SMART SELECTION OF INDUCTORS AND CAPACITORS

POWER INDUCTOR SELECTION

HOW TO CHOOSE A POWER INDUCTOR

Key parameters

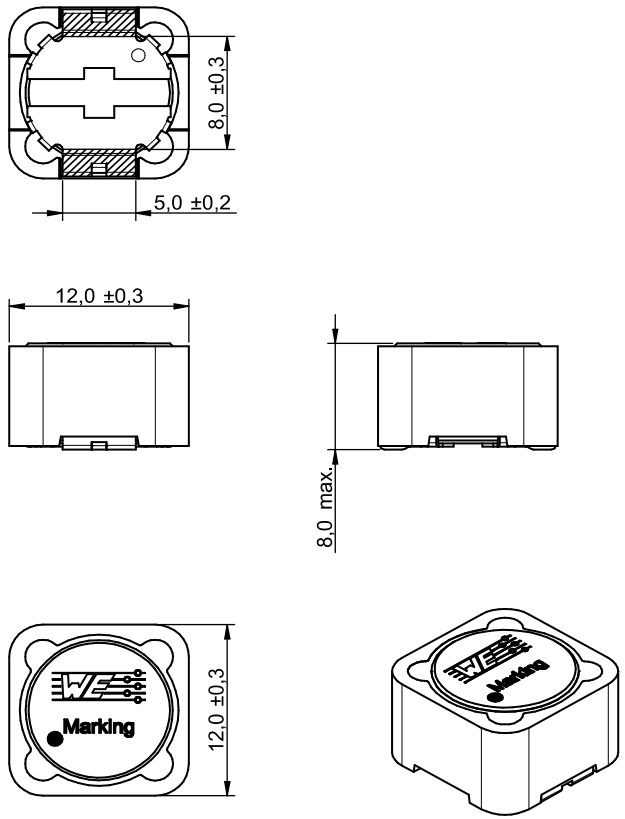
SMART SELECTION OF INDUCTORS

Key parameters and use

- Requirements for customer
  - Value
    - Behavior & tolerances
  - Currents
  - DC resistance (DC losses)
  - AC losses ??
    - **REDEXPERT !**
  - System voltage
  - Temperature limits and behavior
    - **REDEXPERT !**
  - Mechanical aspects
  - Qualifications and standards

- Product parameters: datasheet

Dimensions: [mm]



Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Inductance	L	100 kHz/ 250 mV	10	µH	±20%
Rated Current	$I_{R,40K}$	ΔT = 40 K	7	A	max.
Performance Rated Current [1)]	$I_{RP,40K}$	ΔT = 40 K	8.2	A	max.
Saturation Current @ 10%	$I_{SAT,10\%}$	|ΔL/L| < 10 %	7.5	A	typ.
Saturation Current @ 30%	$I_{SAT,30\%}$	|ΔL/L| < 30 %	9.7	A	typ.
DC Resistance	R_{DC}	@ 20 °C	15	mΩ	typ.
DC Resistance	R_{DC}	@ 20 °C	20	mΩ	max.
Self Resonant Frequency	f_{res}		18	MHz	typ.
Operating Voltage	V	DC	120	V	max.

[1)] refer to IEC 62024-2-2020

Certification:

RoHS Approval	Compliant [2011/65/EU&2015/863]
REACh Approval	Conform or declared [(EC)1907/2006]
Halogen Free	Conform [JEDEC JS709B]
Component Qualification	AEC-Q200 Grade 1
Automotive Approval	Released

General Information:

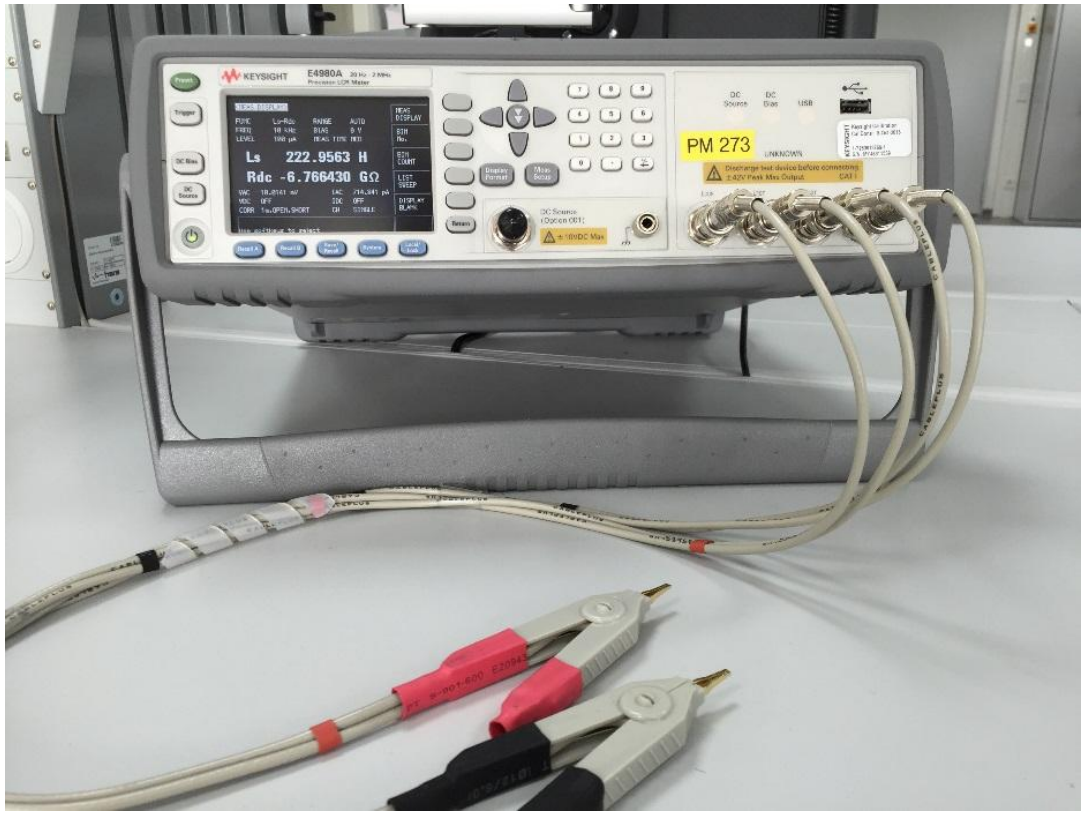
Ambient Temperature (referring to I_{RP})	-40 °C up to +85 °C
Operating Temperature	-40 °C up to +125 °C
Storage Conditions (in original packaging)	< 40 °C ; < 75 % RH
Moisture Sensitivity Level (MSL)	1
Test conditions of Electrical Properties: +20 °C, 33 %RH if not specified differently	
Test conditions of Performance Rated Current: refer to IEC 62024-2-2020, Class B (PCB Copper Width: 40 mm; PCB Copper Thickness: 35 µm)	

INDUCTOR SELECTION

Inductance value production and quality measurement

- Inductance is measured with LCR meter
  - With a specific set up

- Samples can be ordered with the nearest standard values



Electrical Properties:

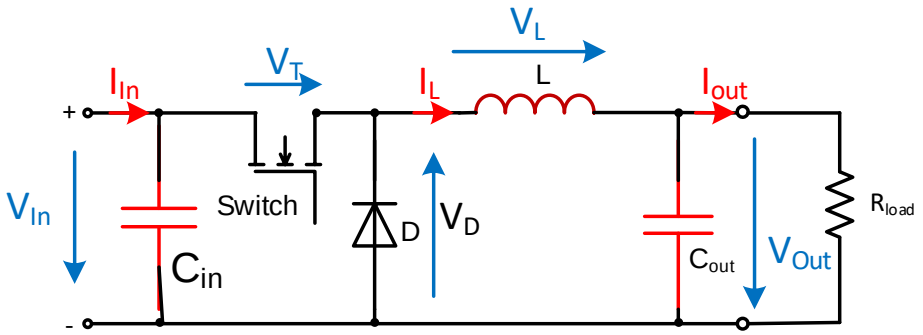
Properties	Test conditions		Value	Unit	Tol.
Inductance	1 kHz/ 250 mV	L	10	µH	±20%
Rated current	ΔT = 40 K	I_R	7.1	A	max.
Saturation current	|ΔL/L| < 10%	I_{sat}	10.5	A	typ.
DC Resistance	@ 20°C	R_{DC}	0.013	Ω	typ.
DC Resistance	@ 20°C	R_{DC}	0.021	Ω	max.
Self resonant frequency		f_{res}	21	MHz	typ.

INDUCTOR SELECTION

Inductance value : the buck converter example

$$D = \frac{V_{out}}{V_{in}} \qquad D = \frac{V_{out} + Vd}{V_{in} - Vsw + Vd}$$

$$D = 0{,}208 \qquad D = 0{,}22$$



$$L = \frac{(V_{in} - Vout) \cdot D}{f_{switch} \cdot r \cdot I_{out}}$$

$$I_{peak} = Iout + \frac{\Delta I}{2}$$

$$I_{nom} = Iout$$

- $V_{in} = 24V$
- $V_{out} = 5V$
- $I_{out} = 2A$
- $F_{sw} = 535\ kHz$
- $V_{sw} = 0{,}3V$
- $V_D = 0{,}3V$

$r = 20\%$

I_{peak} =2,2A

$L = 18{,}5\mu H \quad - 19{,}4\mu H$

$r = 40\%$

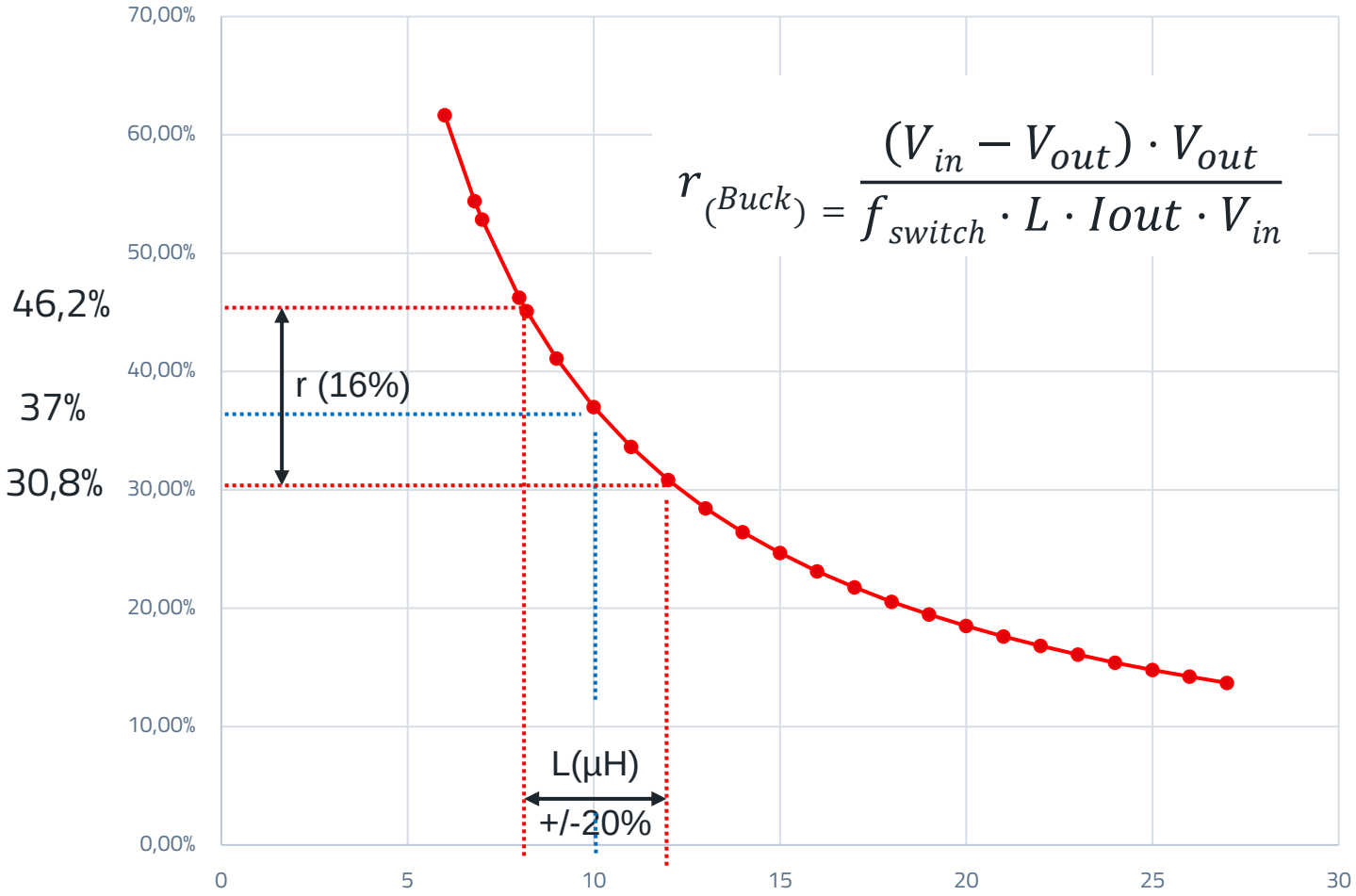
I_{peak} =2,4A

$L = 9{,}3\mu H \quad - 9{,}7\mu H$

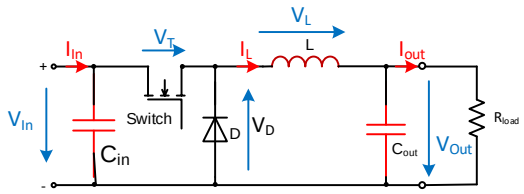
Standard value : 8,2µH; 10µH, 12µH, 15µH, 18µH, 22µH

INDUCTOR SELECTION

Ripple VS Inductance value :



$$r_{(Buck)} = \frac{(V_{in} - V_{out}) \cdot V_{out}}{f_{switch} \cdot L \cdot Iout \cdot V_{in}}$$



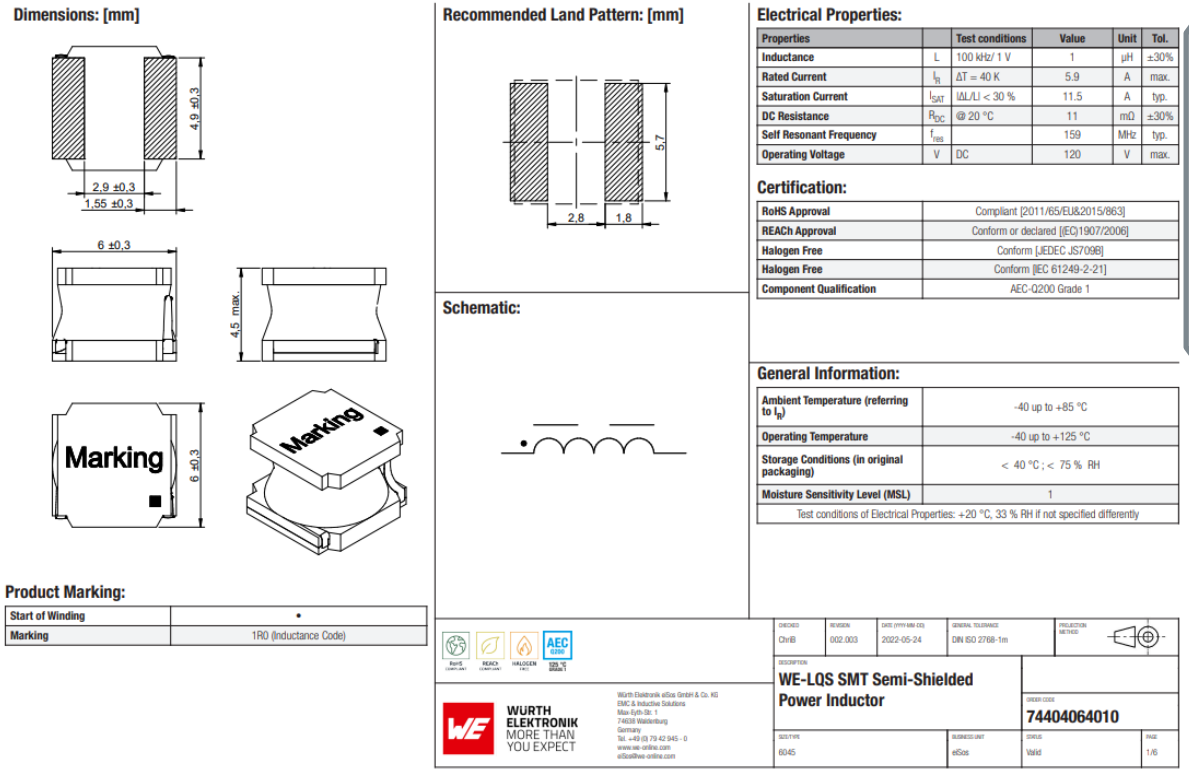
- $V_{in} = 24V$
- $V_{out} = 5V$
- $I_{out} = 2A$
- $F_{sw} = 535\ kHz$
- $V_{sw} = 0{,}3V$
- $V_D = 0{,}3V$

RATED CURRENT

RATED CURRENT

Heating shown in the Datasheet

- Datasheet sample



Dimensions: [mm]

4,9 ±0,3
2,9 ±0,3
1,55 ±0,3
6 ±0,3
4,5 max.
Marking
6 ±0,3
Marking

Recommended Land Pattern: [mm]

5,7
2,8
1,8

Schematic:

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Inductance	L	100 kHz/ 1 V	1	µH	±30%
Rated Current	I_R	ΔT = 40 K	5.9	A	max.
Saturation Current	I_{SAT}	|ΔL/L| < 30 %	11.5	A	typ.
DC Resistance	R_{DC}	@ 20 °C	11	mΩ	±30%
Self Resonant Frequency	f_{res}		159	MHz	typ.
Operating Voltage	V	DC	120	V	max.

