MASTERING ZONE ARCHITECTURES: YOUR GUIDE TO ELECTRIFIED POWER DISTRIBUTION SYSTEMS

Isaac Aboelsaad | Würth Elektronik eiSos GmbH & Co.KG |
Specialist Product Definition Engineer Automotive & E-Mobility

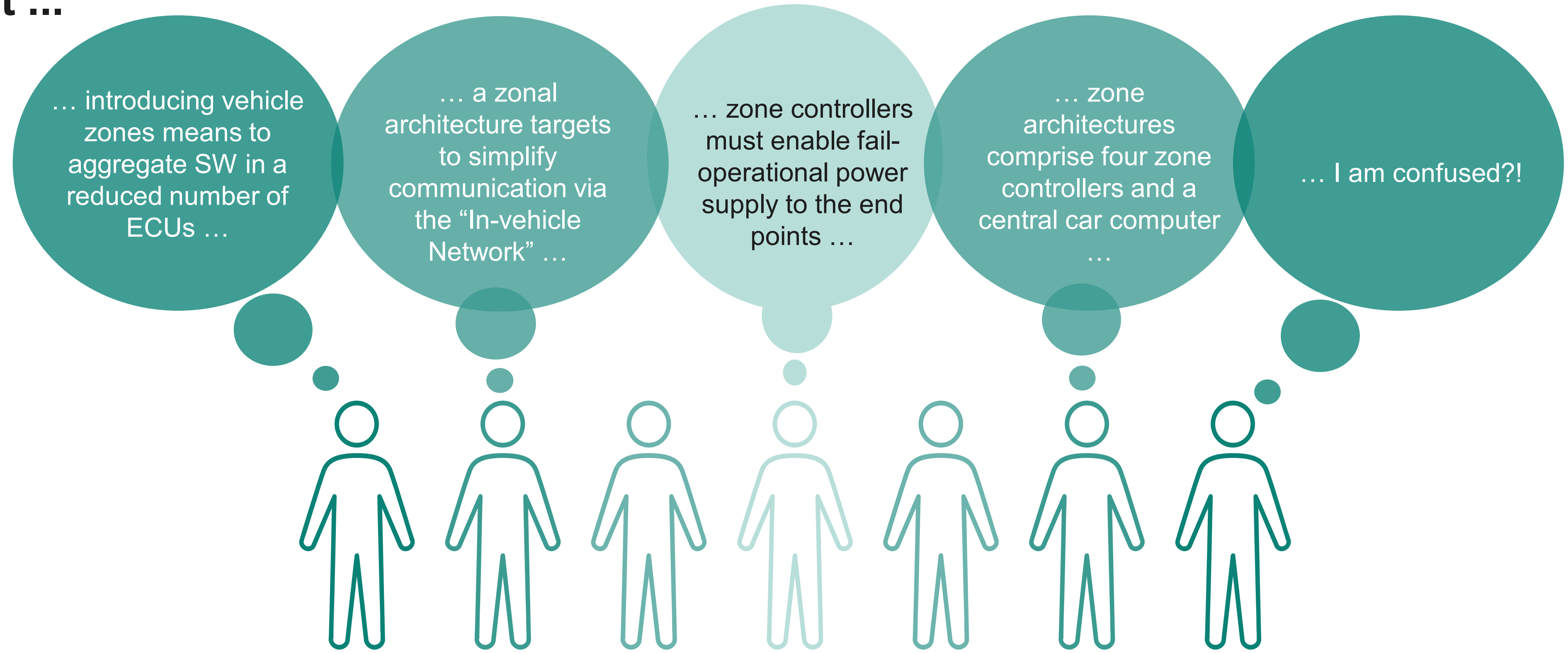
Timon Busse | Infineon Technologies AG |
Senior Application Manager E/E Architectures

There is no clear definition of Zone architectures ...

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

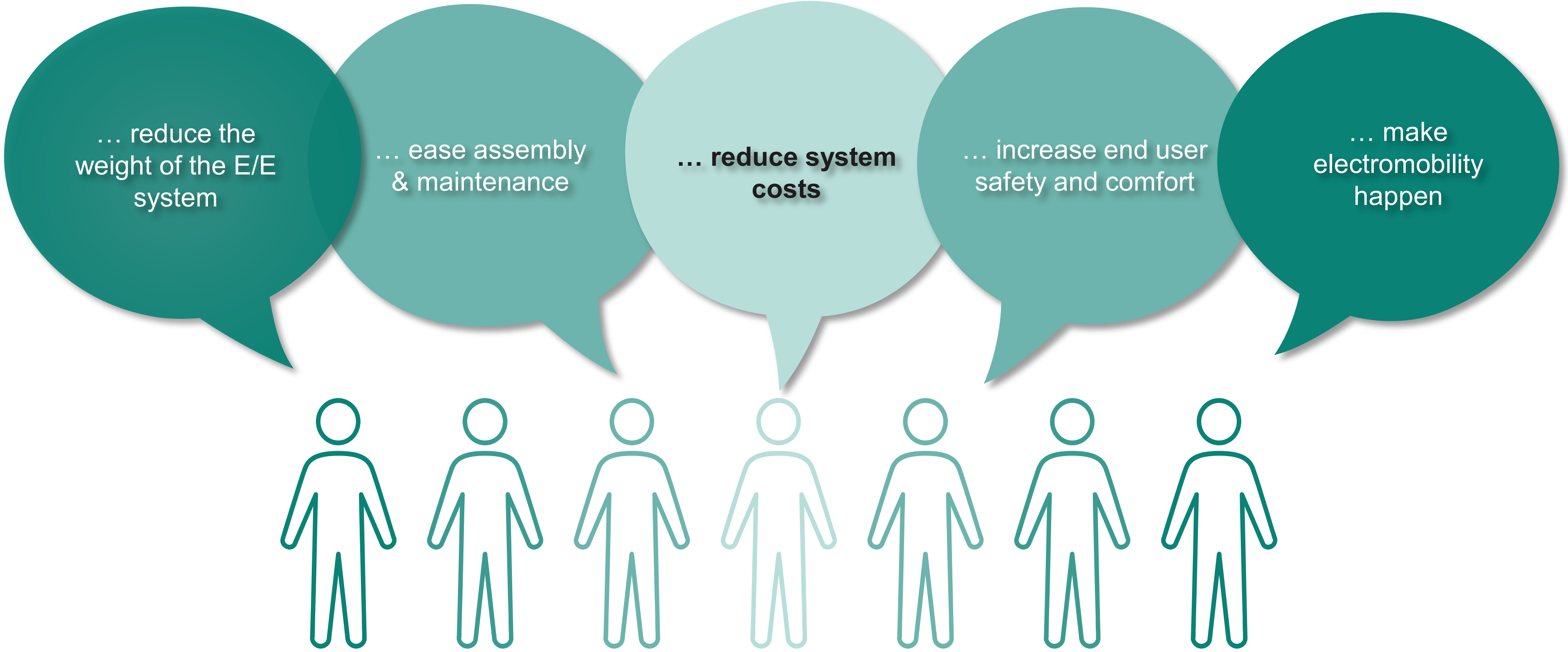
infineon

I think that ...



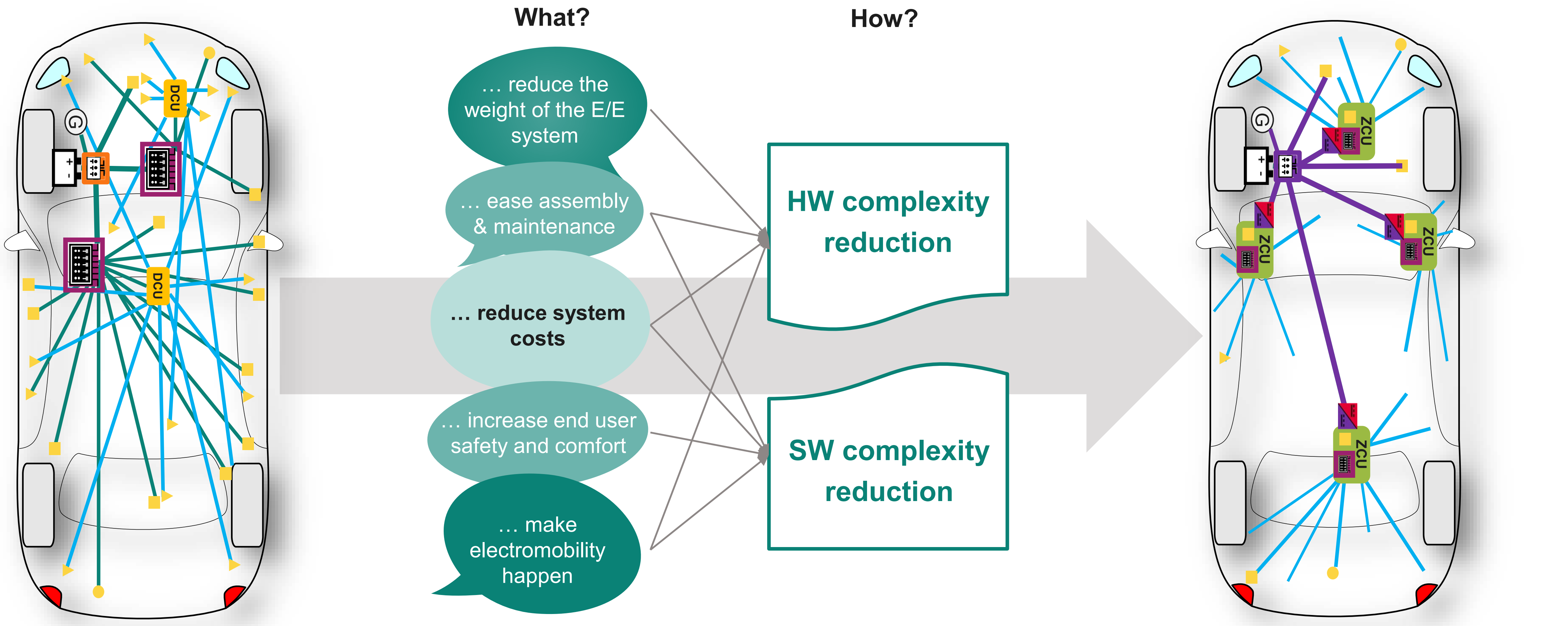
There is no clear definition of Zone architectures ...
So let‘s consider the underlying motivation

I want to ...



The commonly agreed goal is to build better E/E systems at less costs.

Zonal architectures from a customer point of view: „So, what do I do ...“



Zone architectures & Decentralized power distribution enable better E/E systems at less costs.

