Herzlich willkommen zum Webinar der Würth Elektronik eiSos!

Das Webinar beginnt in Kürze …

WÜRTH ELEKTRONIK

WE-MPSB: Der SMD-Ferrit der Einschaltströme meistert und ohne Beschädigung überlebt

Ihre Referenten heute:

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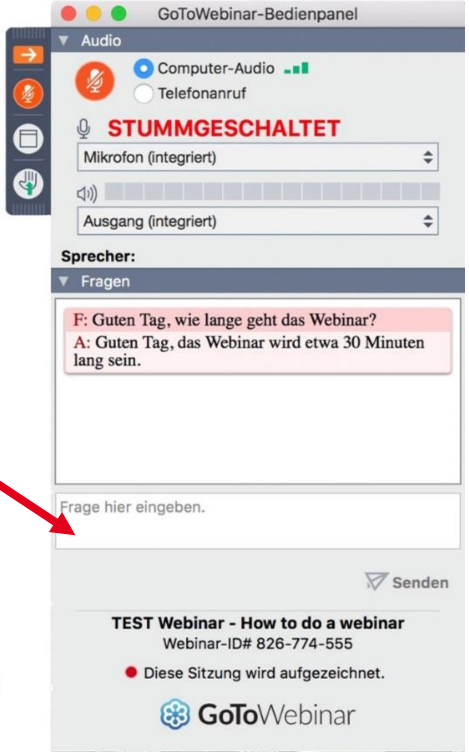
Fragen Sie uns!

WÜRTH ELEKTRONIK

Sie sind während des Webinars stumm geschaltet und können uns über die Chatfunktion Fragen stellen.



Informationen zum Webinar

Dauer der Präsentation: 30 Minuten
Frage-Antwort-Runde: 15 Minuten

Es wurden nicht alle Fragen während des Webinars beantwortet?
Kein Problem! Schreiben Sie uns eine E-Mail an eiSos-webinar@we-online.de.

☹ ☺
FEEDBACK

Sie möchten uns bei der Optimierung unserer Webinare unterstützen?
Wir freuen uns auf Ihr Feedback am Ende des Webinars!

Die Aufzeichnung des Webinars ist einen Tag später verfügbar.
Auf unserem YouTube Kanal « Würth Elektronik Group »
und auf unserer Homepage www.we-online.de/webinare.

WE-MPSB: The multilayer powerful chip bead ferrite, which withstand inrush currents without damage

Speaker:

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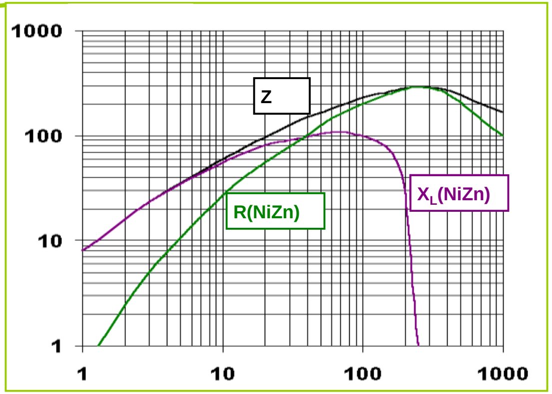
IMPEDANCE

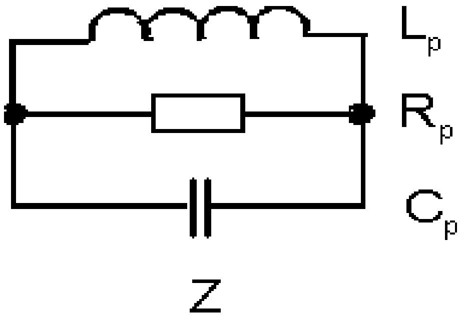
Ferrite Impedance : Measurment



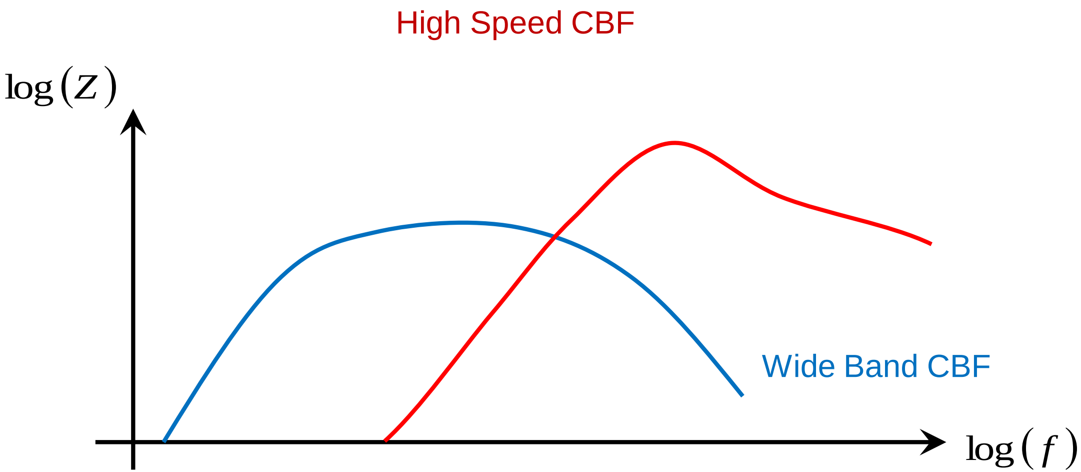
Core material-Parameter

$$Z = \sqrt{R_{(f)}^2 + X_L^2}$$

Ferrite : Equivalent circuit

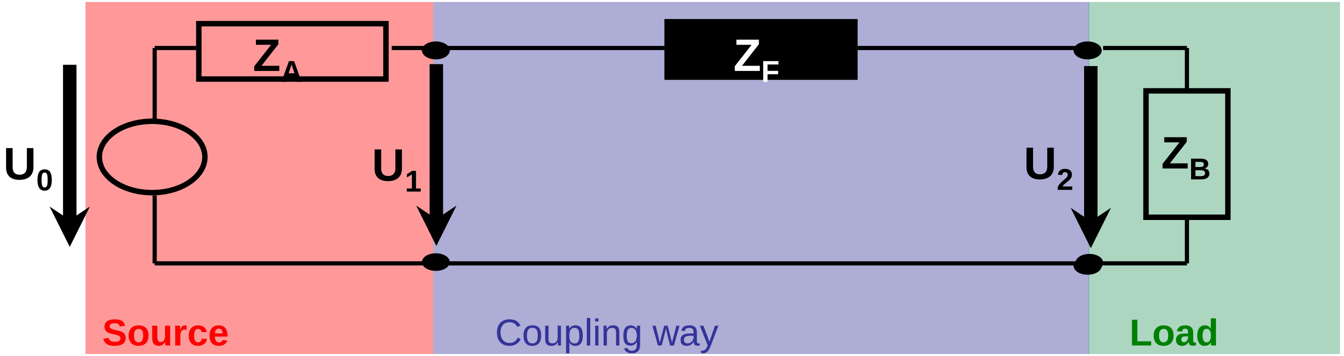


Equivalent circuit of a CBF



APPLICATIONS

Insertion loss – Mathematical Definition



- System attenuation

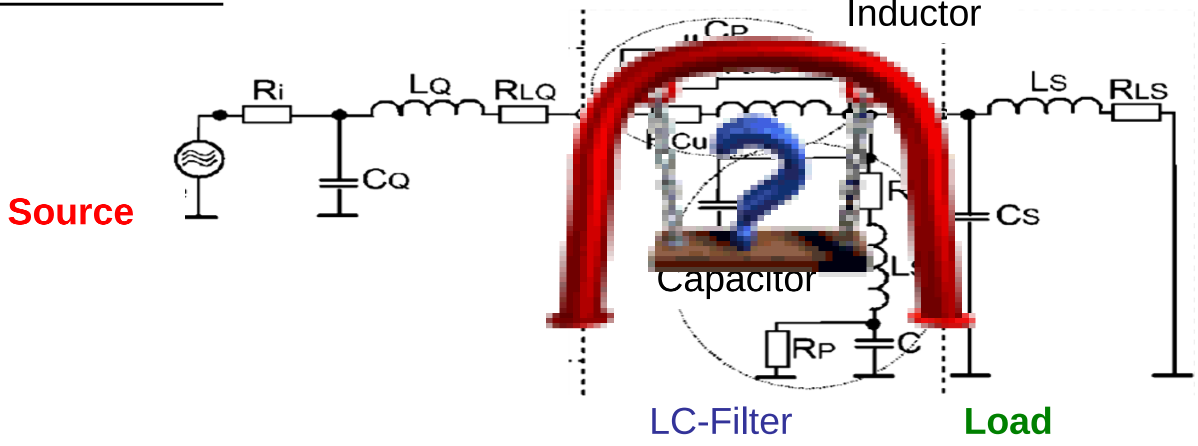
$$A = 20 \cdot \log \frac{Z_A + Z_F + Z_B}{Z_A + Z_B} \quad in\ (dB)$$

- Impedance

$$Z_F = \left[10^{\frac{A}{20}} \cdot (Z_A + Z_B) \right] - (Z_A + Z_B) \quad in\ (\Omega)$$

Insertion loss - Definition

Eqivalent circuit:



- Practical values for source and load impedances:

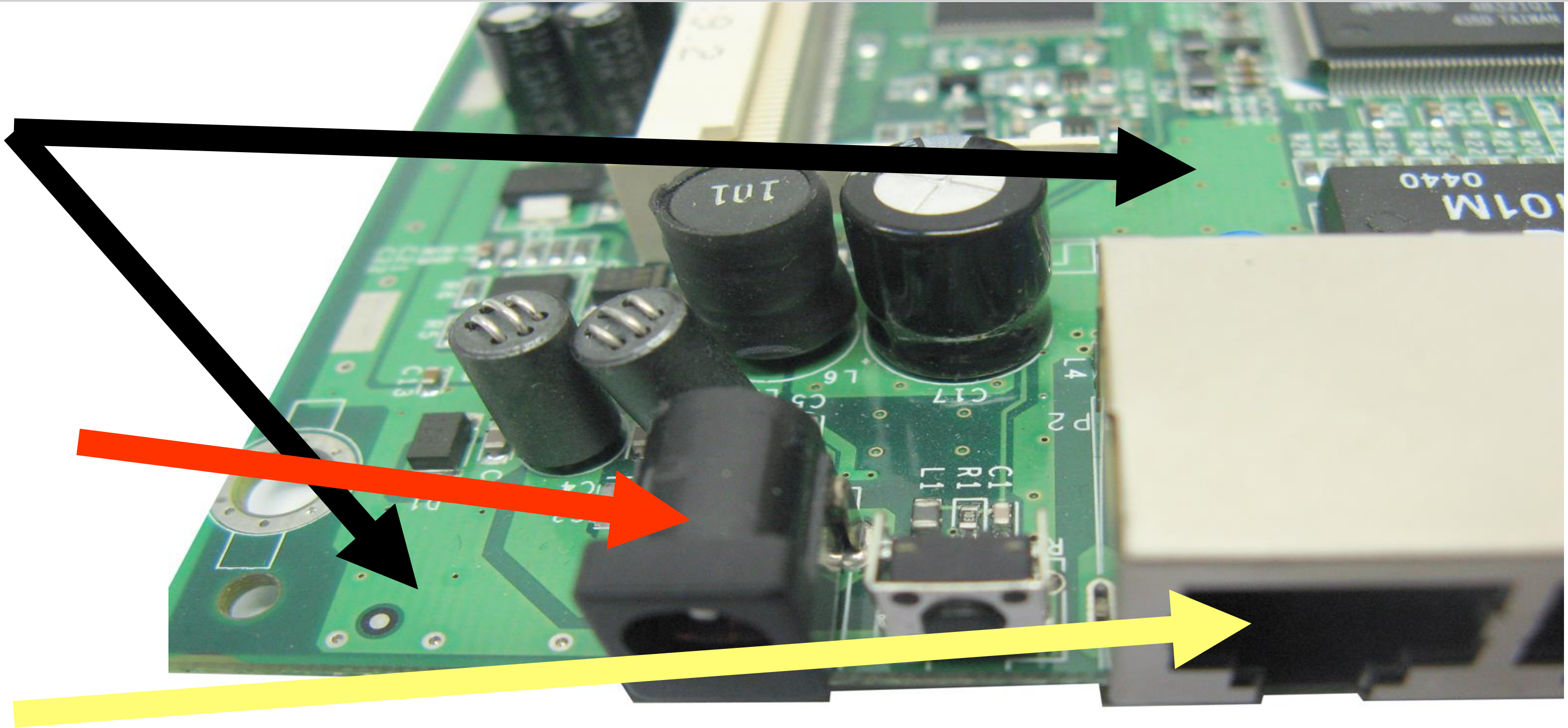
→ Ground planes	<1 … 2 Ω
→ Vcc distribution	10 … 20 Ω
→ Video- /Clock- /Data line	50 … 90
→ long data lines	90 … >150 Ω