Certification:

RoHS Approval	Compliant [2011/65/EU&2015/863]
REACh Approval	Conform or declared [(EC)1907/2006]
Halogen Free	Conform [JEDEC JS709B]
Halogen Free	Conform [IEC 61249-2-21]
Component Qualification	AEC-Q200 Grade 1

General Information:

Ambient Temperature (referring to I_R)	-40 up to +85 °C
Operating Temperature	-40 up to +125 °C
Storage Conditions (in original packaging)	< 40 °C ; < 75 % RH
Moisture Sensitivity Level (MSL)	1

Test conditions of Electrical Properties: +20 °C, 33 % RH if not specified differently

Product Marking:

Start of Winding	•
Marking	1R0 (Inductance Code)

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

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EMC & Inductive Solutions
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Germany
Tel. +49 (0) 79 42 945 - 0
www.we-online.com
eiSos@we-online.com

CHECKED ChriB | REVISION 002.003 | DATE (YYYY-MM-DD) 2022-05-24 | GENERAL TOLERANCE DIN ISO 2768-1m | PROJECTION METHOD

DESCRIPTION: WE-LQS SMT Semi-Shielded Power Inductor

ORDER CODE: 74404064010

SIZE/TYPE 6045 | BUSINESS UNIT eiSos | STATUS Valid | PAGE 1/6

- Rated current mention in the datasheet

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Inductance	L	100 kHz/ 1 V	1	µH	±30%
Rated Current	I_R	ΔT =	5.9	A	max.
Saturation Current	I_{SAT}	|ΔL/L| < 30 %	11.5	A	typ.
DC Resistance	R_{DC}	@ 20 °C	11	mΩ	±30%
Self Resonant Frequency	f_{res}		159	MHz	typ.
Operating Voltage	V	DC	120	V	max.

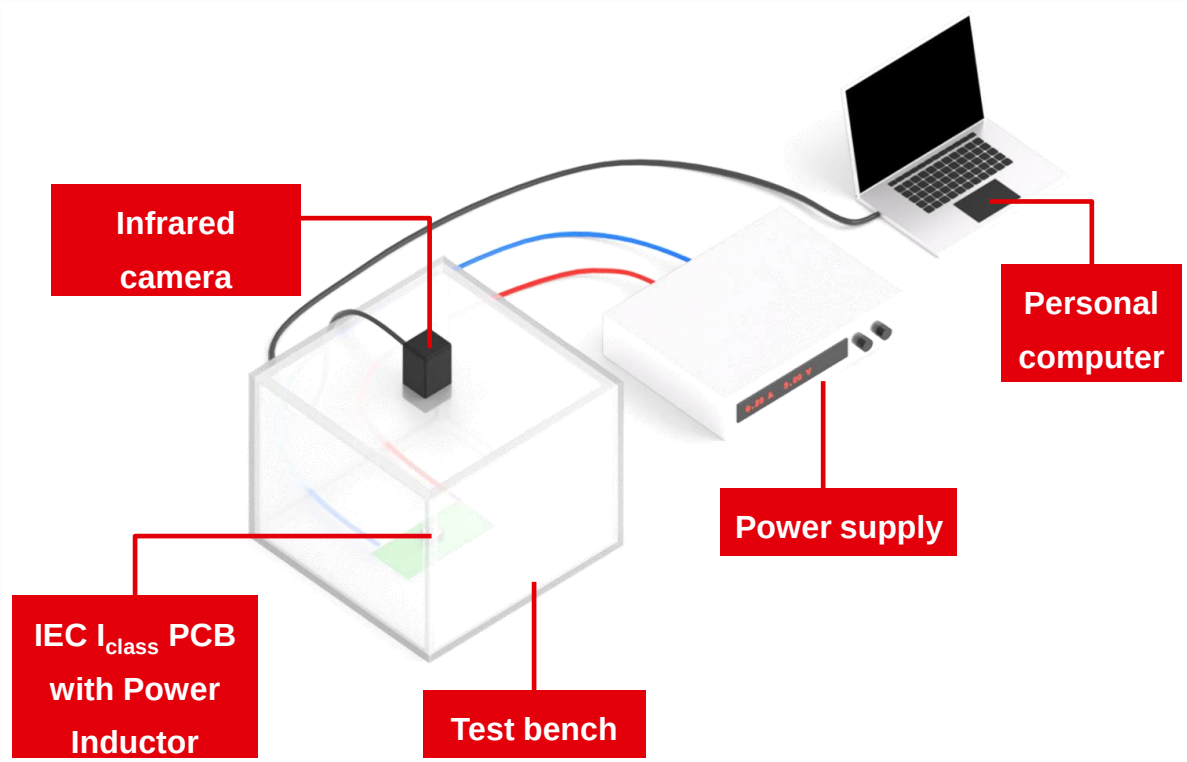
RATED CURRENT

Explained setup

- This value describes the direct current at which the component self heating increases (ΔT)

- The method Würth Elektronik uses to measure the rated current is based upon section 6 of the IEC 62024-2:2020 standard to provide transparent and comparable Ir values. A test PCB with a Power Inductor is contained within a box of roughly 20 cm on each side and does not contact directly with the surrounding box. Only natural heat exchange occurs, with no forced heat transfer applied to the test PCB.

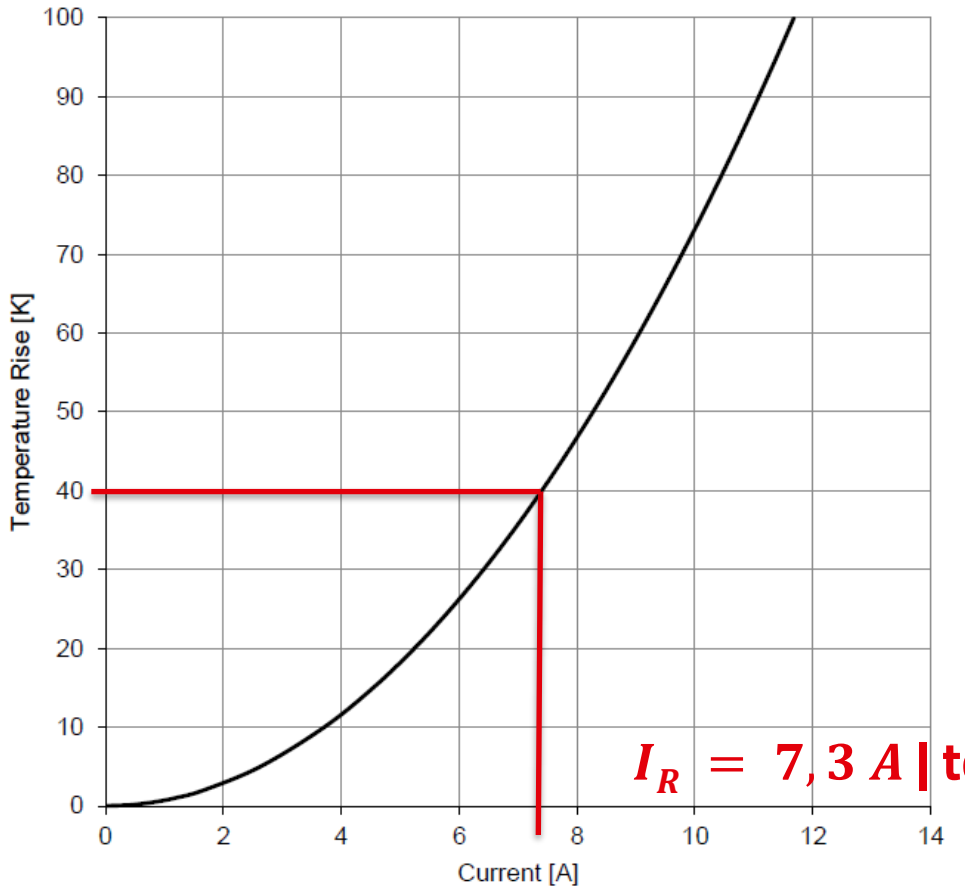
- Overall setup



RATED CURRRENT

Definition with temperature rise

- Temperature rise vs Current



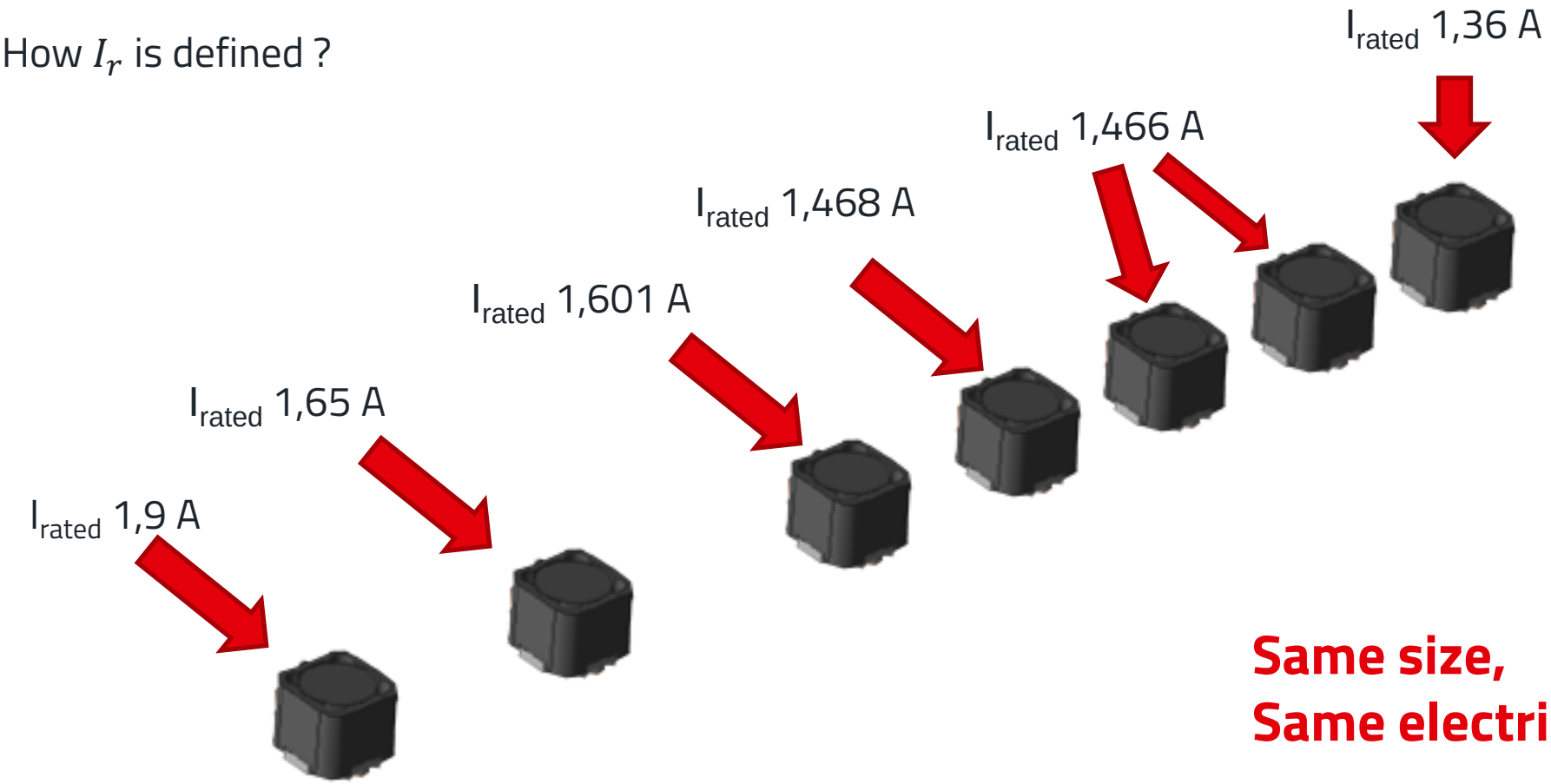
$I_R = 7,3\ A$ | test condition ΔT = 40K

- Losses vs current
  - DC current injection is more convenient and very accurate to define losses and temperature rise accordingly

$$P_{loss} = R_{DC} \cdot {I_{DC}}^2$$

RATED CURRENT

How I_r is defined ?

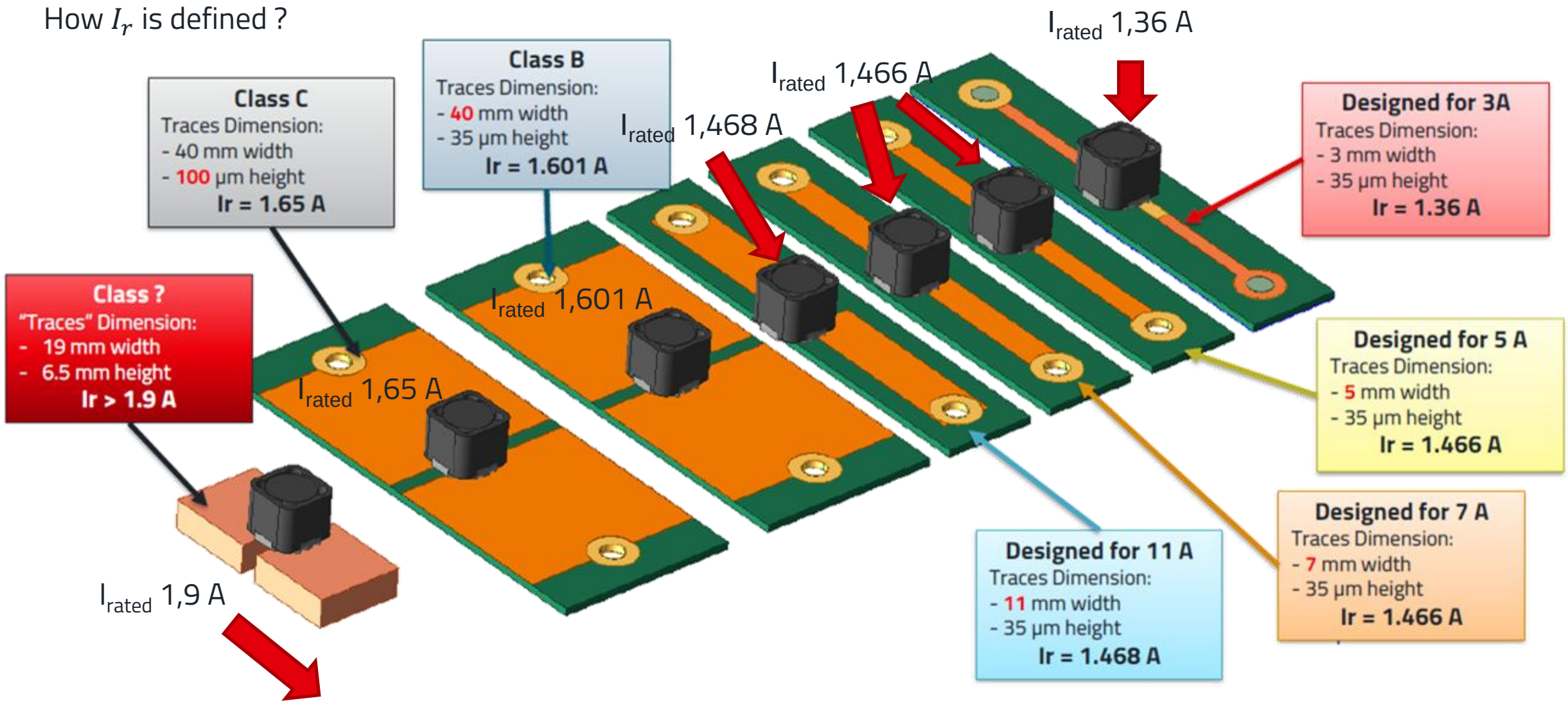


Same size,
Same electrical parameter (L, R_{DC})

Why different rated currents ?

RATED CURRENT

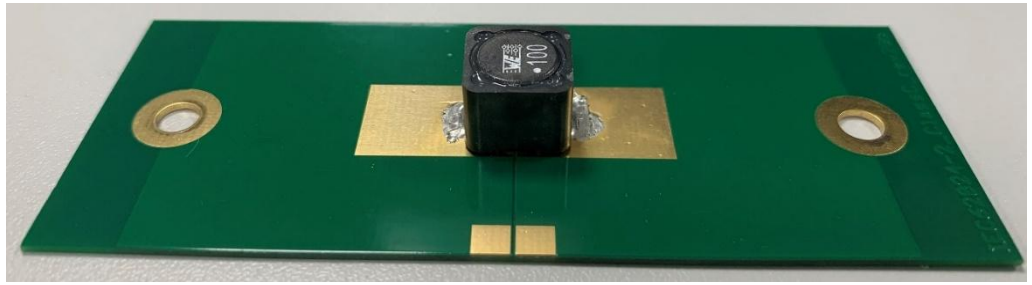
How I_r is defined ?