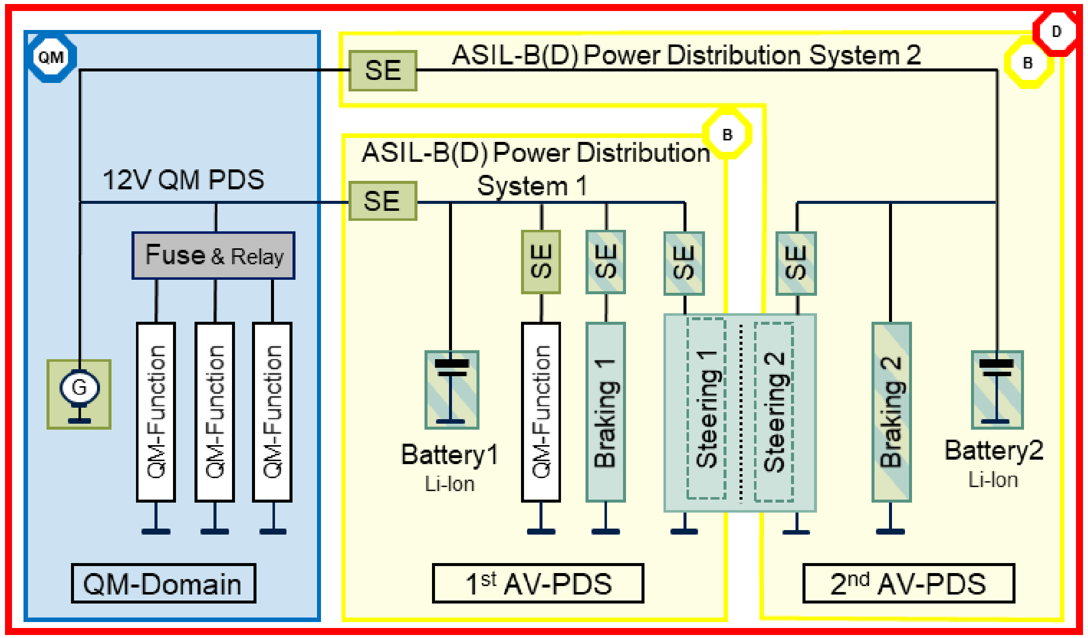
WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

How can you enable Functional Safety (ASIL-D) for my E/E system?

Fail-operational Power Distribution: The introduction of safety elements allows to secure Availability and Freedom-from-Interference

ASIL allocation

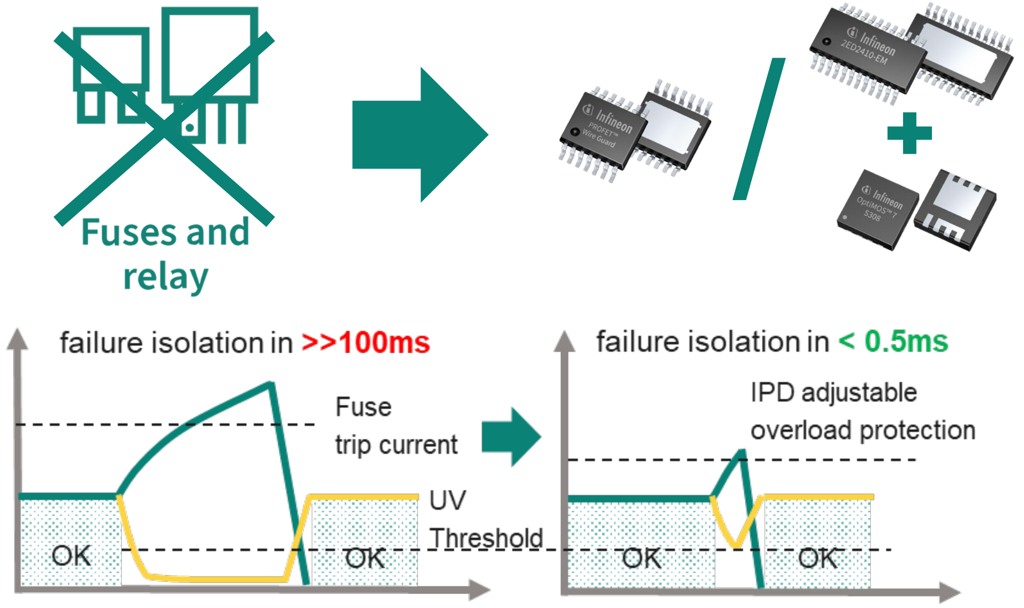
requires



Freedom from Interference

Availability

Prevention of over-current/ under-voltage through fast fault isolation acc. ISO 26262 (<100 µs) …



… requires replacing traditional fuses through semiconductors.

Semiconductor Safety Elements (SEs) protect from under voltage or over current and thus enable available power supply of fail-operational functions.

Smart Power Switches & Gate Driver IC's
Safety conformity levels

Product Category	Product Family	Product(s)	Status	Safety conformity levels		
				QM	PRO SIL ISO 26262 ready	PRO SIL ISO 26262 compliant
Low-side Smart Power Switch	HITFET™ +12 V	BTS3x, BTF3x	Active & preferred	x	x	New
	HITFET™ +24 V	BTT3x	Active & preferred		x	
	Classic HITFET™	BTS1x/ BTS3x/ BTS4x/ BSP7x	Device dependent	x		
High-side Smart Power Switch	Classic PROFET™	BSP7x/ BTS5x/ BTS6x/ BTS7x	Device dependent	x		
	Power PROFET™ + 12 V	BTS5000xx-1LUA	Active & preferred	x	x	New
	Power PROFET™ + 24/48 V	BTH5000xx-1LUA	Coming soon	x	x	
	PROFET™ +24 V	BTT6x	Active & preferred	x		
		BTF6070-2ERV	Active & preferred			x
		BTT6035-1ERL; BTT6080-1ERL	Coming soon	x	x	
	PROFET™ + 2 12 V	BTS7xxx -xEPA/ xEPP/ xESP / xEPZ / xEPG / xEPC / xEPL / xEPR	Active & preferred	x	x	
	SPOC™ +2	BTS7xxx-4ESx / BTS7xxx-6ESx	Active & preferred	x	x	
	PROFET™ Load Guard 12 V	BTG7xxx-2EPL, BTG7xxx-1EPL	Active & preferred	x	x	New
	PROFET™ Wire Guard 12 V	BTG70xxA-1EPW, BTG700xxA-1ESW	Active & preferred			x
Gate Driver ICs	EiceDRIVER™ APD	AUIR324xS	Active	x		
		2ED2410-EM, 2ED4820-EM	Active & preferred	x	x	

Subject to change – please visit Infineon webpage for latest status

OptiMOS™ 7 fits perfectly together with the EiceDRIVER™ APD to support availability and freedome from interference

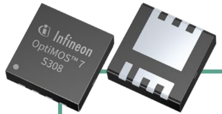
WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

infineon

Available Partly & Coming Soon!

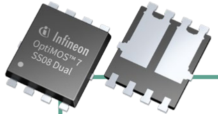
40 V

7 OptiMOS™

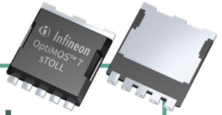


S3O8
10 products
down to 1.20 mΩ

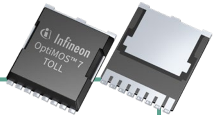
SSO8
16 products
down to 0.42 mΩ



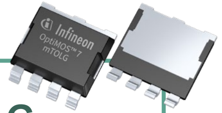
Dual SSO8
8 products
down to 1.8 mΩ



sTOLL
5 products
down to 0.39 mΩ



TOLL with clip
3 products
down to 0.27 mΩ



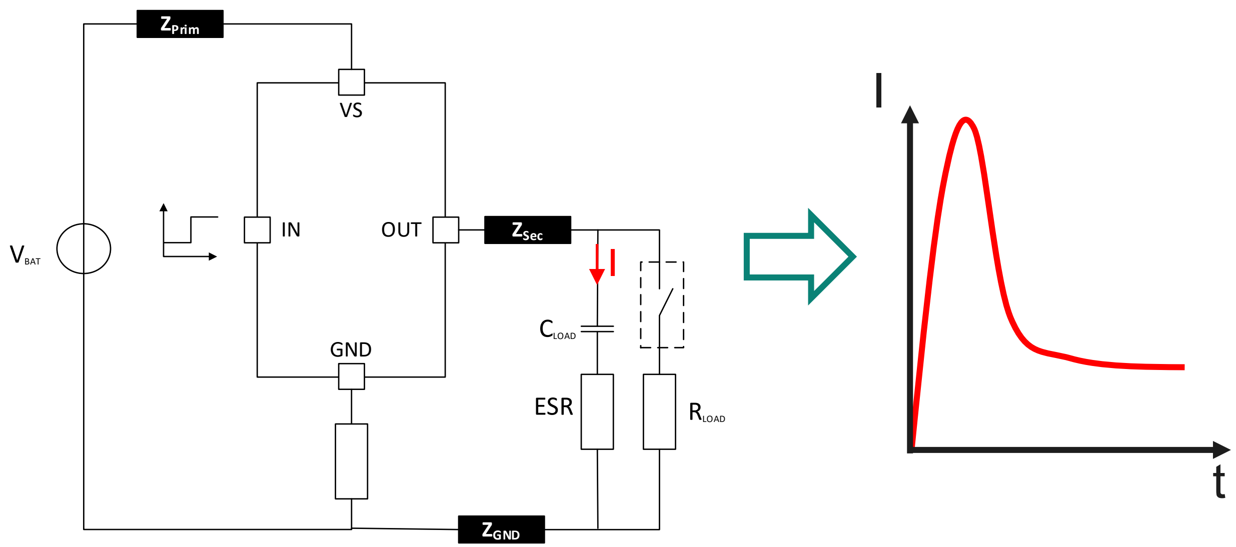
mTOLG
4 products
down to 0.54 mΩ

Features

- 5th IFX **trench technology** for Automotive MOSFET
- State of the art dual poly technology
- More dies per wafer vs other FE technologies → FE capacity increase
- 25% **$R_{DS(on)}$ reduction** OptiMOS™ 7 vs OptiMOS™ 6
- Unique copper metallization
- Outstanding electrical and **thermal conductivity**
- Ruggedness improvement
- **High avalanche current capability**
- Reduction of Switching losses

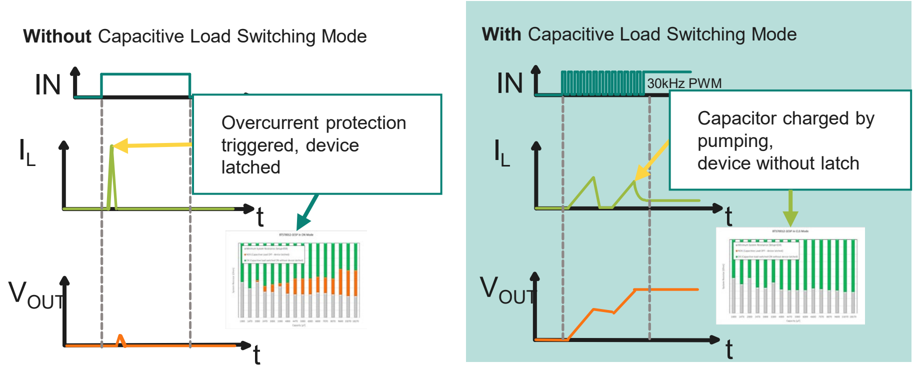
... but ...

Aren‘t capacitive loads and fast-switching semiconductors natural enemies? How do you enable safe capacitive charging?