Practical values

1 Ω

10 Ω

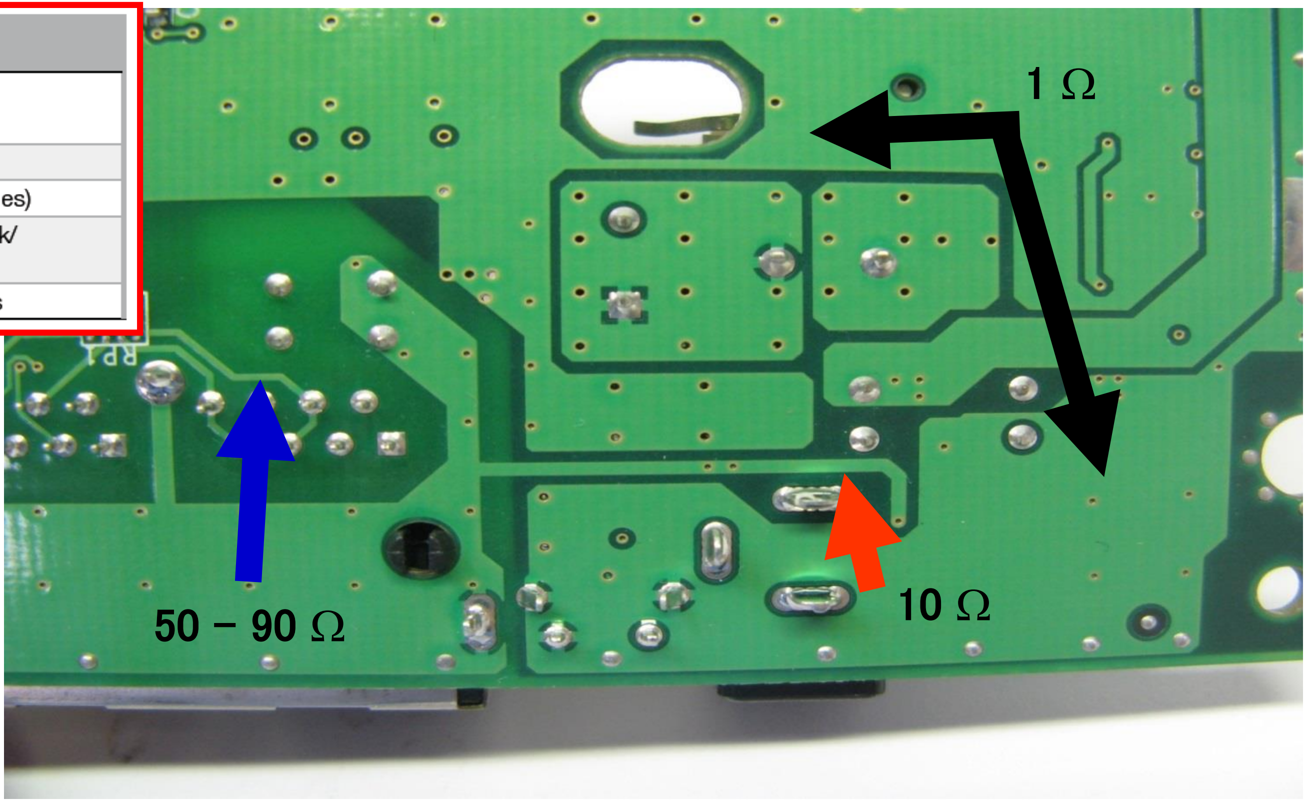
>90 Ω



Practical values

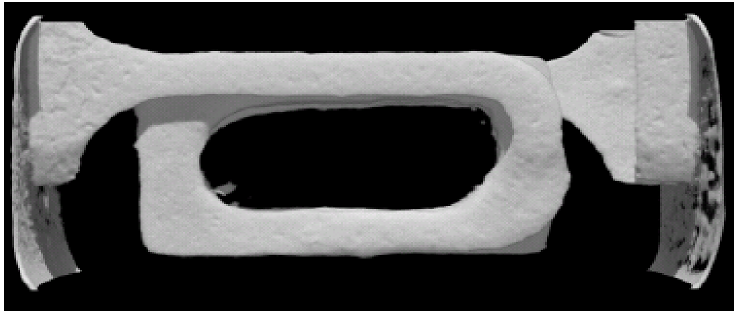
Application overview

Assumend practical system impedance	Application
1 Ω	GND (Ground Planes)
10 Ω	V_{cc} (Supply Voltage lines)
50 Ω – 90 Ω	Datasignal Lines/Clock/ Video Signal/USB
90 Ω – 150 Ω	Long Datasignal Lines

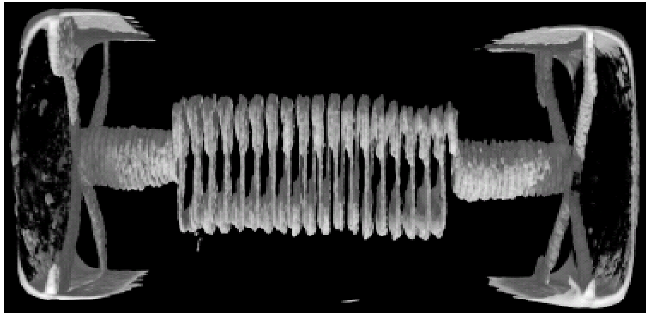


Multilayer ferrite bead construction

Standard (wide band) Structure



High Frequency Structure



Power Line Ferrite

CBF – High Current

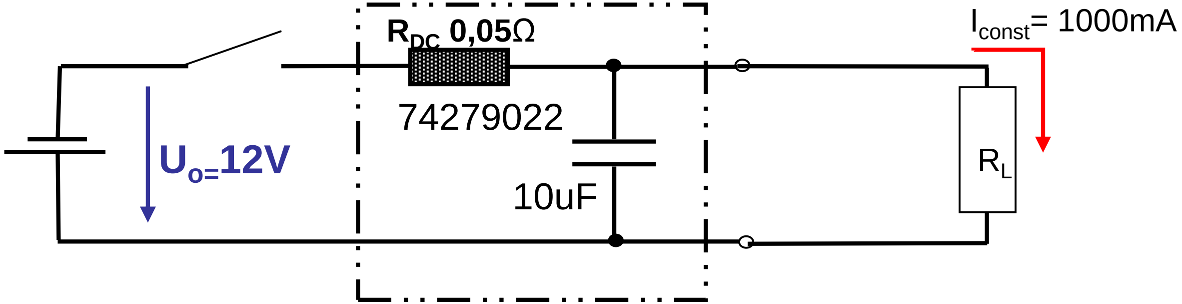
D Electrical Properties:

Properties	Test conditions		Value	Unit	Tol.
Impedance @ 100 MHz	100 MHz	Z	600	Ω	±25%
Maximum impedance	150 MHz	Z	700	Ω	typ.
Rated current	ΔT = 40K	I_R	2000	mA	max.
DC Resistance		R_{DC}	0.15	Ω	max.
Type			High Current		

All high current CBF or MPSB the continuous Rated Current is defined:
at 40K rise

Chip bead ferrite – peak current behavior

Ferrite is destroyed due to over current/in-rush current



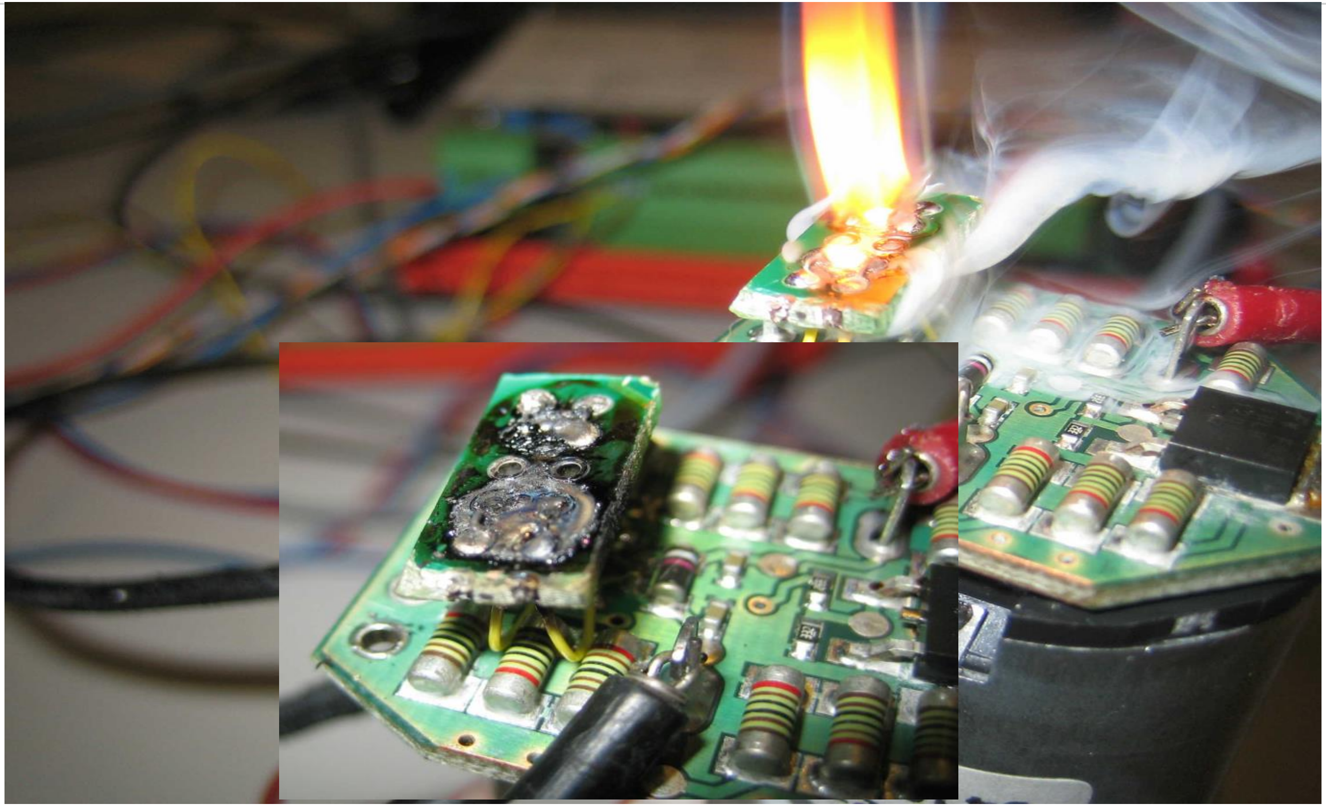
$$I_o = Uo / (R_{DC\ ferrite} + R_{ESR\ capacity})$$

$$= 12V / (0.05\Omega + 0.5\Omega) = 22A$$

⇒ 11 times higher current

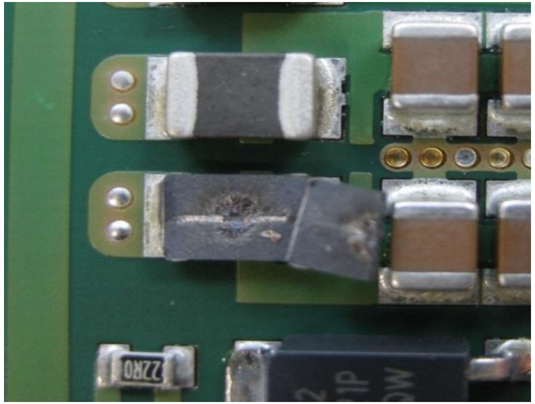
Ferrite can be destroyed, might not fail directly => "creeping process"

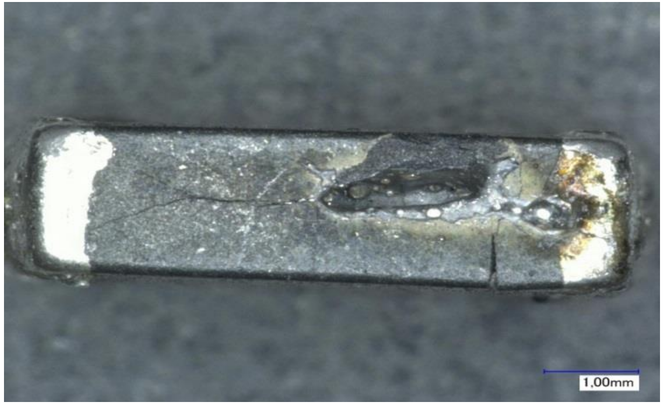
at 22A…you can smell it!