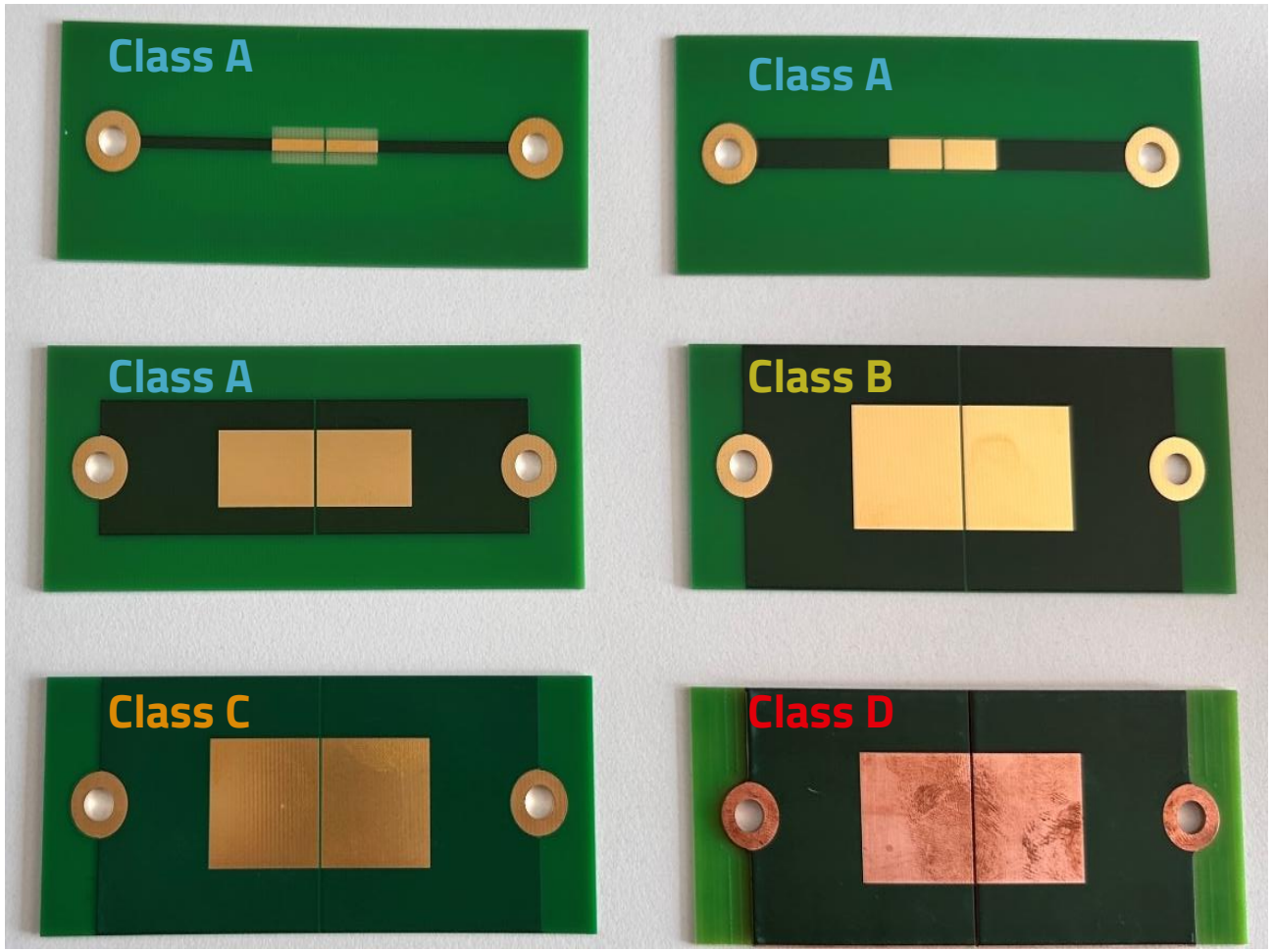


IEC 62024-2:2020

WE Definition and uses of Rated current

- **Class A**: 1 to 22mm pattern width
- **Class B**: Product Series with standard requirement profile
- **Class C**: Product which are used in high packing density application
- **Class D**: Products with current capability higher then 30A





POWER INDUCTORS

Wurth Elektronik current definition ; the truth about it

Redefining Rated Current Measurements for Power Inductors

- The rated current is related from temperature elevation
  - 40K is a “standard” common value often the difference between component temperature and ambient temperature.
  - 40K is also the maximum temperature rise of the **IEC62024-2:2020 standard**; practical to evaluate maximum performances. *§6.4.3 i) into standard page 15*

Table 2 – Circuit pattern width and thickness

Rated current class	Pattern width W mm	Pattern thickness t µm	Example application
$I_{class\ A}$	(1,0 to 22,0) ± 0,2 to 0,5	35 ± 10	Consumer application (single-sided printed circuit boards application)
$I_{class\ B}$	40 ± 0,2	35 ± 10	Consumer application (double-sided printed circuit boards application)
$I_{class\ C}$	40 ± 0,2	105 ± 10	Consumer application (multilayer printed circuit boards application)
$I_{class\ D}$	40 ± 0,2	1000 ± 50	Automotive or large current power line application
NOTE 1 $I_{class\ A}$: see Figure 2a).			
NOTE 2 $I_{class\ B}$, $I_{class\ C}$, $I_{class\ D}$: see Figure 2b).			

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Inductance	L	100 kHz/ 10 mA	1	µH	±20%
Rated Current	$I_{R,40K}$	ΔT = 40 K	15	A	max.
Performance Rated Current [1]	$I_{RP,40K}$	ΔT = 40 K	23.5	A	max.
Saturation Current @ 10%	$I_{SAT,10\%}$	|ΔL/L| < 10 %	15.4	A	typ.
Saturation Current @ 30%	$I_{SAT,30\%}$	|ΔL/L| < 30 %	38	A	typ.
DC Resistance	R_{DC}	@ 20 °C	2.7	mΩ	typ.
DC Resistance	R_{DC}	@ 20 °C	3.5	mΩ	max.
Self Resonant Frequency	f_{res}		41	MHz	typ.

[1] refer to IEC 62024-2-2020

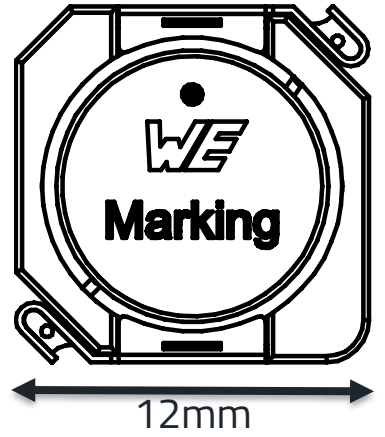
General Properties:

Ambient Temperature (referring to I_R)	-40 up to +85 °C
Operating Temperature	-40 up to +125 °C
Storage Conditions (in original packaging)	< 40 °C ; < 75 % RH
Moisture Sensitivity Level (MSL)	1
Test conditions of Electrical Properties: +20 °C, 33 % RH if not specified differently	
Test conditions of Performance Rated Current: refer to IEC 62024-2, Class C (PCB Copper Width: 40 mm; PCB Copper Thickness: 105 µm)	
Temperature rise is highly dependent on many factors including PCB land pattern, trace size, and proximity to other components. Therefore, temperature rise should be verified in application conditions.	

EXAMPLE CLASS C

7447707033 [1280] size code

- WE-PD **P**erformance variant



Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Inductance	L	100 kHz/ 5 mA	3.3	µH	±30%
Rated Current	$I_{R,40K}$	ΔT = 40 K	9.4	A	max.
Performance Rated Current [1)]	$I_{RP,40K}$	ΔT = 40 K	12.8	A	max.
Saturation Current @ 10%	$I_{SAT,\ 10\%}$	|ΔL/L| < 10 %	17.5	A	typ.
Saturation Current @ 30%	$I_{SAT,30\%}$	|ΔL/L| < 30 %	17.5	A	typ.
DC Resistance	R_{DC}	@ 20 °C	9	mΩ	max.
Self Resonant Frequency	f_{res}		32.3	MHz	typ.
Operating Voltage	V	DC	120	V	max.

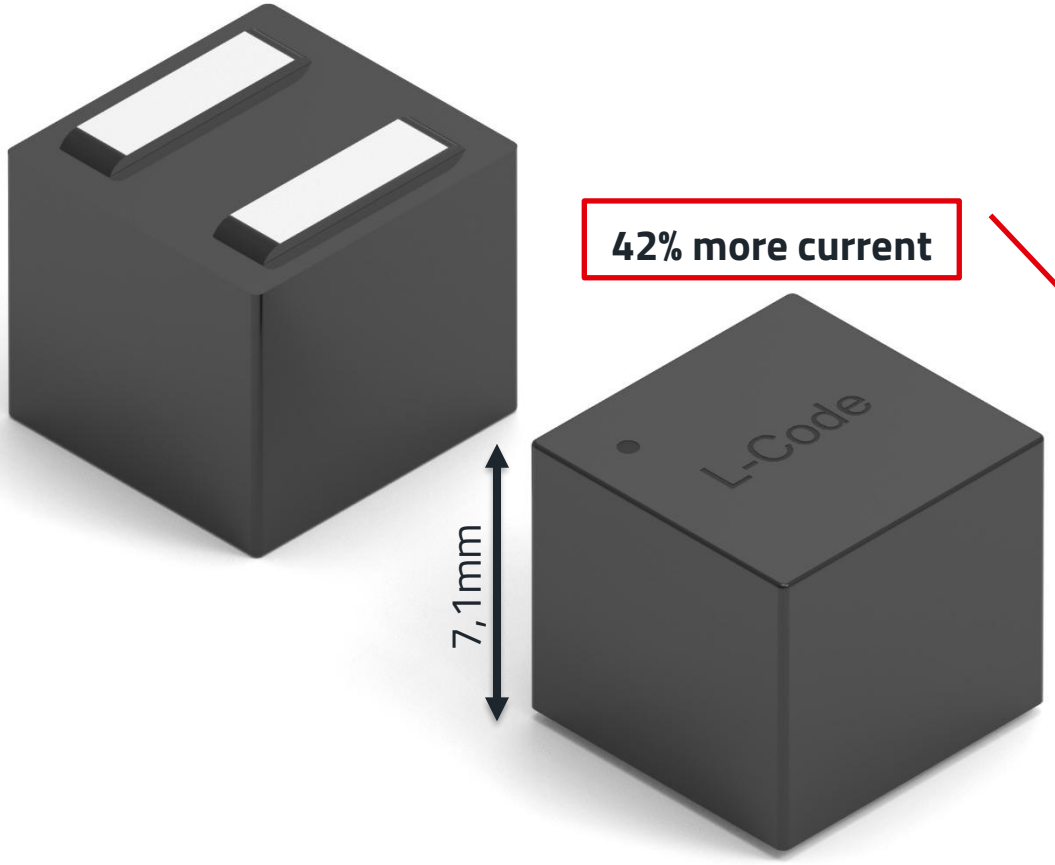
1) refer to IEC 62024-2-2020

Test conditions of Performance Rated Current: refer to IEC 62024-2-2020, Class C (PCB Copper Width: 40 mm; PCB Copper Thickness: 105 µm)

EXAMPLE CLASS C

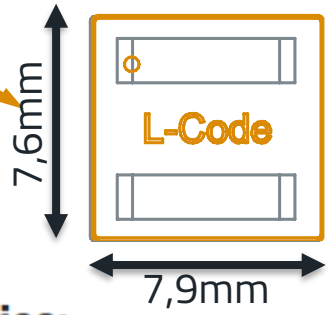
74439387033 [7070] size code

- WE-XHMI



42% more current

X2,4 less surface than PD [1280]



Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Inductance	L	100 kHz/ 10 mA	3.3	µH	±20%
Rated Current	$I_{R,40K}$	ΔT = 40 K	18.2	A	max.
Performance Rated Current [1)]	$I_{RP,40K}$	ΔT = 40 K	18.2	A	max.
Saturation Current @ 10%	$I_{SAT,\ 10\%}$	|ΔL/L| < 10 %	8.8	A	typ.
Saturation Current @ 30%	$I_{SAT,30\%}$	|ΔL/L| < 30 %	18.6	A	typ.
DC Resistance	R_{DC}	@ 20 °C	6.4	mΩ	typ.
DC Resistance	R_{DC}	@ 20 °C	8.76	mΩ	max.
Self Resonant Frequency	f_{res}		23	MHz	typ.

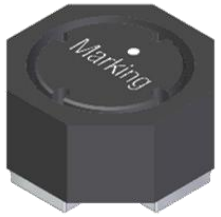
[1)] refer to IEC 62024-2-2020

Test conditions of Performance Rated Current: refer to IEC 62024-2-2020, Class C (PCB Copper Width: 40 mm; PCB Copper Thickness: 105 µm)

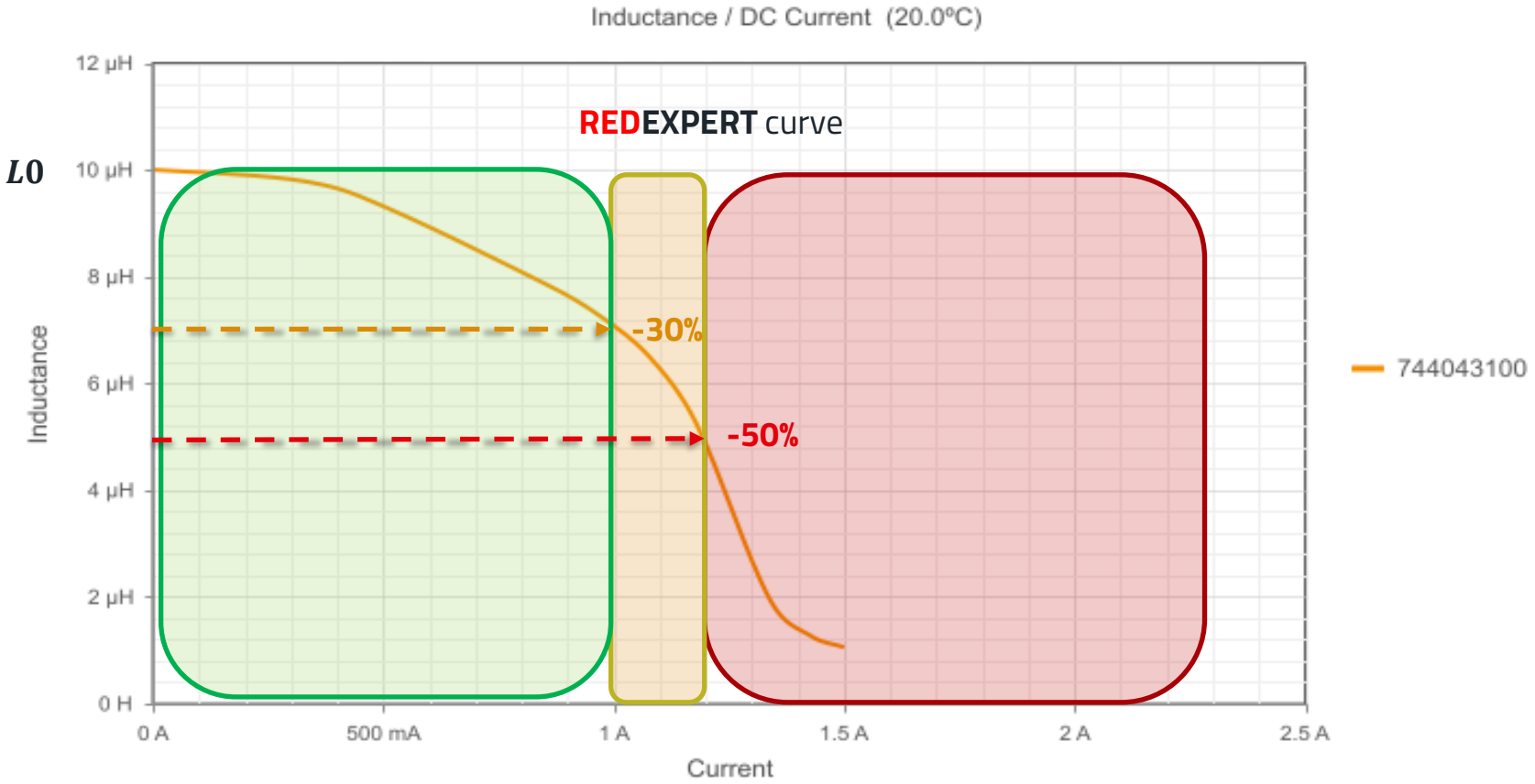
SATURATION CURRENT

POWER INDUCTORS

Inductor value Vs current



- Calculation with estimated reduction of L value (into saturation)