Capacitive load switching mode (CLS) enables turn on of big load capacitors without triggering device protection functions

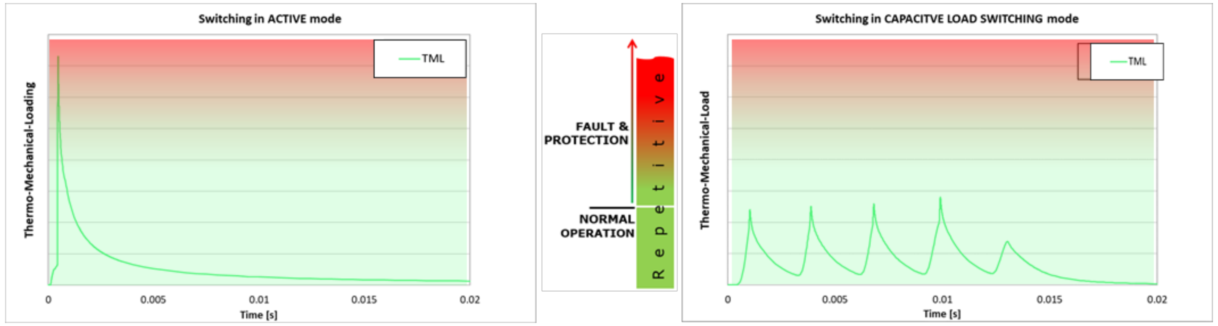
Capacitive load switching (CLS)



System target:

- **Switch-on of big input capacitors** without over dimensioning the device for high inrush currents
- **Easy adoptability** and low integration effort

Benefits of CLS mode



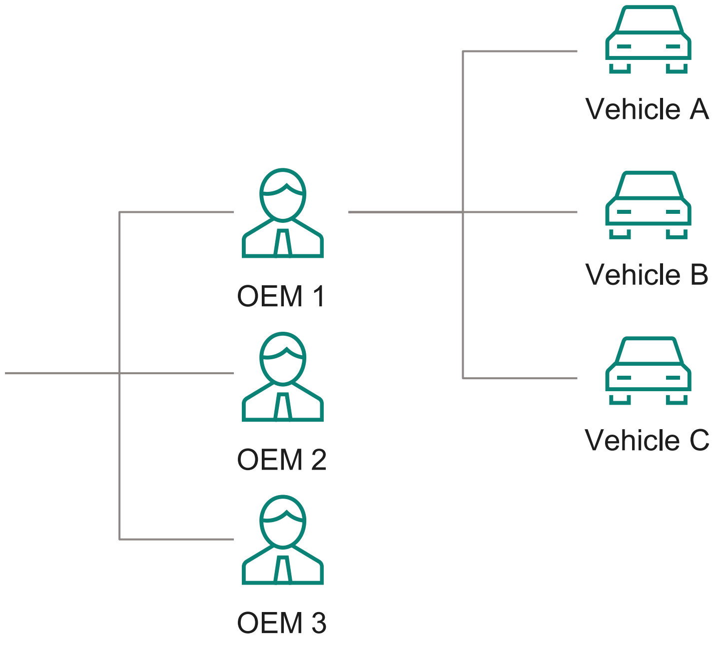
Capacitive load switched within the SOA of the device

Infineon CLS mode offering:

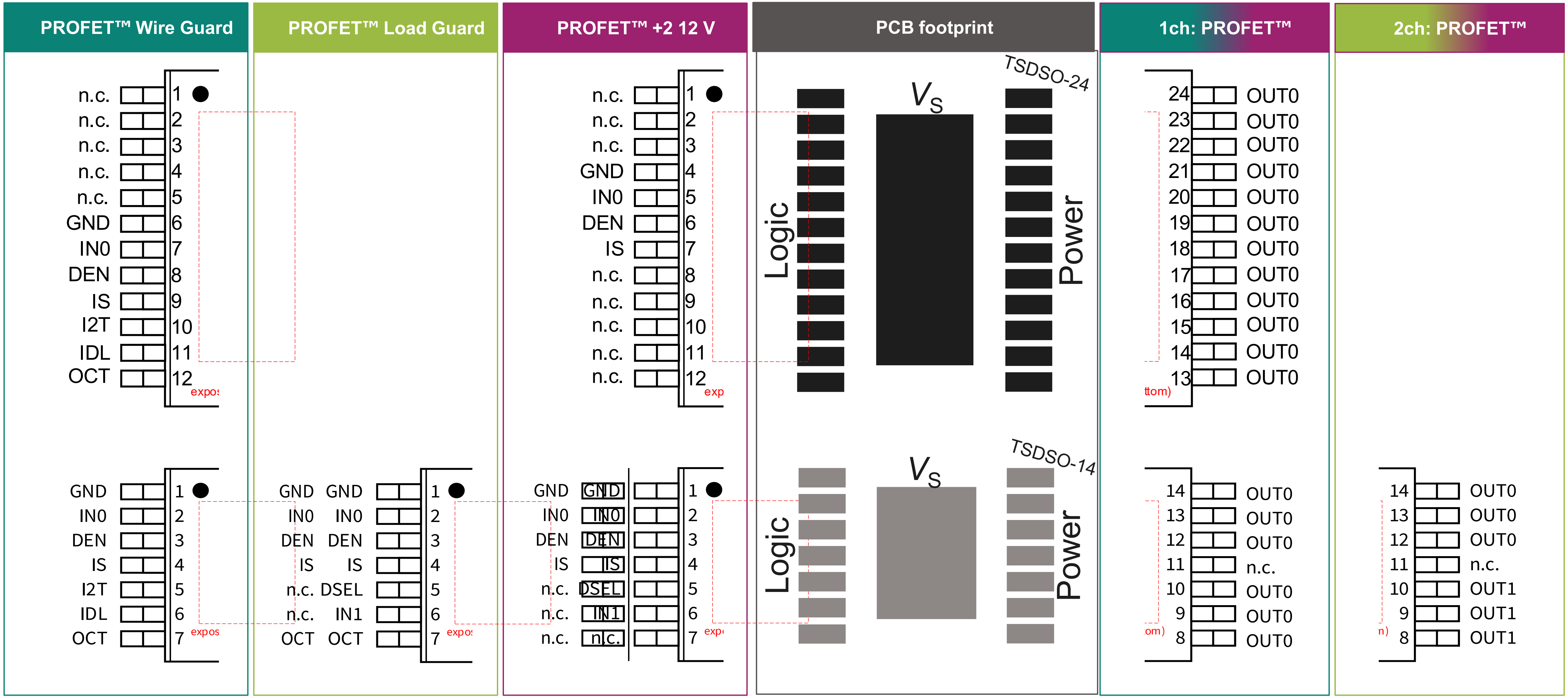
- **Reduced current peak** during switch-on of capacitors (protection of system supply)
- **No discrete pre-charge circuitry** needed (reduced external components, reduced PCB area)
- Technical e-learning available

... but ...

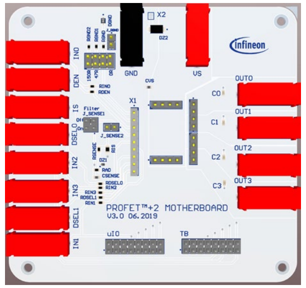
Look, I need a „one-fits-all“ platform solution without reducing time-2-market. Isn‘t your proposal a bit too specific?



Full flexibility, modularity for the customer to always choose the componet which fits best for the application needs

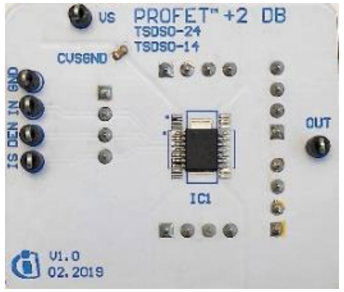


Infineon is offering a broad range of hardware design support via various evaluation boards



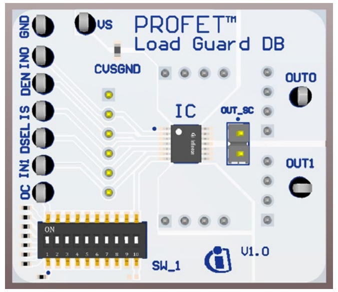
PROFET™ ONE4ALL MB V1

www.infineon.com/switches



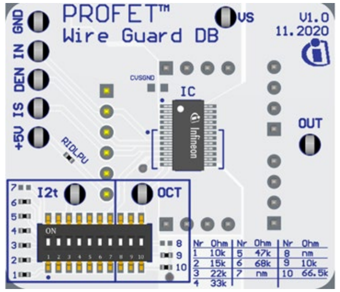
PROFET™ +2 Daughterboards

www.infineon.com/profet+2



PROFET™ Load Guard Daughterboards

www.infineon.com/profetloadguard

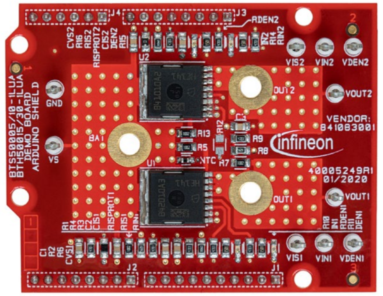


PROFET™ Wire Guard Daughterboards

www.infineon.com/profetwireguard

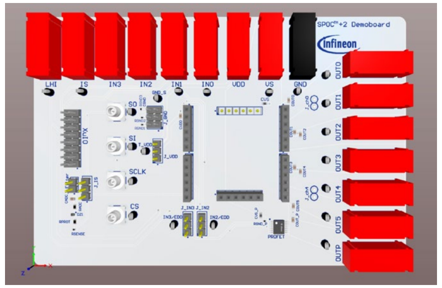
Find more boards at

[*www.infineon.com/switches*](http://www.infineon.com/switches)