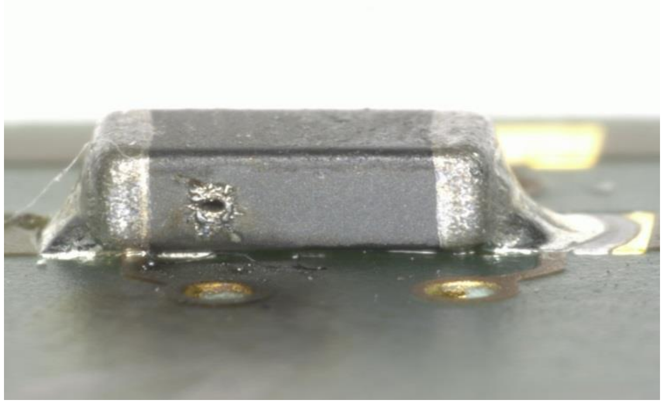


Effect of current and Temperature

Pulse peak after switch on

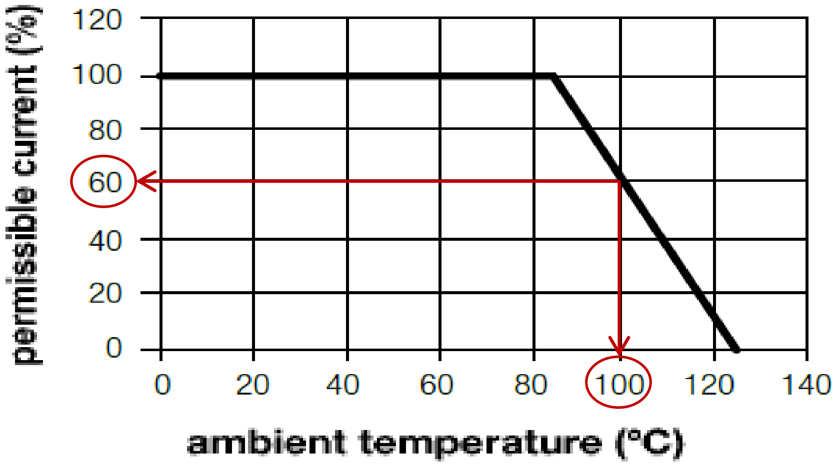




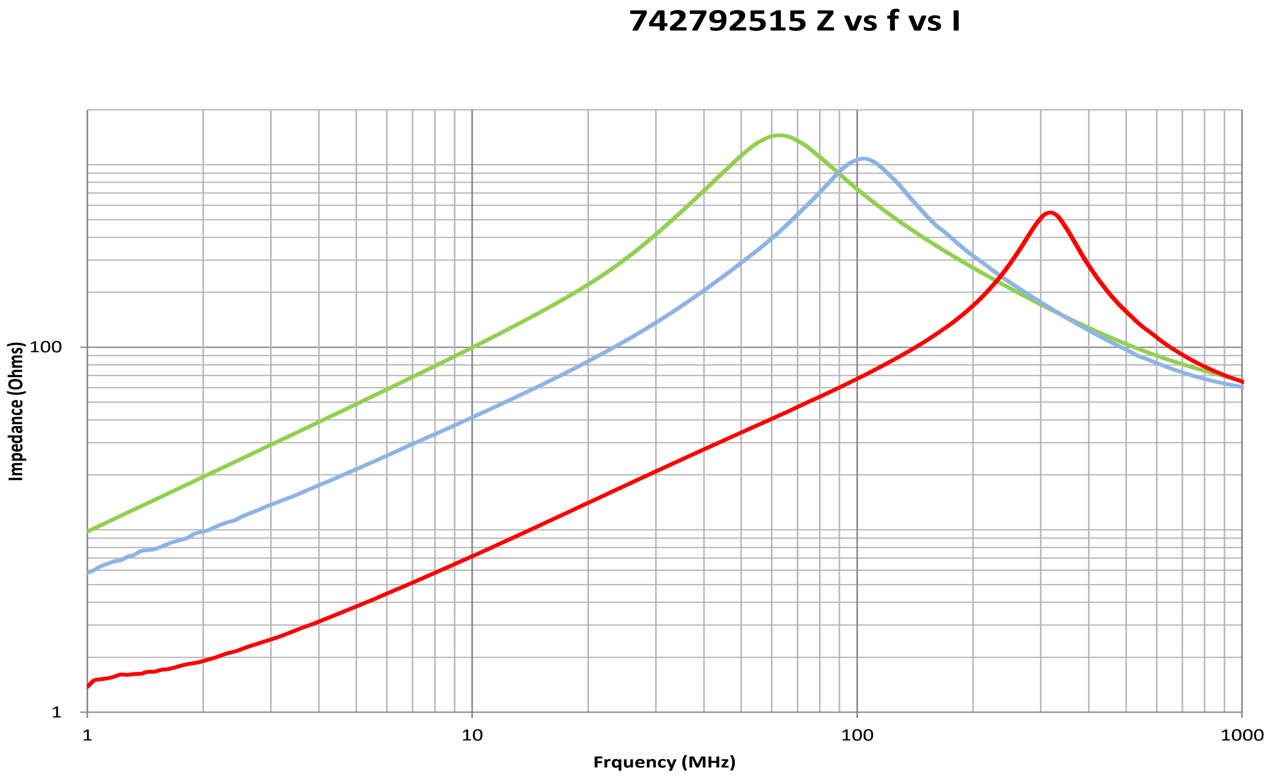


Derating current

Advice: Pay attention for the use of SMD ferrites for high rated current >1 A and ambient temperature over +85°C that the rated current has to be reduced when temperature is above +85°C (Derating).

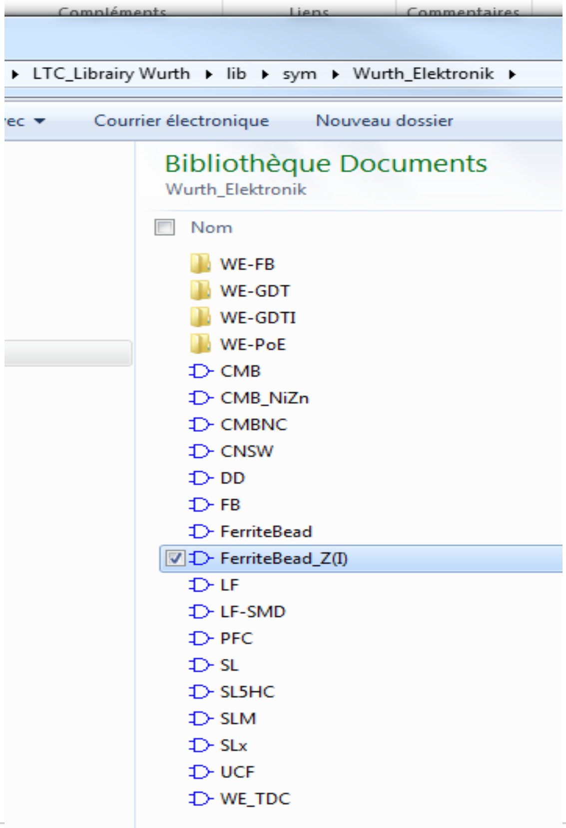


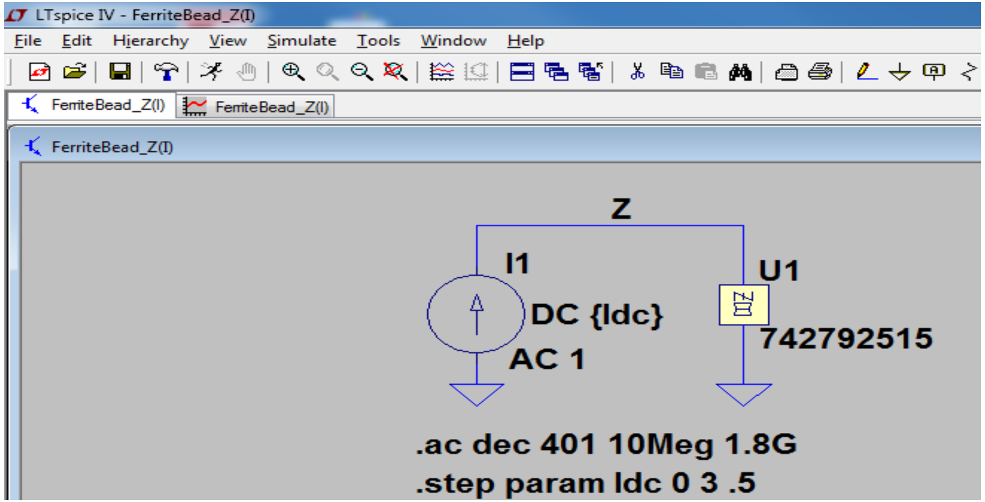
DC Bias : Measurment



- SRF moves to higher frequency
- Impedance decrease

DC Bias : Simulation





DC Bias : Simulation

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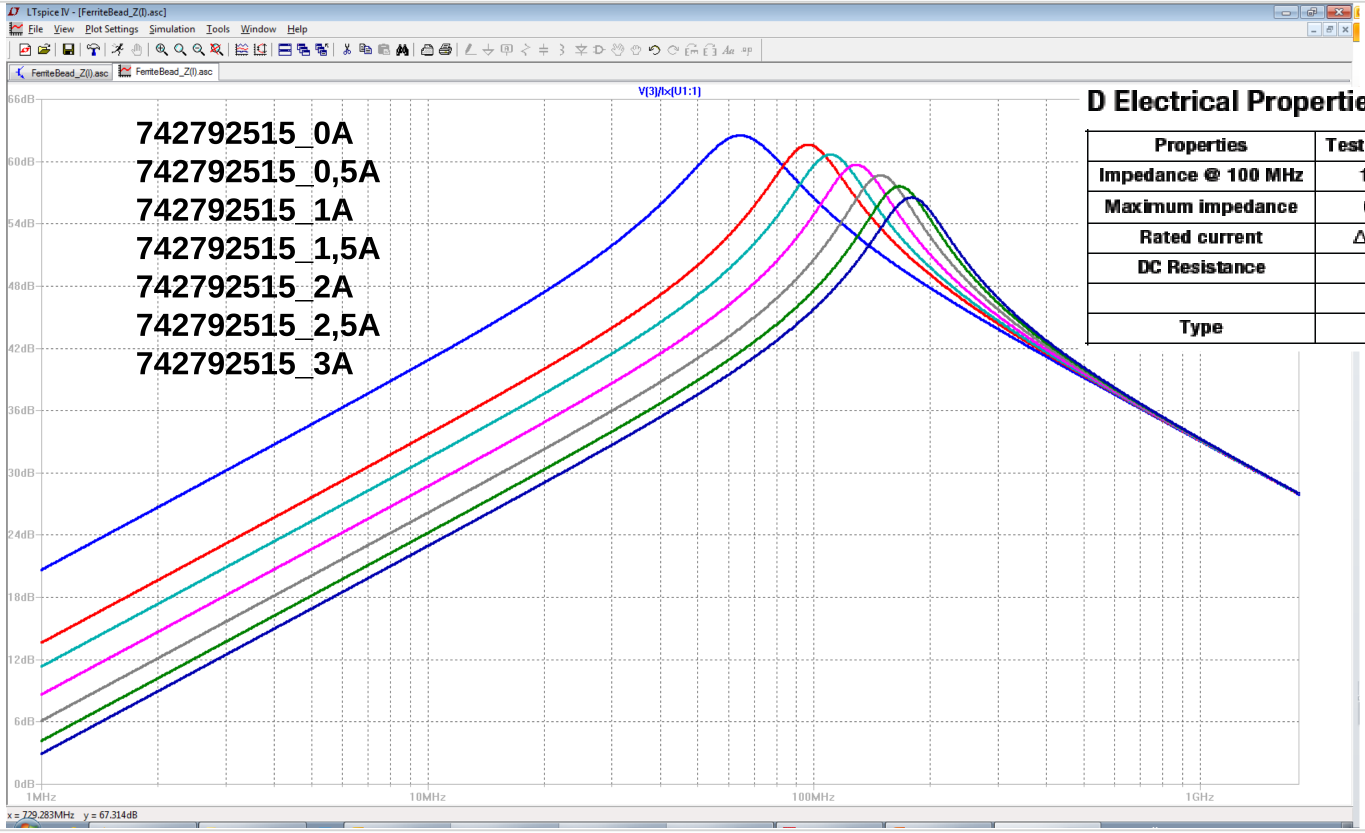
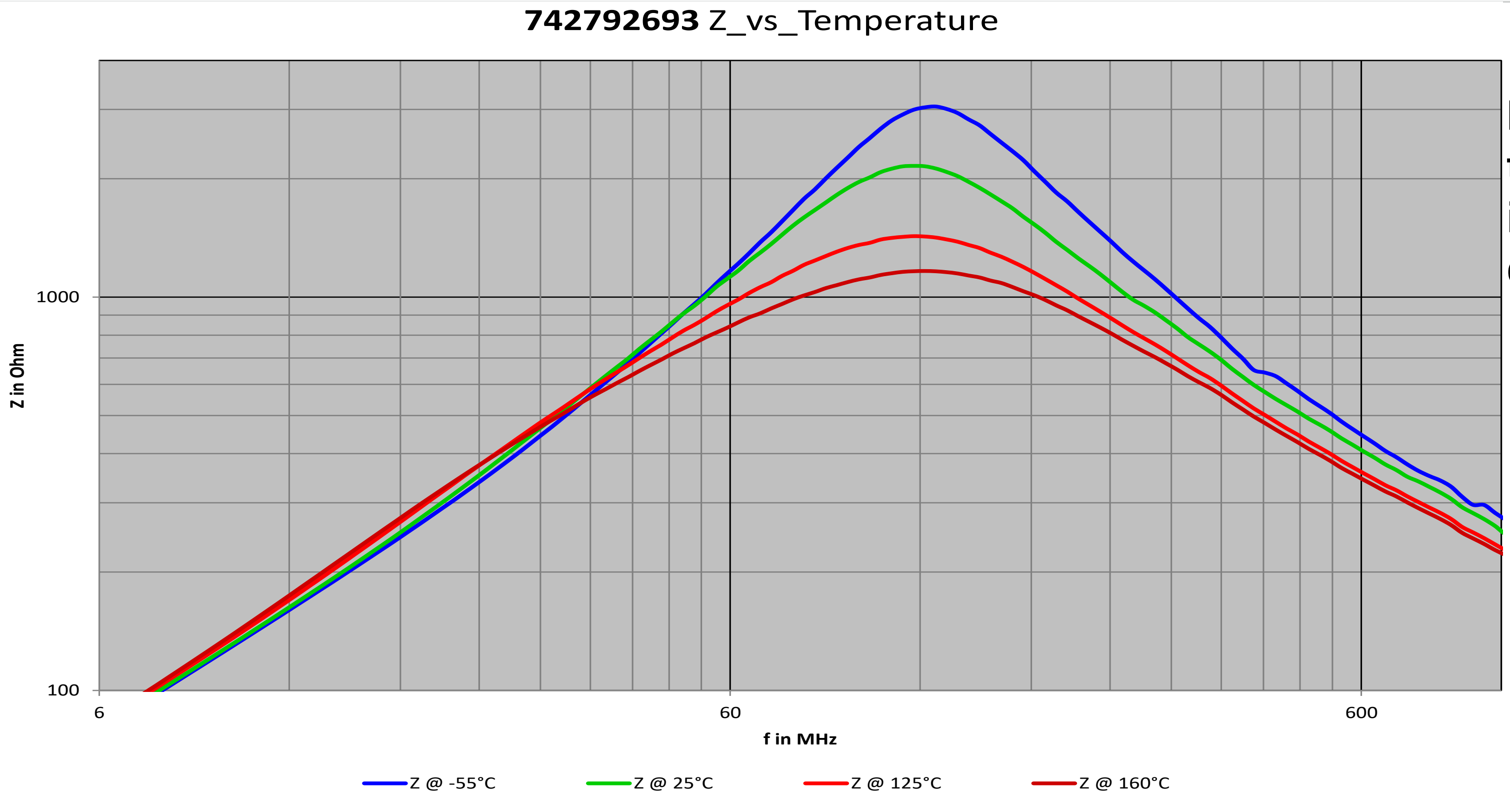