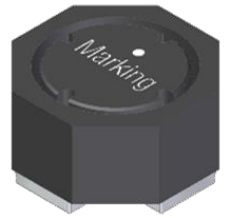
safe operation area

critical operating area

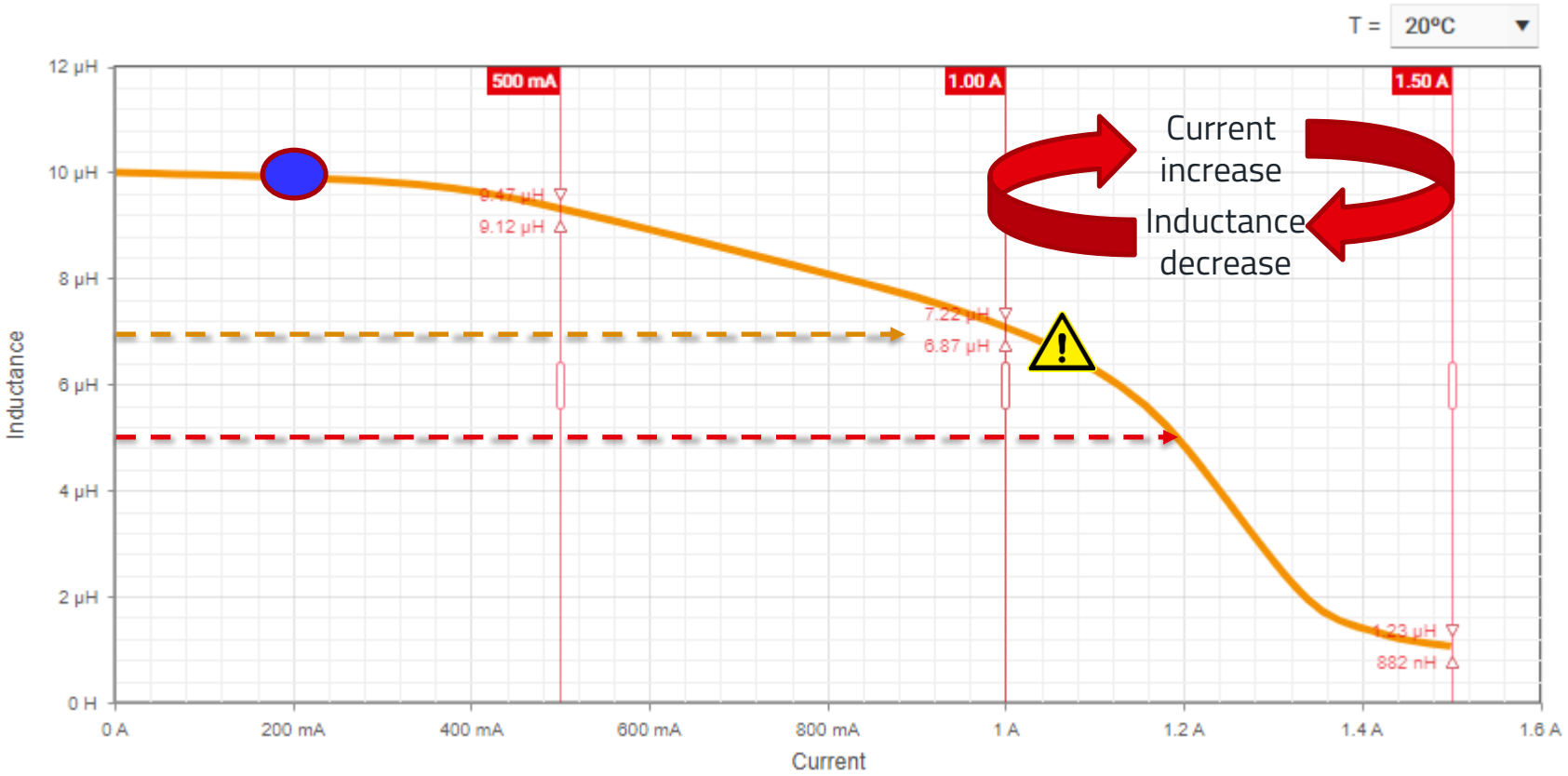
total saturation area

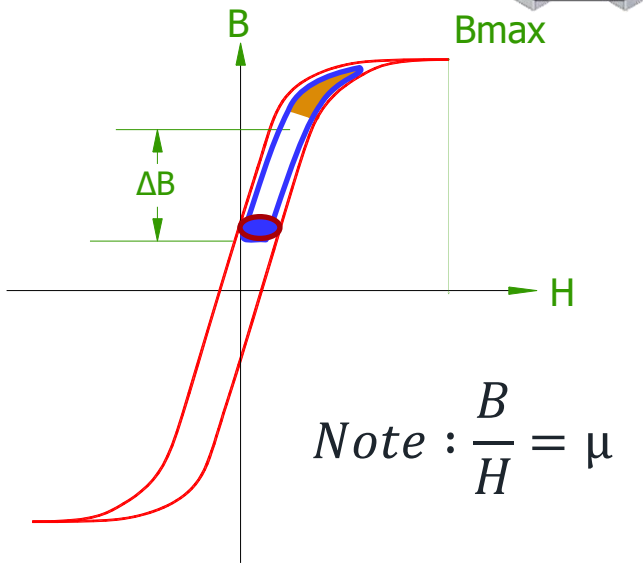
POWER INDUCTORS

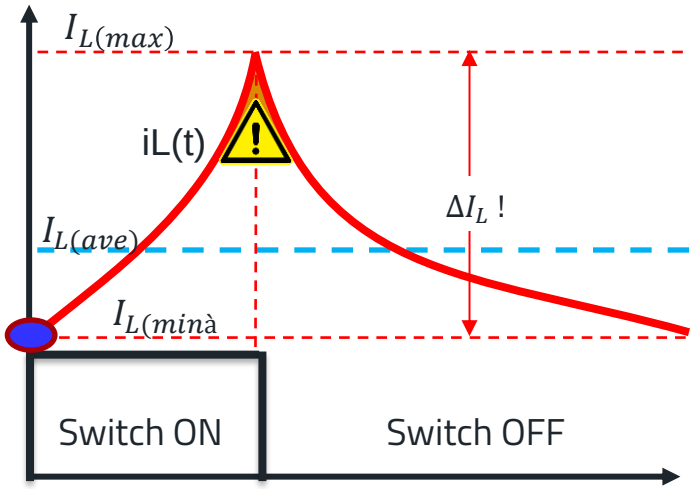
REDEXPERT WE-TPC# 744043100 deviation explanation for 10µH I_{sat} = 1,0A



Saturation behavior



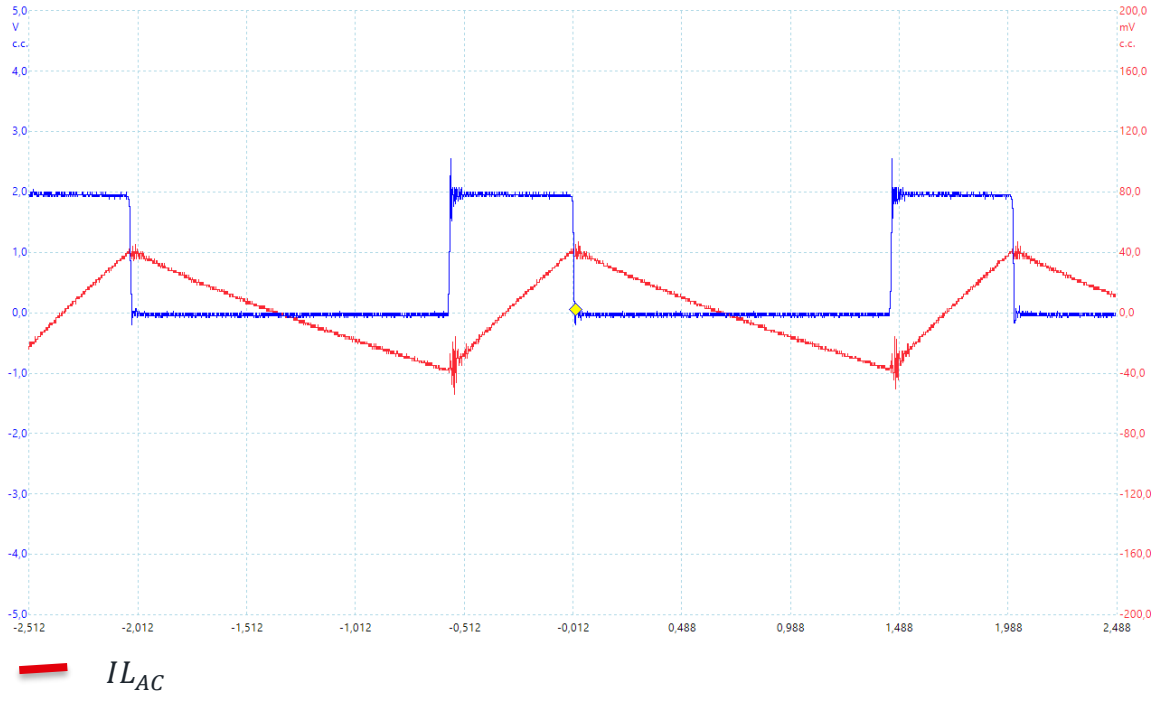




POWER INDUCTORS

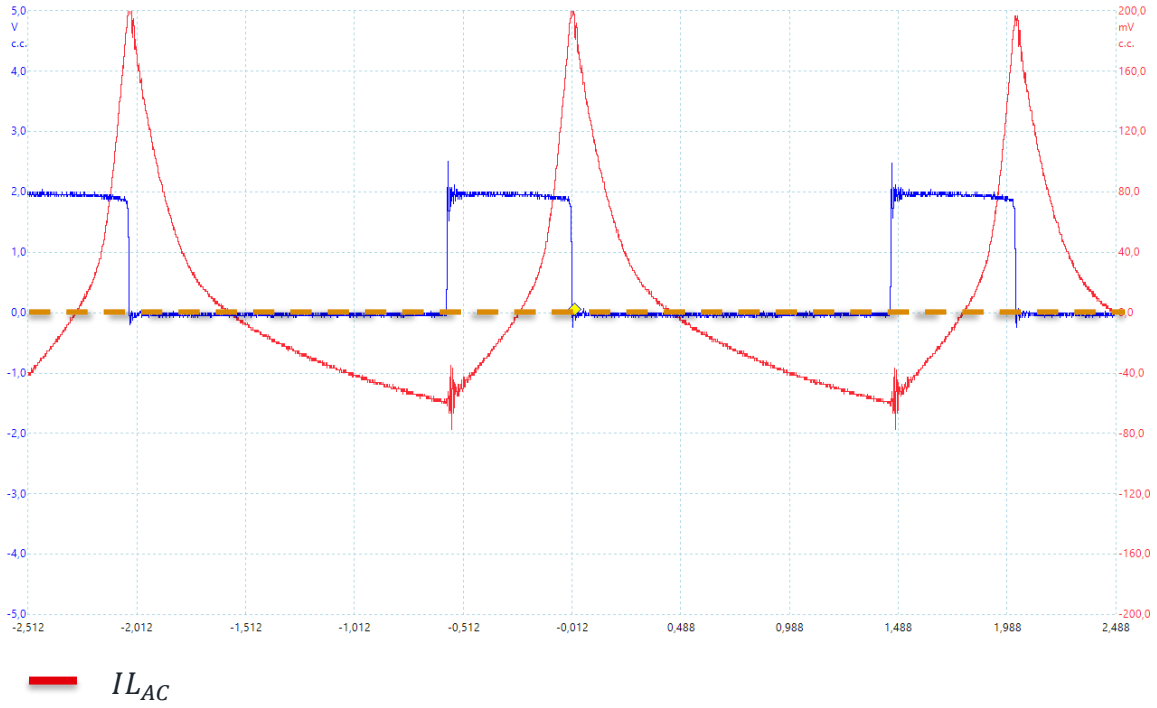
Without saturation

- Saturation effect $I_{out}(Buck) = 1{,}0A$



10µH WE-LHMI# 74437346100 original Isat=7,3A

- Saturation effect : real measurements

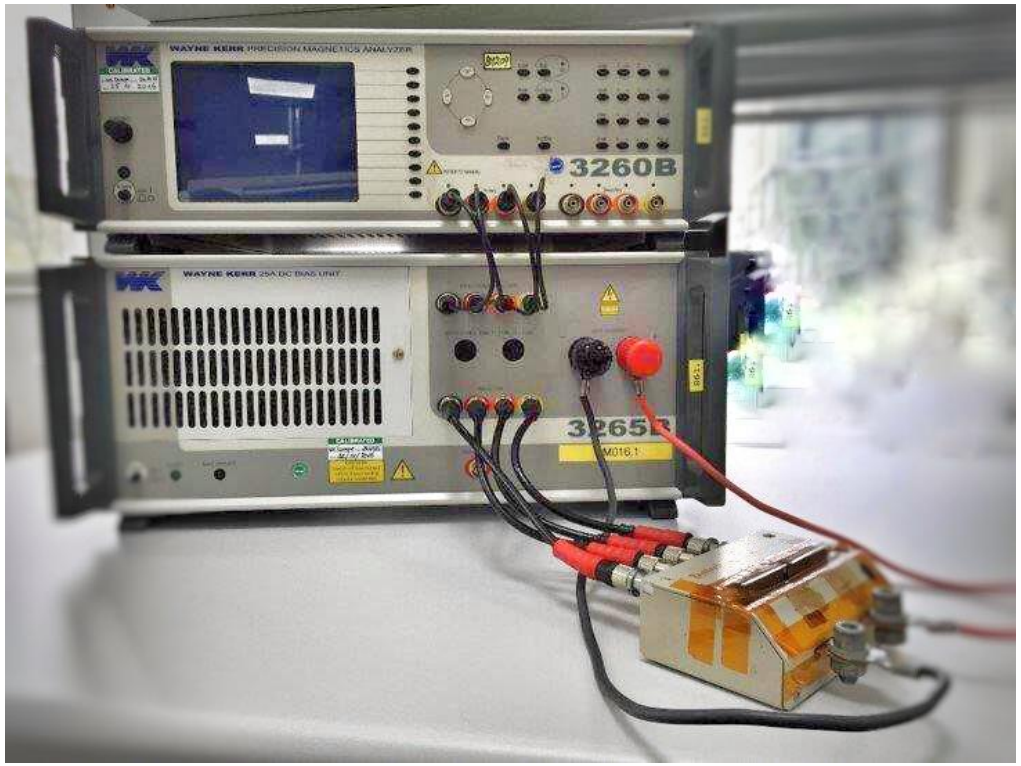


10µH WE-TPC# 744043100 Isat=1,0A

INDUCTOR SELECTION

Saturation Current

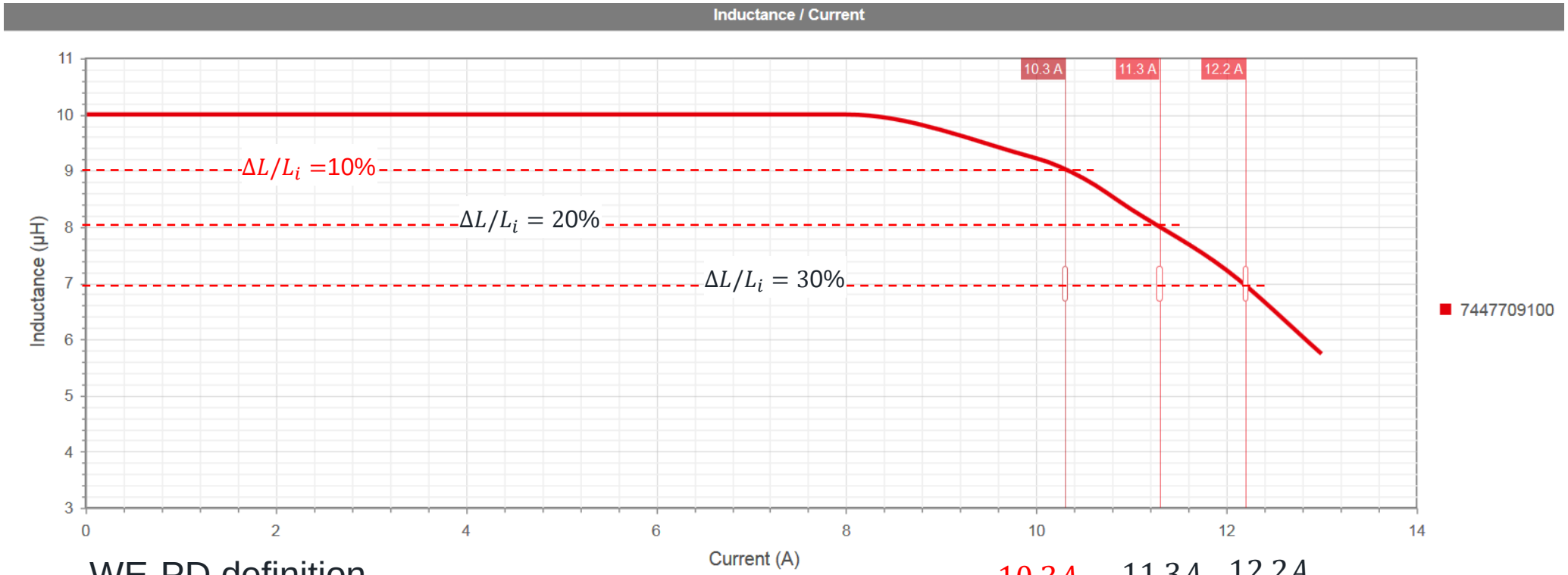
- The current that causes an inductance drop compared to it initial inductance value. In most cases for our inductors a drop of 10% is specified.



Electrical Properties:

Properties	Test conditions		Value	Unit	Tol.
Inductance	1 kHz/ 250 mV	L	10	µH	±20%
Rated current	ΔT = 40 K	I_R	7.1	A	max.
Saturation current	|ΔL/L| < 10%	I_{sat}	10.5	A	typ.
DC Resistance	@ 20°C	R_{DC}	0.013	Ω	typ.
DC Resistance	@ 20°C	R_{DC}	0.021	Ω	max.
Self resonant frequency		f_{res}	21	MHz	typ.

