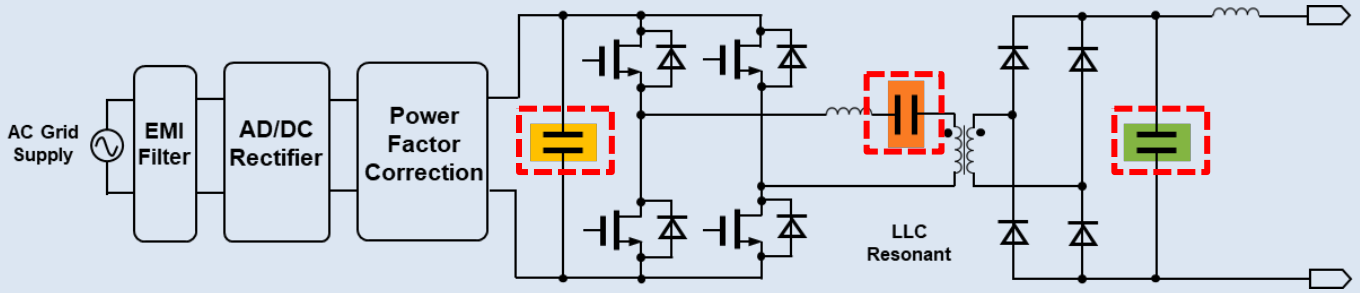
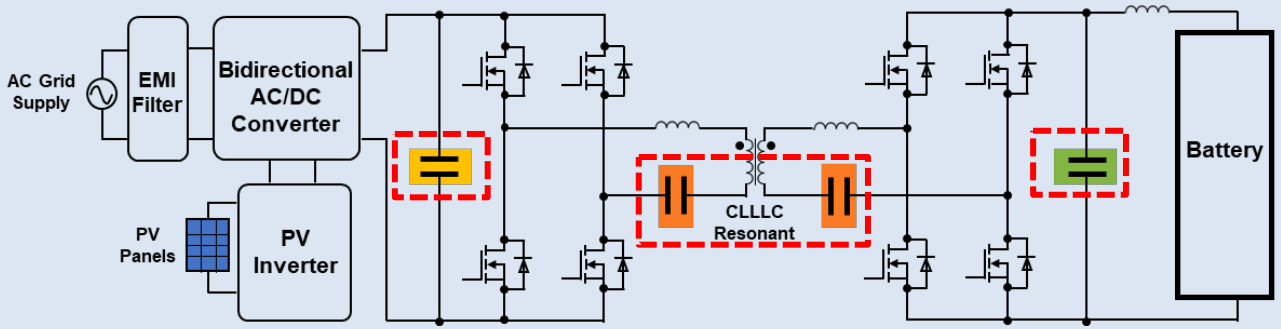
DC Charger

- DC charger power module: 20kW~80kW
- Commonly used scheme



Household ESS

- Hybrid inverter: 3~10kW
- New design trend: CLLLC high frequency isolation



Upcoming Power Film Caps NPI‘s

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MKP AC / MKD AC

Input / Output filter

DC-Link

DC link

POWER FILM DC Link Series Characteristics

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Characteristic	MKP DC Resin Top – B25690X	MKP DC Heavy Duty – B2568X
Voltage / Cap	700 - 3000V / up to 7mF	900 – 3000V / up to 4mF
Imax	120A	120A
ESL	<90nH	<90nH
Life Time	200.000h	200.000h
Temperature	-40 to +85°C	-40 to +85°C
Partial Discharge	1.6kV (10pC) Extinction Voltage	-
85%RH/85°C/Un	500h	1000h
Standard	IEC61071/ UL810 / RoHS Compliance	IEC61071 / RoHS Compliance / EN 45545: R22: HL3 R23,: HL2

HARSH ENVIROMENTAL CONDITION AND HIGHER FREQUENCY

MKP DC 105°C
Improving the DC Link performance

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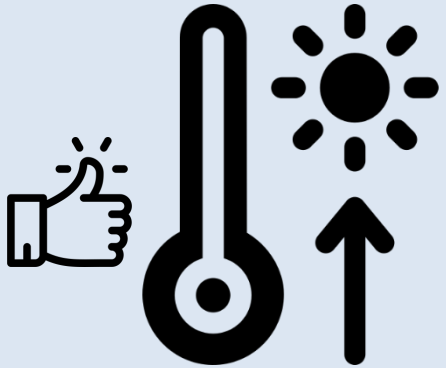
Main Features

- Datasheet available in Dec/2023
- Diameter 85, 116mm , Voltage from 900V till 1.6kV
- Lifetime will be specified for 95°C and 105°C HS
- Design-in upon request. **Samples available**
- Epoxy resin instead of PU, improved process
- Application: Solar and wind inverters, industrial drives, traction inverters



NEW

Series Ramp up Q3 2023

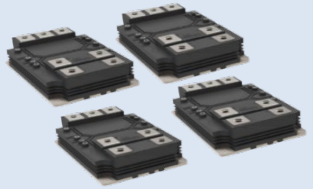
Advantages

- Higher current capability (higher self heating allowed)
- Higher ambient temperature possible (e.g. less cooling)
- Hot spot allowed till 105°C (derating to be considered)
- Solution could be done more compact

Aprox 20 PNs as NPIs by Q3 2023







MKD AC Resin and Gas filled solutions

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MKP AC
Available
Already in stock

Focus application **UPS**
- **Low cost**
- Focus on standard products

1-phase
250 ~ 600 Vrms
20 ~ 600 µF
63 ~ 85 mm diam.
70 ~ 267 mm height

MKD AC resin filled V2.0
Launch **JUL 23**

Focus application **Drive and Traction**
- Metal cover / Tightly sealed
- Large sizes and 3-phase

No overlap with MKP AC

1-phase & 3-phase		
… ~ …	250 ~ 1000	Vrms
… ~ …	3x15 ~ 3x400	µF
… ~ …	75 ~ 136	mm diam.
… ~ …	145 ~ 313	mm height

MKD AC gas filled
Launch **September 23**

Focus application **Solar and Wind**
- Metal cover / Tightly sealed
- **Long lifetime / high reliability**

Overlap with MKD AC resin filled

1-phase & 3-phase		
330 ~ 480	330 ~ 1000	Vrms
40 ~ 300	3x15 ~ 3x330	µF
75	75 ~ 136	mm diam.
164 ~ 200	164 ~ 351	mm height