D Electrical Properties:

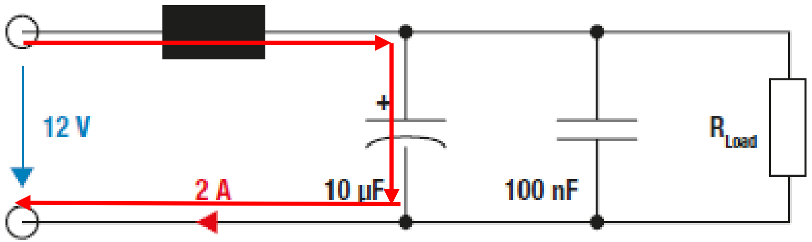
Properties	Test conditions		Value	Unit	Tol.
Impedance @ 100 MHz	100 MHz	Z	785	Ω	±25%
Maximum impedance	60 MHz	Z	1300	Ω	typ.
Rated current	ΔT = 40K	I_R	3000	mA	max.
DC Resistance		R_{DC}	0.05	Ω	max.
Type			High Current		

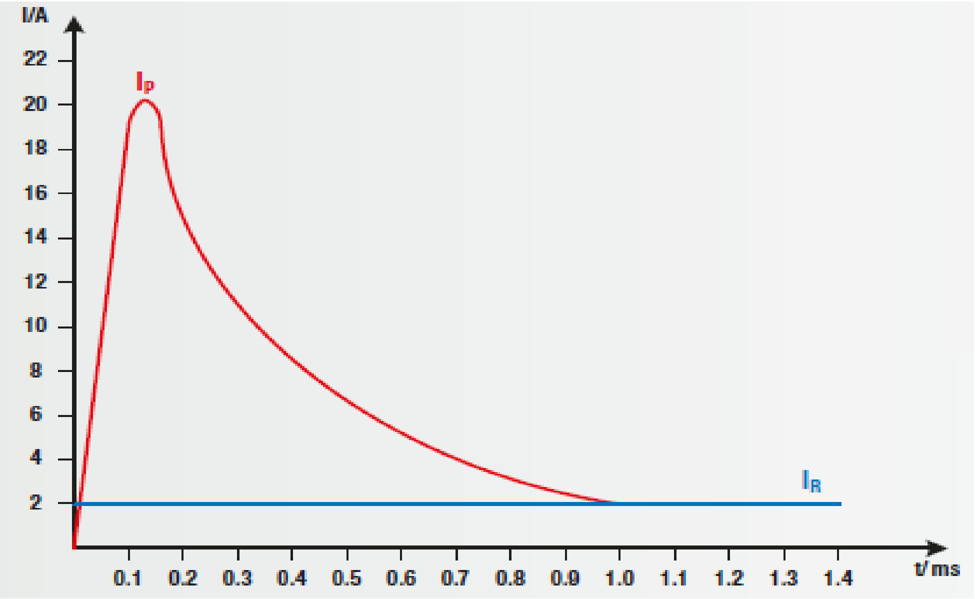
Behavior of the Impedance at temperature



By increasing the temperature, the impedance will decrease

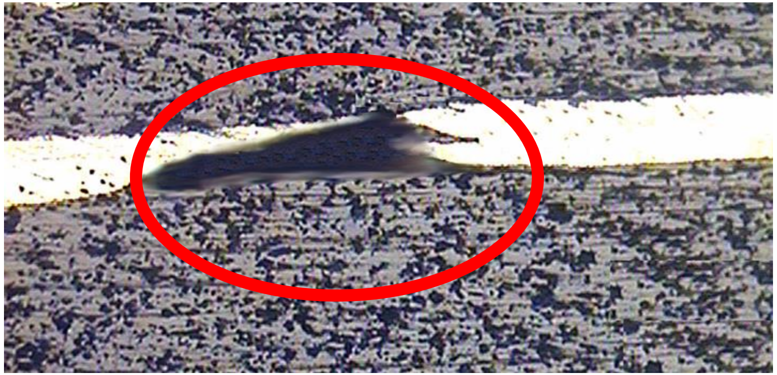
In-Rush Current

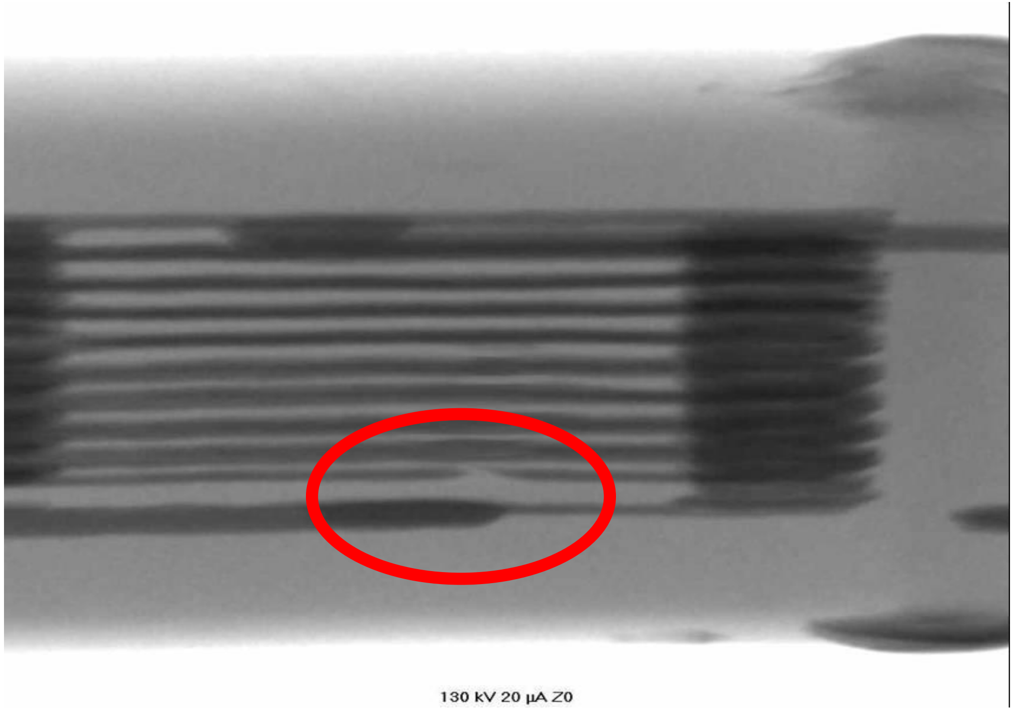




In-Rush Current

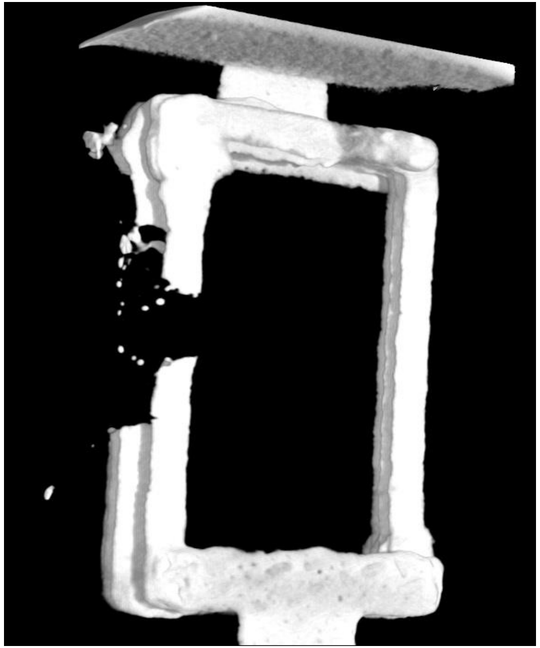
- Open circuit caused by inrush current

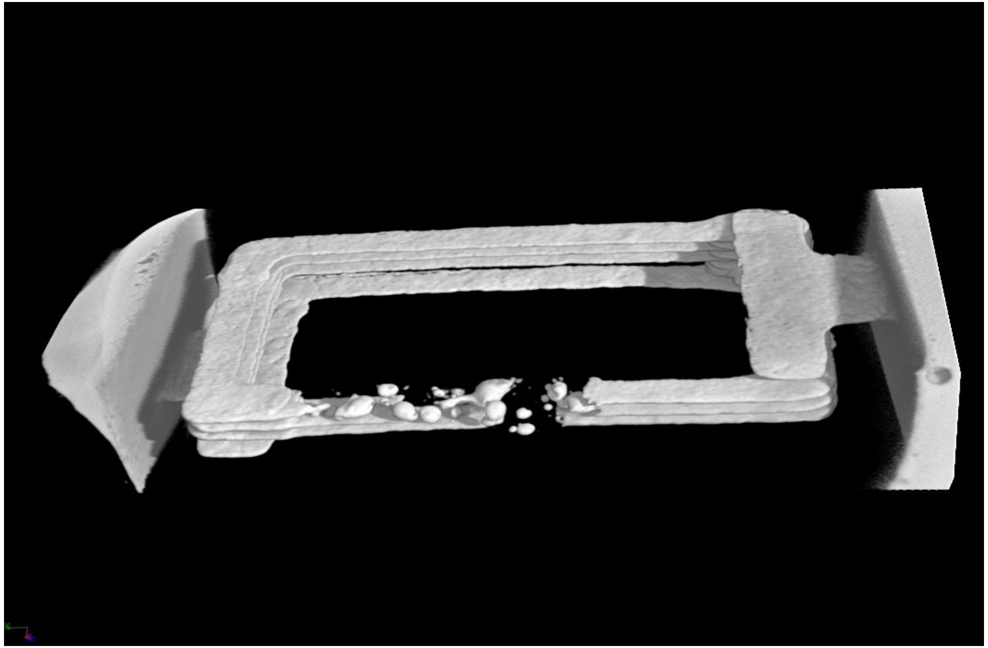




In-Rush Current

- Multilayer Ferrite (0805)
- Destruction at a pulse of 1ms with max. 40A pulse current