INDUCTOR SELECTION : SATURATION CURRENT



WE-PD definition

$Isat\ @\Delta L/L_i = 10\%$

$10{,}3A$ $11{,}3A$ $12{,}2A$

I_{sat} *depends on the definition*

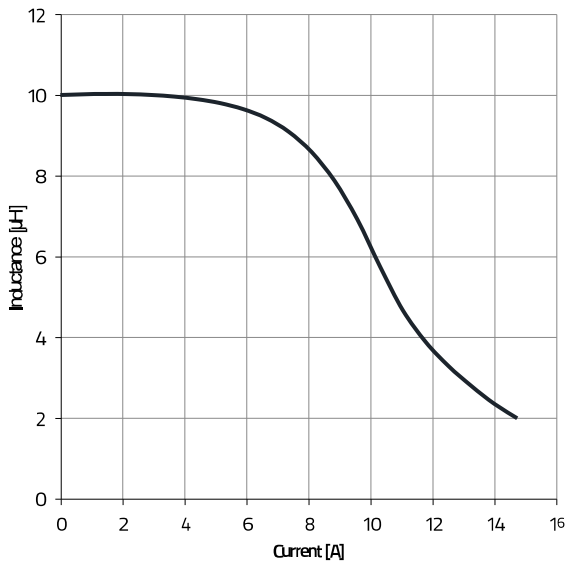
INDUCTOR SMART SELECTION

SMART SELECTION OF INDUCTORS

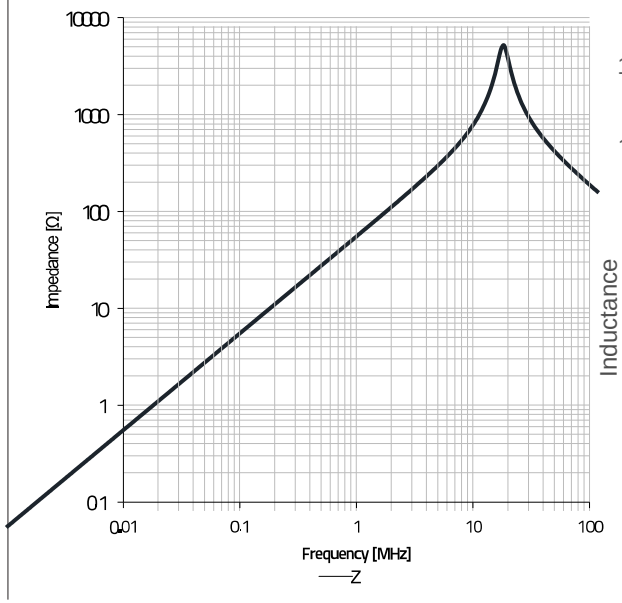
Various tools same results, old VS smart method

- Datasheet

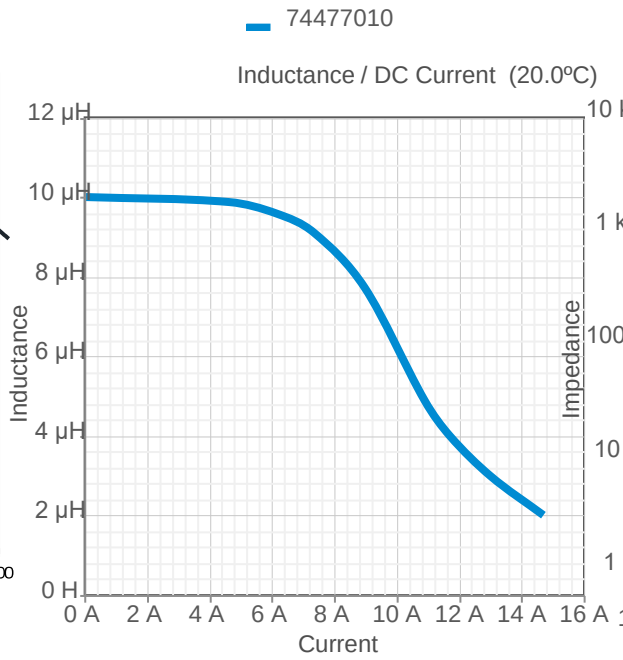
Typical Inductance vs. Current Characteristics:

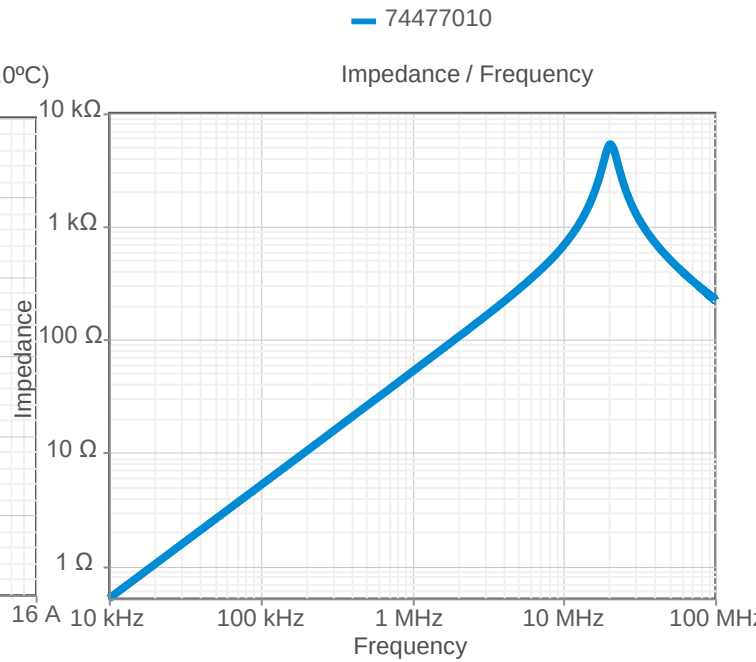


Typical Impedance Characteristics:



- REDEXPERT

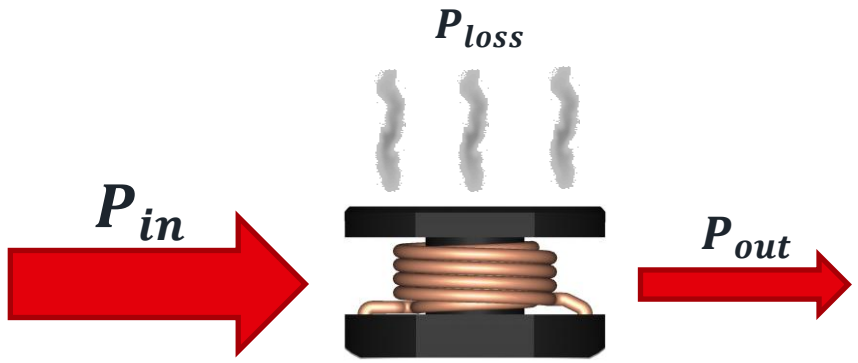


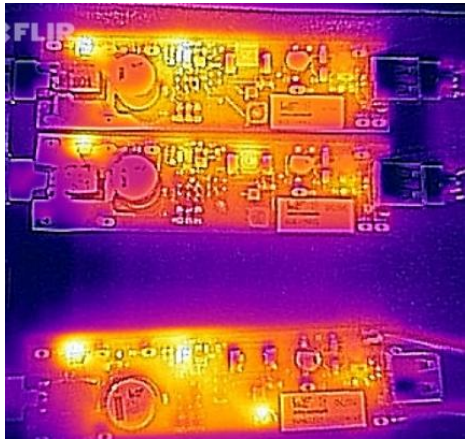


TEMPERATURE VS LOSSES

Why does the component heat up ?

- Losses from energy transit





- Temperature rise specification
  - The overall behavior is :

$$P_{loss} = P_{DC} + P_{AC}$$

  - To be able to simplify measurement only DC is used:

$$P_{loss} = R_{DC} \cdot {I_{DC}}^2$$

- How estimate overall losses?
  - Launch :

REDEXPERT

INDUCTOR : SATURATION AND PACKAGE

Losses with **REDEXPERT** Tool

Calculate Losses

PARAMETERS

Frequency Setup

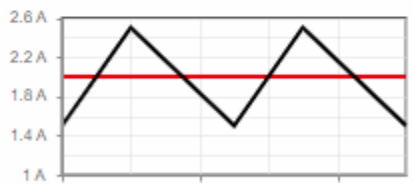
f 800 kHz Duty cycle 0.4

Inductor

type Single Show Suitable

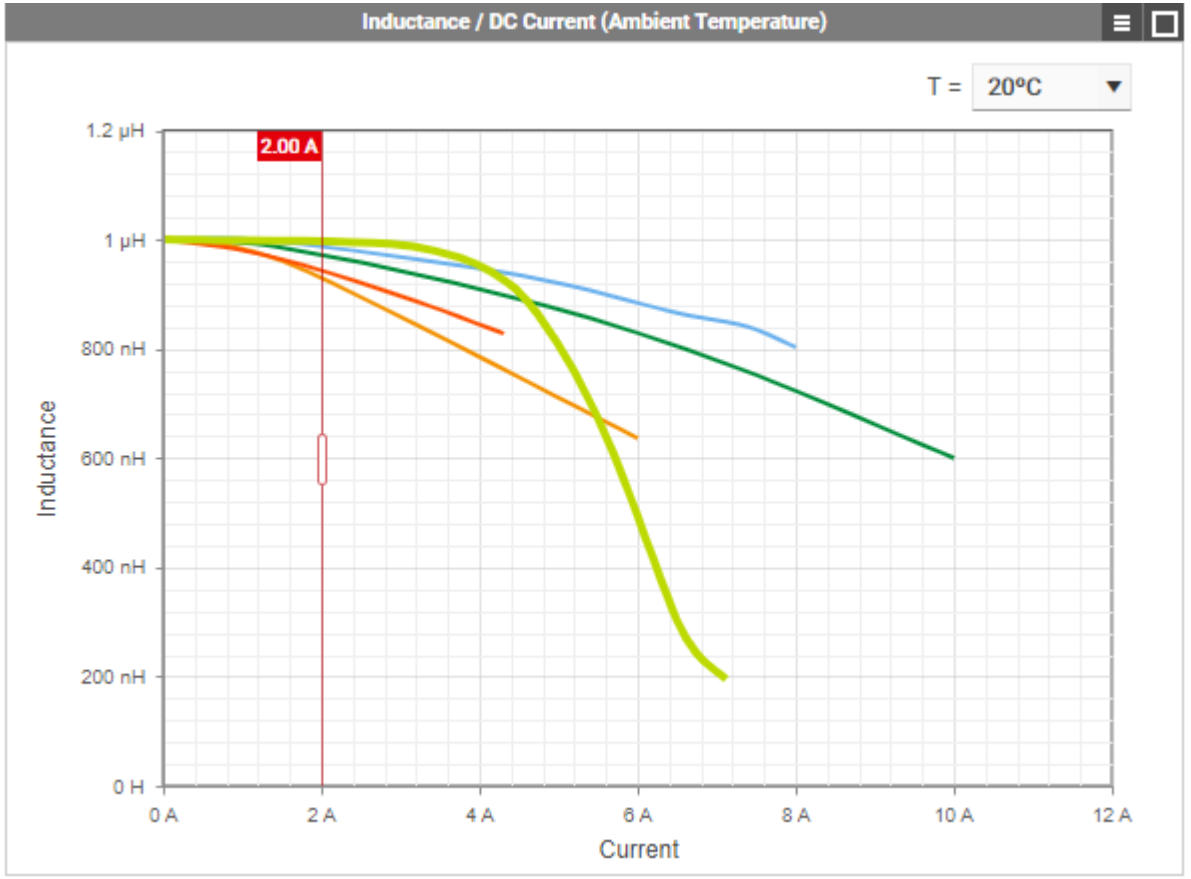
Winding 1

$I_{L,avg}$ 2 A ΔI_L 1 A



UPDATE DETAILS

7447785001	74437321010	74479287210	74405031010	74438334010
WE-PD · 6033	WE-LHMI · 4012	WE-PMCI · 1008	WE-LQSH · 3012	WE-MAPI · 3012
1.00 µH · 31.0 mΩ	1.00 µH · 41.0 mΩ	1.00 µH · 47.0 mΩ	1.00 µH · 45.0 mΩ	1.00 µH · 42.1 mΩ



P_{AC}	P_{DC}	P_{TOT}	ΔT_{TOT}
847 µW	188 mW	189 mW	5.47 K
18.1 mW	168 mW	186 mW	7.80 K
21.8 mW	164 mW	186 mW	8.90 K
15.3 mW	124 mW	139 mW	13.5 K
23.0 mW	180 mW	203 mW	32.7 K

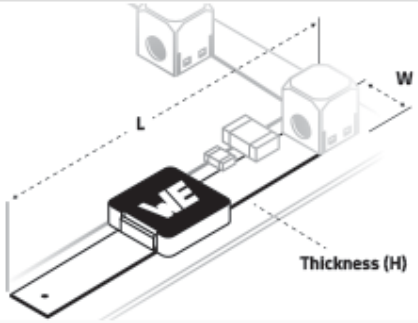
INDUCTOR : RATED CURRENT, TEMPERATURE RISE AND LAYOUT

Temperature rise : **REDEXPERT** Tool

7447785001	74437321010	74479287210	74405031010	74438334010
WE-PD · 6033	WE-LHMI · 4012	WE-PMCI · 1008	WE-LQSH · 3012	WE-MAPI · 3012
1.00 µH · 31.0 mΩ	1.00 µH · 41.0 mΩ	1.00 µH · 47.0 mΩ	1.00 µH · 45.0 mΩ	1.00 µH · 42.1 mΩ