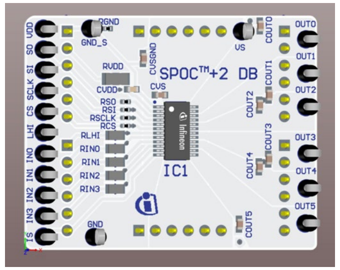
Power PROFET™ + Evaluation boards

www.infineon.com/powerprofet



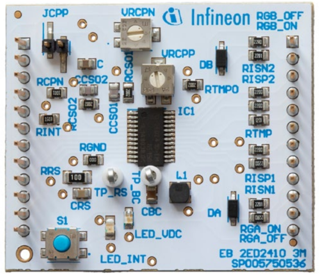
SPOC-2 MOTHERBOARD

www.infineon.com/spoc



SPOC™ +2 Daughterboards

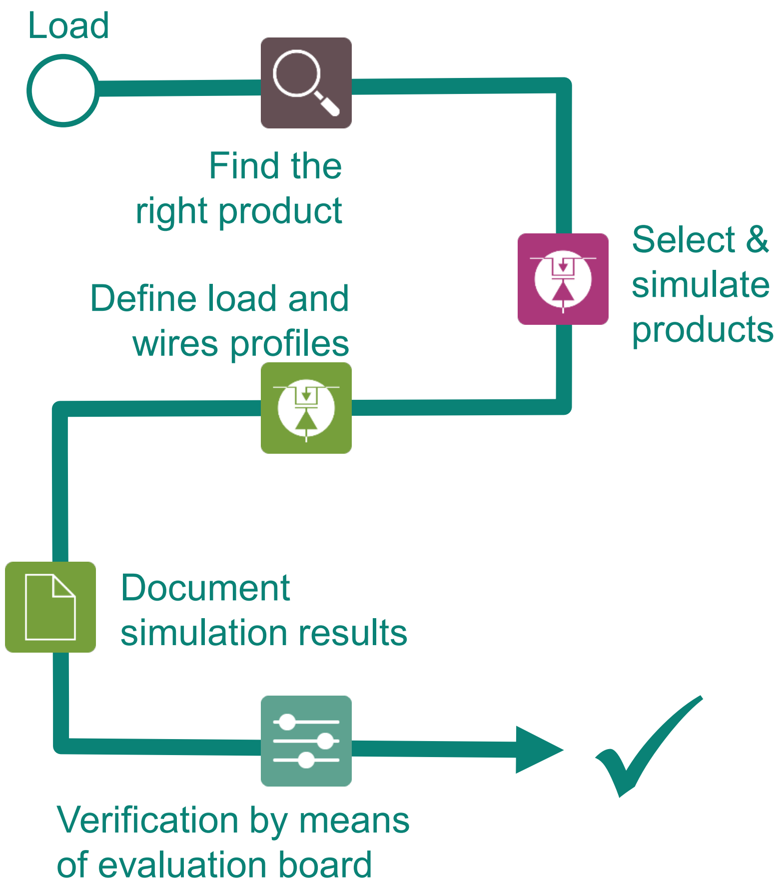
www.infineon.com/spoc



EiceDRIVER™ APD Motherboard

www.infineon.com/automotive-eicedriver

Design-in tools supports starting from product selection until system simulation



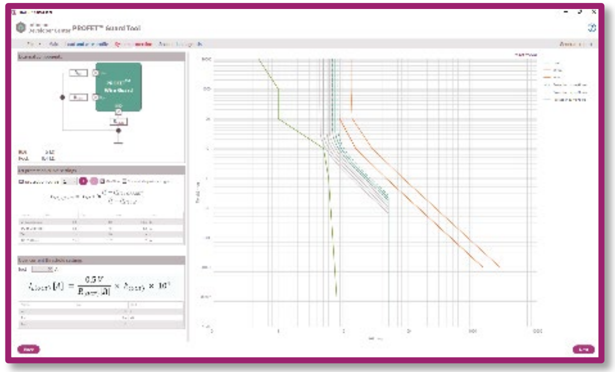
Infineon Smart Power Switches & Gate Driver Tool Suite
accessible via the Infineon Developer Center Launcher

Finder & Selection Tools
- Infineon Smart Power Switches Finder
- Infineon Gate Driver ICs Finder
- Infineon MOSFET Finder

Configuration Tools
- Infineon Smart Power Switches Configuration Wizard
- Infineon EiceDRIVER™ 2ED4820 EB Configuration Wizard

Simulation & Modeling Tools
- Infineon Smart Power Switches PROFET™ Guard Tool
- Infineon Smart Power Switches EiceDRIVER™ 2ED2410 Tool
- Infineon Smart Power Switches kILIS Tool
- Infineon Smart Power Switches Intrinsic Fuse Tool
- Infineon Smart Power Switches Capacitive Load Charging Tool
- Infineon Thermal Transient Multisource Simulator
- Infineon Smart Power Switches Easy APE Pro

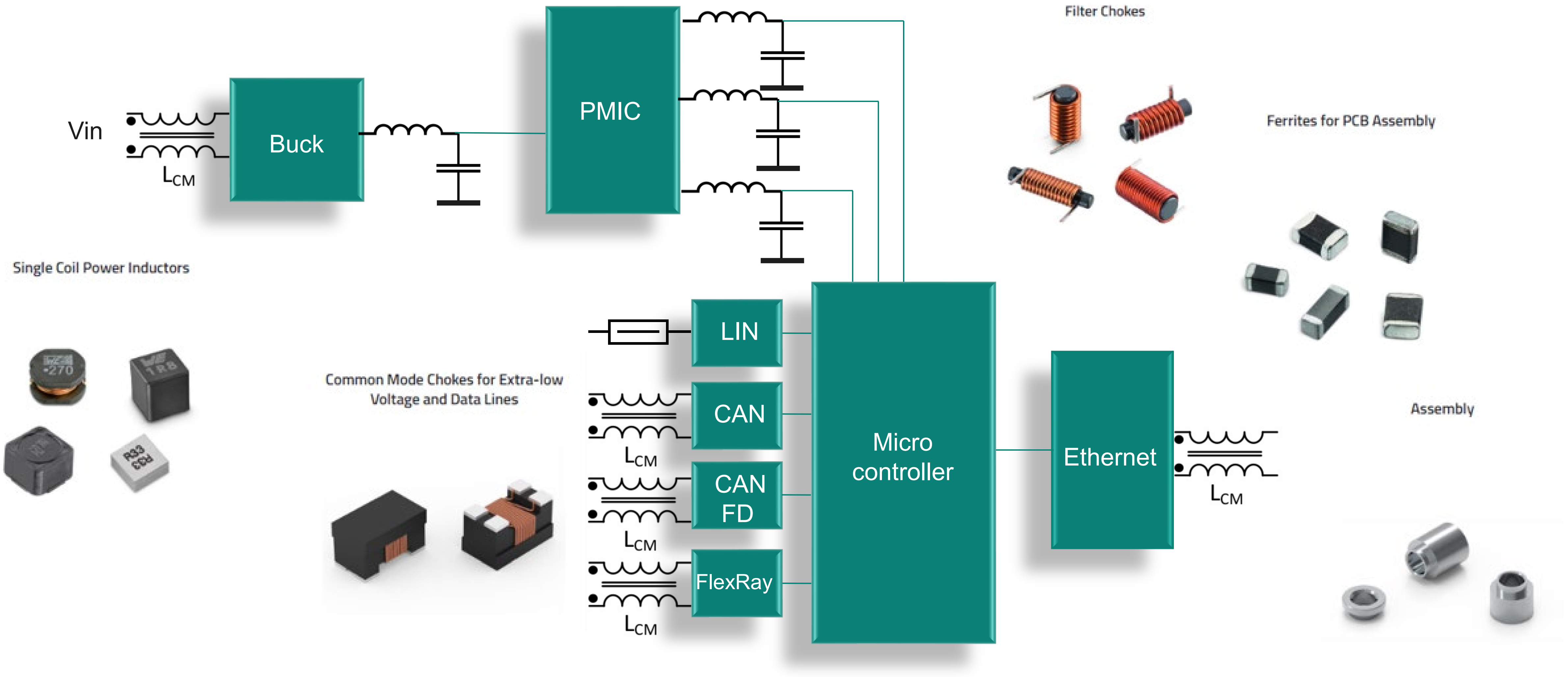
Utility Tools
- Infineon Smart Power Switches Load and Wire Entry Tool
- Infineon Report Tool



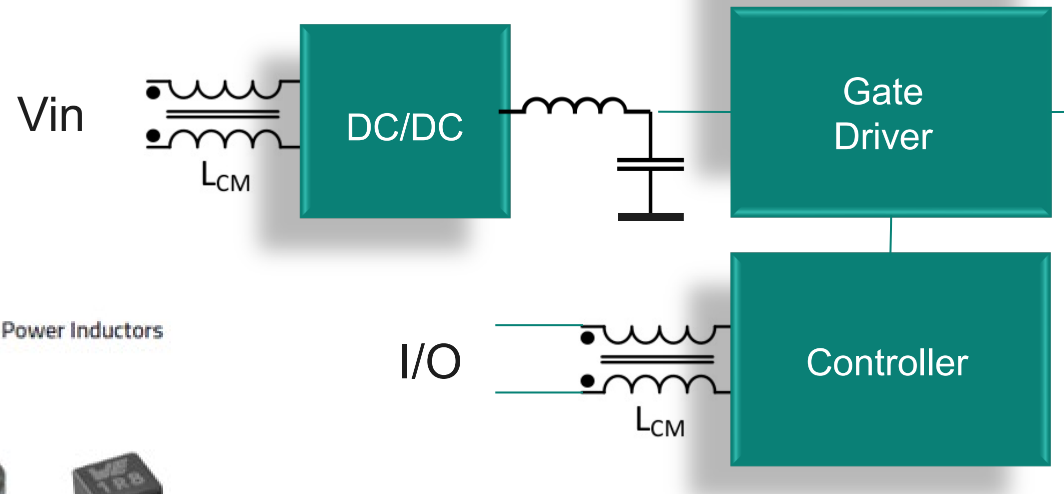
Smart Power Switches Tool Suite

www.infineon.com/SmartPowerSwitchToolSuite/

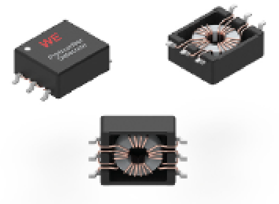
Zonal Electronic control unit ECU



Gate Drive Applications



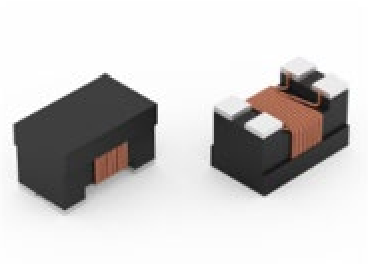
Power Magnetics - Isolated



- Motor Inverter
- On Board Charger (OBC)
- Power Steering
- Brakes
- LED driver
- Engine ECU
- Transmission ECU