In-Rush Current

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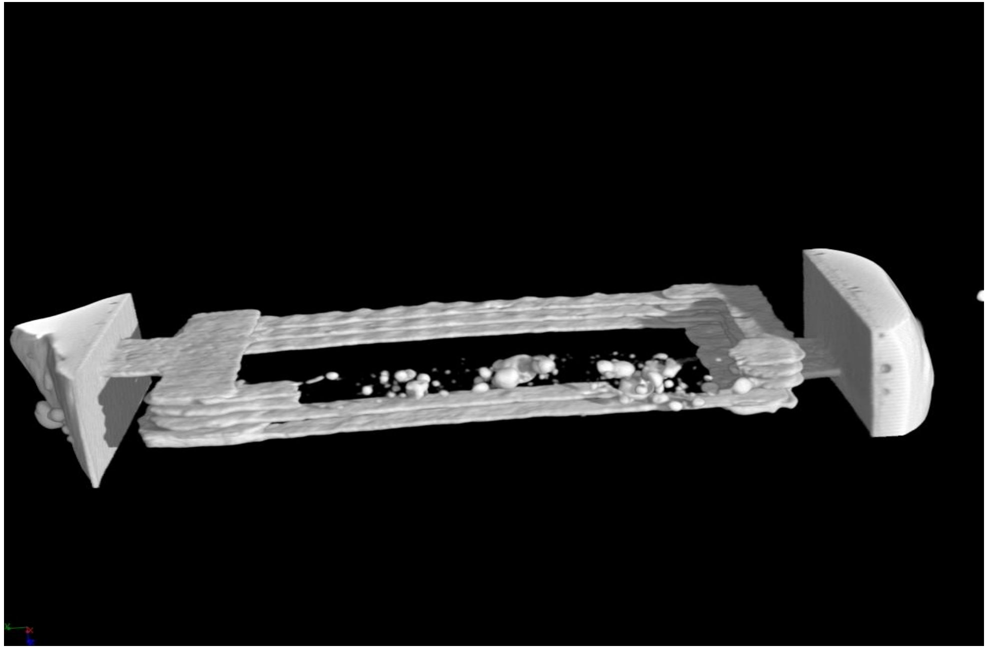
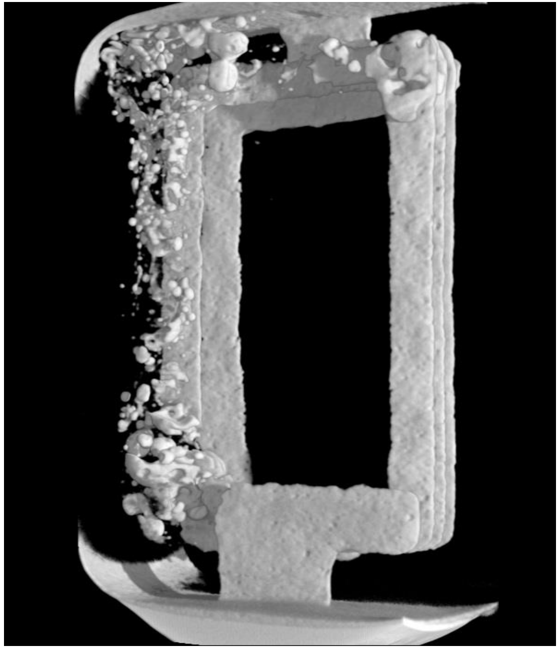
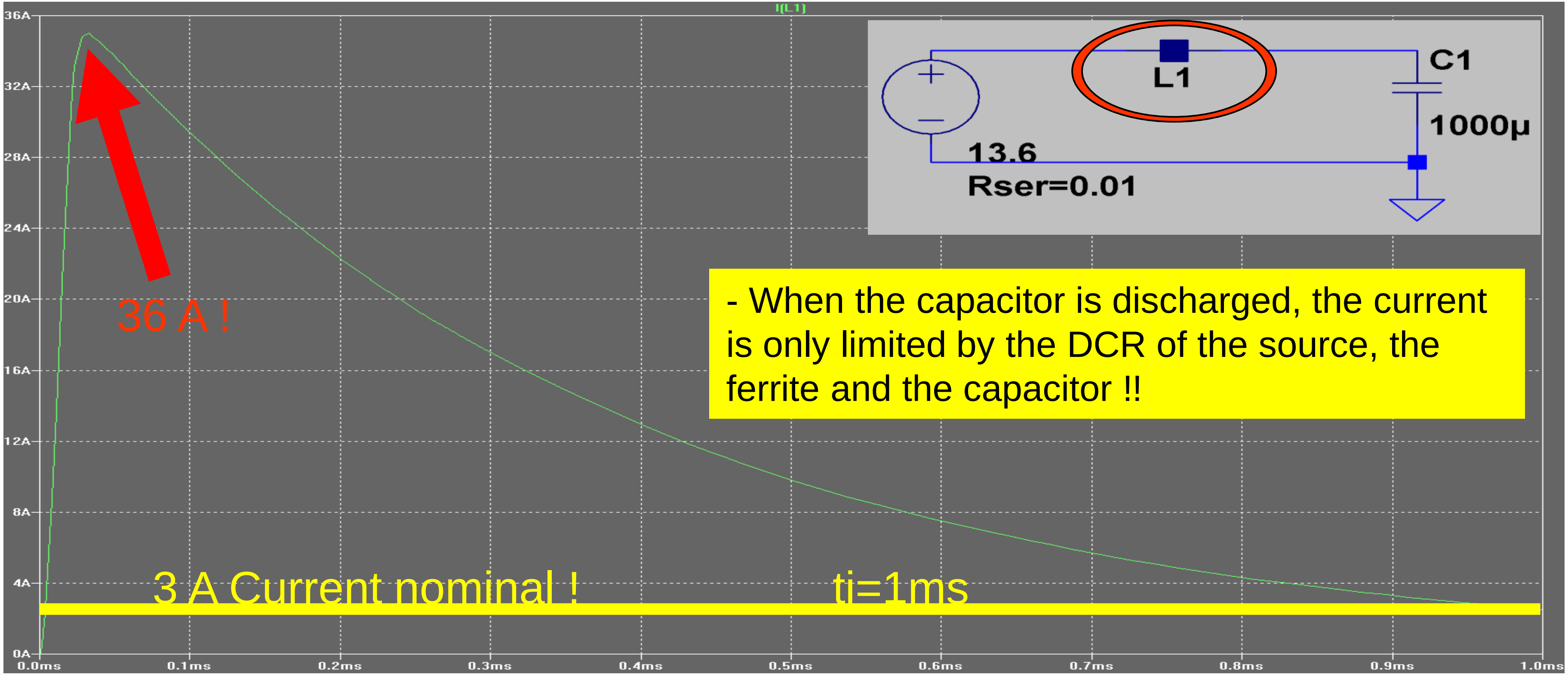


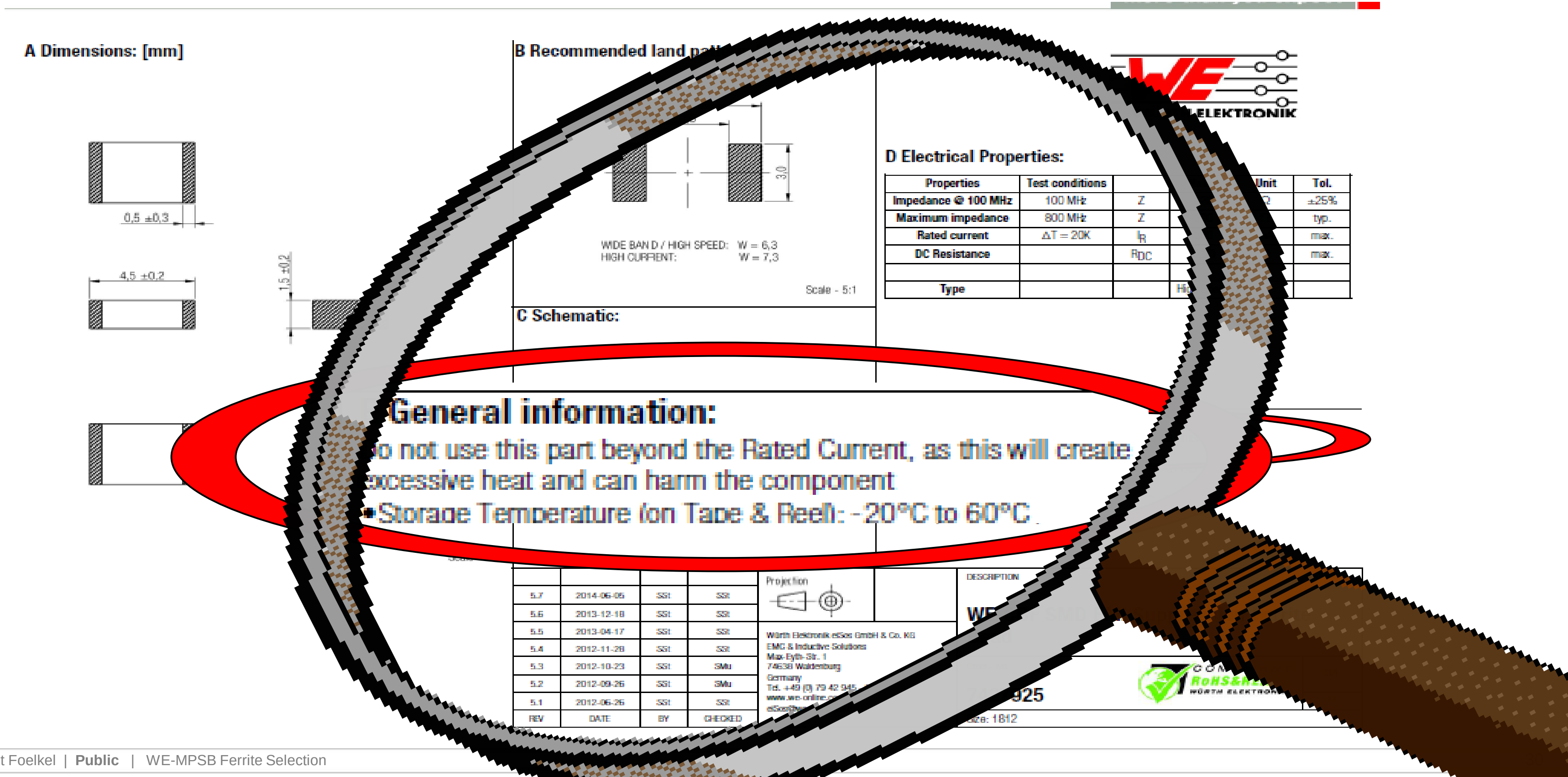


INRUSH Currents : Simulations

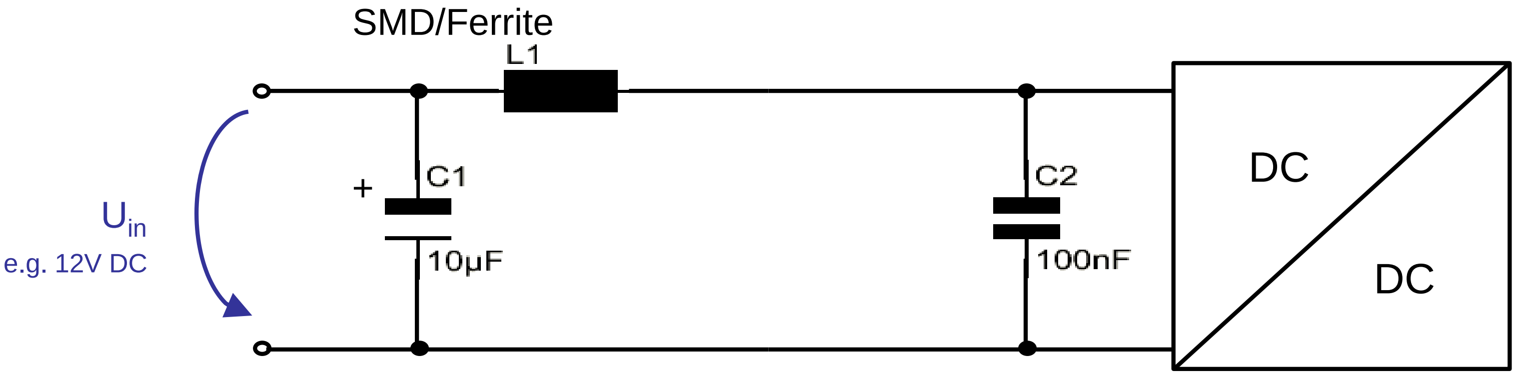


- When the capacitor is discharged, the current is only limited by the DCR of the source, the ferrite and the capacitor !!