Custom Rated Current Calculator

PARAMETERS



Temperature

Ambient Temperature: 20°C

Max. temperature rise: 40 K

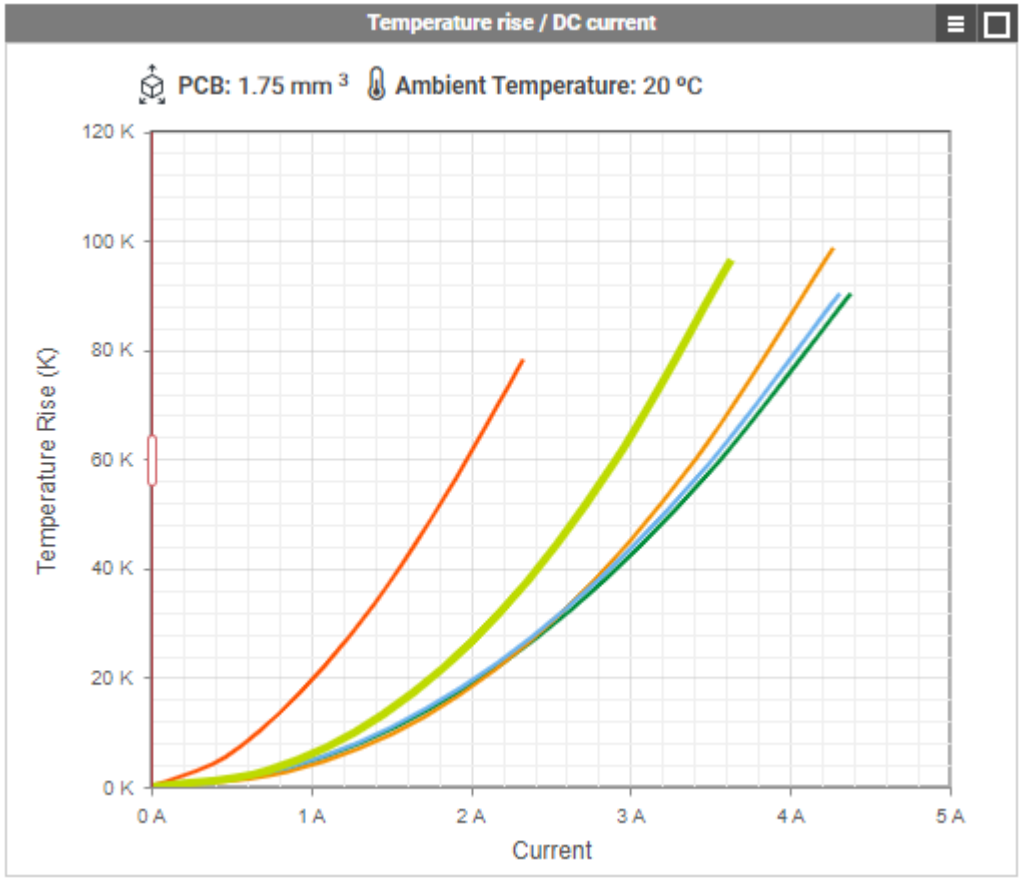
CALCULATE RATED CURRENT

Length (L): 10 mm

Width (W): 5 mm

Copper Thickness (H): 35 µm

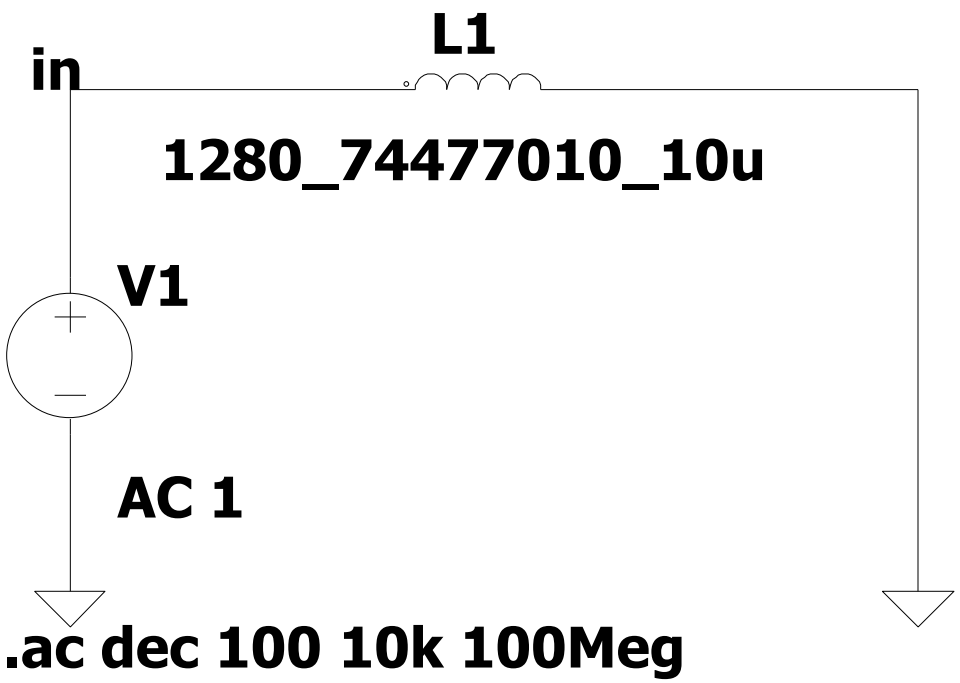
CALCULATE CURRENT



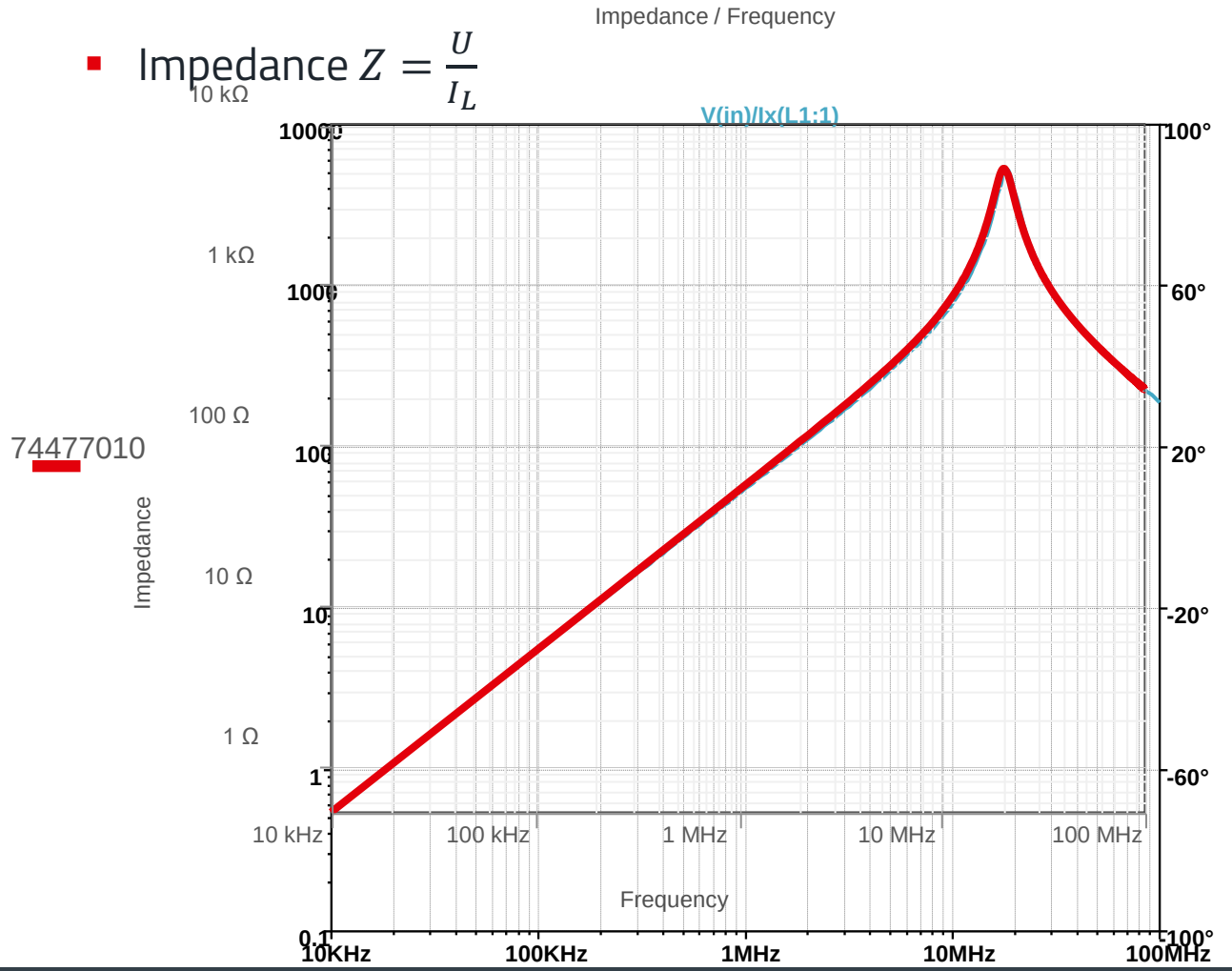
SMART SELECTION OF INDUCTORS

Various tools same results, just choose your preferred

- LtSpice simulation



- Impedance $Z = \frac{U}{I_L}$



CAPACITOR SELECTION

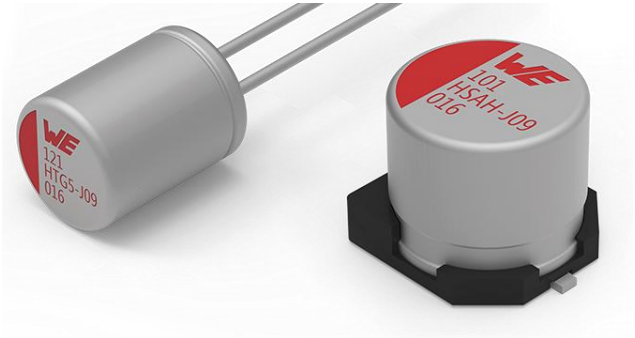
CAPACITORS

Aluminum: Electrolytic / Polymer / Hybrid polymer

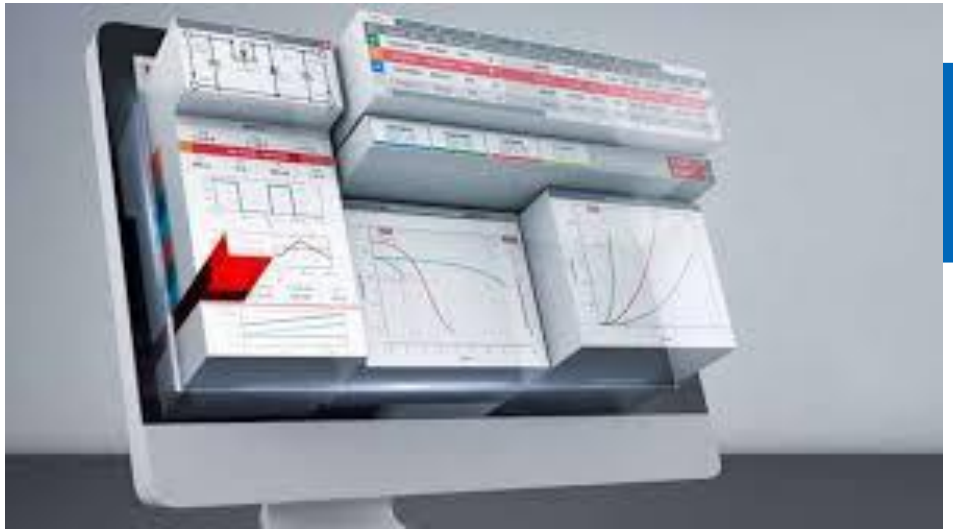
- Electrolytic
  - Wet electrolyte
  - Higher voltage / values
    - Voltage ≤ 450V
    - Capacity up to 33000µF
  - THT / SMT / Snap in mount

- Polymer
  - Solid electrolyte
  - Lower ESR / ESL
    - Voltage ≤100V
    - Capacity up to 2000µF
  - THT / SMT / H-Chip: Low profile & Low ESR versions
  - Lifetime

- Hybrid polymer
  - Low ESR & Low leakage current
  - High ripple current characteristics
  - High stability over the temperature range
  - High lifetime performance



CAPACITOR SMART SELECTION



ANALOG DEVICES

HOW DO YOU FIND THE BEST FITTING INPUT CAP FOR DCDC?

e.g. fsw: 500kHz / Vin: 12V → https://we-online.com/re/5syv8W1J

WÜRTH ELEKTRONIK REDEXPERT Alum. Electrolytic / Alum. Polymer / Hybrid Polymer Capacitors

Filters: Assembling Technology = SMT | T_{max} = 105 °C | 16.0 V ≤ V_R ≤ 25.0 V

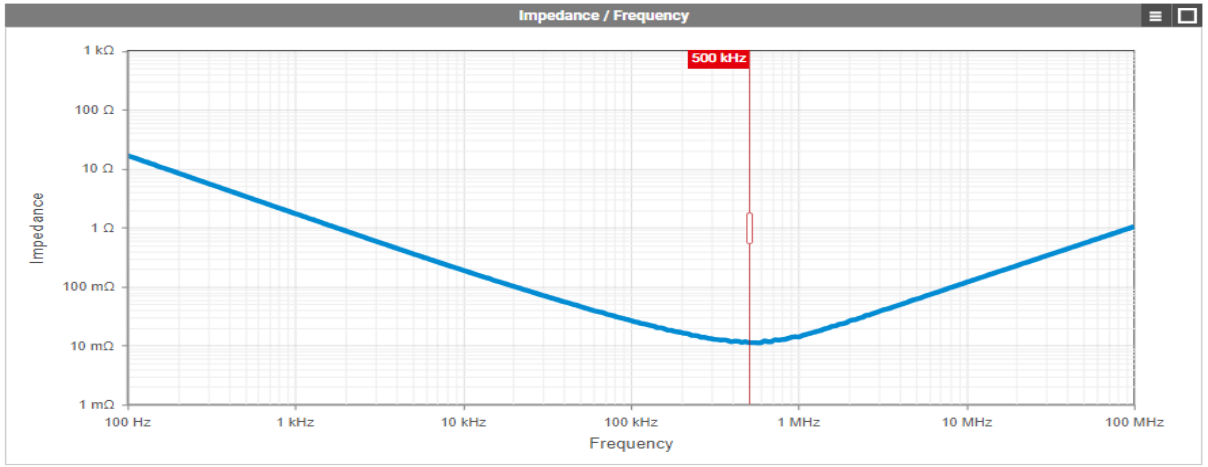
Lifetime calculator

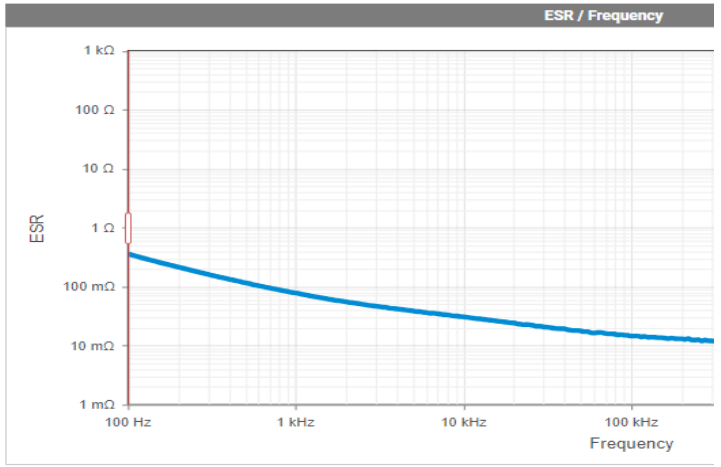
Order Code	Series	I...	Spec		Technology	Series Description	C	To...	V_R	DF	Z@500 kHz	I@2...	Specified Max. I_{Ripple}
875105445006	WCAP-PSLP				Alum. Polymer	SMT - Low Profile	47.0 µF	±20%	20.0 V	< 8.0 %	10.9 mΩ	2.67 A	2.67 A @100 kHz @105 °C
875105344007	WCAP-PSLP				Alum. Polymer	SMT - Low Profile	56.0 µF	±20%	16.0 V	< 8.0 %	11.2 mΩ	2.20 A	2.20 A @100 kHz @105 °C
875105359012	**WCAP-PSLP**	✓			**Alum. Polymer**	**SMT - Low Profile**	**100 µF**	**±20%**	**16.0 V**	**< 12 %**	**11.3 mΩ**	**3.00 A**	**3.00 A @100 kHz @105 °C**
875115452001	WCAP-PSHP				Alum. Polymer	SMT - High Ripple Current	68.0 µF	±20%	20.0 V	< 8.0 %	11.4 mΩ	3.50 A	3.50 A @100 kHz @105 °C
875115452002	WCAP-PSHP				Alum. Polymer	SMT - High Ripple Current	82.0 µF	±20%	20.0 V	< 8.0 %	11.4 mΩ	3.50 A	3.50 A @100 kHz @105 °C
875115552001	WCAP-PSHP				Alum. Polymer	SMT - High Ripple Current	68.0 µF	±20%	25.0 V	< 8.0 %	11.5 mΩ	3.50 A	3.50 A @100 kHz @105 °C
875115560004	WCAP-PSHP				Alum. Polymer	SMT - High Ripple Current	100 µF	±20%	25.0 V	< 10 %	11.5 mΩ	3.10 A	3.10 A @100 kHz @105 °C

875105359012 × WCAP-PSLP 100 µF - 16.0 V

Click and type or drop an Order Code here

Show Panel: Z vs. F | ESR vs. F | I_{RMS} vs. F | I_{RMS} vs. T





OK, BUT WHY NOT A MLCC?

Do you know Bias effect ? Two values two with two packages comparison

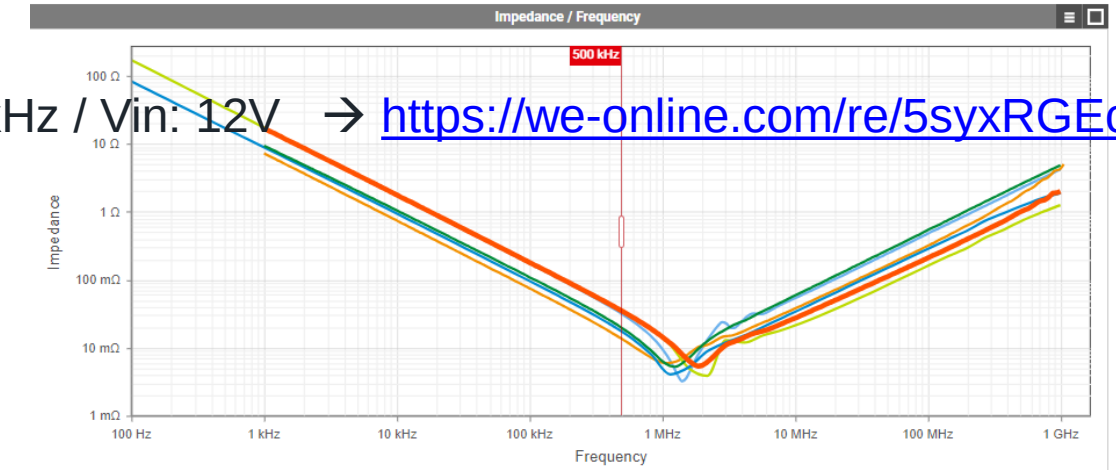
WÜRTH ELEKTRONIK — REDEXPERT — Multilayer Ceramic Chip Capacitors (MLCCs)

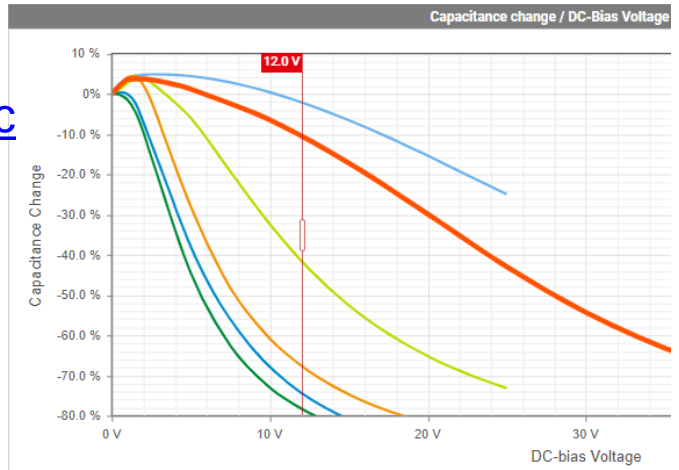
Filters: 16.0 V ≤ V_R ≤ 50.0 V | 1.00 µF ≤ C ≤ 22.0 µF | Is selected

Order Code	Spec	Series	Description	Size	I...	Ce...	C	Tole...	V_R	R_{iso}	Z@500 kHz	$\Delta C(V_{DC\text{-}Bias}\cdots)$	DF	Q	T_{min}	T_{max}
885012108018		WCAP-CSGP	General Purpose	1206		X5R	22.0 µF	±20 %	16.0 V	> 2.00 MΩ	17.0 mΩ	-74.2 %	10 %		-55.0 °C	85.0 °C
885012109015		WCAP-CSGP	General Purpose	1210		X5R	22.0 µF	±10 %	25.0 V	> 5.00 MΩ	13.4 mΩ	-67.4 %	5.0 %		-55.0 °C	85.0 °C
885012107019		WCAP-CSGP	General Purpose	0805		X5R	22.0 µF	±20 %	25.0 V	> 2.00 MΩ	19.3 mΩ	-78.0 %	10 %		-55.0 °C	85.0 °C
885012214004		WCAP-CSGP	General Purpose	2220		X7R	10.0 µF	±10 %	25.0 V	> 10.0 MΩ	31.1 mΩ	-2.18 %	2.5 %		-55.0 °C	125 °C
885012109013		WCAP-CSGP	General Purpose	1210		X5R	10.0 µF	±20 %	25.0 V	> 10.0 MΩ	34.0 mΩ	-41.4 %	5.0 %		-55.0 °C	85.0 °C
885012209073		WCAP-CSGP	General Purpose	1210		X7R	10.0 µF	±10 %	50.0 V	> 5.00 MΩ	34.5 mΩ	-10.8 %	10 %		-55.0 °C	125 °C