We provide a comprehensive ceramic capacitors portfolio

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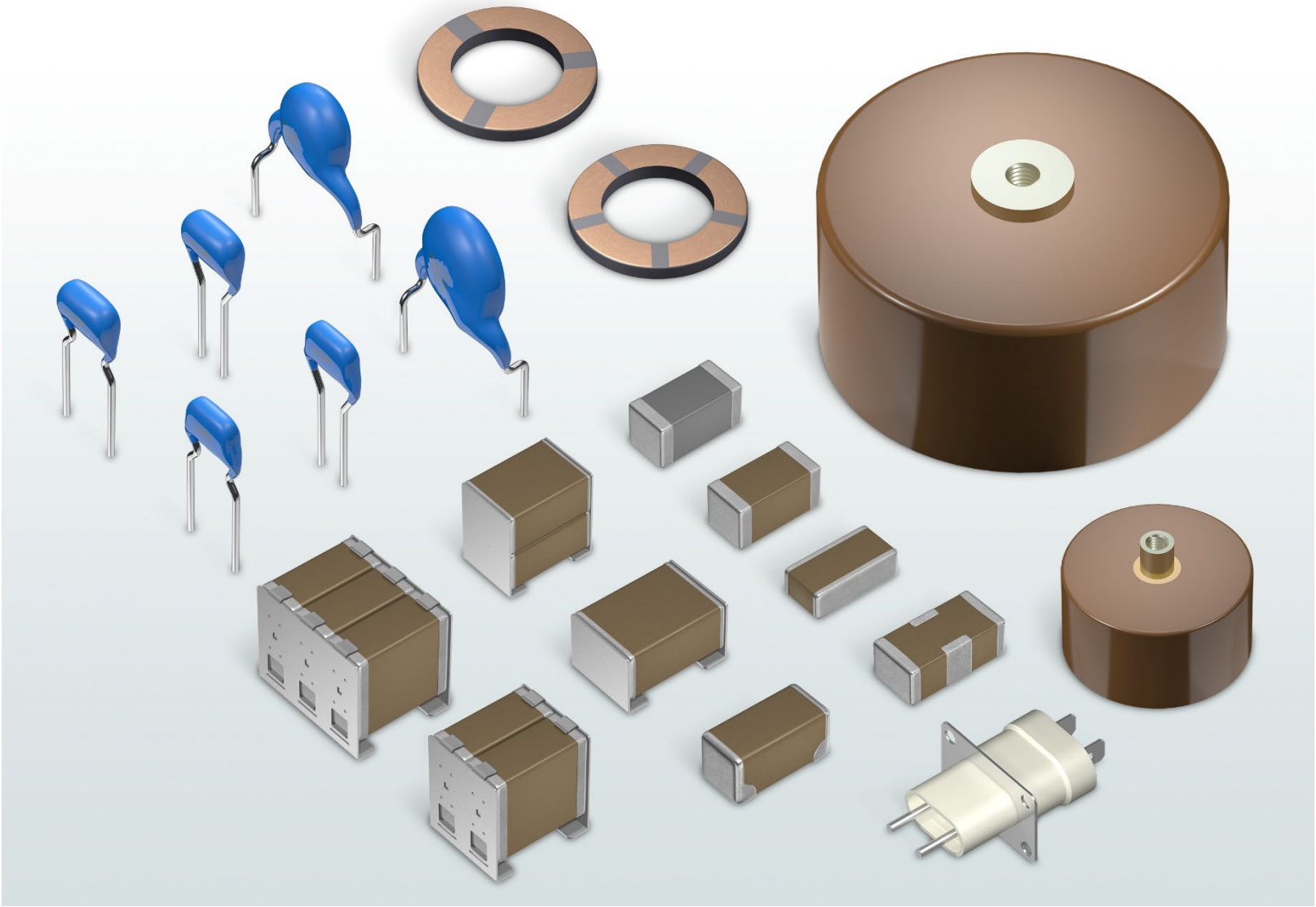
- **Multilayer ceramic chip capacitors** (MLCCs)
  - ¬ Automotive grade
  - ¬ Commercial grade
  - ¬ 3-terminal feed-through type
  - ¬ With dipped radial lead
- **Disc type**
  HV ceramic capacitors with lead
- **Feed-through type**
  HV ceramic capacitors
- **Ultra-HV ceramic capacitors** with metal fitting type terminal
- **Ring varistors**



Our Ceramic Capacitors Business Group has a widespread manufacturing presence

Mid & High Voltage Product

Class1 C0G type 630V~1,250V for LLC resonant capacitor

LINEUP - C0G 630V & 1,000V and higher

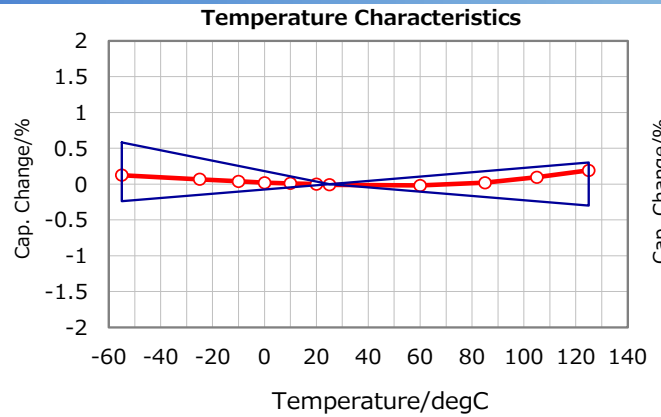
TDK Product and Technologies

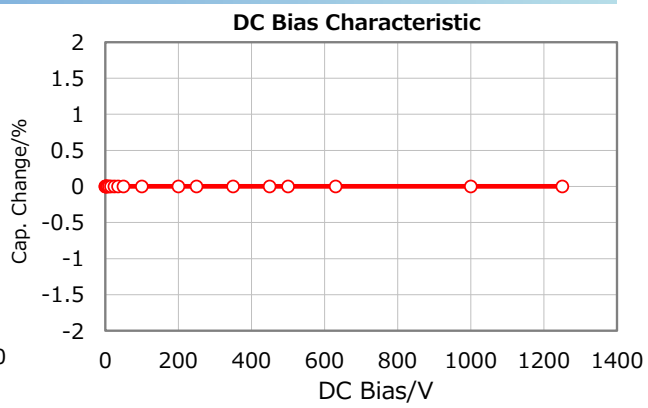
- Higher rated voltage up to 1250V
- Stable characracteristics for temperature change and voltage applying by C0G
- Reduced the number of LLC resonant capacitor

Chip Size (inch)			CGA5 1206		CGA6 1210			CGA9 2220		
R.V.			3A 1000V	2J 630V	3B 1250V	3A 1000V	2J 630V	3B 1250V	3A 1000V	2J 630V
Cap.	102	1nF								
	122	1.2nF								
	152	1.5nF								
	182	1.8nF								
	222	2.2nF								
	272	2.7nF								
	332	3.3nF								
	392	3.9nF								
	472	4.7nF								
	562	5.6nF								
	682	6.8nF								
	822	8.2nF								
	103	10nF								
	123	12nF								
	153	15nF								
	183	18nF								
	223	22nF								
	333	33nF								
	473	47nF								
	683	68nF								
	104	100nF								

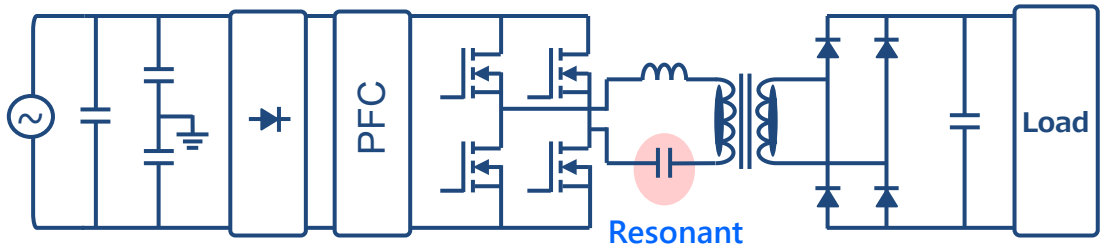
EOL announced

Under development





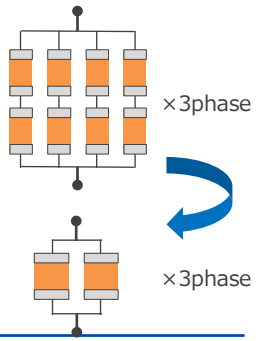
LLC Resonant Circuit Model



Reducing the number of capacitor bank MLCCs by increased allowable voltage

Current Design CGA5L4C0G**2J**103J [1206/**630V**/10nF]
2s4p×3phase = **24**pcs.

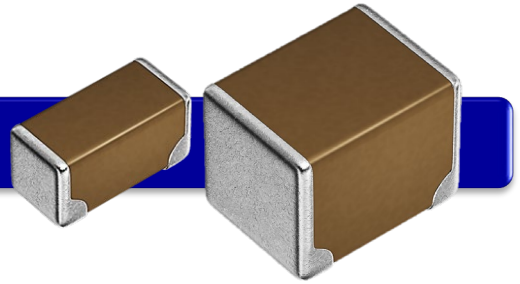
New Suggestion CGA6P1C0G**3B**103J [1210/**1,250V**/10nF]
1s2p×3phase = **6**pcs.