CBF Rated Current



How to protect ferrite

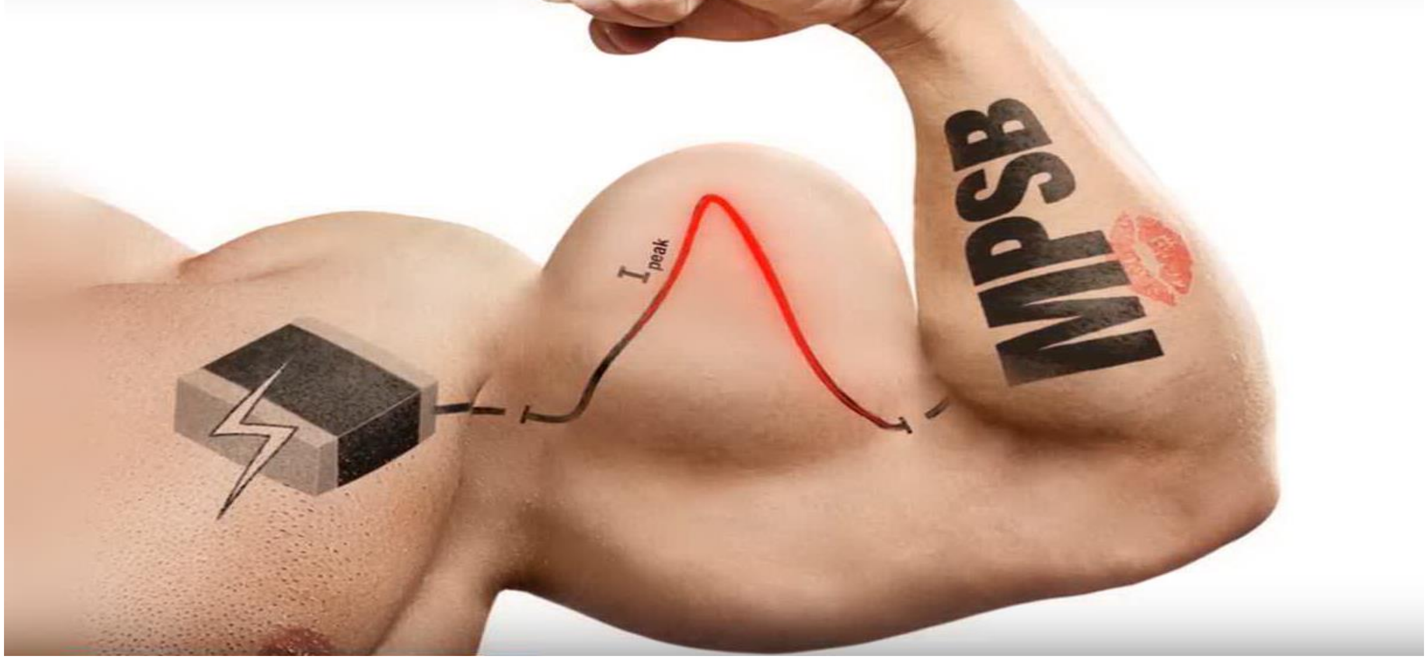


- Protect ferrite from In Rush current during :
  - Power up
  - Hot plugging
  - Line Transient
    - Surge
    - Load dump
    - Safety for SMD ferrite against In-Rush current (load dump) current

MPSB Solution

huge **peak**

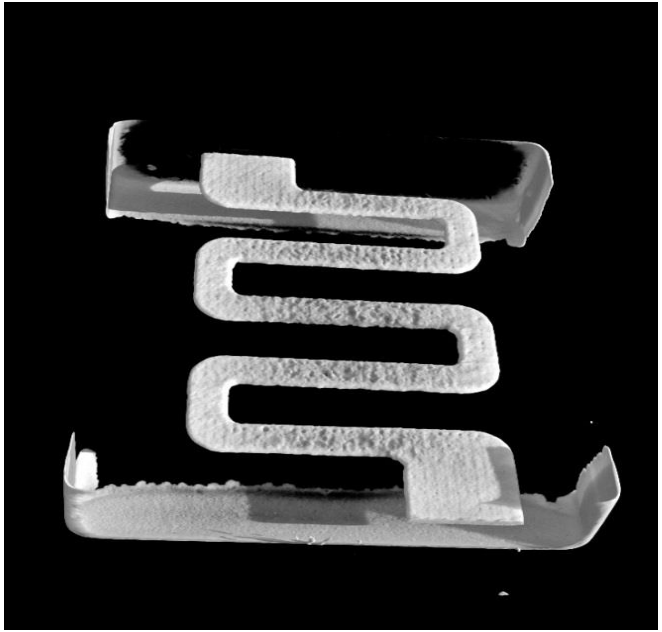
strong **bead !**

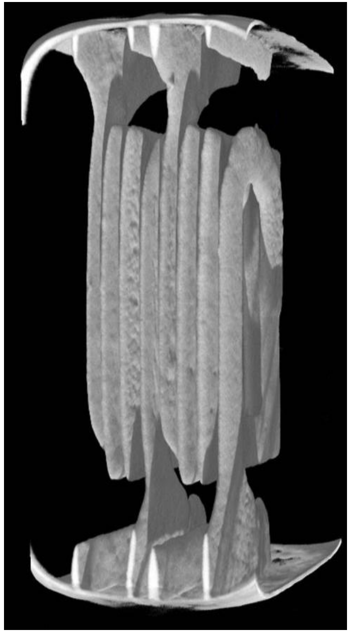


www.we-online.de/we-mpsb and www.we-online.com/we-mpsb

WE-MPSB Multilayer Power Suppression Bead

- High pulse peak possible caused of special internal layer design

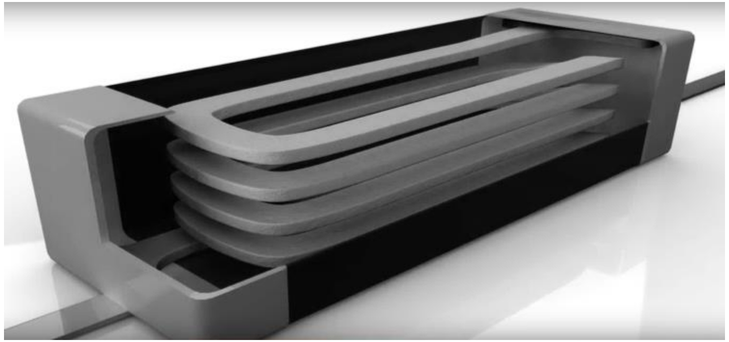


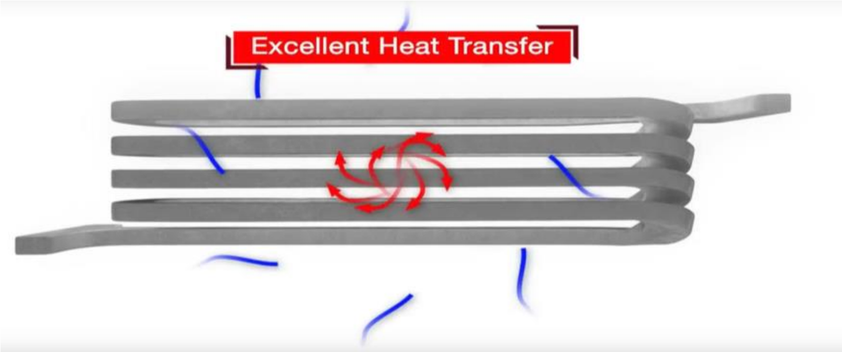


Size 0805

WE-MPSB Multilayer Power Suppression Bead

- High pulse peak possible caused of special internal layer design





WE-MPSB Multilayer Power Suppression Bead

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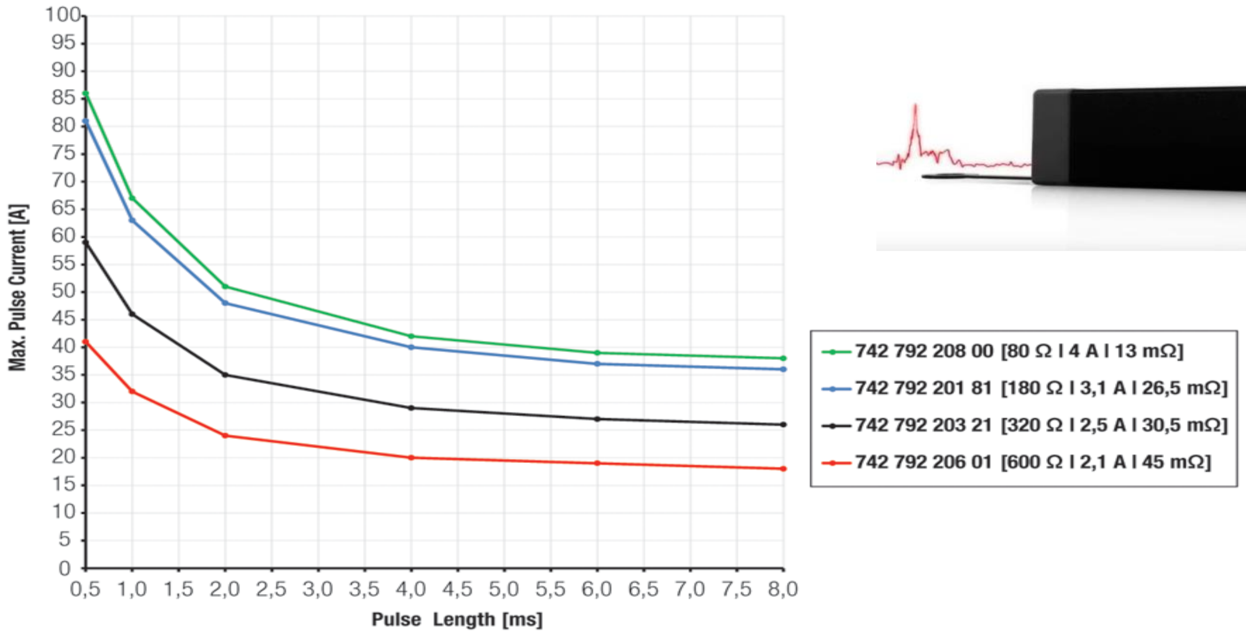
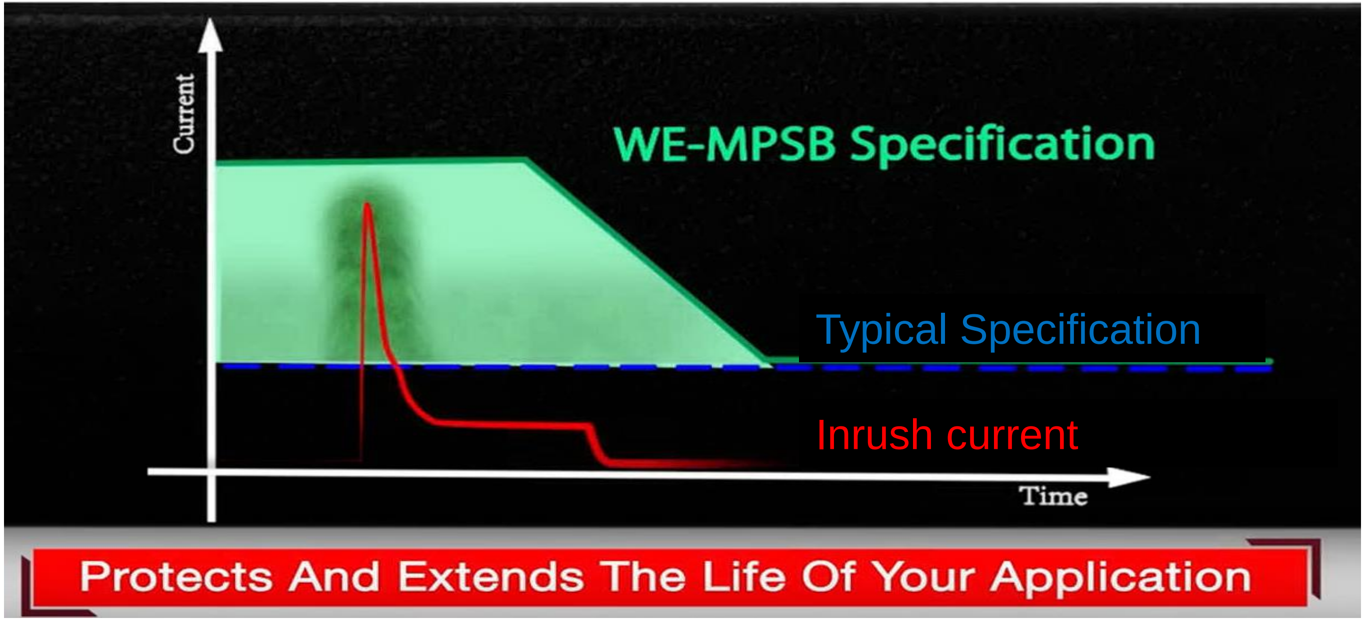
Current vs Pulse Length – Single Pulse – Size 0805



20 Times Higher Peak Current Rating

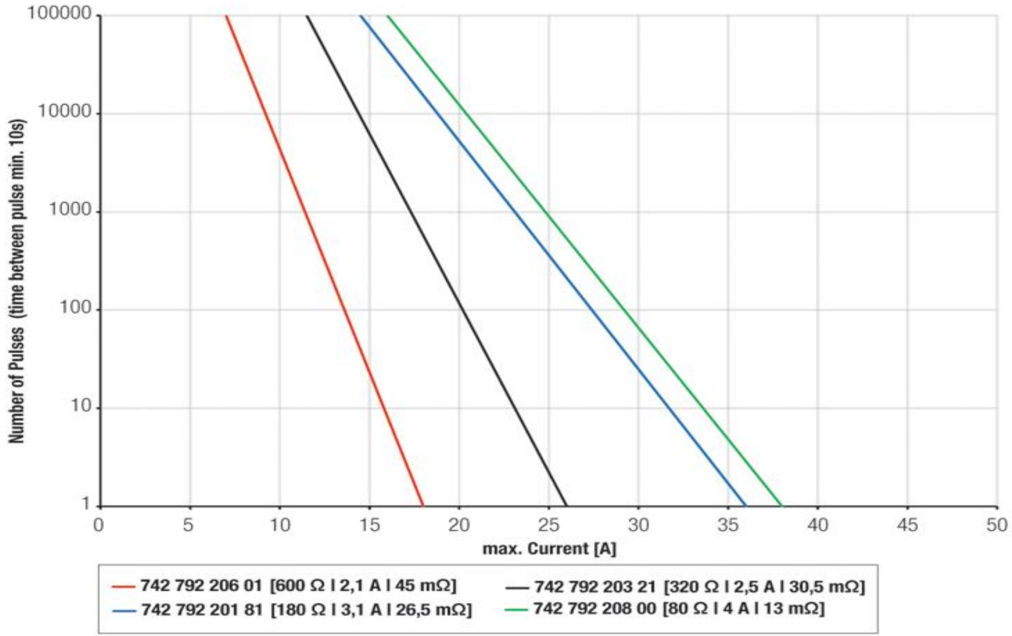
WE-MPSB Multilayer Power Suppression Bead