885012109015 — WCAP-CSGP · X5R · 1210 · 22.0 µF · 25.0 V
885012108018 — WCAP-CSGP · X5R · 1206 · 22.0 µF · 16.0 V
885012107019 — WCAP-CSGP · X5R · 0805 · 22.0 µF · 25.0 V
885012214004 — WCAP-CSGP · X7R · 2220 · 10.0 µF · 25.0 V
885012109013 — WCAP-CSGP · X5R · 1210 · 10.0 µF · 25.0 V
885012209073 — WCAP-CSGP · X7R · 1210 · 10.0 µF · 50.0 V
Click and type or drop an Order Code here

Show Panel: Z vs. F | ESR vs. F | ΔC vs. $V_{DC\text{-}Bias}$ | C vs. $V_{DC\text{-}Bias}$ | ΔC vs. V_{AC} | C vs. T | ΔT vs. $I_{RMS}(F)$



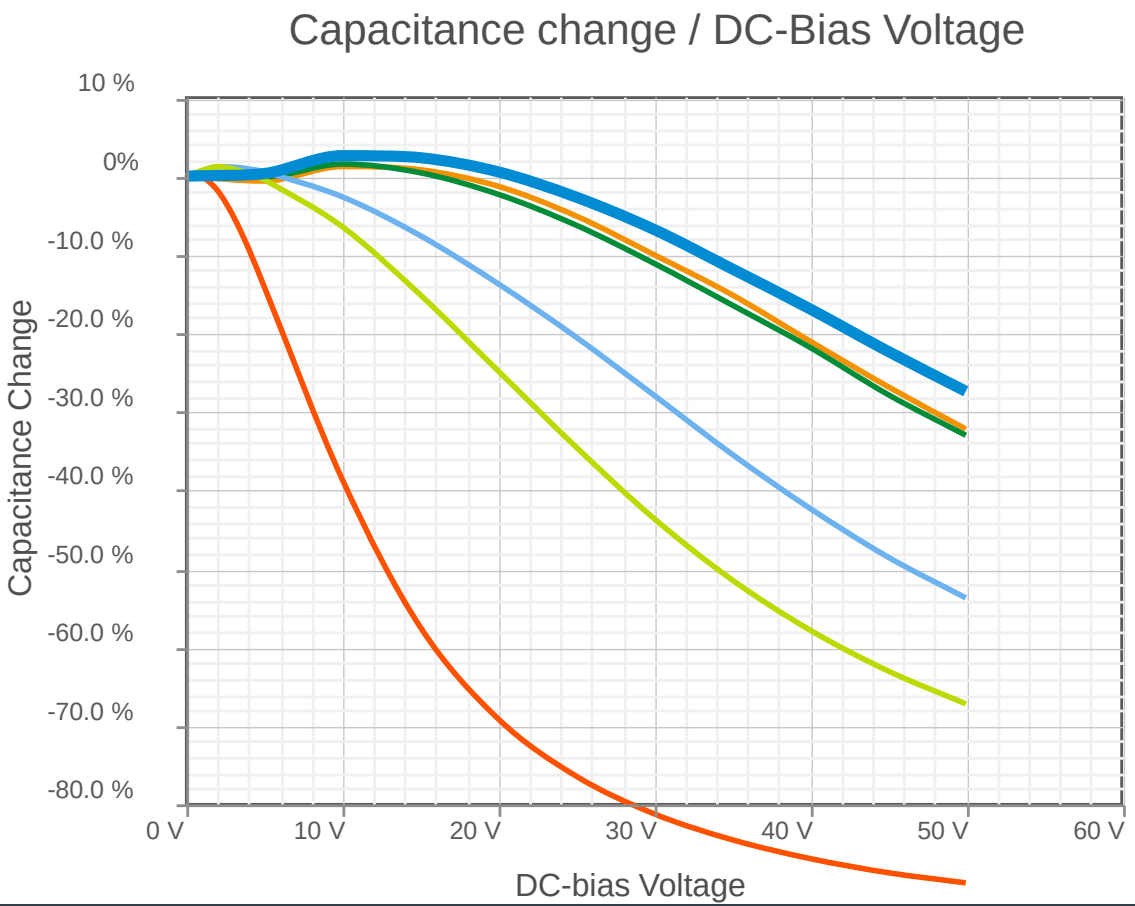


e.g. fsw: 500kHz / Vin: 12V → https://we-online.com/re/5syxRGEc

CAPACITORS : BIAS AND PACKAGE

MLCC DC Bias behavior : Size impact onto technology

885012210025	885012209041	885012208087	885012207098	885012206095	885012205086
WCAP-CSGP · X7R · 1812	WCAP-CSGP · X7R · 1210	WCAP-CSGP · X7R · 1206	WCAP-CSGP · X7R · 0805	WCAP-CSGP · X7R · 0603	WCAP-CSGP · X7R · 0402
100 nF · 50.0 V	100 nF · 50.0 V	100 nF · 50.0 V	100 nF · 50.0 V	100 nF · 50.0 V	100 nF · 50.0 V

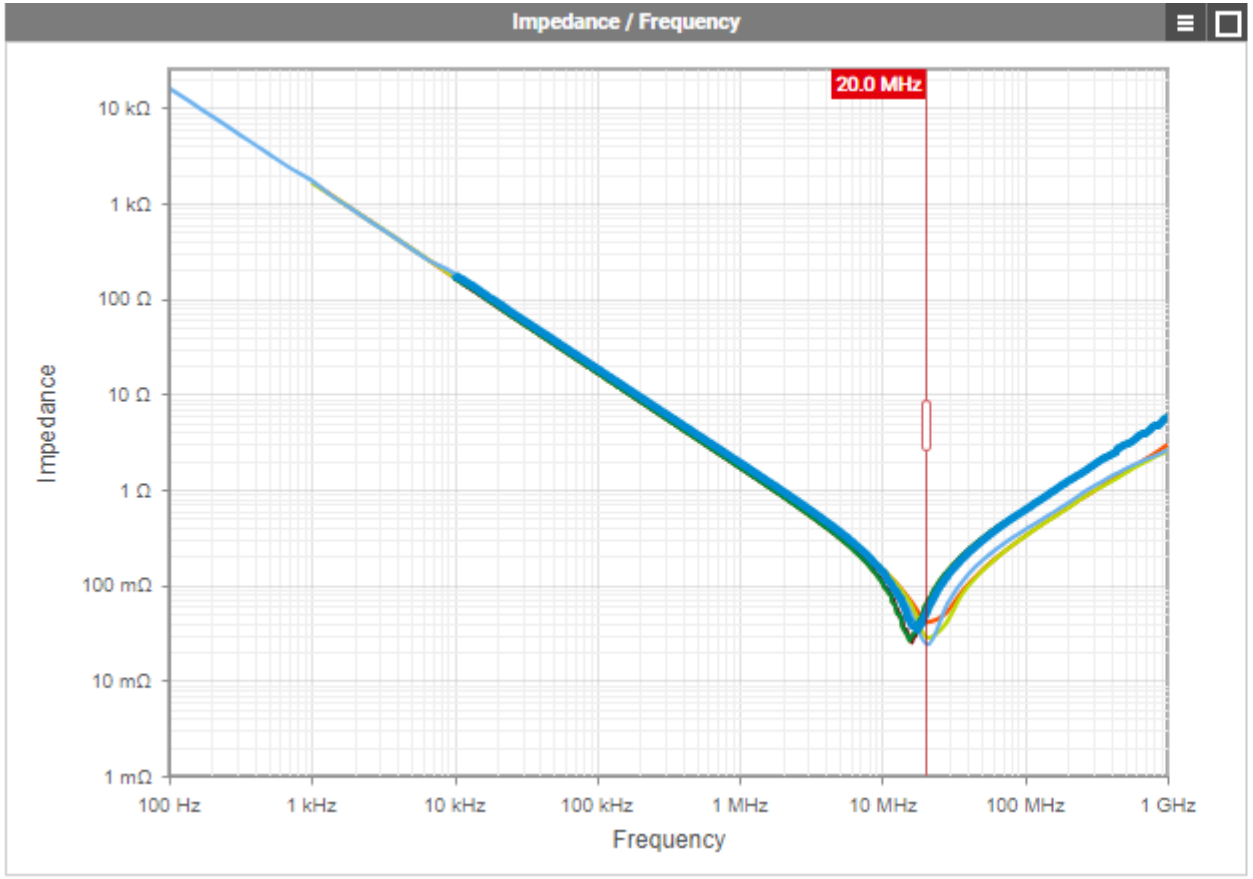


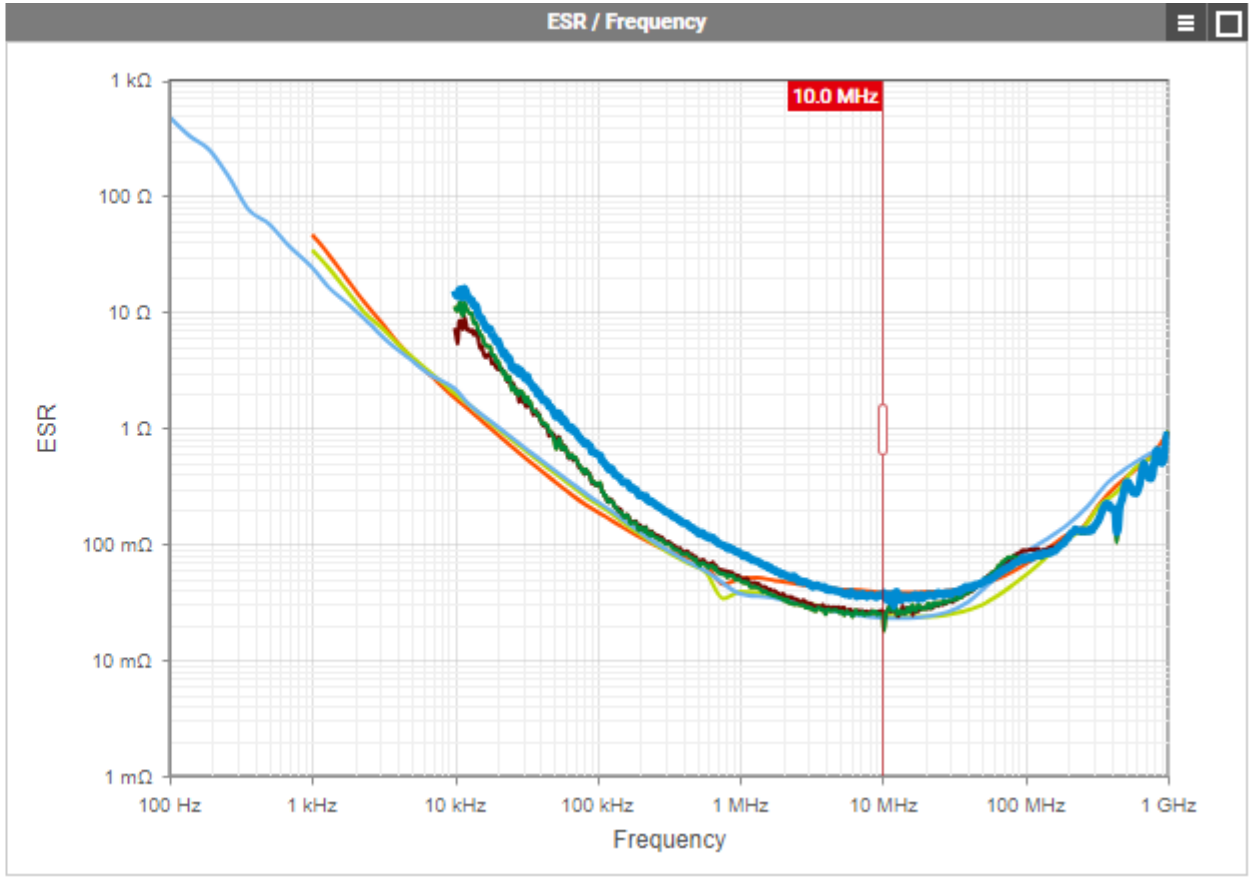
https://we-online.com/re/5t07mVB4

CAPACITORS : ESR AND FREQUENCY

MLCC behavior : global impedance and ESR behavior

885012205086	885012206095R	885012206095	885012208087	885012209041	885012210025	885012207098
WCAP-CSGP · X7R · 0402	WCAP-CSGP · X7R · 0603	WCAP-CSGP · X7R · 0603	WCAP-CSGP · X7R · 1206	WCAP-CSGP · X7R · 1210	WCAP-CSGP · X7R · 1812	WCAP-CSGP · X7R · 0805
100 nF · 50.0 V	100 nF · 50.0 V	100 nF · 50.0 V	100 nF · 50.0 V	100 nF · 50.0 V	100 nF · 50.0 V	100 nF · 50.0 V