Single Coil Power Inductors

Common Mode Chokes for Extra-low Voltage and Data Lines



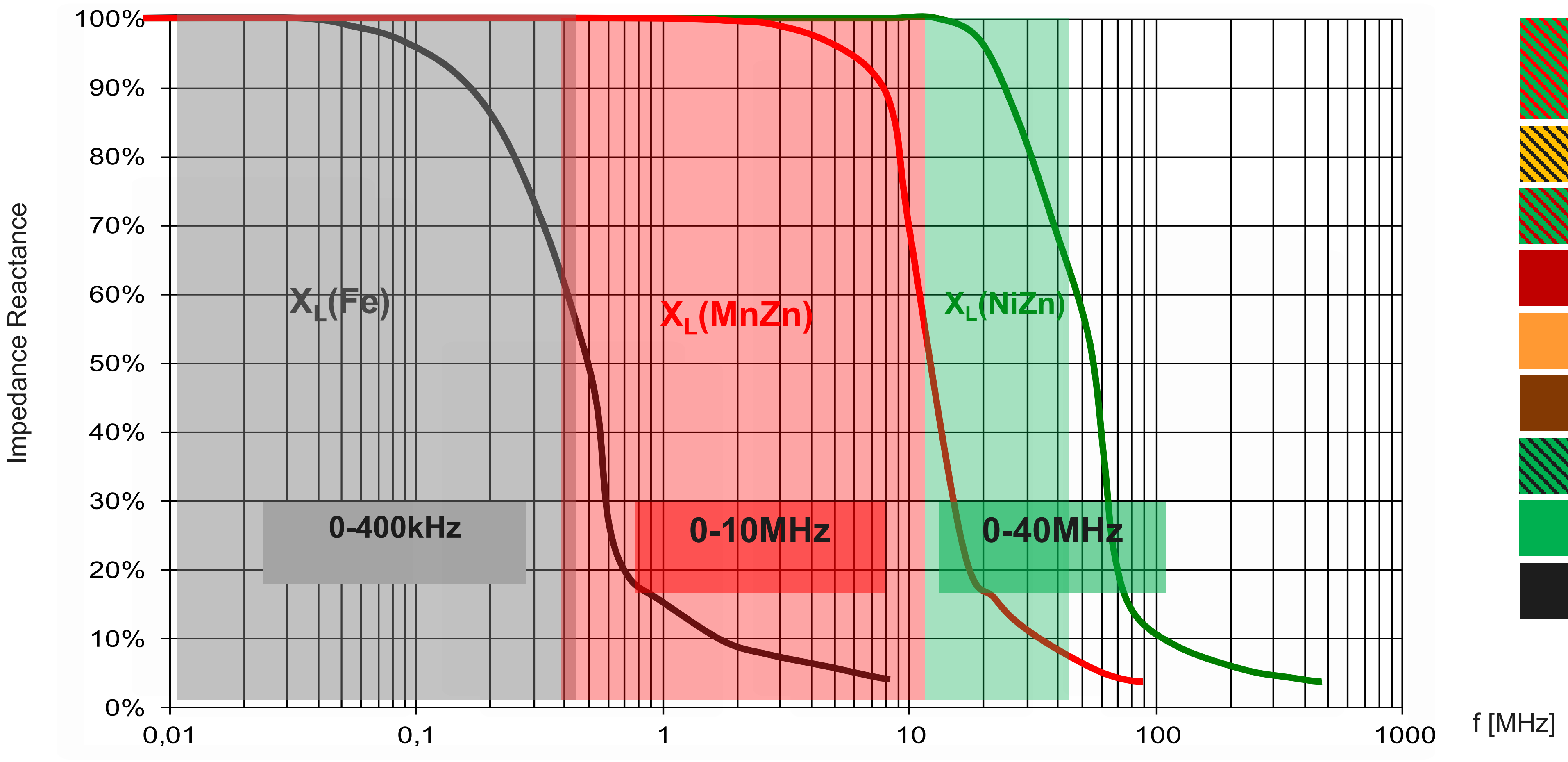
Filter Chokes

Ferrites for PCB Assembly

Assembly

Power Inductors

Reactance vs Frequency vs material



Core Material

Core Materials	Core Loss	Perm f(DC biais)	Relative Cost	Frequency Range	Saturation Flux density (B_{sat})	Temp Stability
Iron Powder	Highest	-	Lowest	200kHz	15.000 Gauss (1,5 Tesla)	-
NiZn	Lowest	-	Low	10MHz	4.500 Gauss (0,45 Tesla)	-
WePerm®	Low	+ +	Low	3 MHz	10.000 Gauss (1.0 Tesla)	++
SuperFlux®	Medium	+++	Medium	1.0 MHz	12.000 Gauss (1,2 Tesla)	+++

Switching Frequency ⇔ Core Material

Core Material

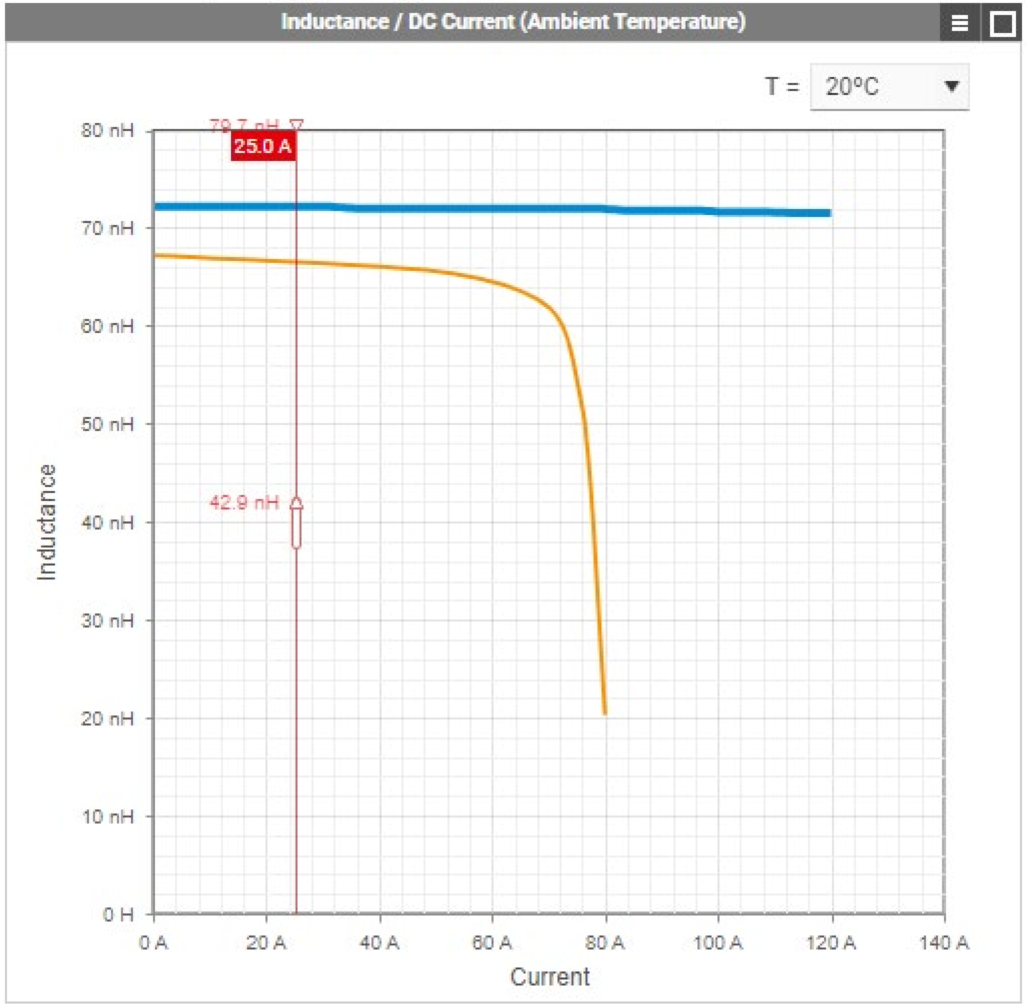
Hard Saturation vs Soft Saturation

Hard Saturation:

1. **Behavior**: Inductance drops drastically as soon as the saturation point is reached.
2. **Core Material**: Typically found in inductors with winding on a solid core (e.g., high permeability iron alloys).
3. **Application**: Less suitable for high-current transients due to abrupt saturation behavior

Soft Saturation:

1. **Behavior**: Inductance reduces progressively as current increases.
2. **Core Material**: Commonly used in power inductors with winding on a powdered core (e.g., ferrites).
3. **Advantages**: Better for handling higher current transients and maintaining stable behavior at elevated temperatures



WÜRTH ELEKTRONIK

REDEXPERT

Menu

Low entry access to electronics design with REDEXPERT®

Navigate by order code

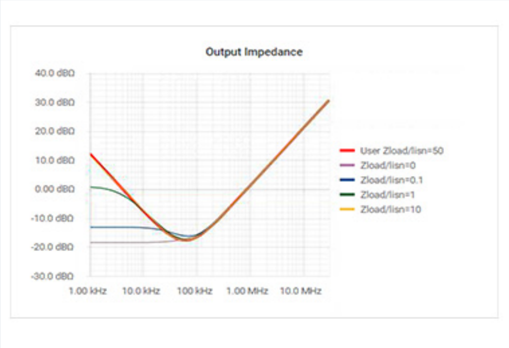
Enter at least first 4 characters

Design Tools

- EMI Filter Designer
- Magl³C Power Module Designer
- Resonance Tank Calculation for Wireless Power
- Filter Circuits
- DC/DC Converter
- Flyback Transformer
- AC/DC Converter
- Wireless Connectivity and Sensors

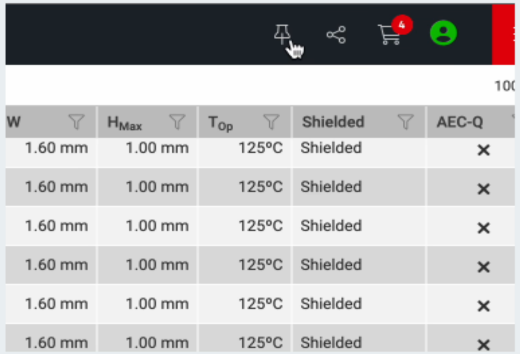
Product selection

- EMC Components
- Power Inductors and Magnetics
- Magl³C Power Products
- Signal & Communications
- Capacitors & Resistors
- Optoelectronics
- Quartz Crystals & Oscillators
- EMC Shielding & Grounding



Filter Designer shows the output impedance for many load impedances

Our EMI Filter Designer shows the output impedance for a variety of different load / LISN impedances from 0 up to 10 Ohms.



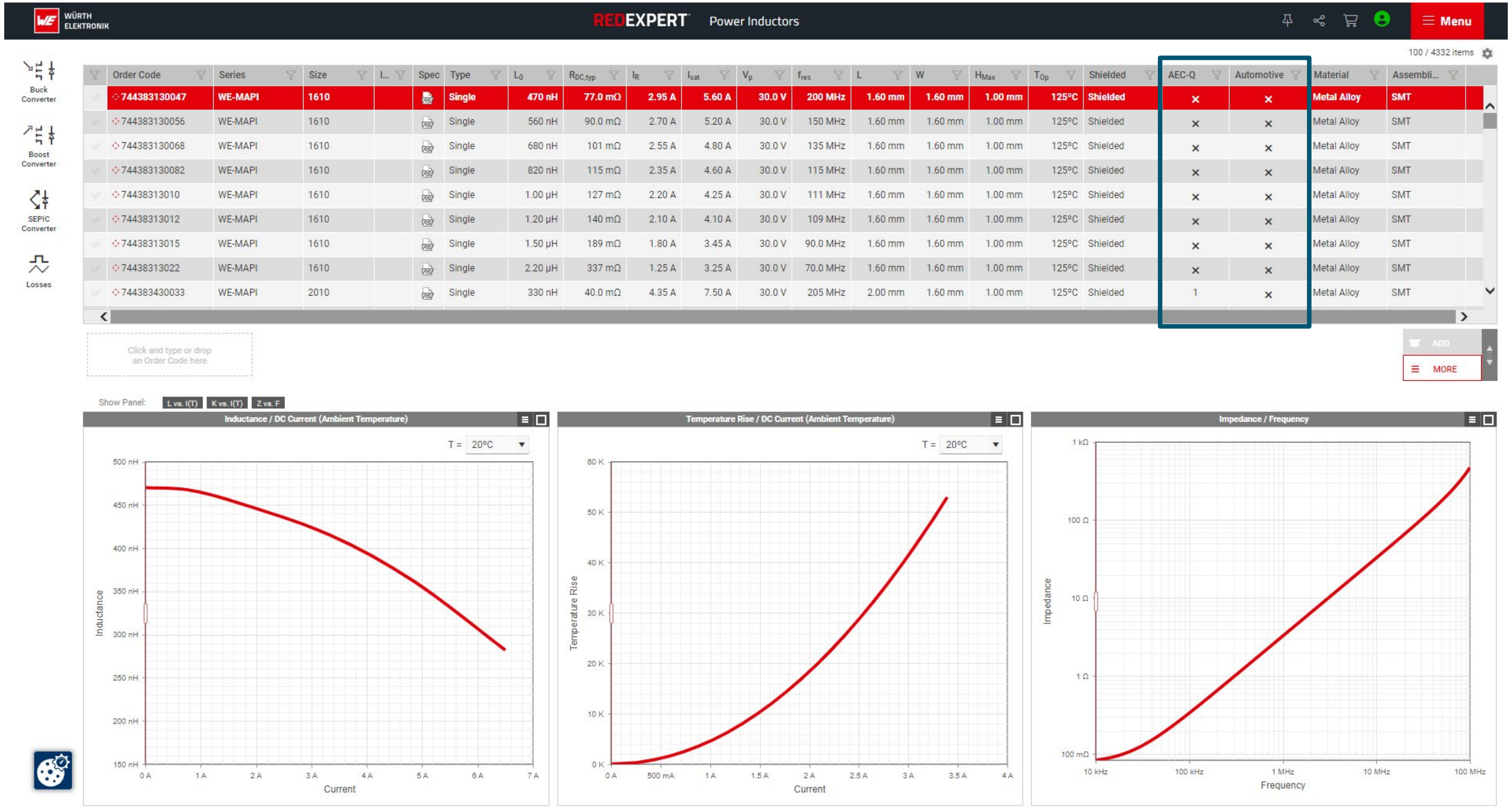
W	H_{Max}	T_{Op}	Shielded	AEC-Q
1.60 mm	1.00 mm	125°C	Shielded	×
1.60 mm	1.00 mm	125°C	Shielded	×
1.60 mm	1.00 mm	125°C	Shielded	×
1.60 mm	1.00 mm	125°C	Shielded	×
1.60 mm	1.00 mm	125°C	Shielded	×
1.60 mm	1.00 mm	125°C	Shielded	×

Bookmark the actual module

Add the actual module to your favorites (Login required), to have quick access directly on the REDEXPERT start page. Warning: It might save you time!