WE-MPSB Multilayer Power Suppression Bead

- **Current Load Measurments :**

No. of Pulse vs Current – 8 ms Pulse – Size 0805



WE-MPSB T-n-t Triangle

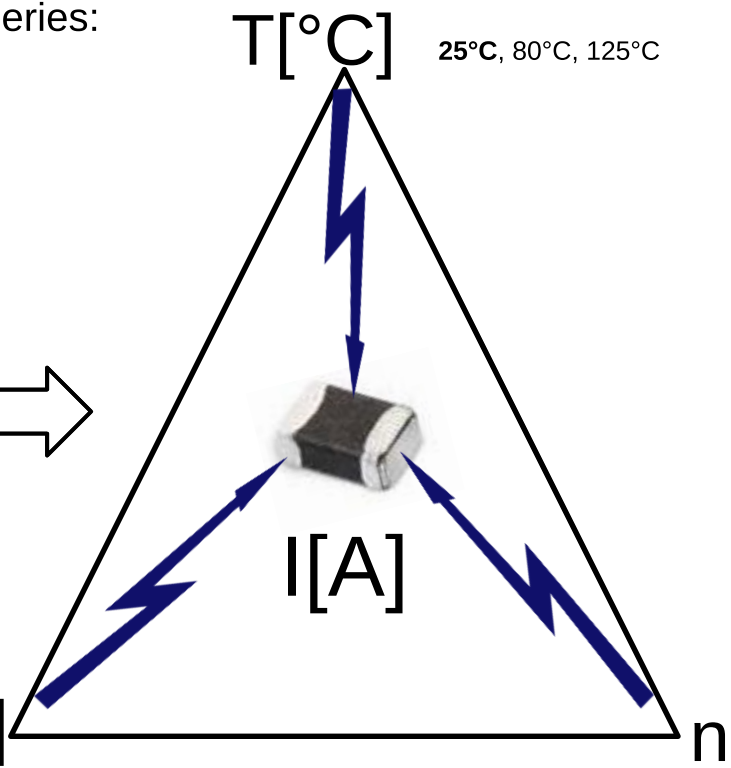
Peak Current Capability of the MPSB Series:

- Pulse length **t [ms]**
- Repetition of the pulse **n**
- Ambient temperature **T [°C]**
- Pulse-Pause **p [s]**

p 1s, 2.5s, **5s**

For each pulse-pause you have a different triangle with the influences of the parameters T-n-t

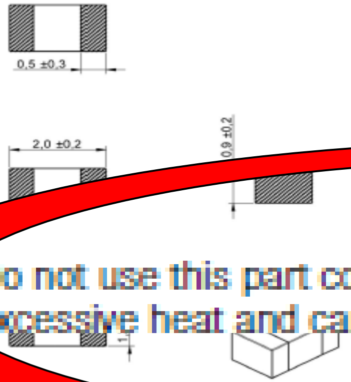
25°C, 80°C, 125°C



0.5ms , 1ms, 2ms, 4ms, 6ms, **8ms**

1, 10, 100, 1k, 10k, 100k

MPSB Rated Current



A Dimensions: [mm]

B Recommended land pattern: [mm]

C Schematic:

D Electrical Properties:

Properties	Test conditions		Value	Unit	Tol.
Impedance @ 100 MHz	100 MHz	Z	180	Ω	±25%
Maximum impedance	155 MHz	Z	202	Ω	typ.
Rated current	ΔT = 40K	I_R	3100	mA	max.
DC Resistance	@ 25°C	R_{DC}	26.5	mΩ	typ.
DC Resistance	@ 25°C	R_{DC}	37.0	mΩ	max.
Type of application					

Do not use this part constantly beyond the Rated Current, as this will create excessive heat and can harm the component

- Operating Temperature: -55°C to 125°C
- Test conditions of Electrical Properties: 20°C, 33% ... if not specified differently

REV	DATE	BY	CHECKED
1.1	2015-01-07	SSt	MHB
1.0	2014-11-05	SSt	MHB

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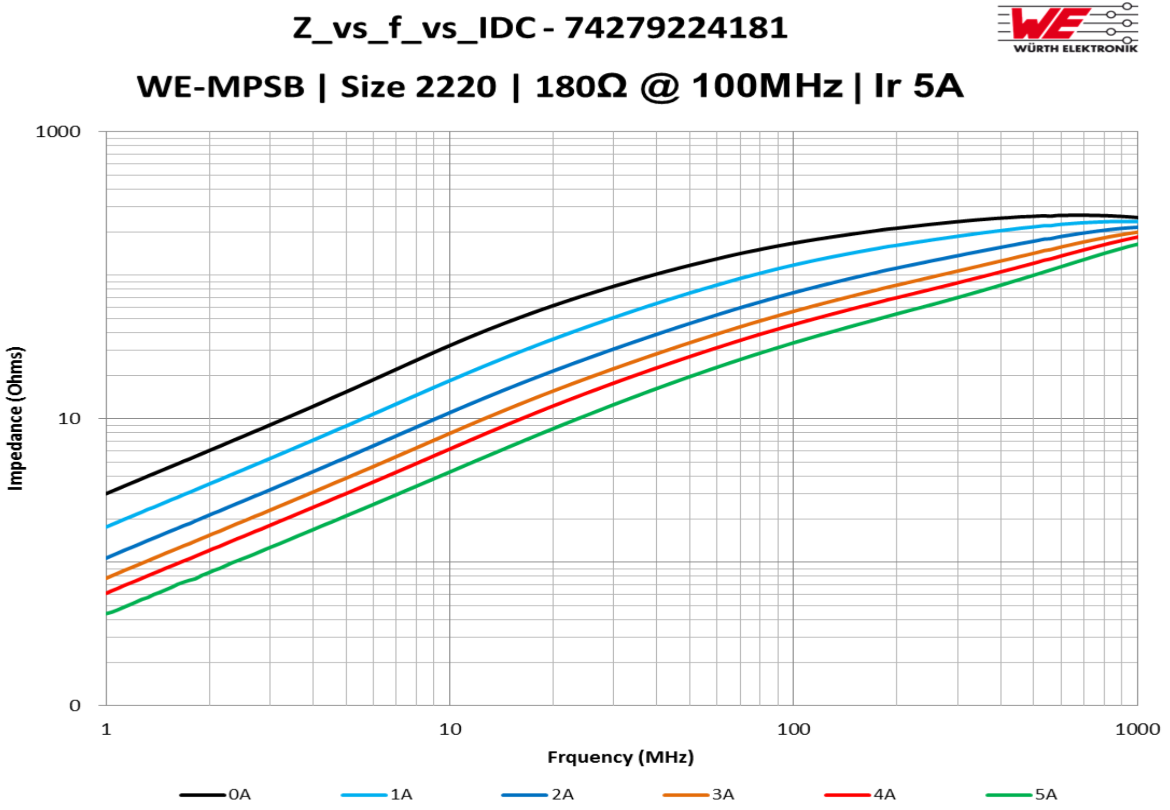
eiSos@we-online.com

DESCRIPTION
WE-MPSB EMI Multilayer Power Suppression Bead
Order.- No. 74279220181
Size: 0805
SIZE A4

MPSB : DC bias



Datasheet: 0 A_{DC}

Z (I) in 50Ω System

Design In:
check the working point

WE-SUKW, WE-PBF Advantages

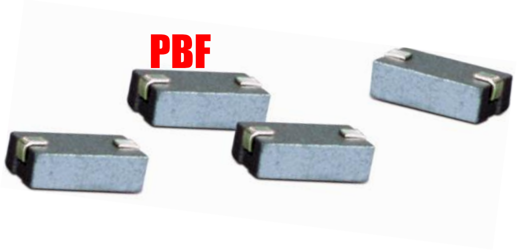
SUKW

D Electrical Properties:

Properties	Test conditions		Value	Unit	Tol.
Impedance @ 25 MHz	25 MHz	Z	425	Ω	typ.
Impedance @ 100 MHz	100 MHz	Z	580	Ω	±25%
Rated current	ΔT= 40K	I_R	5.0	A	max.
DC Resistance	@ 20°C	R_{DC}	12	mΩ	max.

High impedance in lower frequency

PBF



D Electrical Properties:

Properties	Test conditions		Value	Unit	Tol.
Impedance @ 25 MHz	25 MHz	Z	65	Ω	±25%
Impedance @ 100 MHz	100 MHz	Z	98	Ω	±25%
Rated current	ΔT= 40K	I_R	6.0	A	max.
DC Resistance		R_{DC}	0.9	mΩ	max.

Very low DCR

WE-PF Advantages

PF

D Electrical Properties:

Properties	Test conditions		Value	Unit	Tol.
Impedance @ 100 MHz	100 MHz	Z	1180	Ω	±25%
Maximum impedance	90 MHz	Z	2900	Ω	typ.
Rated current	ΔT= 40K	I_R	10.0	A	max.
DC Resistance		R_{DC}	0.009	Ω	max.

High impedance and high current

D Electrical Properties:

Properties	Test conditions		Value	Unit	Tol.
Impedance @ 100 MHz	100 MHz	Z	185	Ω	±25%
Maximum impedance	15 MHz	Z	15000	Ω	typ.
Rated current	ΔT= 40K	I_R	4.5	A	max.
DC Resistance		R_{DC}	0.030	Ω	max.

High impedance in very low Frequency

RECOMMENDATIONS

Recommendations – Filter Topologies

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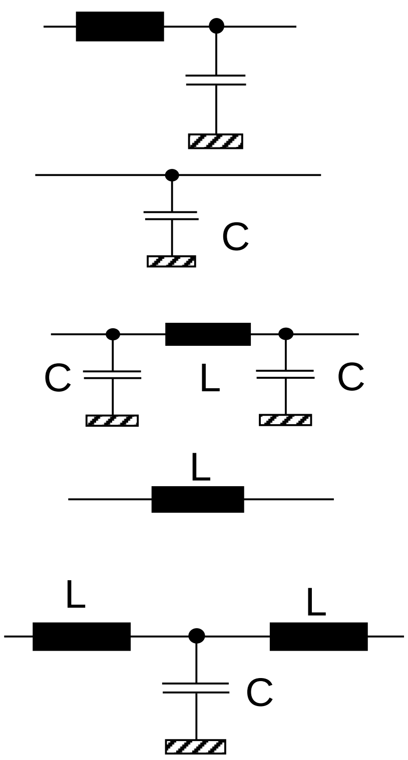
Source Impedance	Load Impedance
low	high
high	high
high or unknown	high or unknown
low	low
low or unknown	low or unknown



→ small C = higher SRF

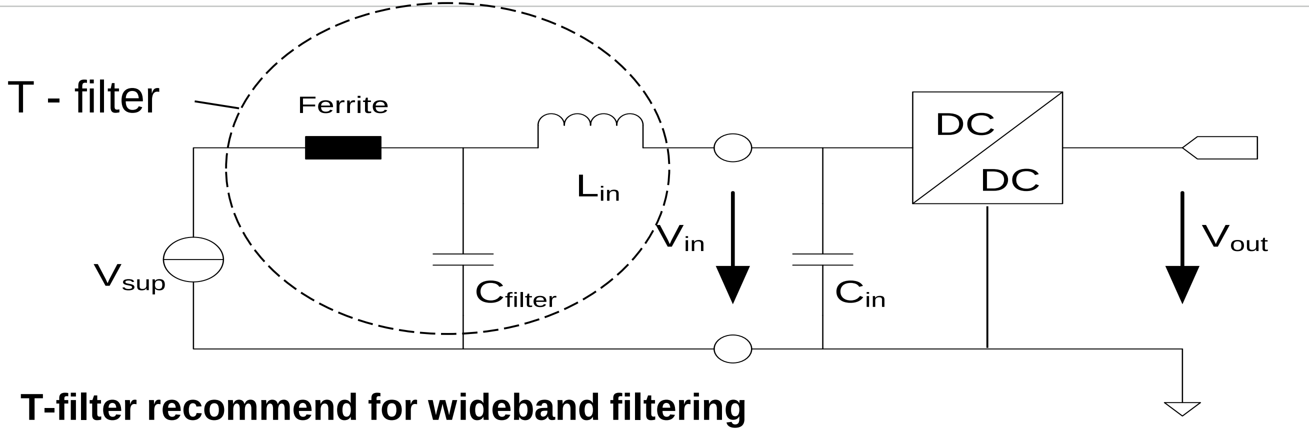
Choose ferrite bead or inductors L which
= build no resonance with C
= wideband filter

Pay attention to:

SRF of used components

Wideband input filter

(recommended filter solution)