Approximately 75% reduction would be expected.

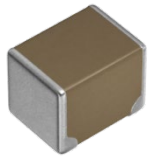
Redundant Concept Product

Low-Resistance Type Soft Termination (CNA Series)



LINEUP : CNA series -Soft Termination (Low resistance type)

Appearance



- Automotive grade
- For Mid voltage power line
- For Resonant capacitor

Line UP

In production | New | U.d.

LW Size mm (inch)	RV	Capacitance Range (F)								
		10n	15n	22n	33n	2.2u	4.7u	10u	22u	47u
3216 (1206)	75V					X7R				
	50V					X7R	X7R	X7R		
	25V							X7R		
	16V							X7R		
	10V								X7S	
3225 (1210)	1000V	C0G	C0G	C0G						
	630V				C0G					
	100V						X7R			
	50V						X7R	X7R		
	25V								X7R	
	10V									X7S

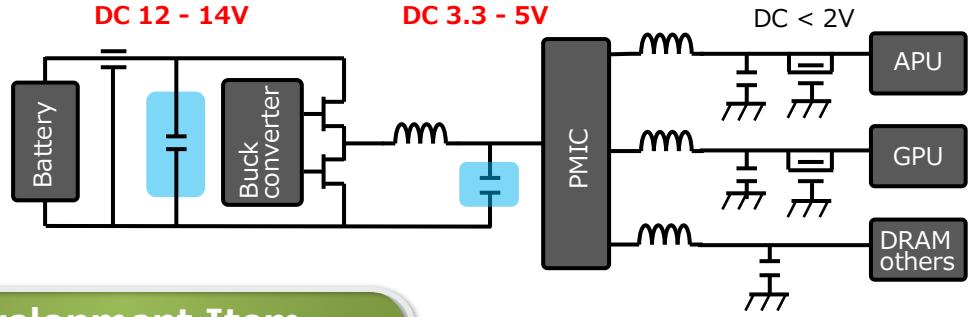
New Products

MP [Released : CY22/Oct.]

- 3216(1206) 10µF 50V X7R CNA5L1X7R1H106K160AE
- 3216(1206) 22uF 10V X7S CNA5L1X7S1A226M160AE
- 3225(1210) 47µF 10V X7S CNA6P1X7S1A476M250AE

Applications

■ ADAS ECU



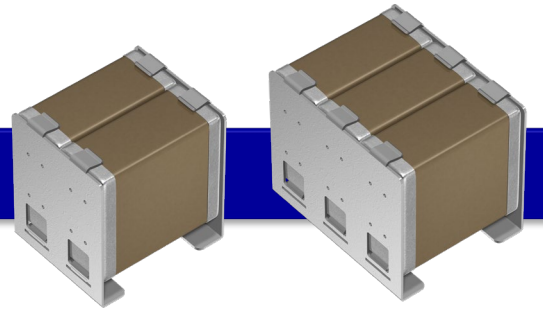
Development Item

- 3225(1210) 22nF 1000V C0G
- 3225(1210) 15nF 1000V C0G
- 3225(1210) 10nF 1000V C0G
- 3225(1210) 33nF 630V C0G

Sample : Ready
MP : CY23/Dec.

Redundant Concept Product

In-Line Mega Cap Type (CAA Series)



New type (In-Line Type) Mega Cap for Power Conversion/ High power consumption

Downsizing

Large-sized Capacitor (Alu, Film) to Small MLCC
MEGACAP can contribute to downsizing, low profile

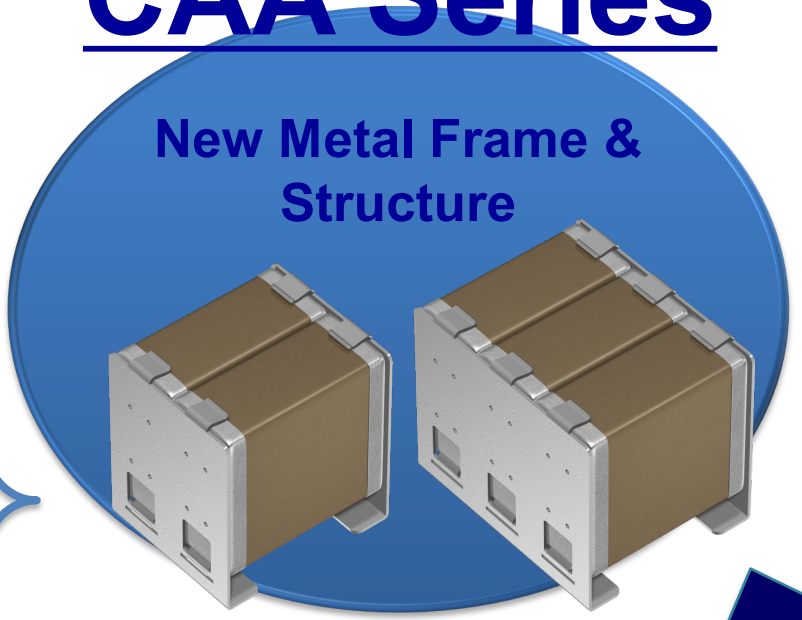
Higher Capacitance

Higher Capacitance by New Structure
2, 3, 5pcs of MLCC can be stacked in a package
by the new “Side by Side” MLCC alignment

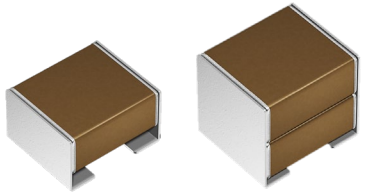
Low ESR

Higher Permissive Ripple Current
High conductive frame material can realize low ESR ➔
higher permissible current than conventional MEGACAP.
Guarantee of the permissive current is under consideration.

CAA Series



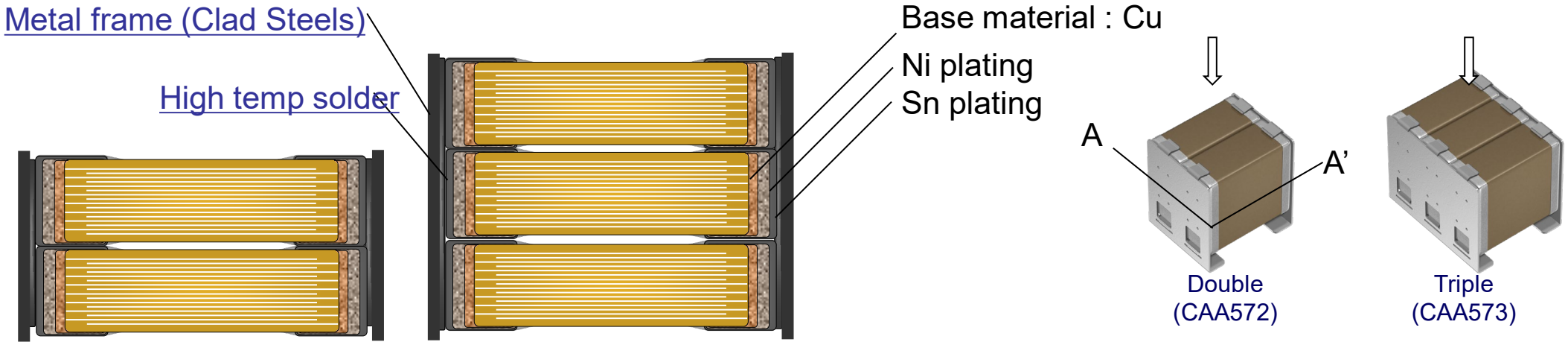
Upgrade



Conventional type (CKG Series)

FEATURE - In-Line Type MEGA CAP : MLCC with Metal Frame - CA Series

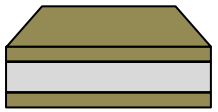
A-A' (Inside structure image from top side)

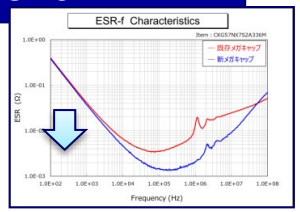


The metal frame absorbs the thermal and mechanical stress same as conventional Mega cap, Lower ESR/ESL than conventional type is achieved by Clad metal frame shows better performance on heat generation. High capacitance reduces the mounting area.