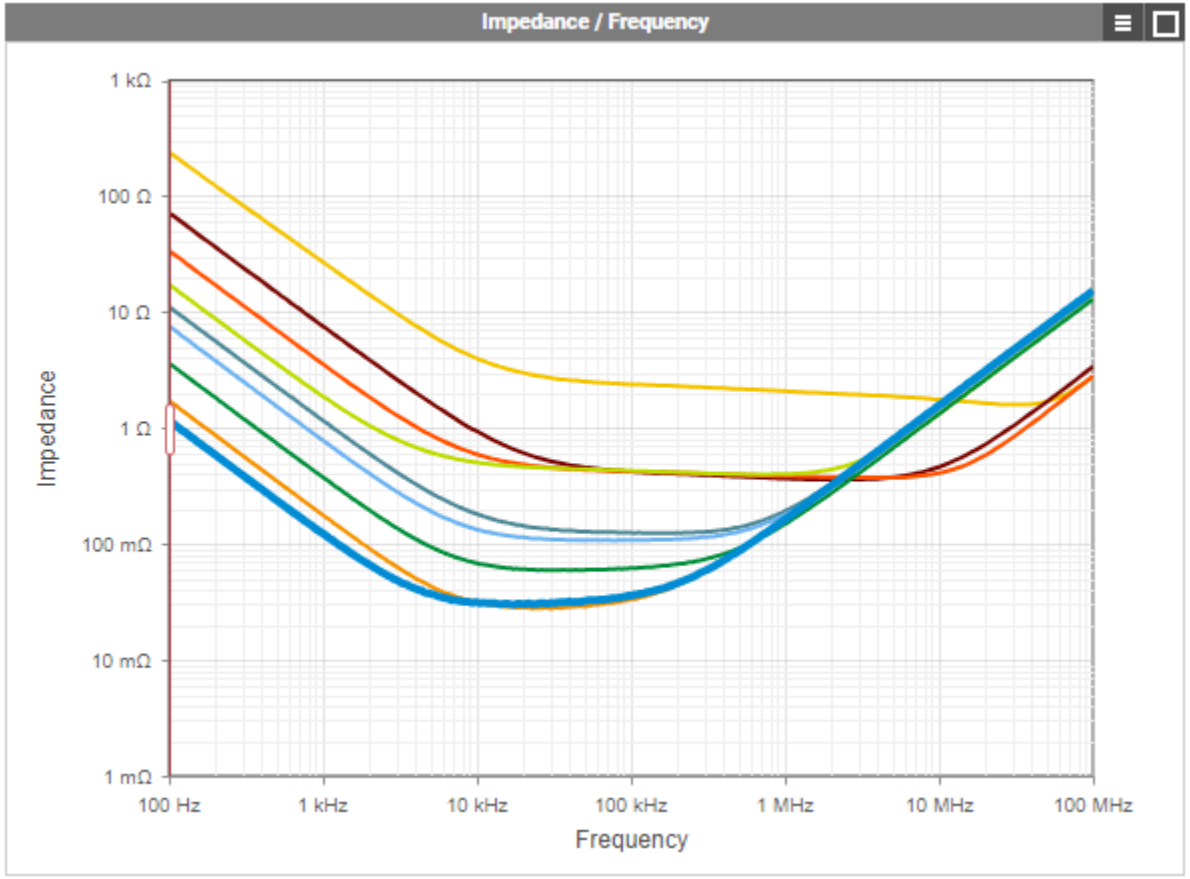


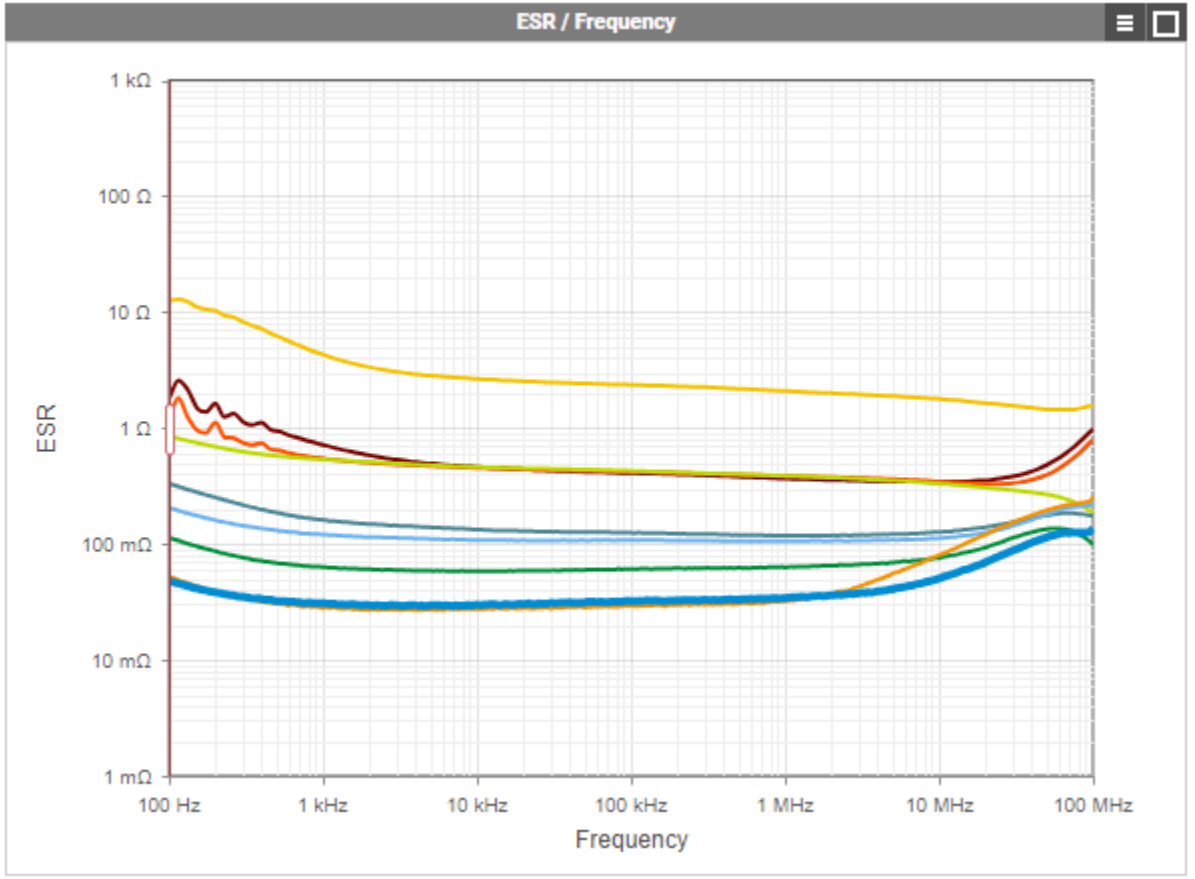


CAPACITORS : ESR AND FREQUENCY

Aluminum caps behavior : global impedance and ESR behavior

860020781027	860020780025	860020778021	860020775019	860020775015	860020773013	860020773011	860020772009	860020775017
WCAP-ATG5	WCAP-ATG5	WCAP-ATG5	WCAP-ATG5	WCAP-ATG5	WCAP-ATG5	WCAP-ATG5	WCAP-ATG5	WCAP-ATG5
1.50 mF · 63.0 V	1.00 mF · 63.0 V	470 µF · 63.0 V	220 µF · 63.0 V	100 µF · 63.0 V	47.0 µF · 63.0 V	22.0 µF · 63.0 V	6.80 µF · 63.0 V	150 µF · 63.0 V

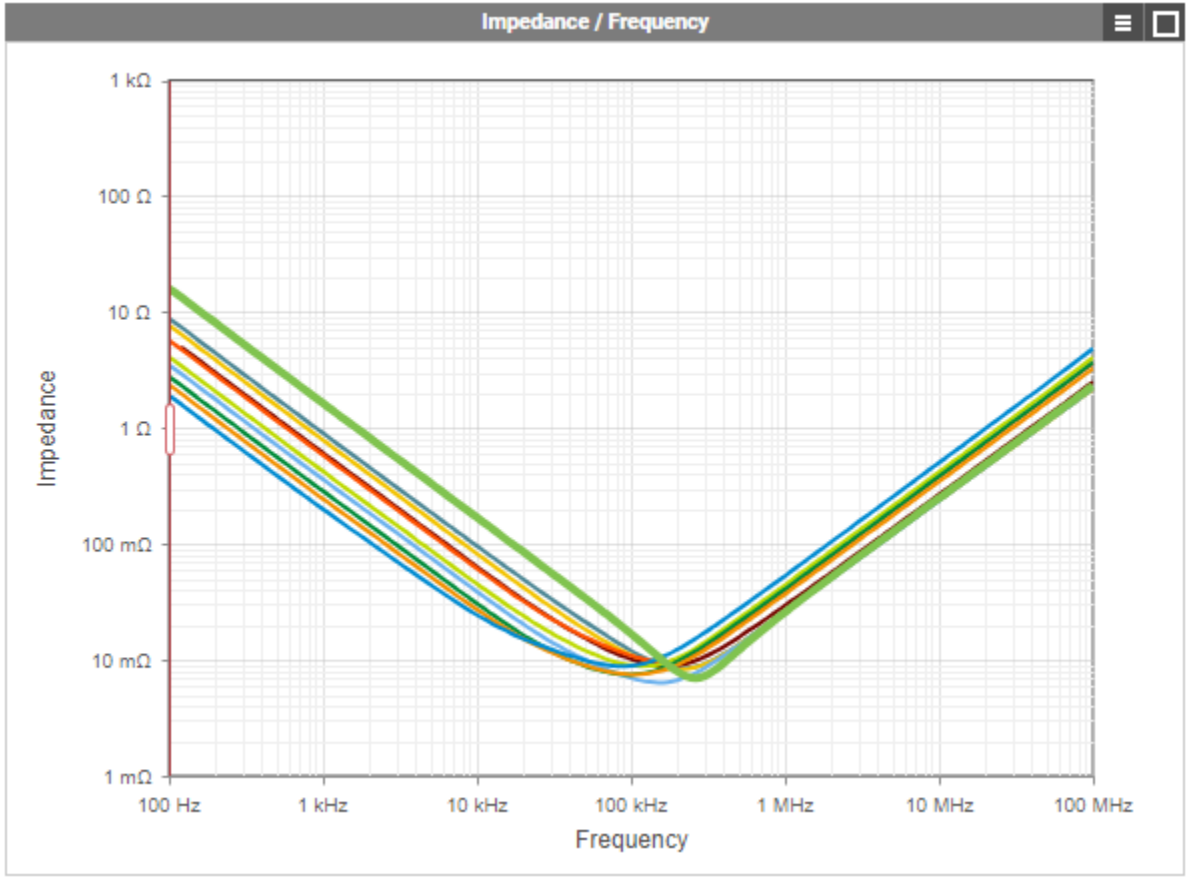


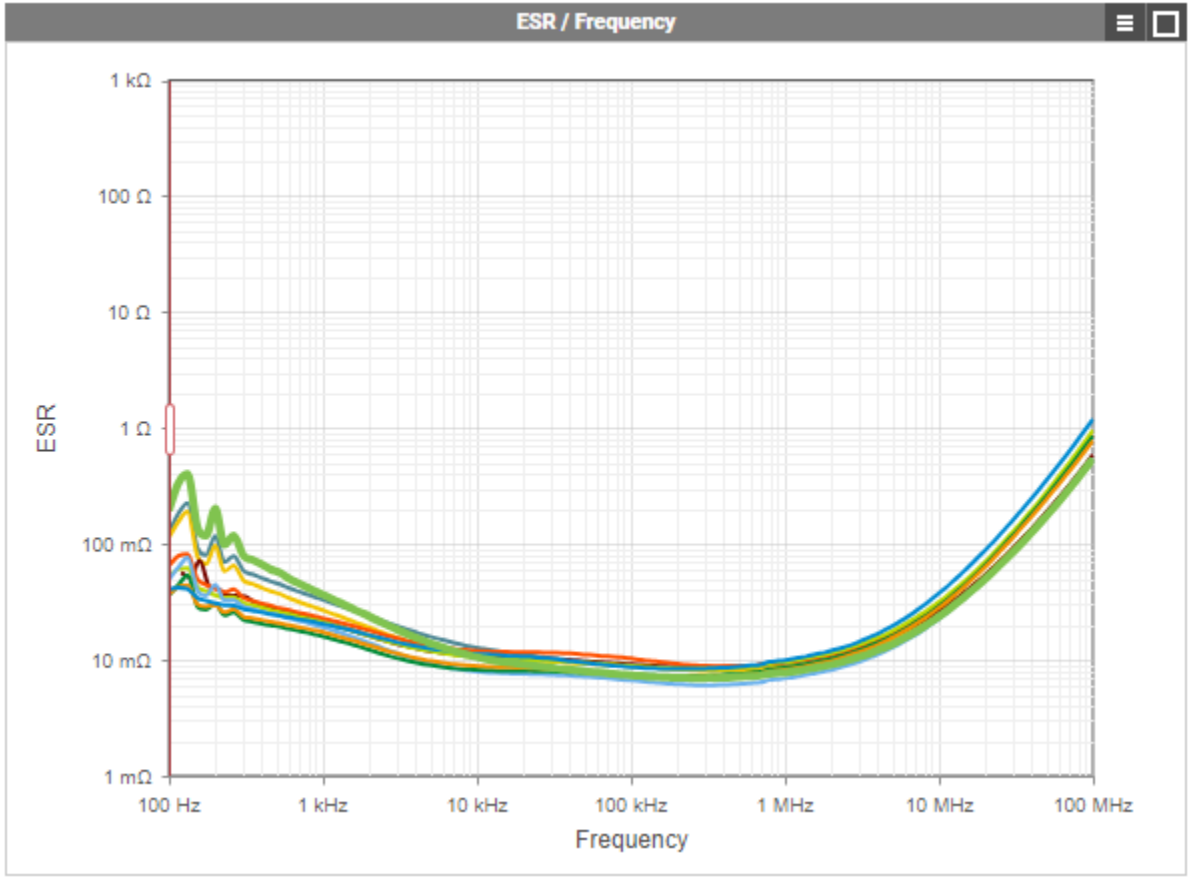


CAPACITORS : ESR AND FREQUENCY

Aluminum Polymer caps behavior : global impedance and ESR behavior

870025375010	870025375009	870025375008	870025374007	870025374006	870025374005	870025374004	870025374003	870025374002	870025374001
WCAP-PTG5 820 µF · 16.0 V	WCAP-PTG5 680 µF · 16.0 V	WCAP-PTG5 560 µF · 16.0 V	WCAP-PTG5 470 µF · 16.0 V	WCAP-PTG5 390 µF · 16.0 V	WCAP-PTG5 330 µF · 16.0 V	WCAP-PTG5 270 µF · 16.0 V	WCAP-PTG5 220 µF · 16.0 V	WCAP-PTG5 180 µF · 16.0 V	WCAP-PTG5 100 µF · 16.0 V

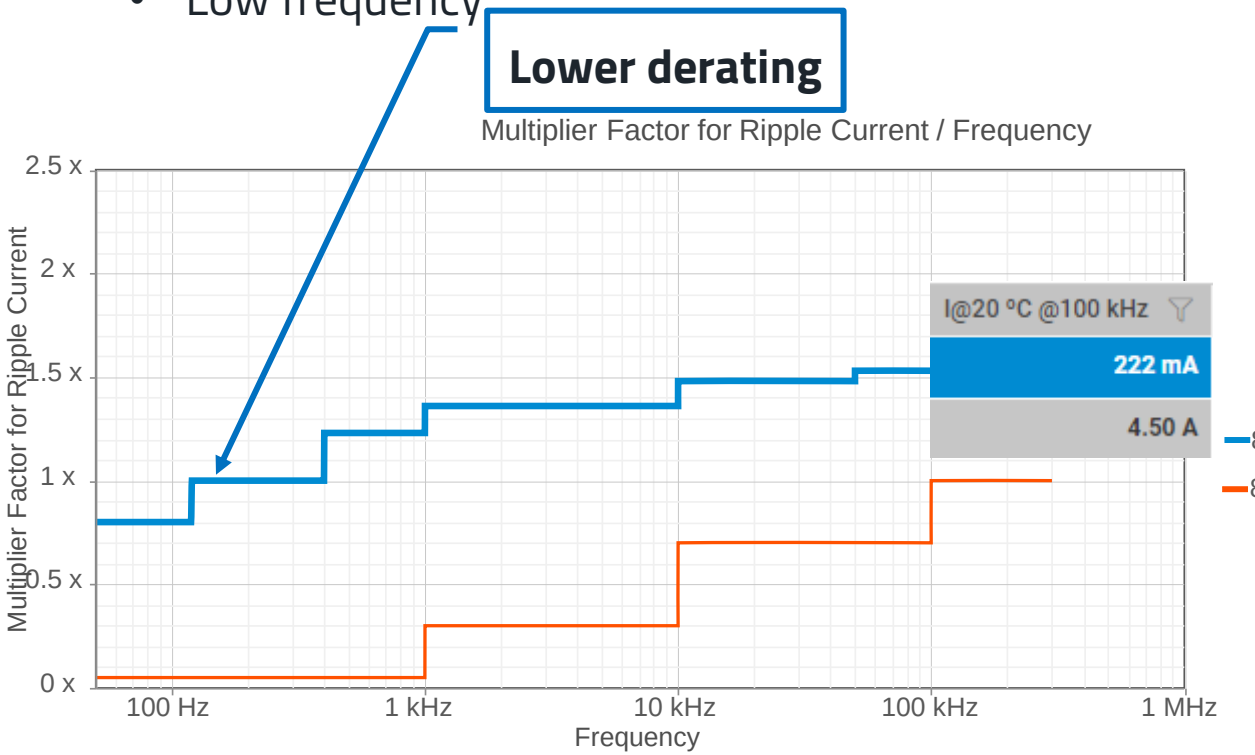




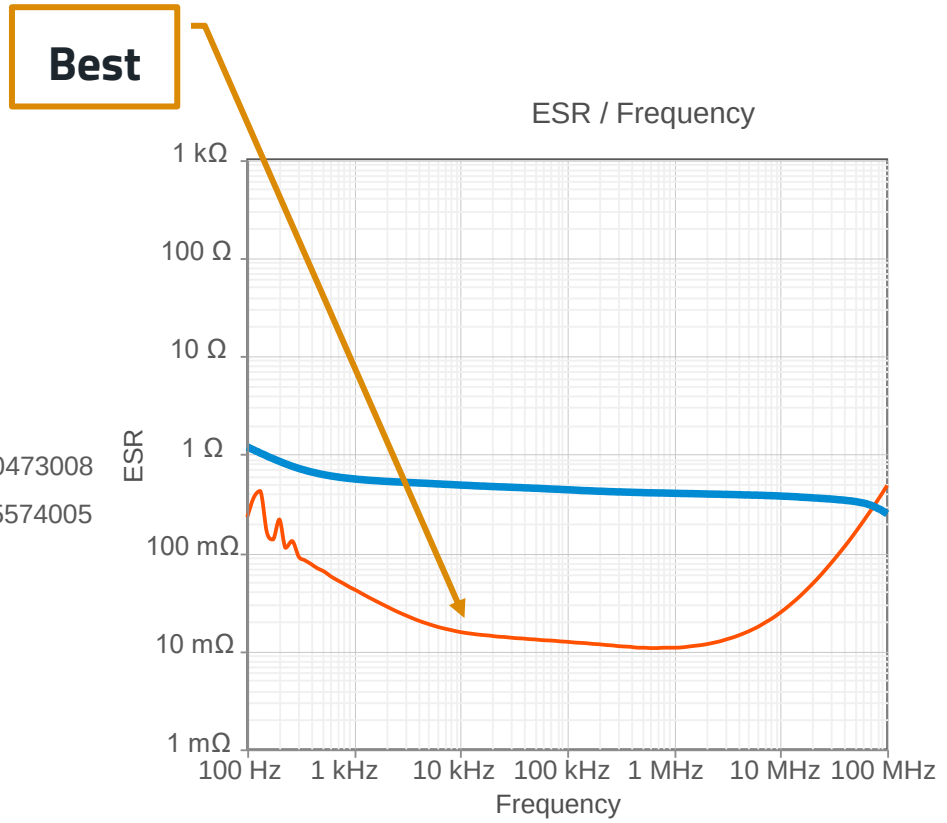
RIPPLE CURRENT

Order Code	Series	Spec	Technology	Series Description	C	To...	V_R	DF
860020473008	WCAP-ATG5	PDF	Alum. Electrolytic	THT - General Purpose +105°C	100 µF	±20%	25.0 V	< 14 %
870025574005	WCAP-PTG5	PDF	Alum. Polymer	THT - General Purpose +105°C	100 µF	±20%	25.0 V	< 8.0 %

- **Aluminum Electrolytic** Capacitors
  - **Recommended** for mains rectification / filtering
    - Low frequency



- **Aluminum Polymer** Capacitors
  - **Lower** ESR and high frequency dedicated



GOOD TO KNOW

CAPACITORS

Some other technologies and structure

- Snap-in and screw…

https://www.we-online.com/en/components/products/pbs/capacitors/aluminium_electrolytic_capacitors/aluminium_electolytic_snap-in_capacitors

https://www.we-online.com/en/components/products/pbs/capacitors/aluminium_electrolytic_capacitors/wcap_screw_capacitors

- Non polar

https://www.we-online.com/en/components/products/WCAP-ASNP

CAPACITOR

Vibration-proof Aluminum Electrolytic- and Aluminum Hybrid Polymer Capacitors!

- Capacitors with high base plates are available on request for Aluminum Electrolytic- and Aluminum Hybrid Polymer Capacitors, as project parts.

- What are the benefits? - The SMT capacitor is surrounded by a high base plate that also has larger soldering pads, due to that, the results in vibration tests improve and the parts can withstand up to 30G.

- Ask eiCap BU for more information « High Baseplate »