# DIGITAL WE DAYS 2024





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WURTH ELEKTRONIK MORE THAN YOU EXPECT

# **AGENDA**

- 1. Market trends in the power converters
- 2. From ferrite to molded inductors
- 3. Characteristics of molded inductors
- 4. Thermal aging



# **MARKET TRENDS IN THE POWER CONVERTERS**



Emergency call Gearbox control Gearbox control Traction control Traction control Anti lock brakes Anti lock brakes Electronic fuel injection Cruise control Cruise control

-2000-

Electronic fuel injection

Cruise control

-1980

Airbag system Electronic stability control Active body control Adaptive gearbox control Adaptive cruise control Electronic fuel injection

Active steering Curve warning Stop and Go Lane keeping assistance Automated parking Collision mitigation Hybrid powertrain Road trains Electronic brake control Telediagnosis Car-2-car communication Software updates Airbag system Electronic stability control Active body control Adaptive gearbox control Adaptive cruise control Emergency call Gearbox control Traction control Anti lock brakes Electronic fuel injection Cruise control

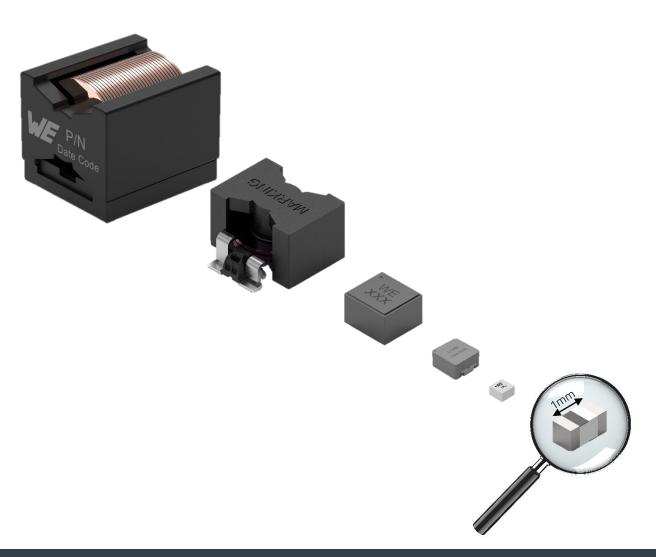
Adaptive headlights



-2020→

# **MARKET TRENDS IN THE POWER CONVERTERS**

- > Miniaturization
- Power density increase
- Reliability





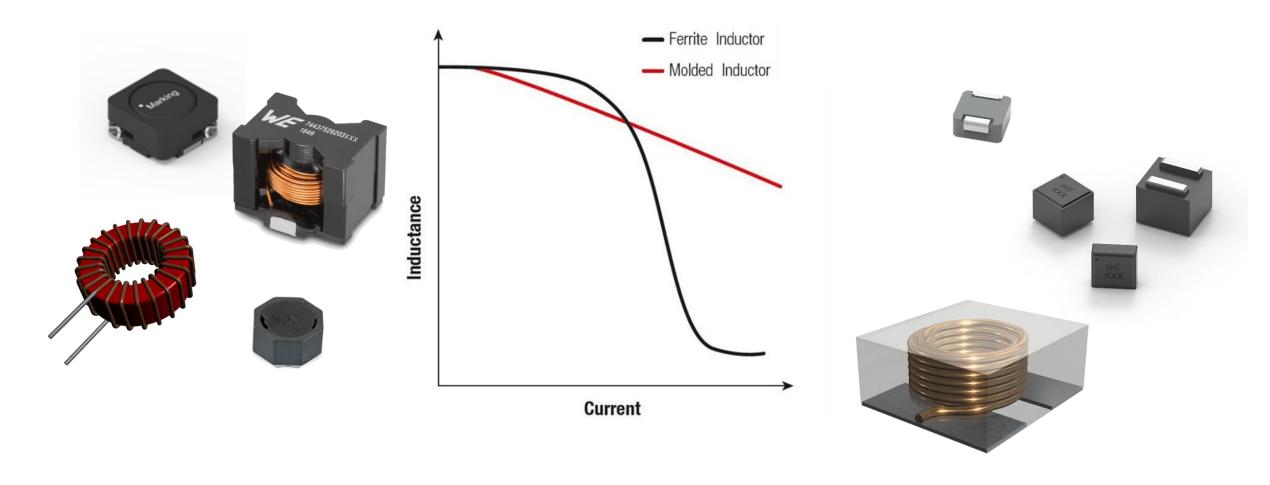
# **FROM FERRITE TO MOLDED INDUCTORS**



- > Long time experience
- > Relatively economic
- Wide variety of solutions

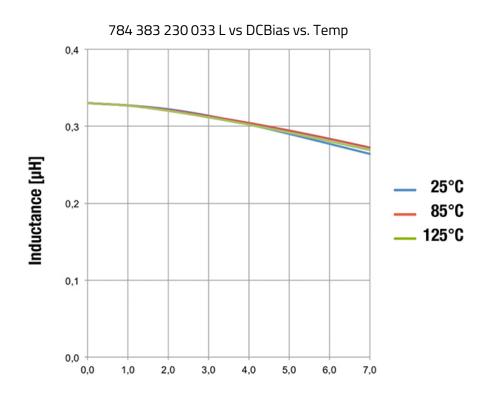
# **FROM FERRITE TO MOLDED INDUCTORS**

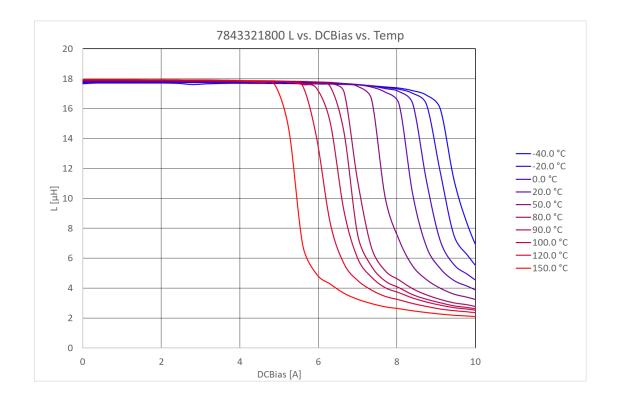
Molded inductors vs Ferrite inductors



# **FROM FERRITE TO MOLDED INDUCTORS**

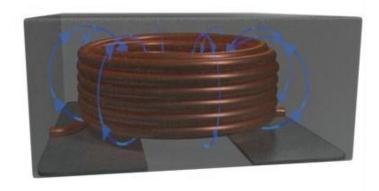
Molded inductors vs Ferrite inductors vs Temperature

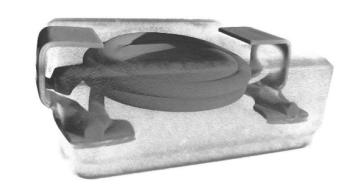




# **CHARACTERISTICS OF MOLDED INDUCTORS**

Molded inductor construction

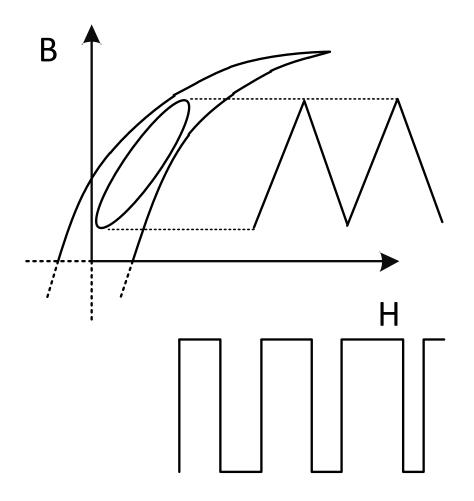






# **CHARACTERISTICS OF MOLDED INDUCTORS**

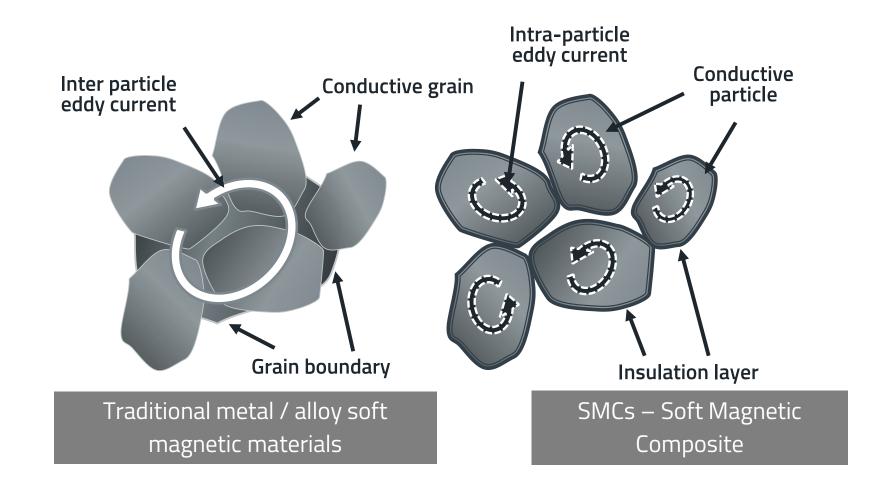
Inductor losses



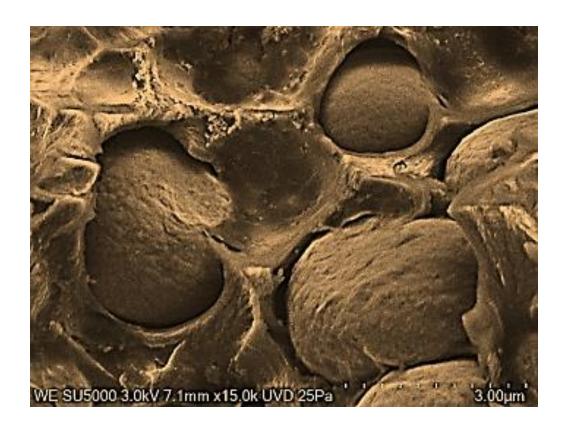
- Winding losses
  - Ohmic losses
  - Skin effect losses
  - Proximity effect losses
- Core losses
  - Hysteresis losses
  - Eddy current losses