High Permissive Current

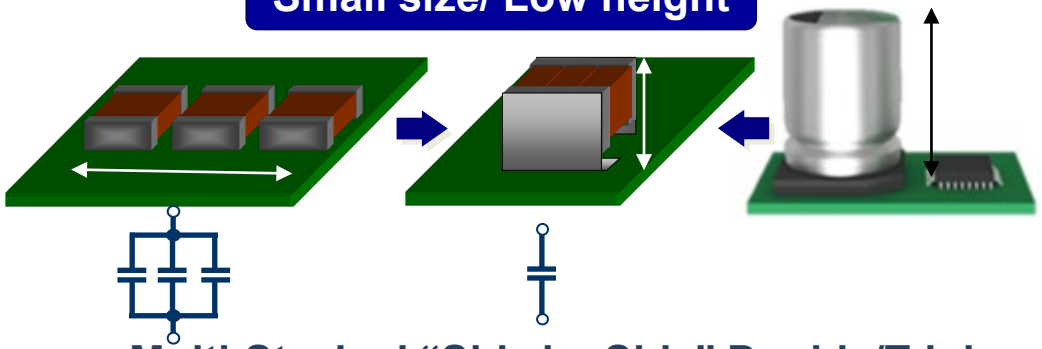
Clad Steels





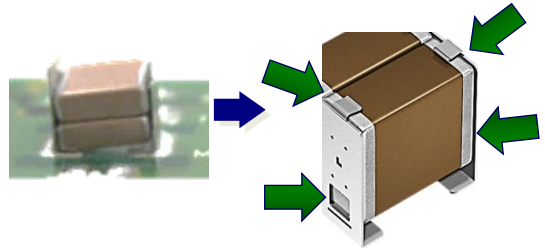
・Low ESR by
High conductive frame

Small size/ Low height



・Multi-Stacked "Side by Side" Double/Triple

Reflow Resistivity

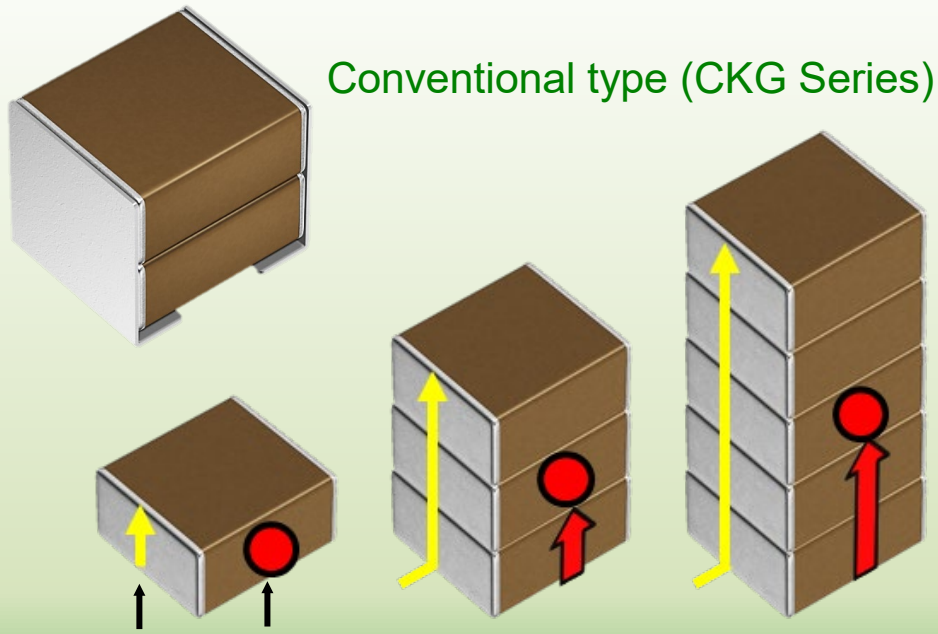


・Clamp + Soldering

Construction and the benefits (Vertical vs Side by side)

Conventional Type (CKG type)

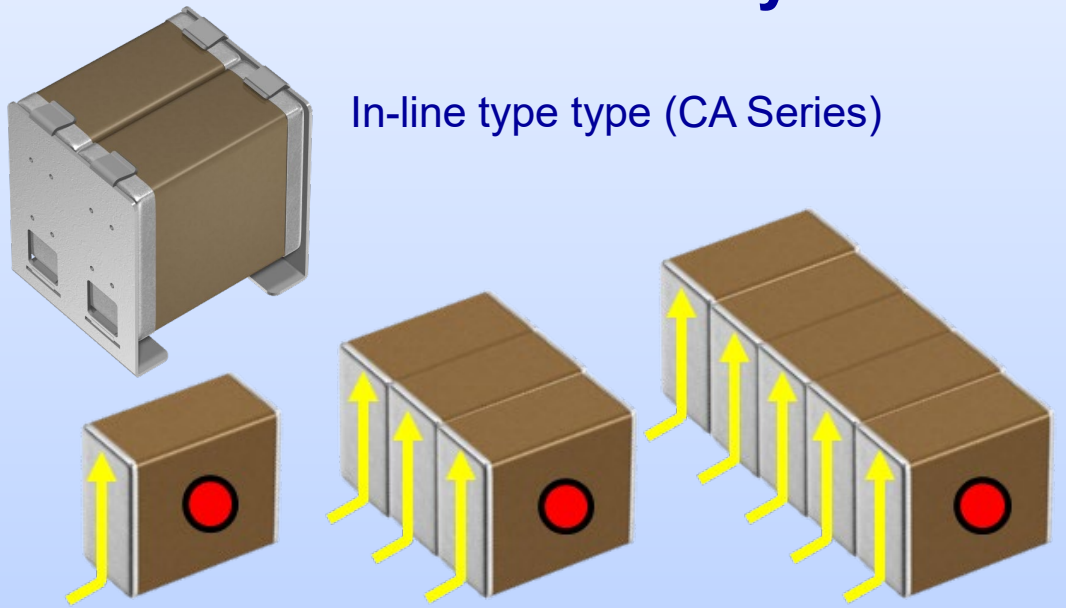
MLCCs are stacked up vertically



- The product height and the gravity center become higher. ➔High risk to vibration.
- The distance between upper MLCC and the board becomes longer. ➔ESR/ESL increase.