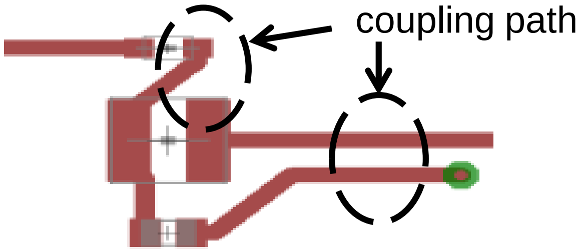


- **T-filter recommend for wideband filtering**
  - **L_{in} for low frequency filtering (DC/DC converter switching frequency)**
  - **Ferrite for high frequency filtering**
  - **C_{filter} shorting ACnoise to GND (220pF < C_{filter} < 1nF, low ESR)**

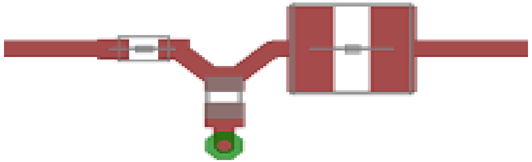
Attention!!! This filter is not efficient to reduce common mode noise on input lines

PCB-Layout recommendations

T-filter



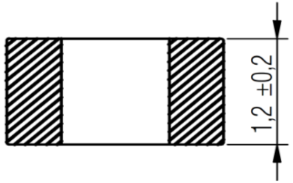
not recommended



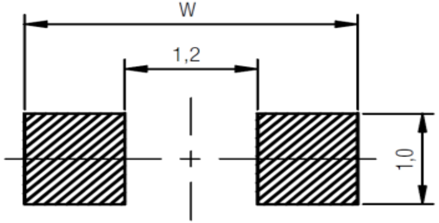
recommended

- Keep PCB traces as short as possible
- Avoid indirect trace routing
- Avoid any kind couplings → "*capacitive*", "*inductive*"
- AC-current should flow across capacitor
- Short way for AC-current direct to GND (place double via's to GND)

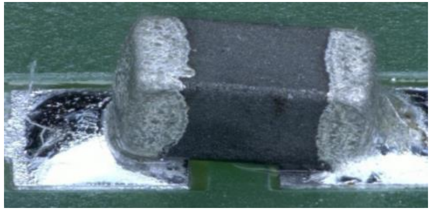
Land Pattern Recommendations

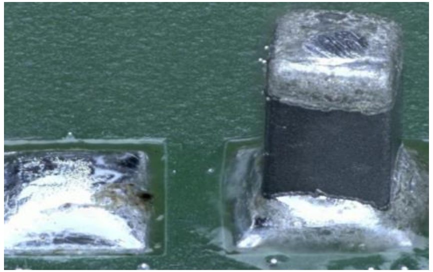


Land pattern (in mm)



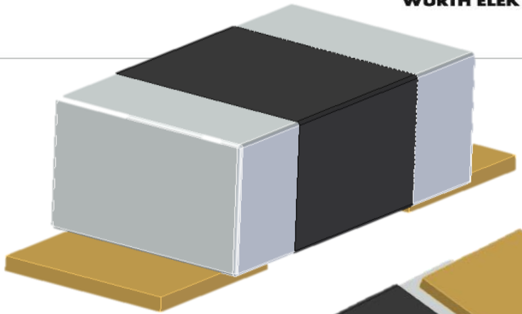
WIDE BAND / HIGH SPEED: W = 3,0
HIGH CURRENT: W = 4,0

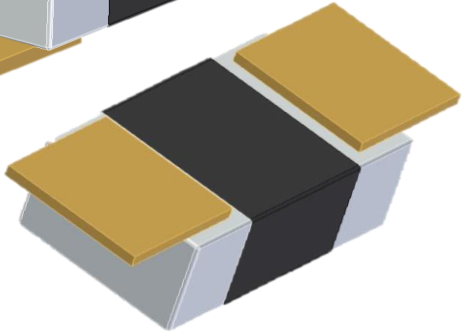


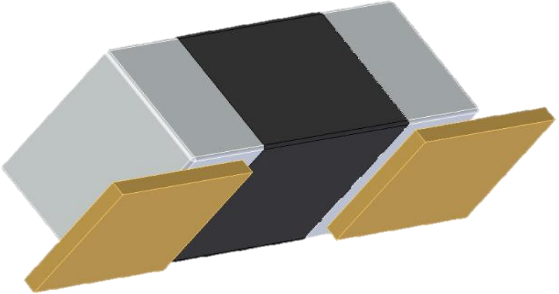


Low Tombstone Effect

Full Tombstone Effect

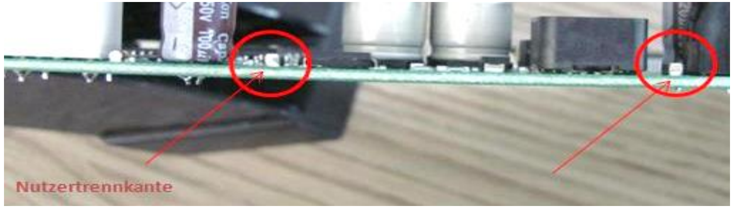


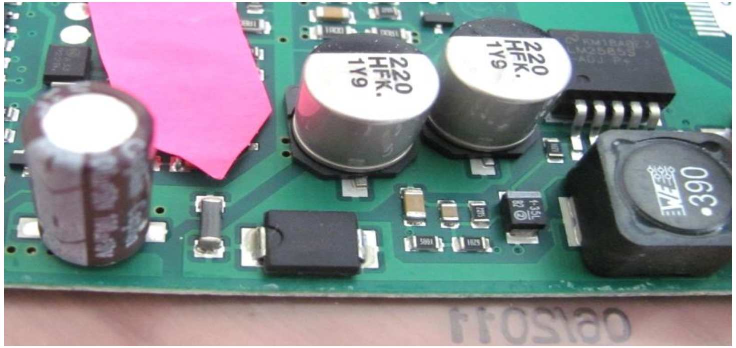




Recommendations – Flexing Stress

- **Flexing stress on PCB**
  - **Not recommended position of CBF**
    - **At the edge of circuit**
    - **Near to connectors**
- **Recommendation**
  - **Orientation of the ferrite perpendicular to the direction of the twist of the card**

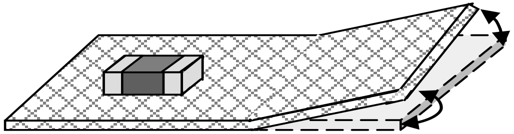
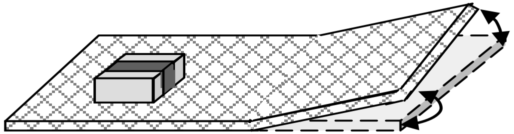


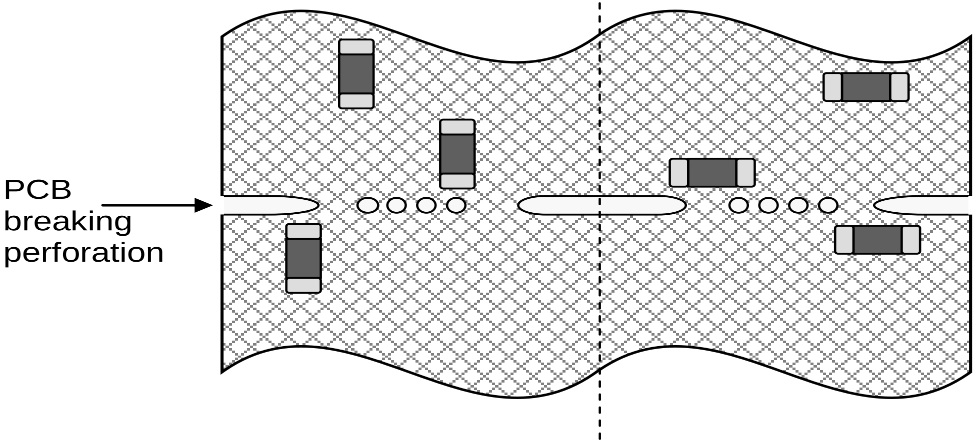


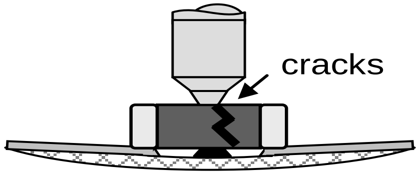
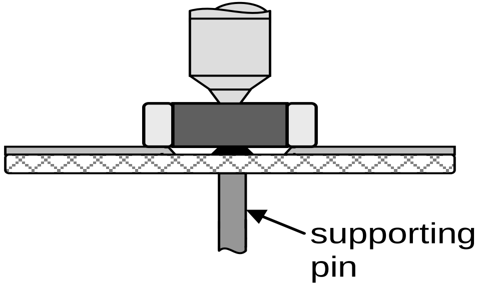
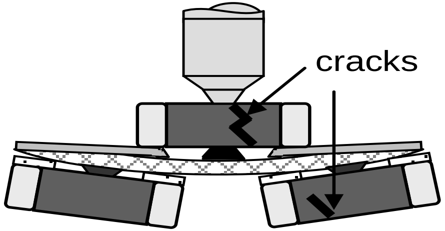
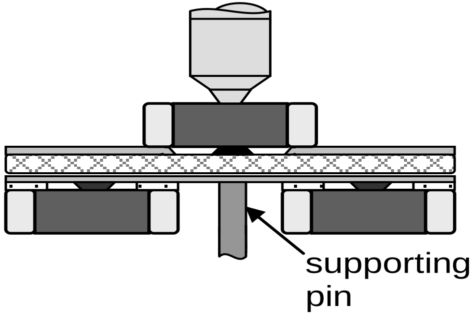
Images Source: WE PM & TQM

Mechanical break of a SMD Ferrite caused through bending stress at separation of the PCB use

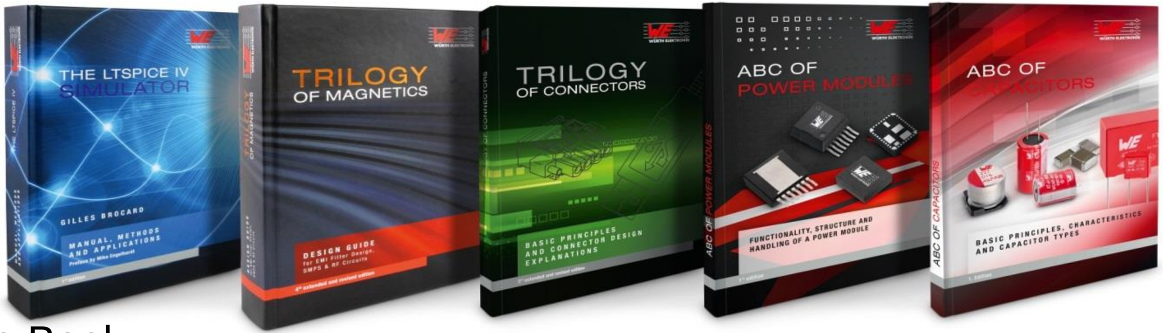
Bending

Not recommended	Recommended
	



	Not recommended	Recommended
Single – sided mounting		
Double – sided mounting		

Trilogy of Magnetics



- 1. LTspice Book
  How to use and build spice models
- 2. Trilogy of Magnetics
  Design Guide for EMI Filter Design, SMPS & RF Circuits
- 3. Trilogy of Connectors
  Basic Principles and Connector Design Explanations
- 4. ABC of Power Modules
  Functionality, Structure and Handling of a Power Modul
- 5. ABC of Capacitors
  Basic principles, characteristics and capacitor types

If you still have questions?

Just call us: we try to help you

Don’t give up !!!

Technical support needed?

Ask our design engineer Lorandt Fölkel

WÜRTH ELEKTRONIK

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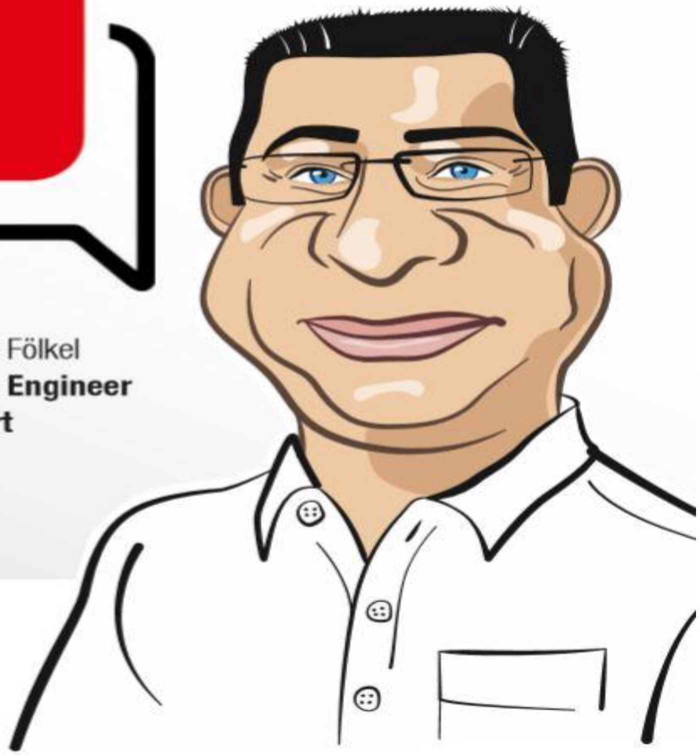

Lorandt Fölkel
Design Engineer at heart

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