# **CHARACTERISTICS OF MOLDED INDUCTORS**

Molded inductor construction



### Effects



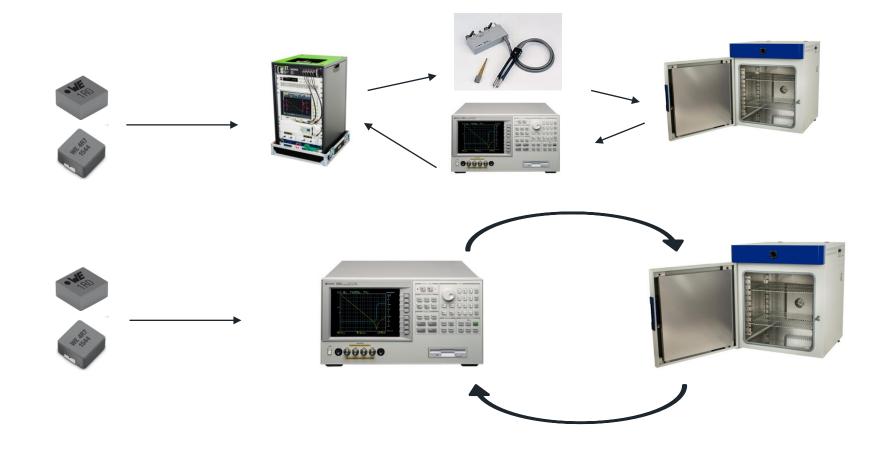
- Thermal aging refers to degradation of the insulation between the iron particles
- ➤ It is triggered by the continuous exposition to high temperatures
- The effect on the electrical characteristics is permanent

Effect





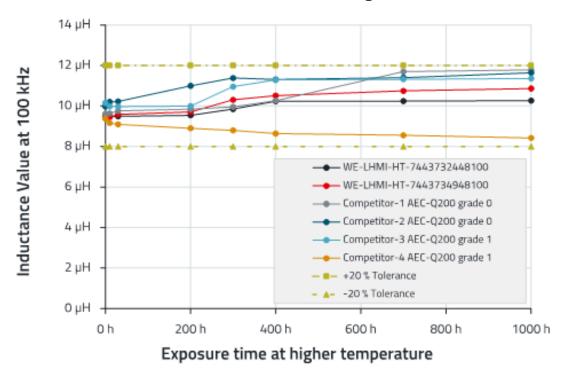
# Testing procedures



Results

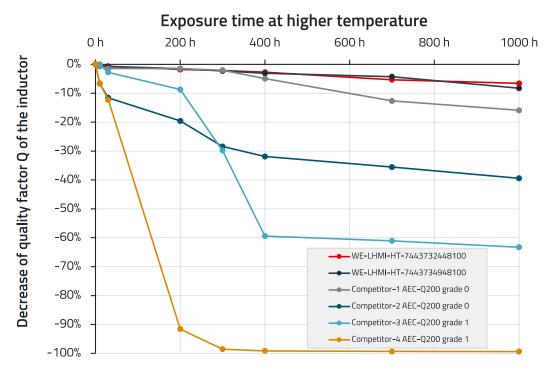
- Inductance value suffer minimum variations due to thermal aging
- > The AC losses increases due to degradation of the insulation between particles
- Bigger conductive paths for the formation of eddy current are formed

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



### Results

- Q value decreases over time
- We can use as indicator of the thermal aging phenomena
- Q value has a correlation with the increase of the AC losses in the core



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



# Würth Elektronik molded inductor portfolio







<ul><li>WE-LHMI</li></ul>	<ul><li>WE-LHCA</li></ul>	<ul><li>WE-XHMI</li></ul>	<ul><li>WE-XHMA</li></ul>	<ul><li>WE-MAPI</li></ul>	<ul><li>WE-MAIA</li></ul>
4020HT	7030	4020	6030	2512HT	4020HT
5020HT	1040	4030	6060	3015HT	
7030HT	1365	5030	8080	3020HT	
7050HT	1770	7070	1090	4020HT	
			1510		

# Questions & Answers



We are here for you now!
Ask us directly via our chat or via E-Mail.

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Mode Totem-Pole PFC