Low resistance inline (CA type)

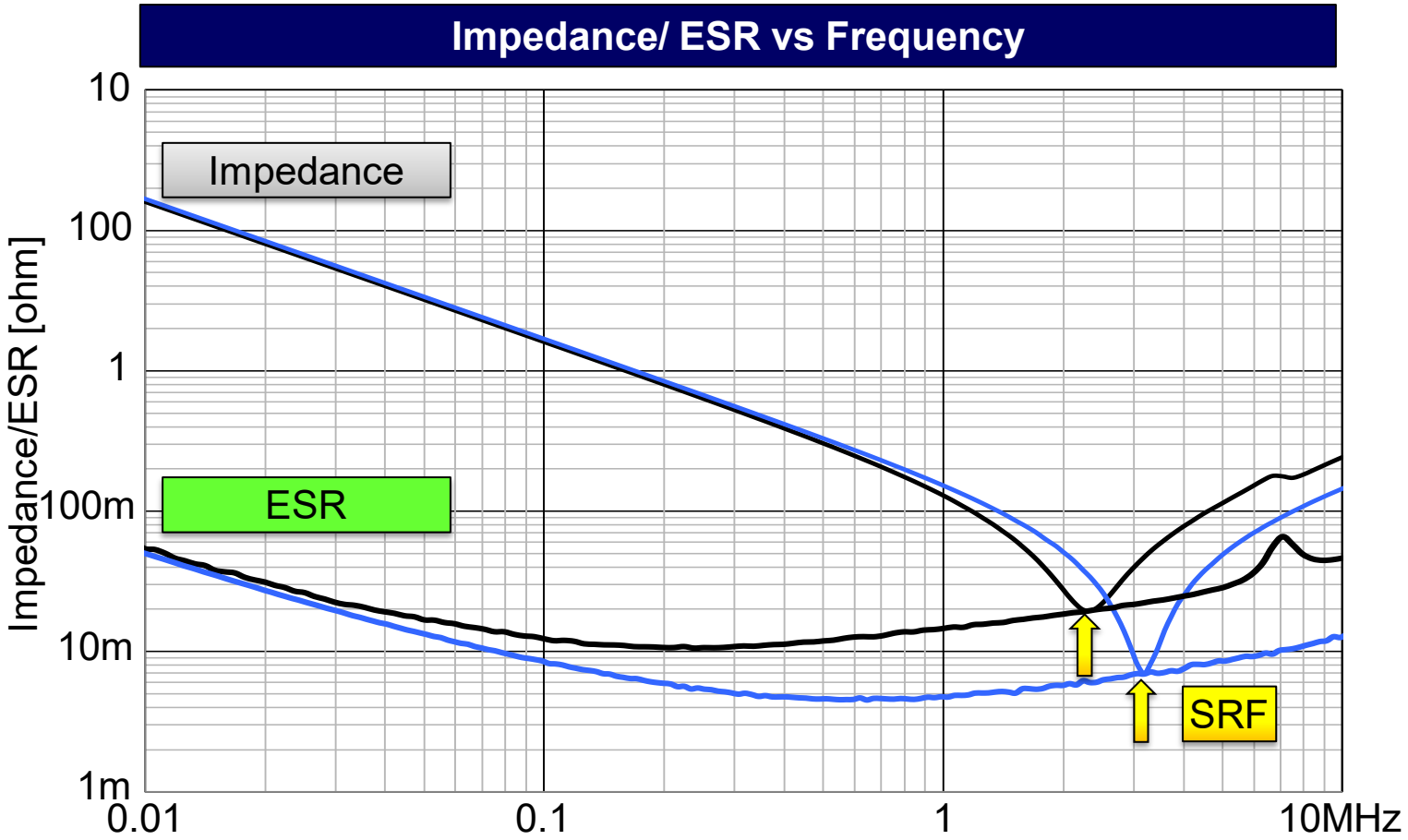
MLCCs are stacked side by side

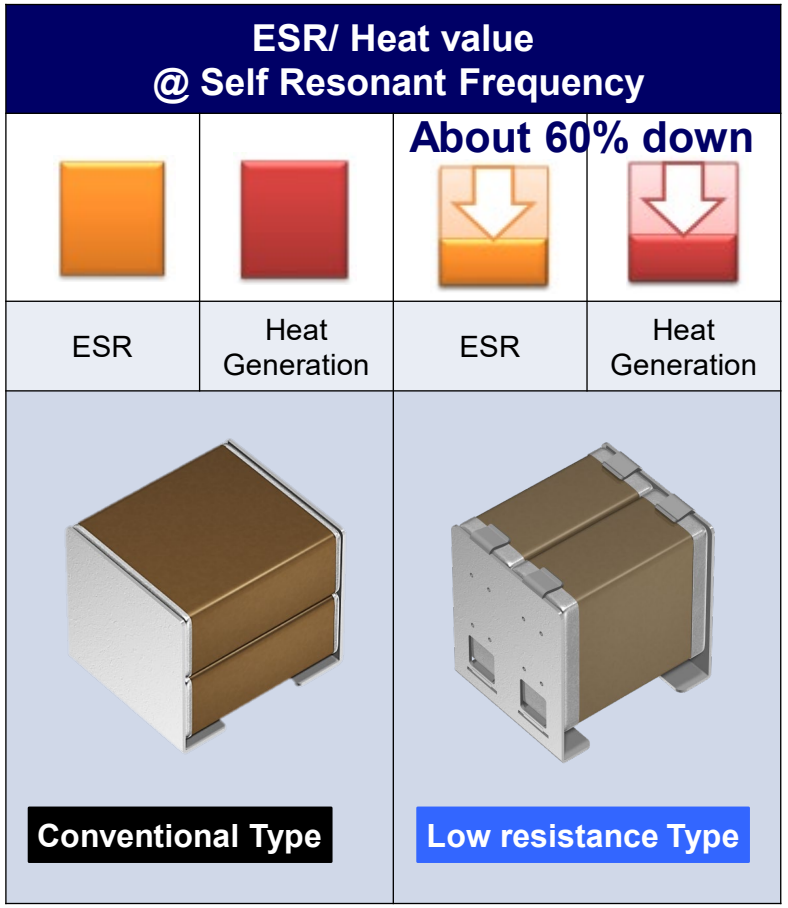


- Keep low height and the gravity center.
  ➔High durability to vibration
- The distance between each MLCC and the board is same. ➔Suppress ESR/ESL increment.

Low Resistance (ESR) and reduced heat generation (Example : 5.70 x 5.00mm x 2MLCC 1uF)

Low resistance (ESR) and reduced heat generation

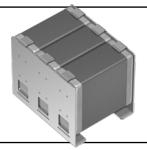




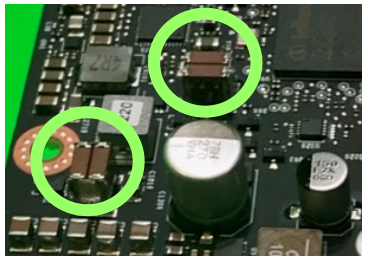
Low resistance type Mega Cap. has low ESR. **The risk of heat generation can be reduced.**

LINEUP (Under development for Automotive Grade)

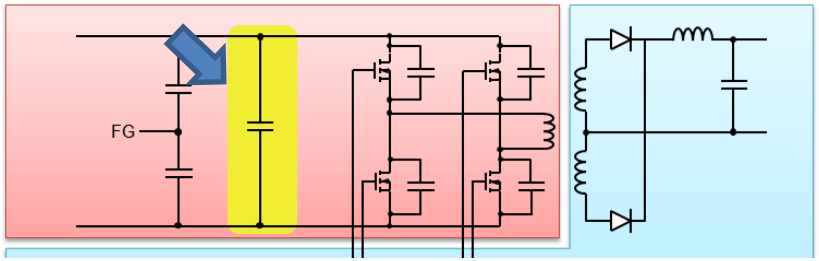
Number of MLCC		TC	RV	Capacitance	TDK P/N
CAA572 (2pcs)		X7T	630V	1uF	CAA572X7T2J105M
			350V	2.2uF	CAA572X7T2V225M
		X7S	100V	33uF	CAA572X7S2A336M
		X7R	35V	100uF	CAA572X7R1V107M
CAA573 (3pcs)		X7T	630V	1.5uF	CAA573X7T2J155M
			350V	3.3uF	CAA573X7T2V335M
		X7S	100V	47uF	CAA573X7S2A476M
		X7R	35V	150uF	CAA573X7R1V157M