Automotive Standard Products - Portfolio

How to find them?



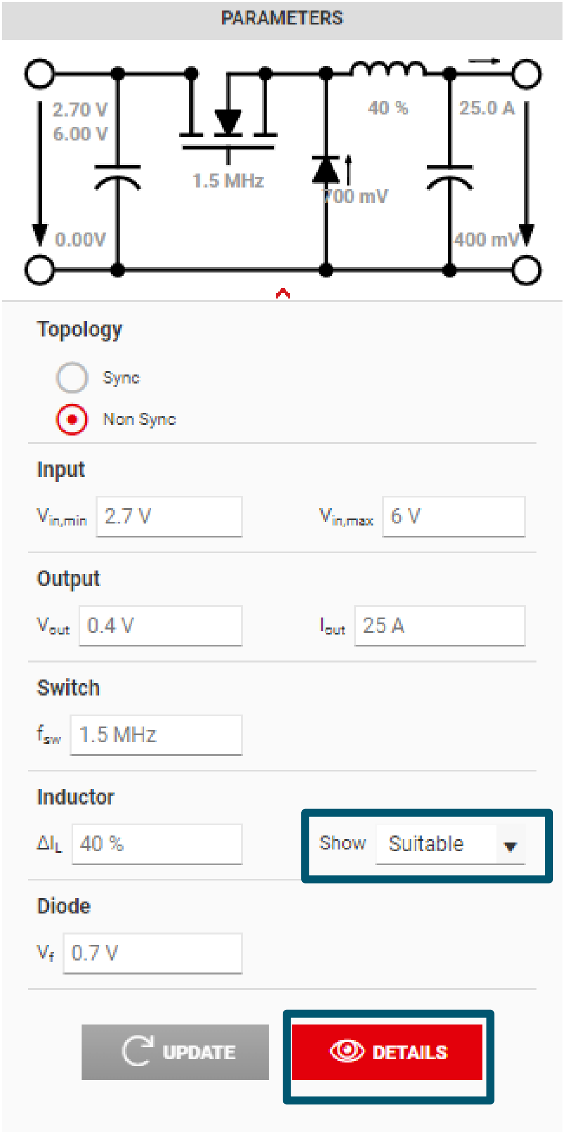
Order Code	Series	Size	I...	Spec	Type	L_0	$R_{DC,typ}$	I_R	I_{sat}	V_p	f_{res}	L	W	H_{Max}	T_{Op}	Shielded	AEC-Q	Automotive	Material	Assembli...
744383130047	WE-MAPI	1610		PDF	Single	470 nH	77.0 mΩ	2.95 A	5.60 A	30.0 V	200 MHz	1.60 mm	1.60 mm	1.00 mm	125°C	Shielded	×	×	Metal Alloy	SMT
744383130056	WE-MAPI	1610		PDF	Single	560 nH	90.0 mΩ	2.70 A	5.20 A	30.0 V	150 MHz	1.60 mm	1.60 mm	1.00 mm	125°C	Shielded	×	×	Metal Alloy	SMT
744383130068	WE-MAPI	1610		PDF	Single	680 nH	101 mΩ	2.55 A	4.80 A	30.0 V	135 MHz	1.60 mm	1.60 mm	1.00 mm	125°C	Shielded	×	×	Metal Alloy	SMT
744383130082	WE-MAPI	1610		PDF	Single	820 nH	115 mΩ	2.35 A	4.60 A	30.0 V	115 MHz	1.60 mm	1.60 mm	1.00 mm	125°C	Shielded	×	×	Metal Alloy	SMT
74438313010	WE-MAPI	1610		PDF	Single	1.00 µH	127 mΩ	2.20 A	4.25 A	30.0 V	111 MHz	1.60 mm	1.60 mm	1.00 mm	125°C	Shielded	×	×	Metal Alloy	SMT
74438313012	WE-MAPI	1610		PDF	Single	1.20 µH	140 mΩ	2.10 A	4.10 A	30.0 V	109 MHz	1.60 mm	1.60 mm	1.00 mm	125°C	Shielded	×	×	Metal Alloy	SMT
74438313015	WE-MAPI	1610		PDF	Single	1.50 µH	189 mΩ	1.80 A	3.45 A	30.0 V	90.0 MHz	1.60 mm	1.60 mm	1.00 mm	125°C	Shielded	×	×	Metal Alloy	SMT
74438313022	WE-MAPI	1610		PDF	Single	2.20 µH	337 mΩ	1.25 A	3.25 A	30.0 V	70.0 MHz	1.60 mm	1.60 mm	1.00 mm	125°C	Shielded	×	×	Metal Alloy	SMT
744383430033	WE-MAPI	2010		PDF	Single	330 nH	40.0 mΩ	4.35 A	7.50 A	30.0 V	205 MHz	2.00 mm	1.60 mm	1.00 mm	125°C	Shielded	1	×	Metal Alloy	SMT

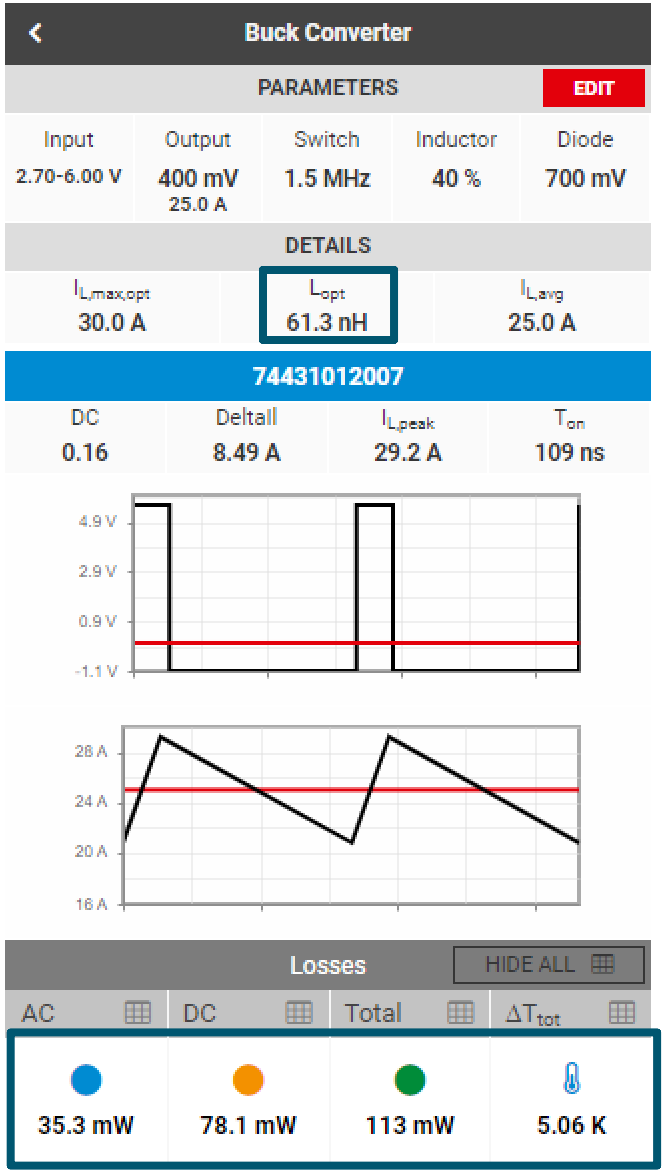
REDEXPERT®

Power Inductor Selection

REDEXPERT will not only find all suitable inductors but will also calculate the expected losses and temperature rise with high accuracy

Suggestion: The „perfect" inductance wont exist anyway, order a sample for one inductance value above and below your results





Datasheet Values

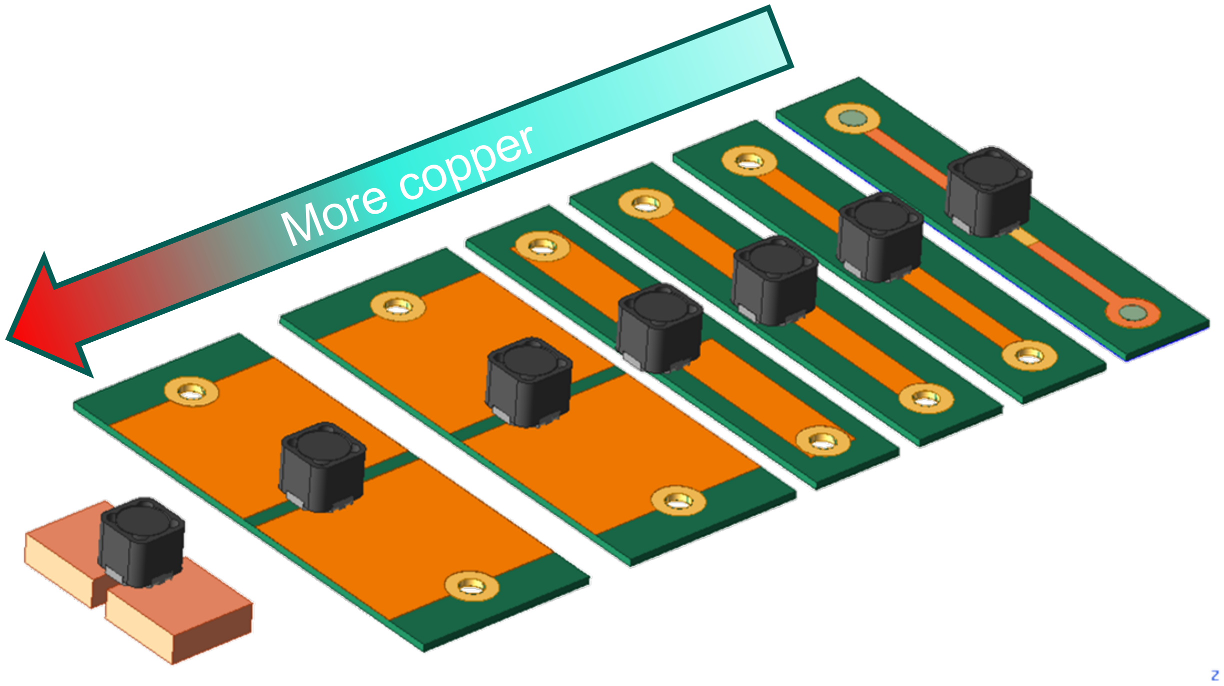
- Datasheet!
- Power Inductors do have tolerances up to 30%
- Saturation effects and Tolerances have to be considered