Number of MLCC		TC	RV	Capacitance	TDK P/N
CAA572 (2pcs)		C0G	1kV	20nF	CAA572C0G3A203J
				30nF	CAA572C0G3A303J
				44nF	CAA572C0G3A443J
				66nF	CAA572C0G3A663J
			630V	200nF	CAA572C0G2J204J
CAA573 (3pcs)			1kV	99nF	CAA573C0G3A993J
			630V	300nF	CAA573C0G2J304J

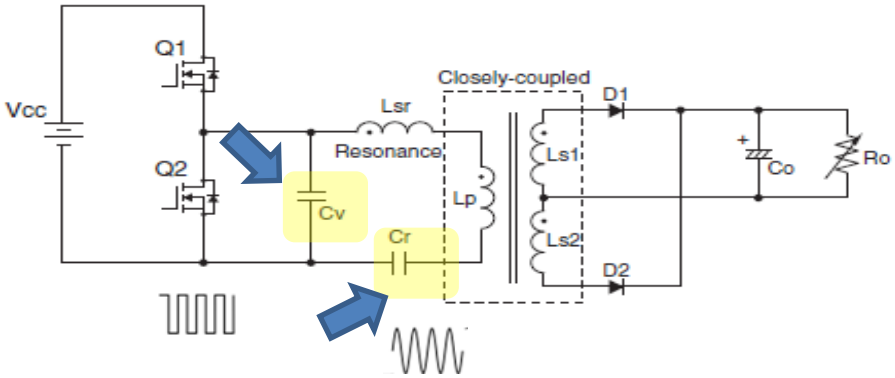
C0G : -55~125℃/ 0±30ppm/℃
X7R : -55~125℃/ ±15%
X7S : -55~125℃/ ±22%
X7T : -55~125℃/ +22,-33%



Focused ECU
xEV DC-DC Converter, Inverter, OBC
48V System, Electrical Pump, Electrical Turbo, Autonomous ECU



Focused ECU
xEV DC-DC, OBC, Wireless Charging



Planned release schedule : Sept,2024

CeraLink in a shot - optimized for conditions under operation in power electronics

Attracting Tomorrow

Use CeraLink when

- Space requirement is tight
- Temperature is demanding (+150 °C)
- High current rating is vital
- Requirements for capacitance density are tough
- High switching frequencies are applied (SiC, GaN)

Main Application

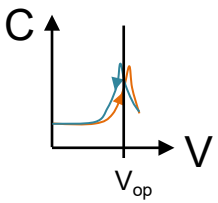
- Snubber capacitor
- DC-Link capacitor
- Filter capacitor

CeraLink technology supports

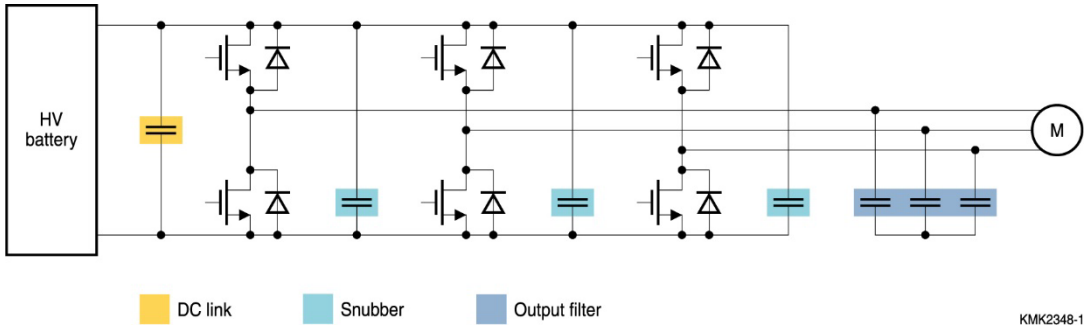
- Increasing capacitance with DC bias and best in class capacitance density at operating point (V_{op} + T_{op})
- High current capability due to low losses at high frequencies (up to several MHz) and high temperatures (up to +150 °C)
- No limitation of dV/dt
- Good self-regulating properties
- Qualification based on AEC-Q200 rev. D

RoHS Compliant

Full Performance Potential

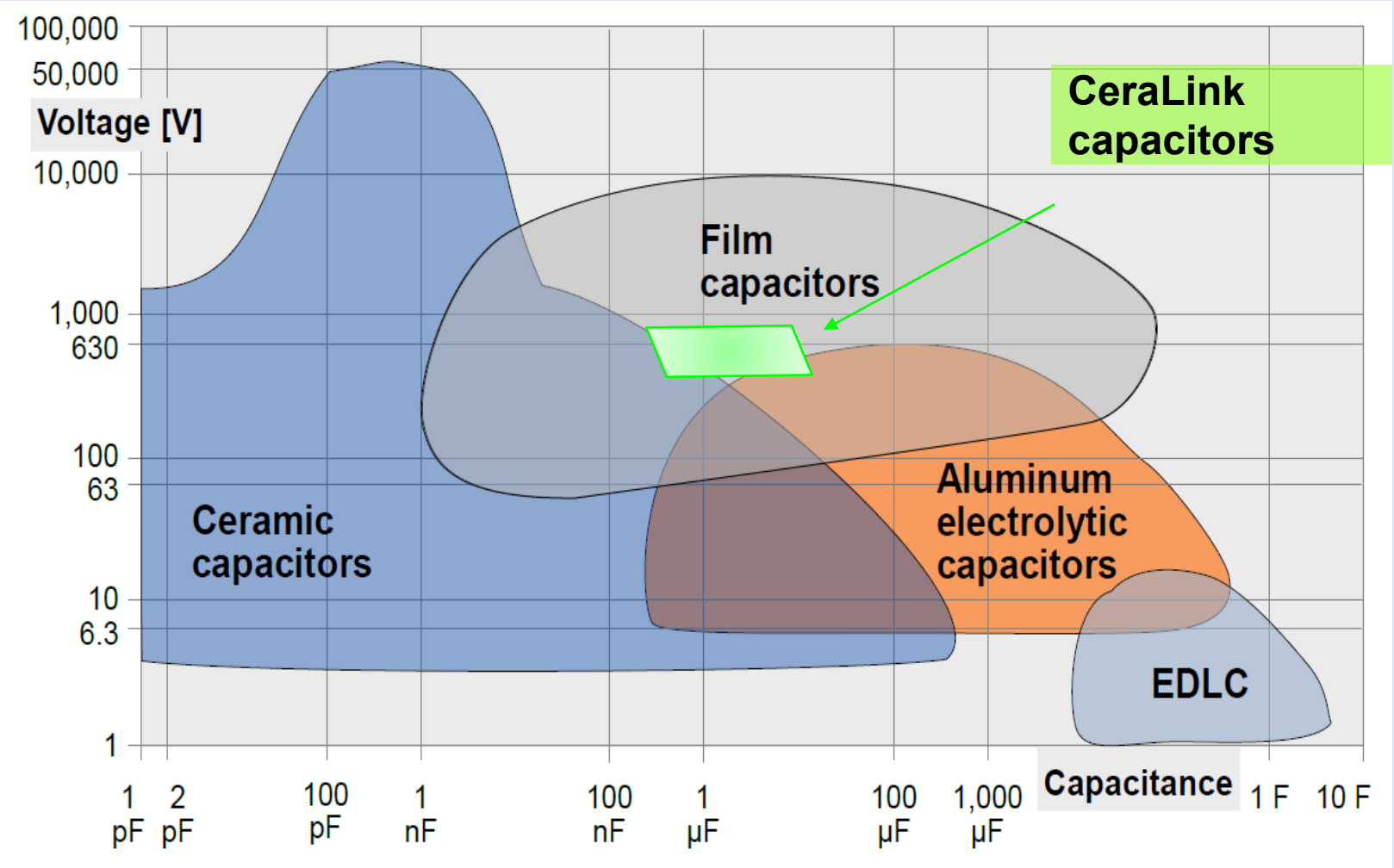


Main Application



Measurement condition	Film capacitor	Class 2 MLCC	CeraLink
Typical capacitance density @ DC link voltage, 20 V_{RMS}, 25°C	0.7 µF/cm³	2.5 µF/cm³	**4.9 µF/cm³**
Typical current rating per capacitance @ 100 kHz, 105°C	< 1 A/µF	< 4.5 A/µF	**12 A/µF**