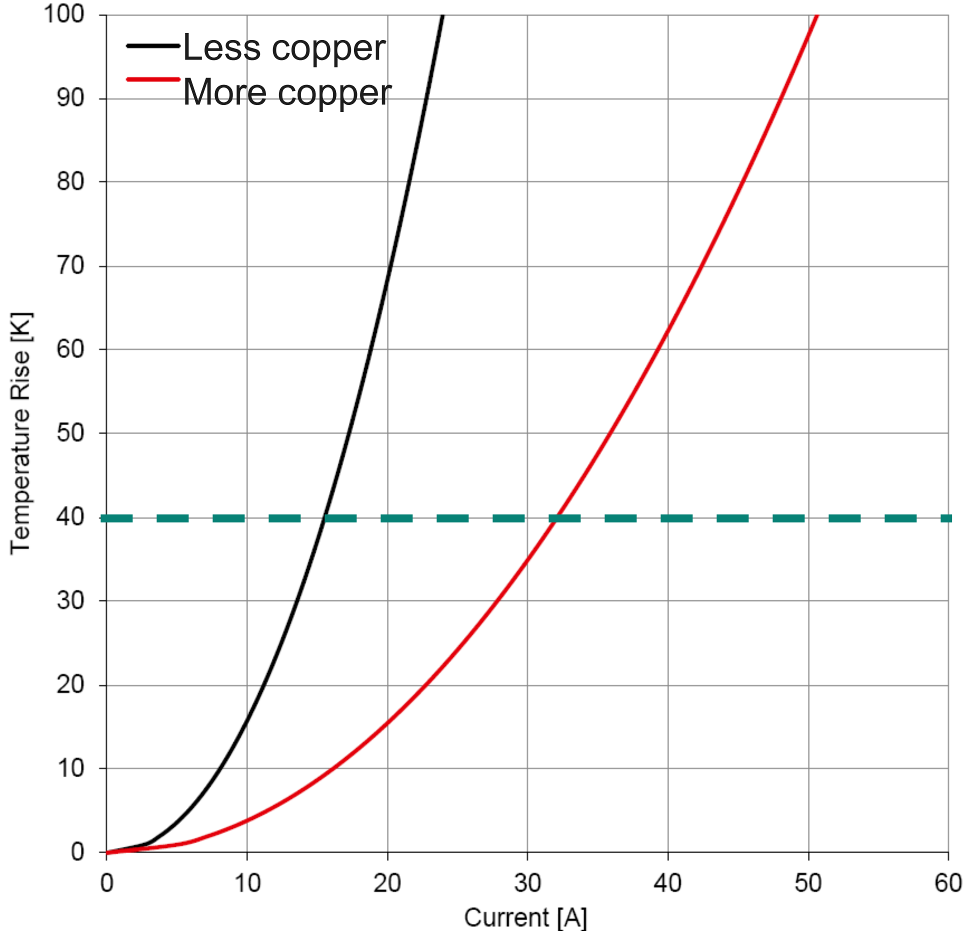
Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Inductance	L	100 kHz/ 100 mA	72	nH	±20%
Rated Inductance	L_R	100 kHz/ 10mA/ 30.0 A	71	nH	typ.
Rated Current	I_R	$\Delta T = 40$ K	30	A	max.
Performance Rated Current [1]	$I_{RP,40K}$	$\Delta T = 40$ K	76.1	A	max.
Saturation Current @ 10%	$I_{SAT,\ 10\%}$	$\lvert\Delta L/L\rvert < 10$ %	62	A	typ.
Saturation Current @ 30%	$I_{SAT,30\%}$	$\lvert\Delta L/L\rvert < 30$ %	64	A	typ.
DC Resistance	R_{DC}	@ 20 °C	0.235	mΩ	±7%
Self Resonant Frequency	f_{res}		150	MHz	typ.

[1] refer to IEC 62024-2-2020

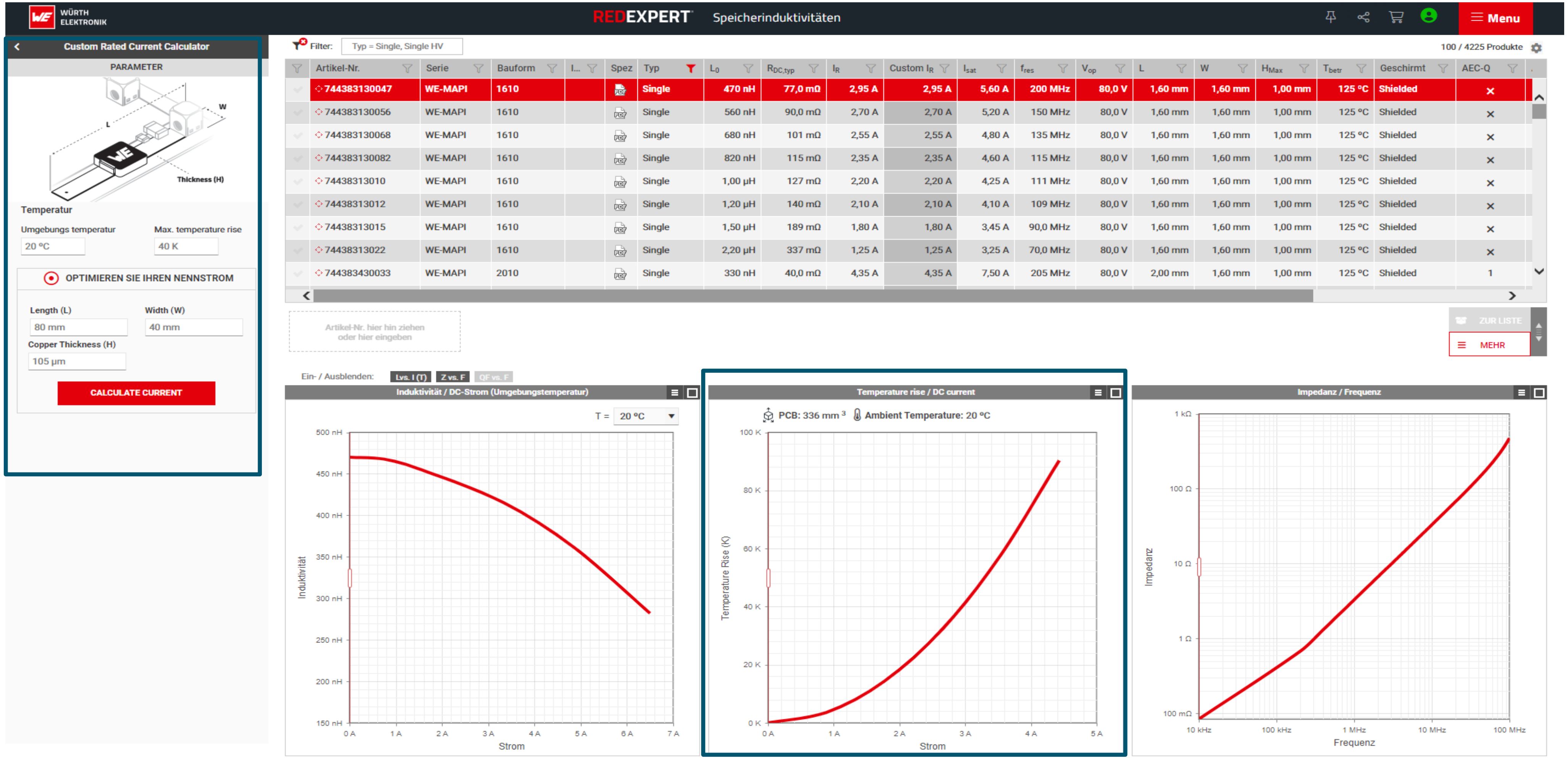
Rated current
Impact of the PCB





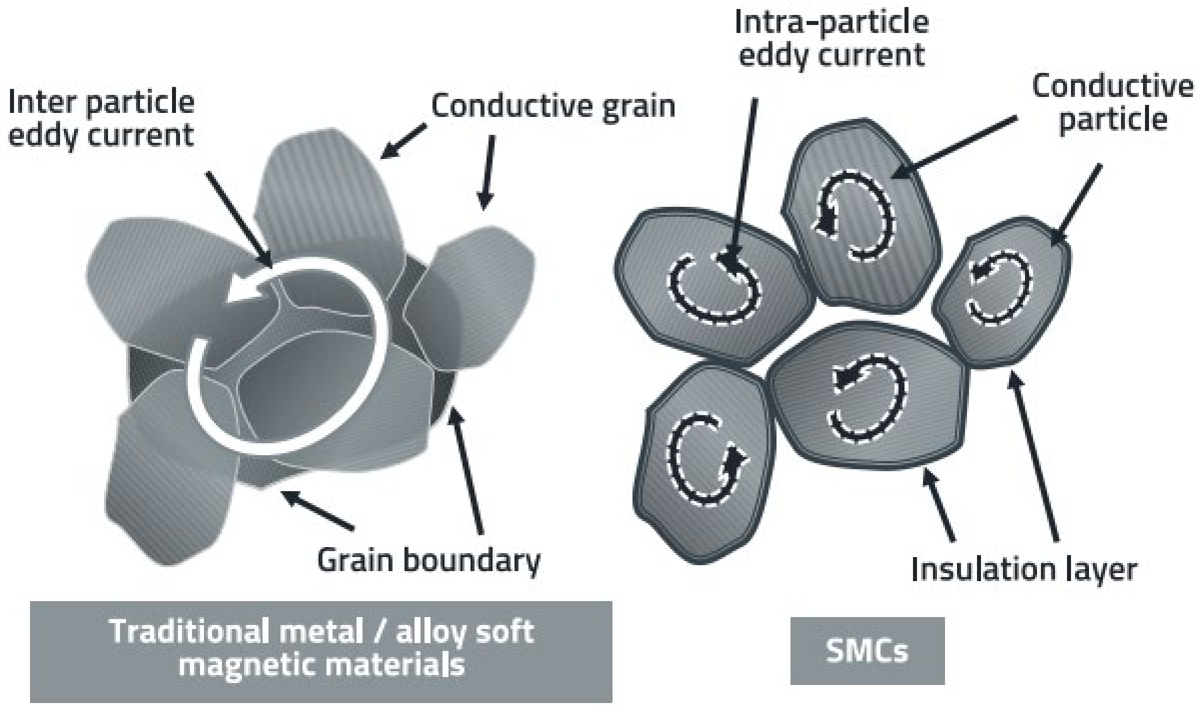
Rated current

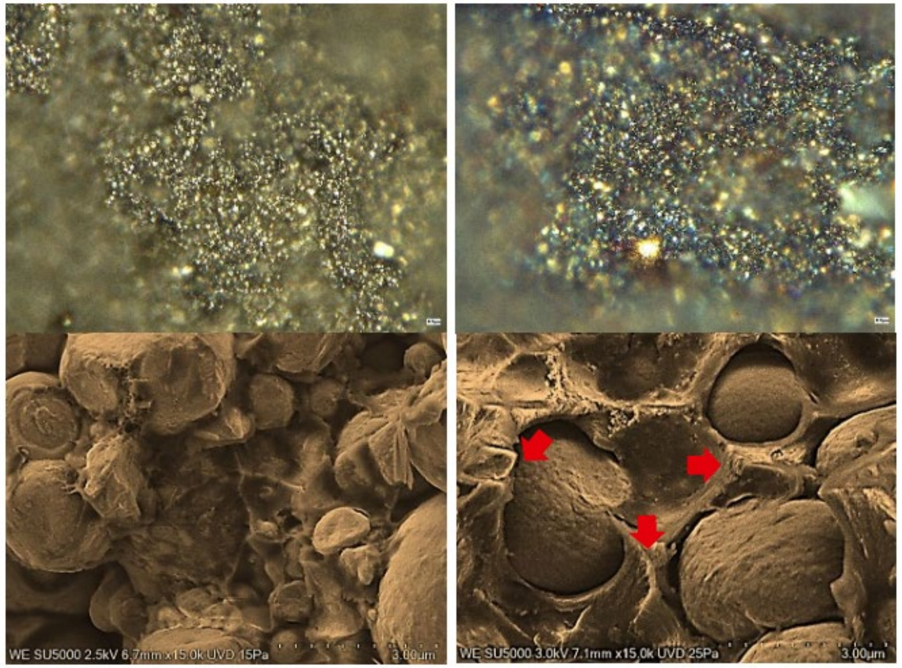
And more….