CeraLink at a first glance



High capacitance density at operating condition

Due to antiferroelectric behavior, the characteristics of CeraLink are strongly non-linear and optimized for conditions under operation in power electronics

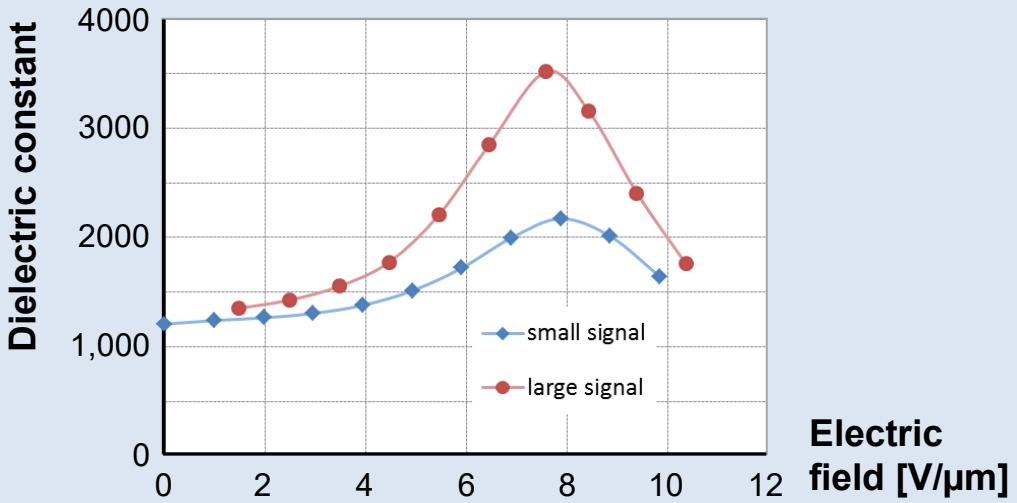
Film capacitors and class 1 ceramics have a dielectric constant (nearly) independent on the electrical field (ε < 100)

The permittivity of ferroelectric (e.g. X7R) MLCC capacitors is decreasing with electrical field

CeraLink features an increasing dielectric constant up to the operating voltage.

At higher AC voltage (peaks), the material is able to provide even higher permitivity.

DC bias characteristics at room temperature

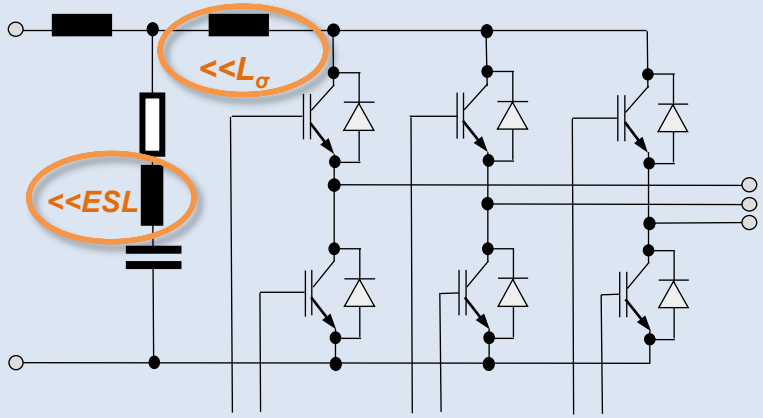


	Film capacitor	Class 2 MLCC	CeraLink	
Nominal / rated capacitance	100 %	100 %	**100 %**	
No bias voltage 0.5 V_{RMS}	100%	100 %	**35 %**	
DC link voltage 0.5 V_{RMS}	100 %	35 %	**60 %**	**DC link (energy)**
DC link voltage 20 V_{RMS}	100 %	35 %	**100 %**	**Snubber**

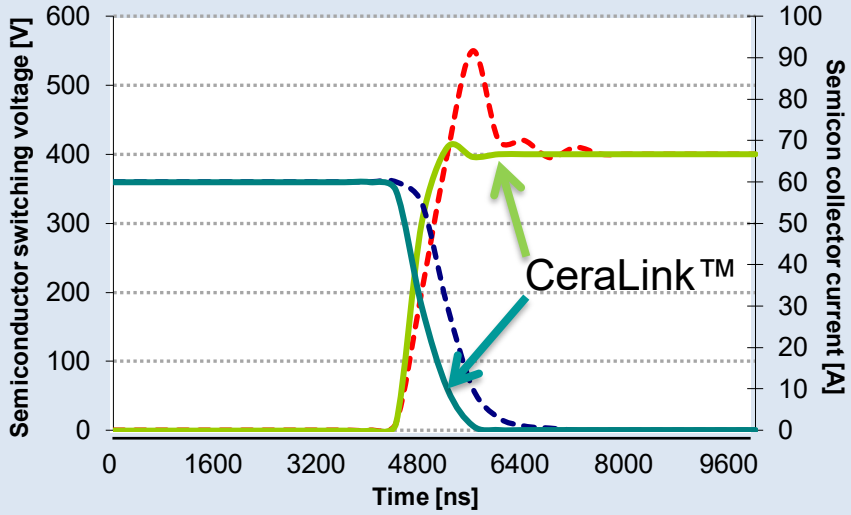
CeraLink is ideal for fast switching

Device characteristics lead to a low inductive commutation loop

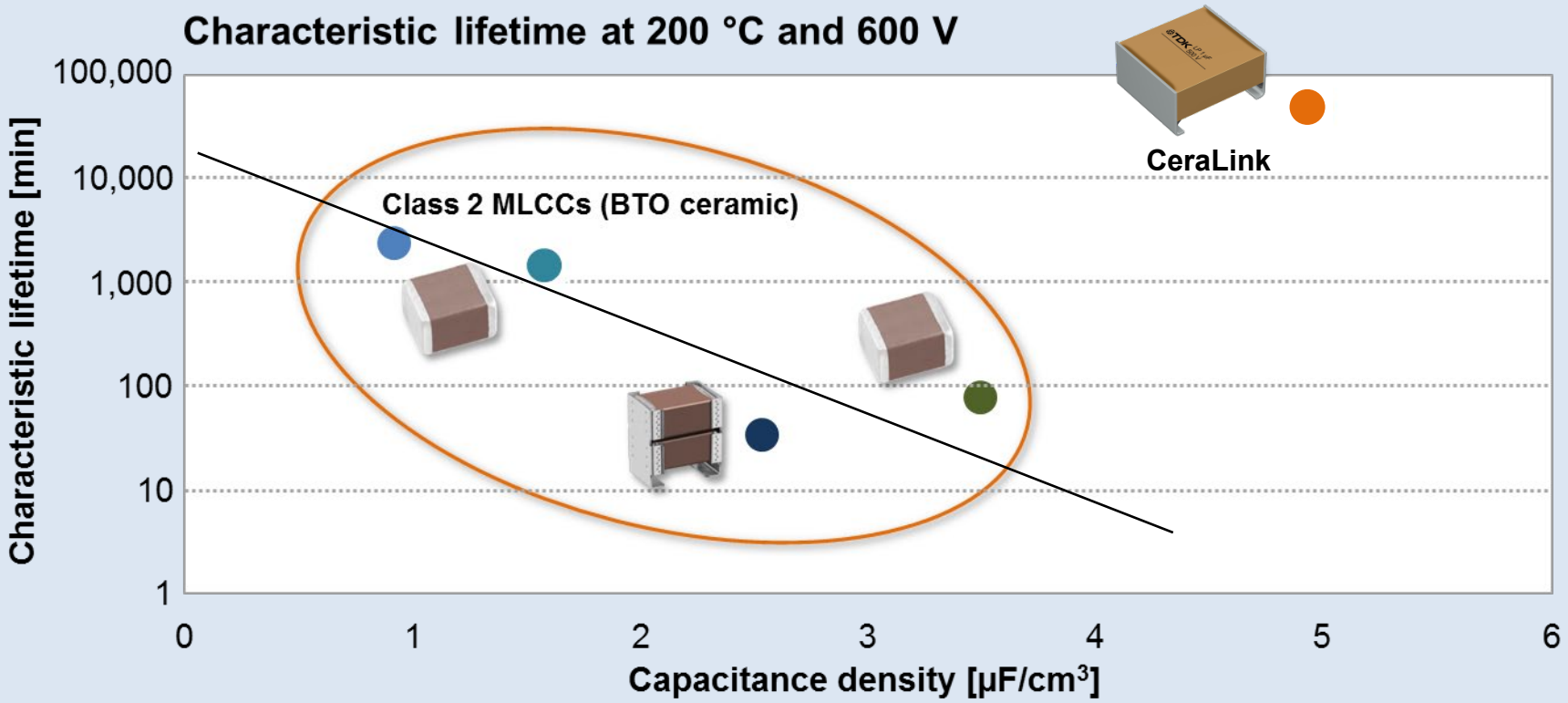
- High capacitance density of 2 to 5 µF/cm³
- **Low self-inductance (ESL) of 2.5 to 4 nH**
- High thermal robustness allows CeraLink to be placed very close to the semi-conductor with operation up to 150 °C permissible
- **No limitation of dV/dt**



Semiconductor overshoot principle

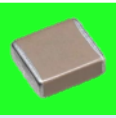


Lifetime at high temperatures – comparison of ceramic capacitors

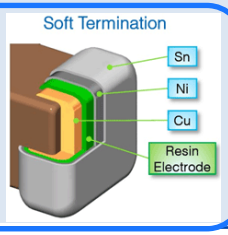


CeraLink offers highest lifetime and capacitance density compared to conventional ceramic capacitors

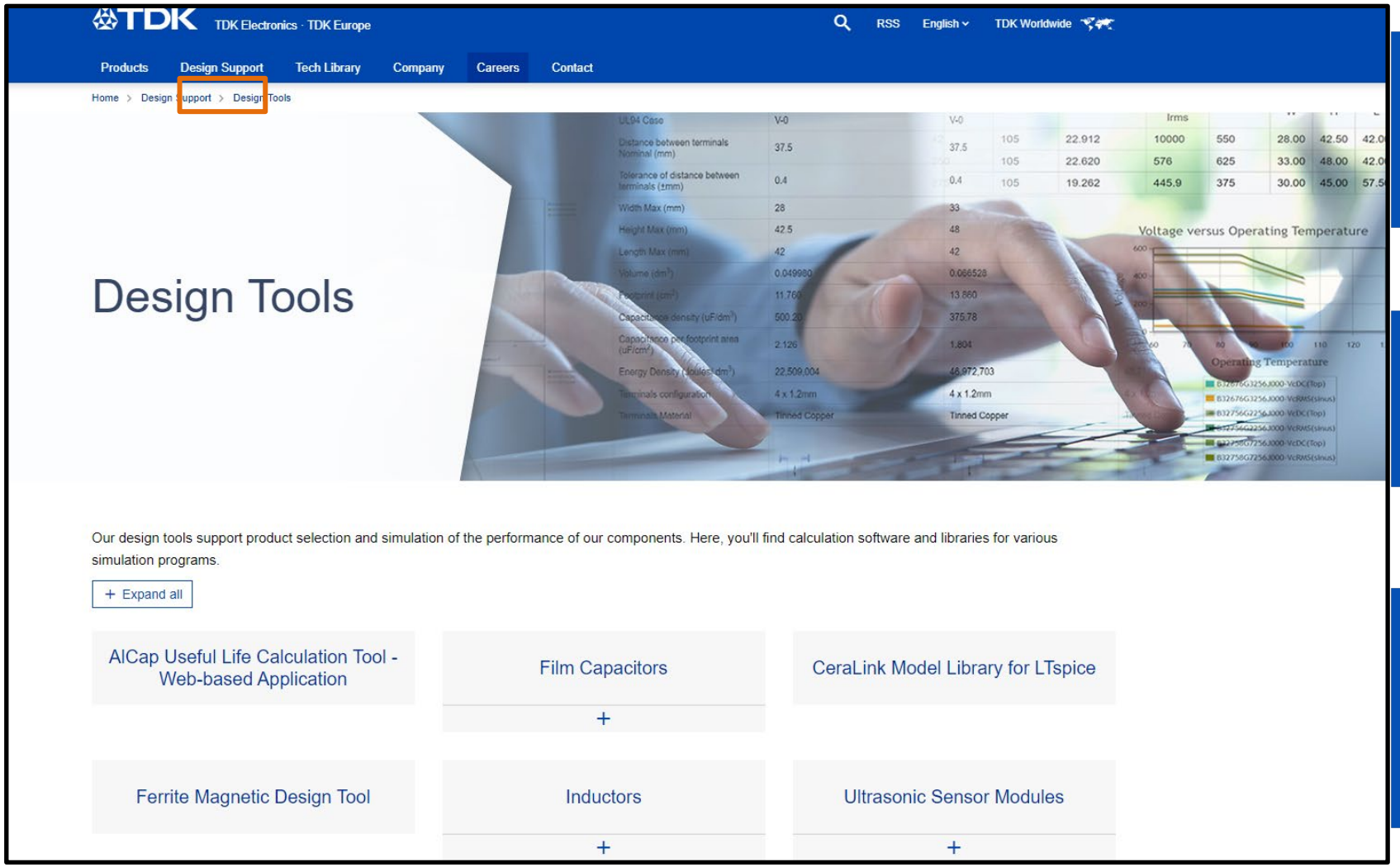
CeraLink product range

Series	Nominal capacitance / rated voltage		
Designed for	650 V semiconductors	900 V semiconductors	1300 V semiconductors
Low Profile **LP (L leads)** 	**1 µF / 500 V**	**0.5 µF / 700 V**	**0.25 µF / 900 V**
Low Profile **LP (J leads)** 	**1 µF / 500 V**	**0.5 µF / 700 V**	**0.25 µF / 900 V**
Flex Assembly **FA10** 	**10 µF / 500 V**	**5 µF / 700 V**	**2.5 µF / 900 V**
Flex Assembly **FA2 / FA3** 	**2/3 µF / 500 V**	**1/1.5 µF / 700 V**	**0.5/0.75 µF / 900 V**
Solder Pin **SP** 	**20 µF / 500 V**	**10 µF / 700 V**	**5 µF / 900 V**
2220 series **SMD 2220 - New** 	**0.25 µF / 500V**		

Also available with Soft Termination



TDK Design Support tools



Homepage
- ➔ Design Support
- ➔ Design Tools
- ➔ Different products specific tools

In such applications, designers can search for products based on application conditions, and perform simulations based on usage conditions.

Other useful information found:
- Updated Datasheets
- Distribution stocks available
- Application guides
- Sample Kits

www.tdk.com www.tdk-electronics.tdk.com

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Background:

- Over 20 years experience with knowledge on Manufacturing, Quality and Application of Electronic Components.
- Responsible for Technical Marketing for Film Capacitors in North America

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