Thermal Aging

Molded Power Inductors

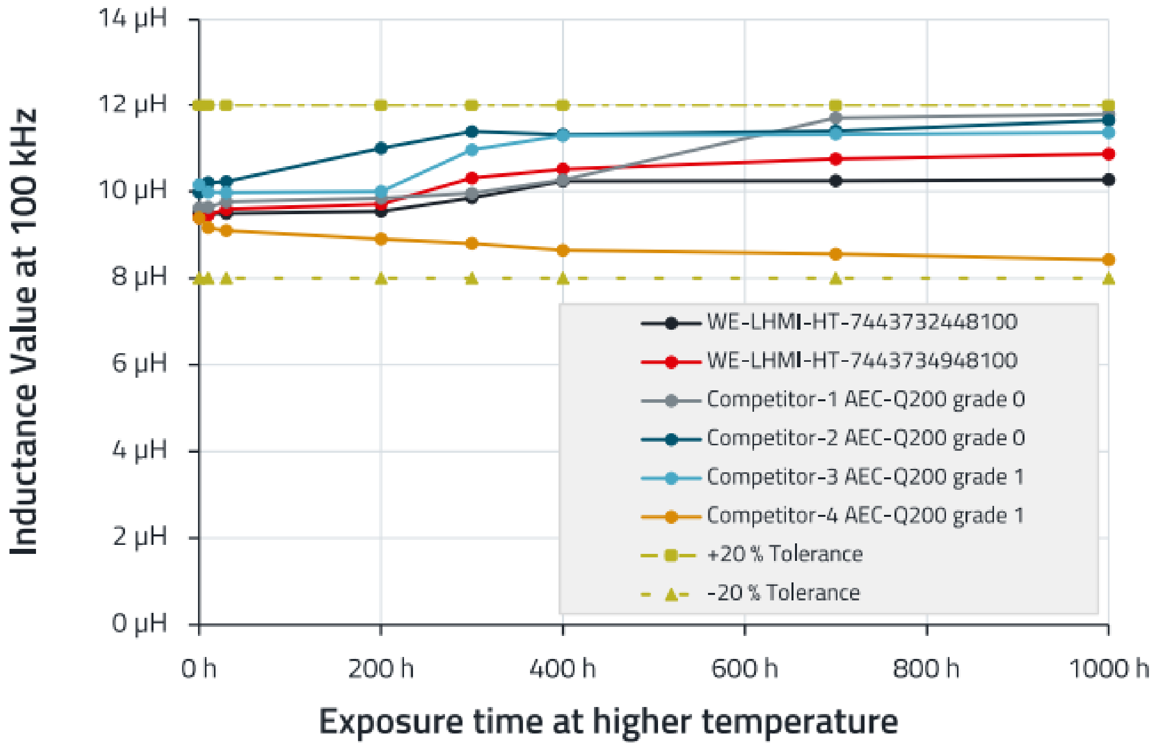




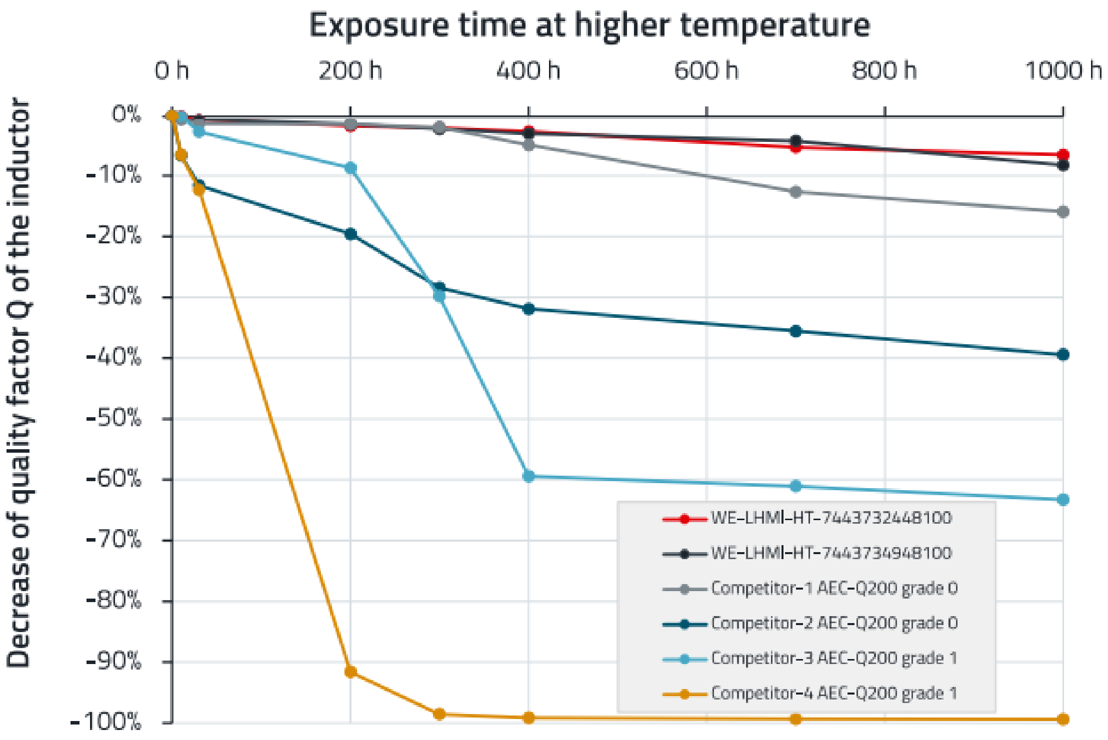
a. Left Column: Before test
b. Right Column: After test

App Note: ANP128

Thermal Aging



a. Inductance L value at 100 kHz during 1000 h at 200 °C.



b. Decrease of Q value at 2 MHz during 1000 h at 200 °C.

See Also:
ANP126 | Voltage specification for molded inductors

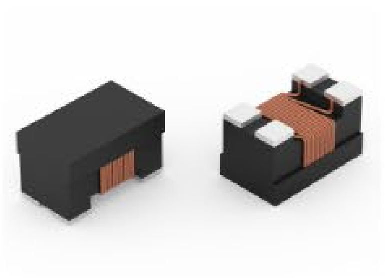
Automotive Standard Products - Portfolio

Ferrites for Cable Assembly

Ferrites for PCB Assembly

Filter Chokes

Common Mode Chokes for Extra-low Voltage and Data Lines

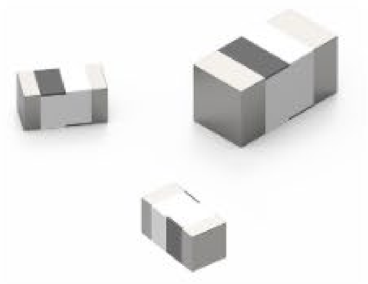


Single Coil Power Inductors

Power Magnetics

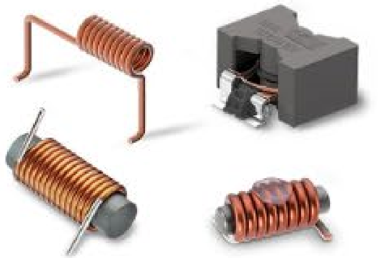
NEW

RF Inductors



Assembly

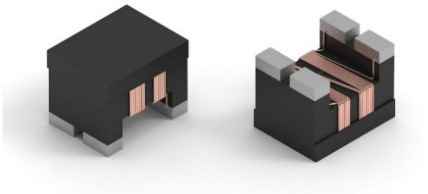
Customized Solutions



Design Kits Automotive

Product New Release

SIGNAL & COMMUNICATION

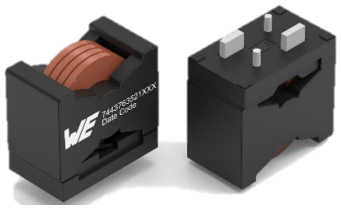


WE-CNSA
(SMD Common Mode Choke for Data line)
Size 1210
CAN / CAN FD BUS Certification
A2B Automotive

EMC COMPONENTS

WE-OEFA LFS
(Oval EMC Suppressor Bead MnZN Core)
Size 65 mm OD
Impedance up to 112 Ω (100MHz)

POWER APPLICATIONS



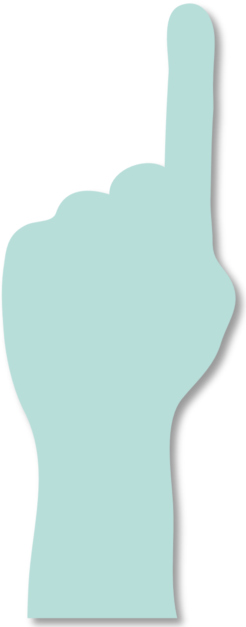
WE-HCFA-T
(THT High Current Inductor)
Size 3521/3540
Very Low RDC from 0.35mΩ
Saturation Current up to 175A

WE-HEPA
(Tiny Shielded Power Inductor)
Size 6030/5030
Up to 2 A
Full Automated

WE-LHCA
(SMD Molded Power Inductor)
Size 7030/1040/1365/1770
Soft Saturation current up to 95 A
Low RDC

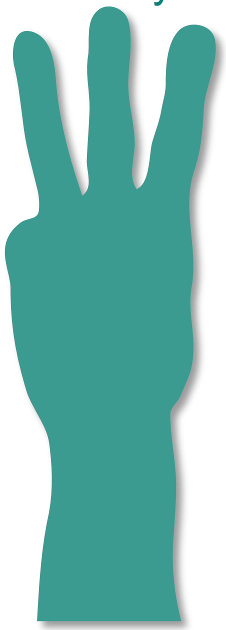
3 things to remember!

Smart power switches, gate driver ICs & MOSFETs are the better fuses and thus enable safe and modern power distribution systems



Along with semiconductors comes a need for complementary passive components that helps achieving high efficiency and reduce EMC problems

Check out Infineon‘s and Würth‘s design-in resources via the respective webpages and reach out to your sales representatives to launch your Power Distriution System design!



THANK YOU

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT