EMC DESIGN ESSENTIALS: MASTERING VARISTORS AND COMMON MODE CHOKES

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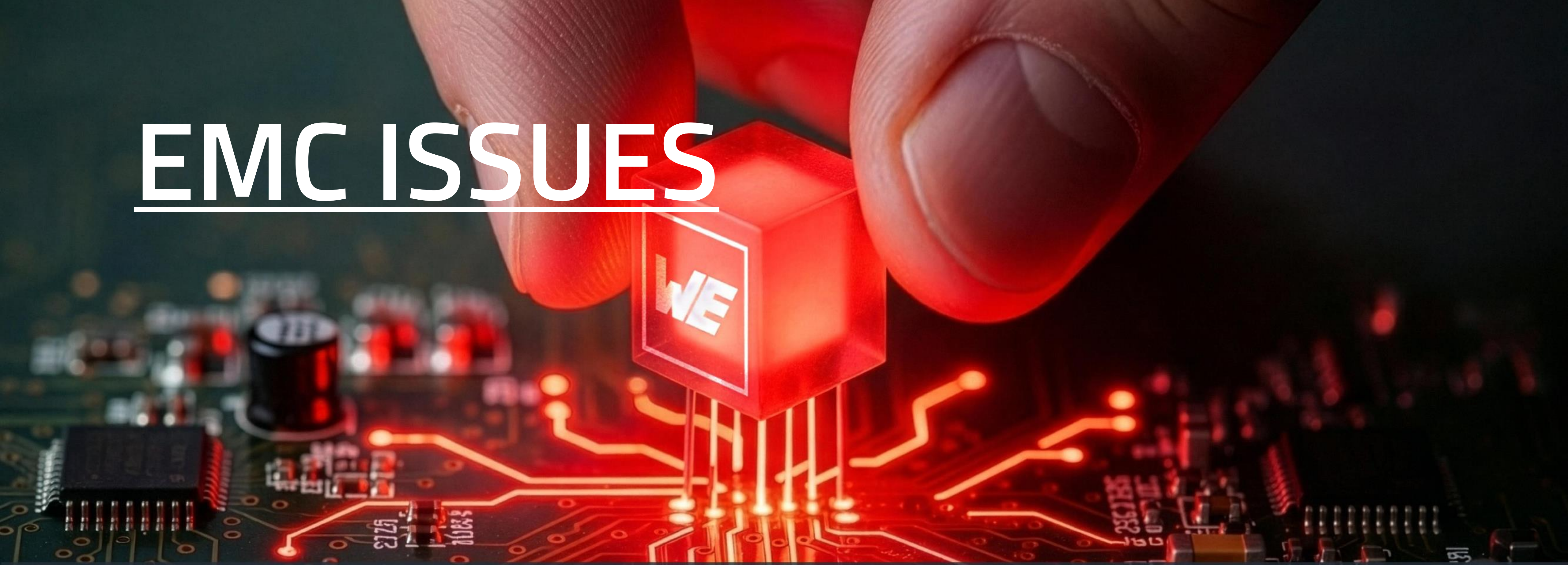
WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

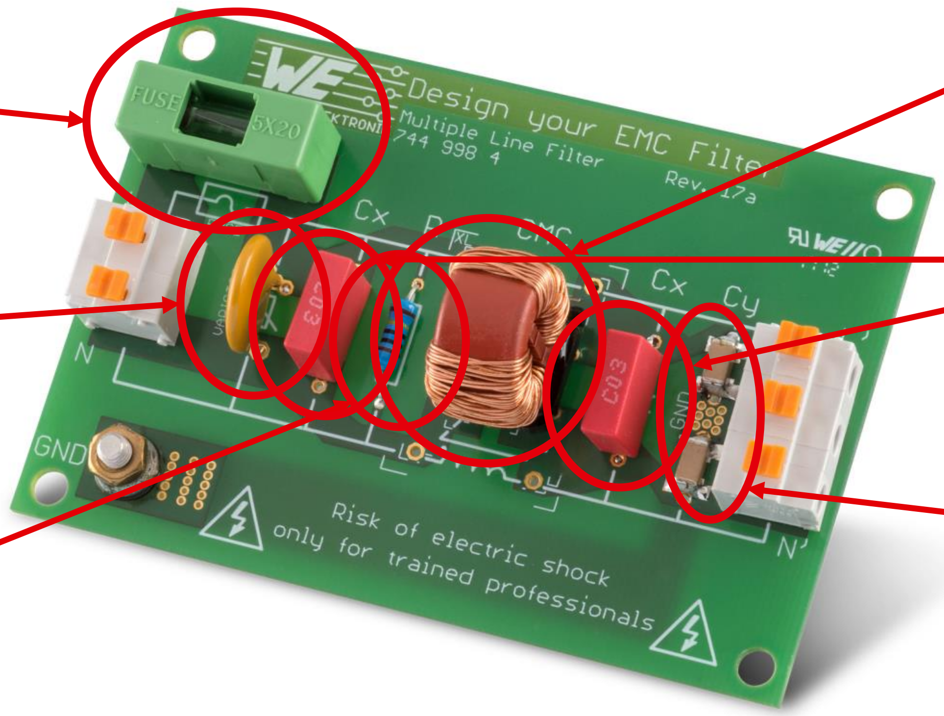
EMC ISSUES



To be the **FIRST CHOICE** for our customers through serving **MORE THAN YOU EXPECT** in every customer interaction!

SOLUTION

Build the right filter for your application



Fuseholder

Varistor

Discharge Resistor

Common Mode Choke

X-Capacitors

Y-Capacitors

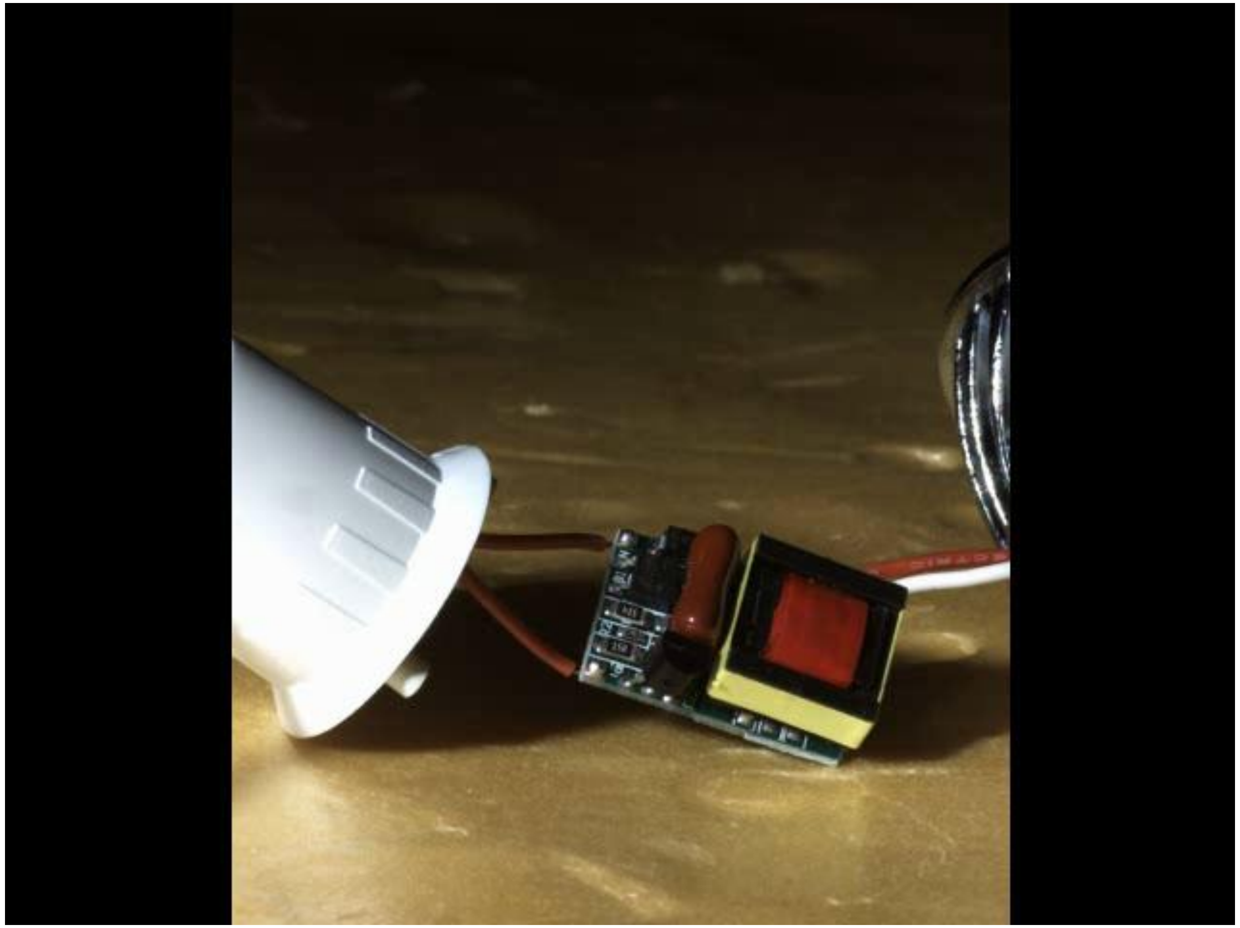
https://www.we-online.com/en/components/products/EVALUATION_BOARD_MULTIPLE_LINE_FILTER?srsltid=AfmBOool2uW7YX45Yl5fK__5GUEXA8O5p_uDzYLMqVNtBFvOO_hcKX9R

BASIC KNOWLEDGE OF OVERVOLTAGE PROTECTION

EXAMPLE OF OVERVOLTAGE

What will happen if there is not overvoltage protection?

Many times the overvoltage signal can cause permanente damage to the components. In the worst case, ignition/fire may happen.



OVERVOLTAGE DEFINITION

Classification according to standard

Natural Phenomenon

- High voltage, low repetition and high energy
- For example, lightning

IEC 61000-4-5 (EN 61000-4-5)

- Surge

Industrial

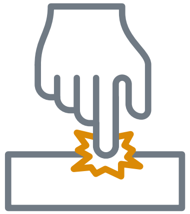
- High voltage, high repetition and low energy
- For example, swtich on/off of the circuit

IEC 61000-4-4 (EN 61000-4-4)

- E.F.T.B. (Electrical fast transient burst)

Electrostatic discharge

- Very high voltage, low repetition and low energy
- For example, contact between bodies



IEC 61000-4-2 (EN 61000-4-2)

- ESD (Electrostatic discharge)

OVERVOLTAGE CLASSIFICATION

Overview of different overvoltage pulses

Overvoltage	Voltage	Current	Rise time	Pulse length	Energy
Surge	0.5-4 kV	0.1-2 kA @2 Ω load	1.25 µs	50 µs	10-80 J
EFTB	0.5-4 kV	10-100 A @50 Ω load	5 ns	15 ms	100-1000 mJ
ESD	4-15 kV	1-50 A @50 Ω load	0.8 ns	60 ns	1-10 mJ

Key parameters

PROTECTION AGAINST SURGE PULSE

WE COMPONENTS AGAINST SURGE PULSES

Surge Protection

Product series (3) | Articles (482)

Diode

WE-TVSP Power TVS Diode

V_{DC} 5 to 440 V | I_{Peak} 0.6 to 326.1 A

WE-VS SMT Varistor

V_{DC} 3.3 to 85 V | I_{Peak} 10 to 200 A | W_{max} 0.02 to 1.1 J

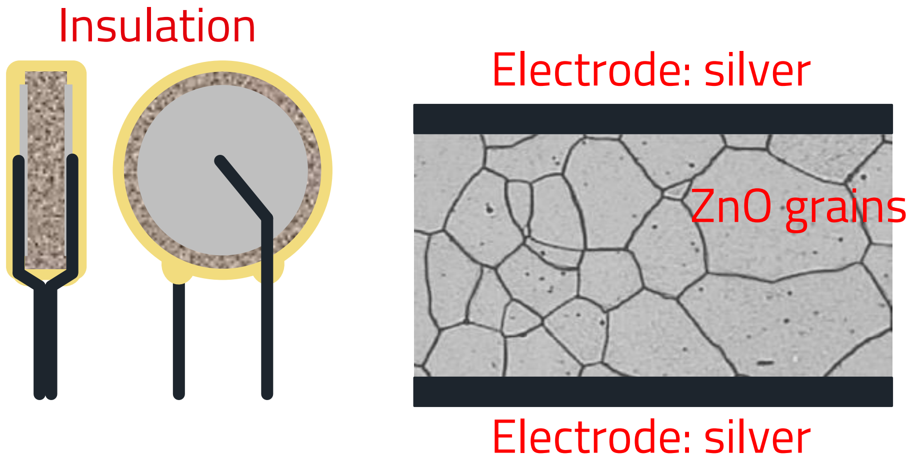
WE-VD Disk Varistor

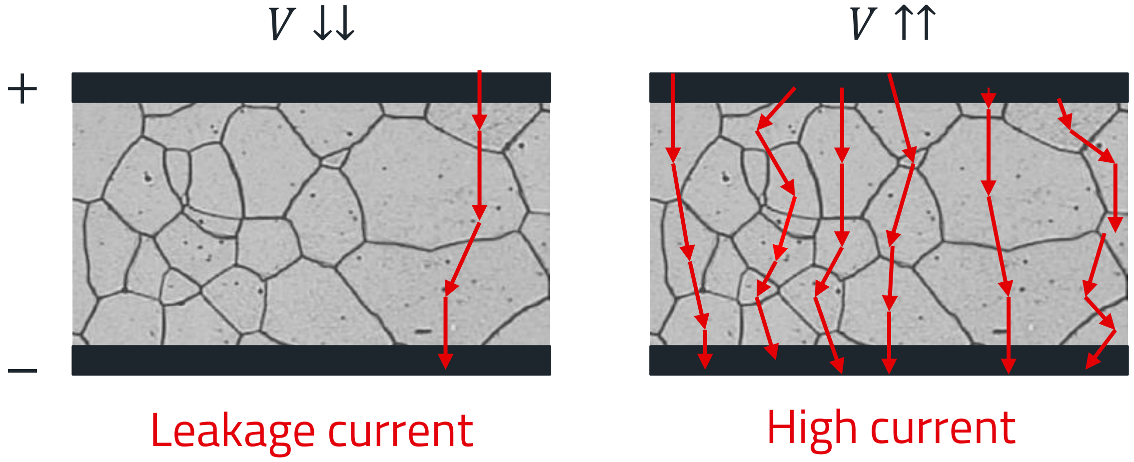
V_{DC} 18 to 1465 V | I_{Peak} 100 to 10000 A | W_{max} 0.7 to 620 J

Varistor

VARISTOR

Basic concepts

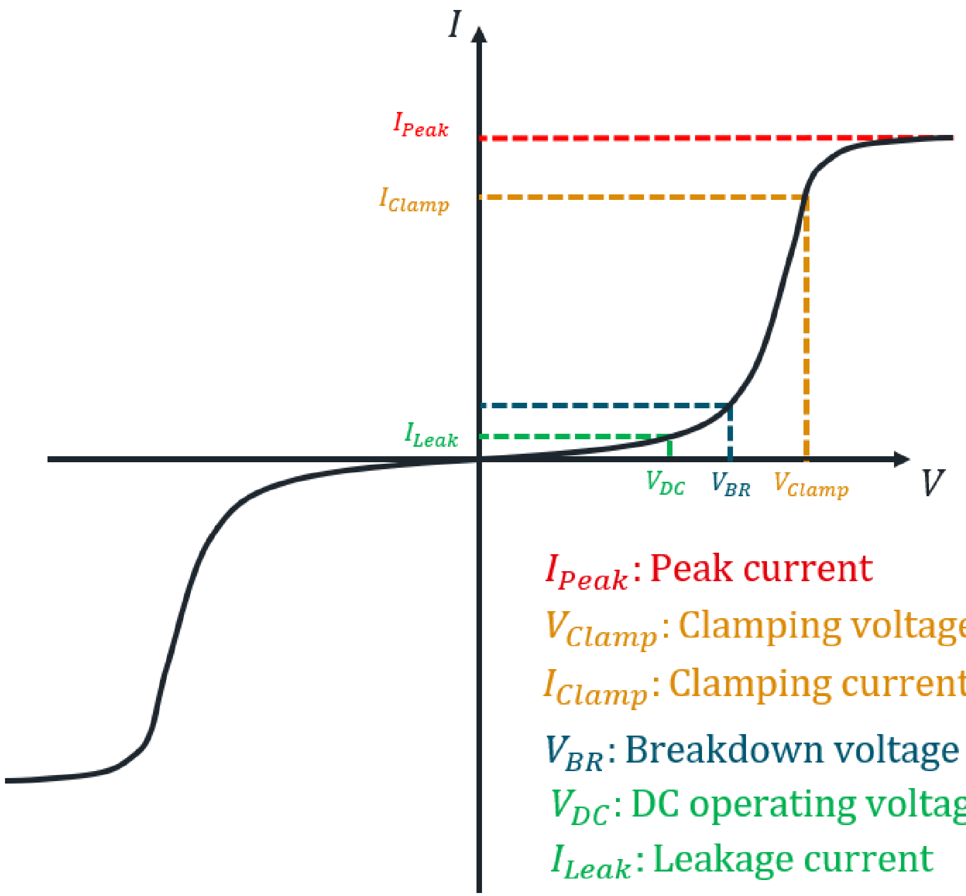




- The varistor is composed mainly by 3 layers: **insulation**, **electrode** and **core**.
- The core is formed by ZnO grains, the grains play a role like **allowed region** for the current; the border between grains are like **forbidden region.**
- The **forbidden region** can be passed by force when the voltage is **high** enough.
- When the voltage is **low**, only leakage current can pass between electrodes. When the voltage is **high**, all the ways are possible for electrons and the resistance of the varistor will become really low.

VARISTOR

Electrical parameters



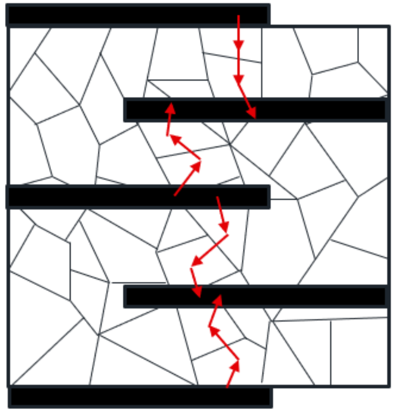
I_{Peak}: Peak current
V_{Clamp}: Clamping voltage
I_{Clamp}: Clamping current
V_{BR}: Breakdown voltage
V_{DC}: DC operating voltage
I_{Leak}: Leakage current

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
AC Operating Voltage	V_{RMS}		300	V	max.
DC Operating Voltage	V_{DC}		385	V	max.
Clamping Voltage	V_{Clamp}	50 A @ 8/20 µs	775	V	max.
(Reverse) Peak Pulse Current	I_{Peak}	8/20 µs	6000	A	max.
Power Dissipation	P_{Diss}		0.6	W	max.
Energy Absorption	W_{max}	10/1000 µs	175	J	max.
Nominal Discharge Current	I_n		3	kA	max.
Measured Limiting Voltage	V_{ML}		1200	V	max.
(Reverse) Breakdown Voltage	V_{BR}	1 mA	470	V	±10%
(Channel) Input Capacitance	C_{Ch}	1 kHz	420	pF	typ.

MULTILAYER VARISTOR

Basic concepts

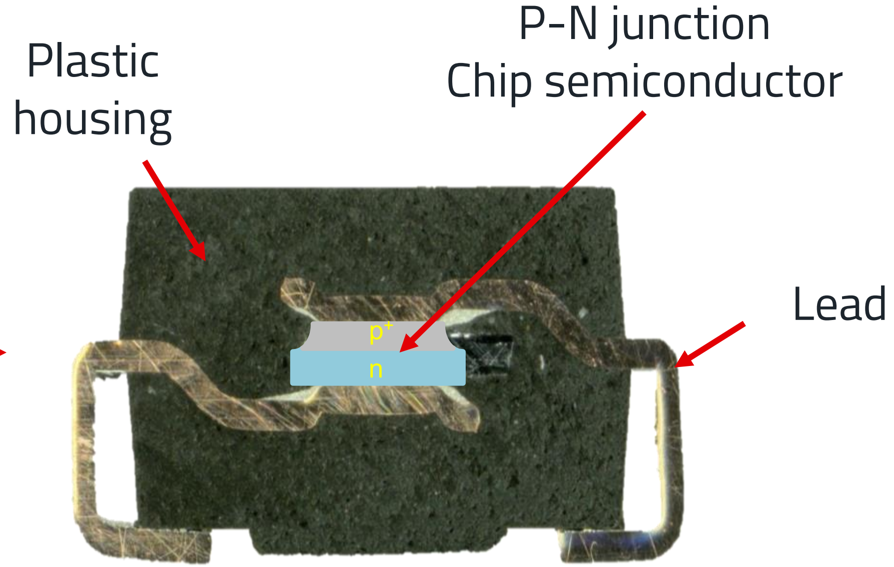


Serie	THT Varistor	Multilayer varistor
Mount	THT	SMD
V_{Rms} (V)	14-1000	2.5-60
I_{Peak} (A)	100-10000	10-200
W_{max} (J)	0.7-620	0.02-1.10
C (pF)	32-12100	70-3600
Reaction time	<25 ns	<1 ns

- The **multilayer varistor** is designed for **surface-mount** technology (SMT), allowing it to be soldered directly onto the PCB surface.
- The **internal structure** of multilayer varistor is practically **same** as THT varistor. The **ZnO core** is connected with **electrode of silver**.
- Comparing both series, it can be observed that **THT varistor** is **bigger** and it is based on **THT**, meanwhile **Multilayer varistor** is **smaller** and is based on **SMT**. Due to the **size difference**, the THT varistor has higher current and power capability, but its reaction time is also slower than multilayer varistor.

TVSP DIODE

Basic concepts

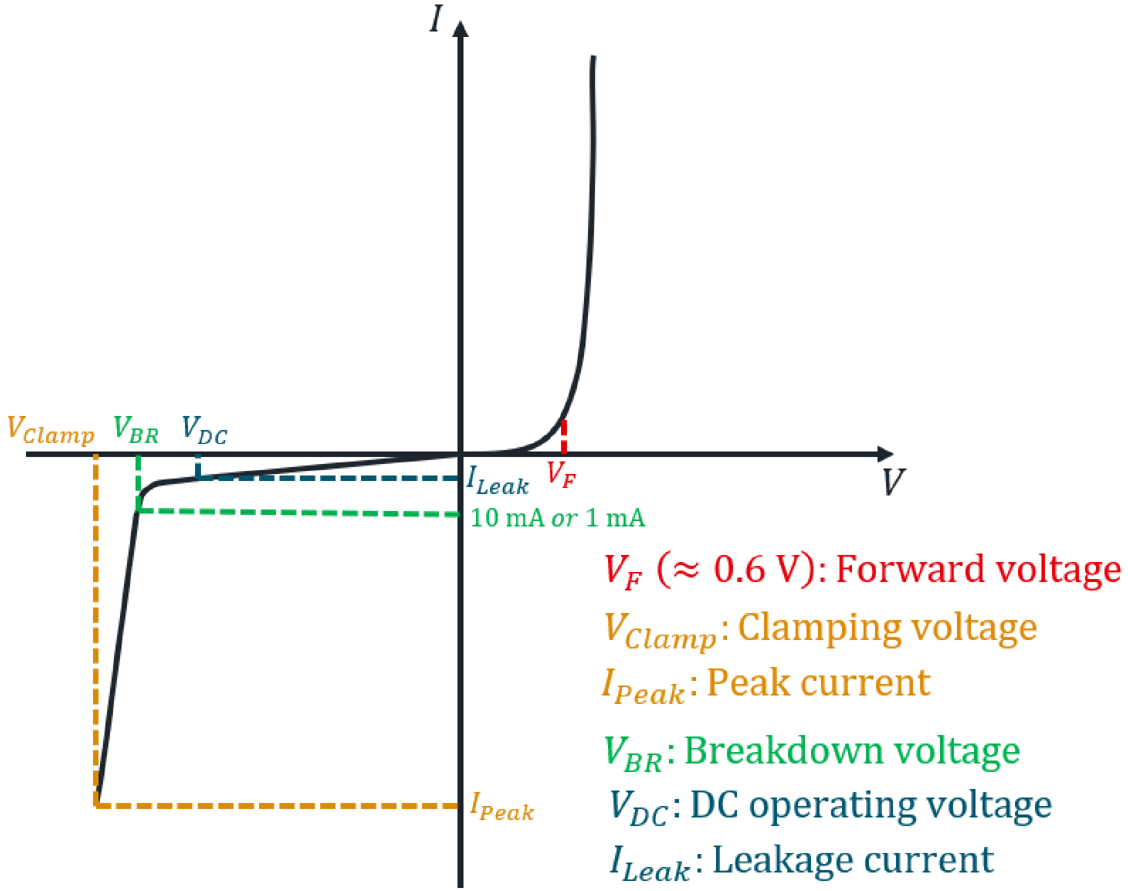


Serie	THT varistor	Multilayer varistor	TVS Diode
Mount	THT	SMD	SMD
$V_{DC}(V)$	18-1470	3.3-85	5-440
$I_{Peak}(A)$	100-10000	10-200	0.6-326.1
$W_{max}(J)$	0.7-620	0.02-1.10	-
C (pF)	35-12100	70-3600	1-20000
Reaction time	<25 ns	<1 ns	<1 ns

- Different than varistors, **TVSP diode** is based on **silicon technology**, P-N junction.
- The junction is connected with **2 leads** so that it can be connected to the circuit. Then the whole chip is protected by a **plastic housing**, avoiding contamination of the chip.
- The MSL is classified to **level 1**.

TVS DIODE

Basic properties



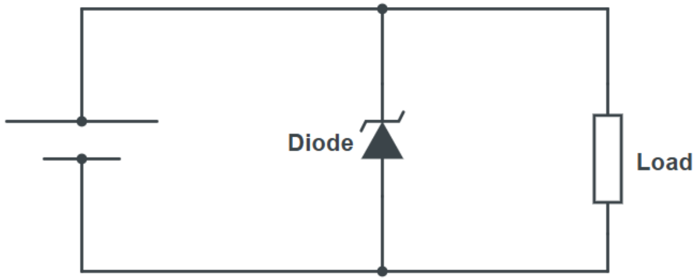
Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
DC Operating Voltage	V_{DC}		7.5	V	max.
(Reverse) Breakdown Voltage	V_{BR}	1 mA	8.77	V	±5%
Clamping Voltage	V_{Clamp}	I_{PEAK}	12.9	V	max.
(Reverse) Peak Pulse Current	I_{Peak}	10/1000 µs	31	A	max.
(Forward) Peak Pulse Current [1]	I_{Peak}		40	A	max.
Leakage Current	I_{Leak}	V_{DC}	100	µA	max.
Steady State Power Dissipation	P_{Diss}	T_A = 50 °C	3.3	W	max.
Power Dissipation [2]	P_{Diss}	10/1000 µs	400	W	max.
Polarity	Unidirectional				

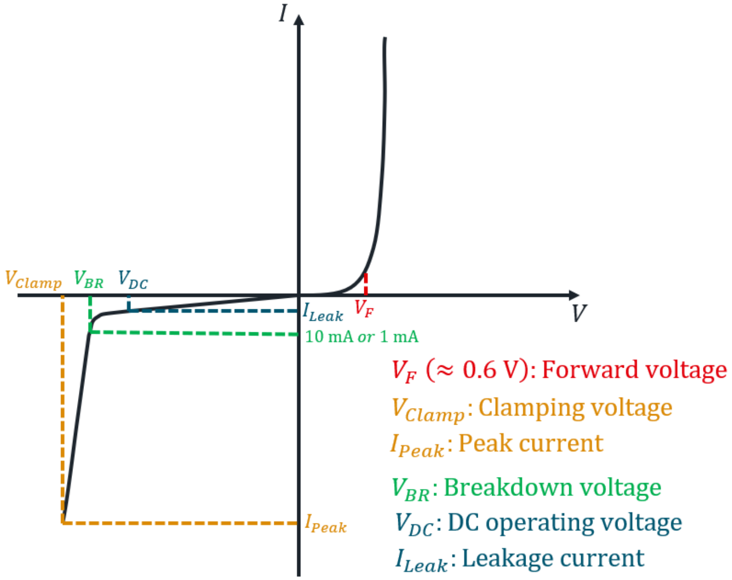
1) 8.3 ms single half-sine wave or equivalent square wave. Duty cycle = 4 pulses per minute
2) Mounted on 5.0 mm x 5.0 mm (0.03 mm thick) Copper Pads to each terminal

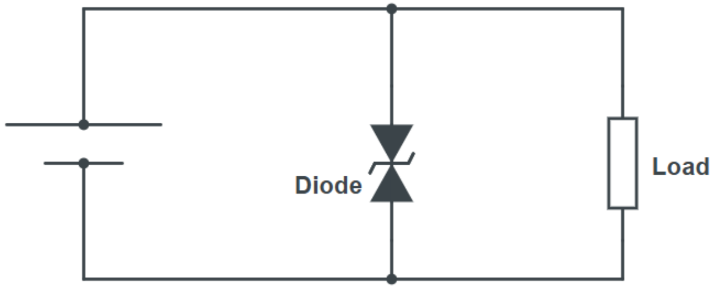
TVS DIODE

Unidirectional and bidirectional

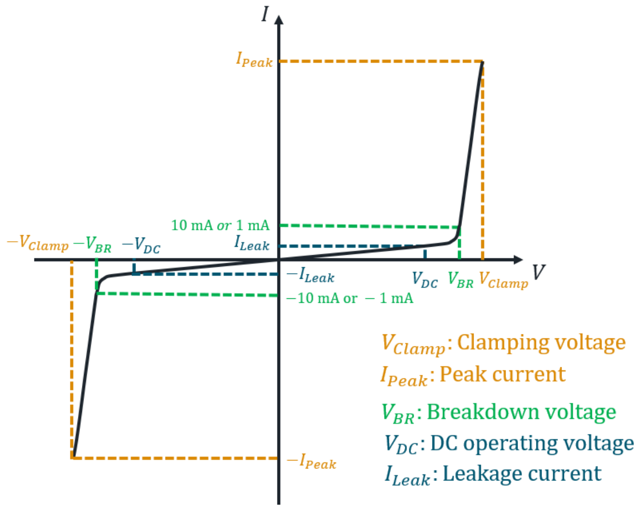


Unidirectional





Bidirectional



PROTECTION AGAINST ESD PULSE

COMPONENTS AGAINST ESD

ESD Protection

Product series (7) | Articles (61) | New ESD diode model

Diode

WE-TVS TVS Diode – Standard Series
$V_{Ch\ max.}$ 3.3 to 24 V | $C_{Ch\ typ.}$ 12 pF to 1.65 nF | $V_{ESD\ Contact}$ 10 to 30 kV

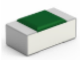
WE-TVS TVS Diode – High Speed Series
$V_{Ch\ max.}$ 3.3 to 5 V | $C_{Ch\ typ.}$ 1 to 3 pF | $V_{ESD\ Contact}$ 8 to 30 kV

WE-TVS TVS Diode – Super Speed Series
$V_{Ch\ max.}$ 3.3 to 5 V | $C_{Ch\ typ.}$ 0.18 to 0.55 pF | $V_{ESD\ Contact}$ 8 to 15 kV

Varistor

WE-VE ESD Suppressor
V_{DC} 5 to 24 V | $C_{Ch\ typ.}$ 0.05 pF

WE-VE ULC ESD Suppressor
V_{DC} 5 to 12 V



WE-VE femtoF
V_{DC} 6 to 26 V | $C_{Ch\ typ.}$ 0.05 pF | $V_{ESD\ Contact}$ 8 kV

WE-VEA ESD Suppressor-Array
V_{DC} 5 to 18 V

When higher is the "speed", lower is the capacitance.

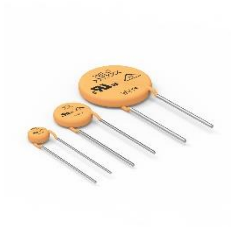
OVERVOLTAGE PROTECTIVE COMPONENTS

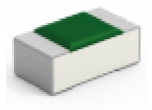
General overview

The components against ESD pulse have in general lower capacitance



Component	Surge	EFT/Burst	ESD	Reaction time	Capacitance
GDT Gas discharge tube	X			µs	1 pF
MOV Metal Oxide Varistor	X	X		>25 ns	10 p - 10 nF
MLV Multilayer Varistor	X	X	X	<1 ns	70 p - 14 nF
TVS Diode Transient Voltage Suppression			X	<1 ns	0,1-30 pF
TVSP Diode TVS Power	X	X	X	<1 ns	20-2000 pF
ESD Suppressor			X	<1 ns	0,2-100 pF





WHY IS THE CAPACITANCE IMPORTANT?

- The insertion loss of a circuit depends on the input impedance.

$$IL(dB) = -20\log_{10}|1-\Gamma|$$

$$\Gamma = \frac{Z_{in} - Z_o}{Z_{in} + Z_o}$$

IL = Insertion loss Z_{in} = Input impedance Z_o = Characteristic impedance

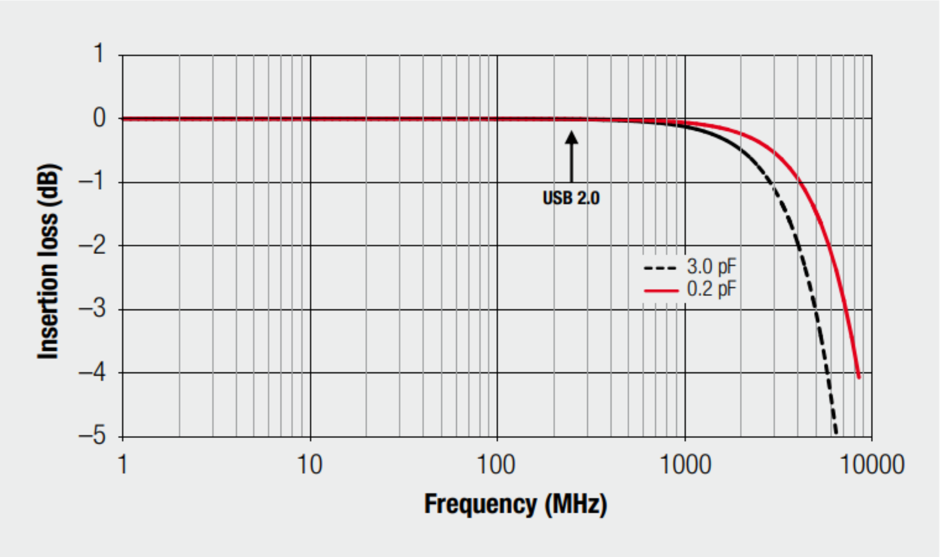
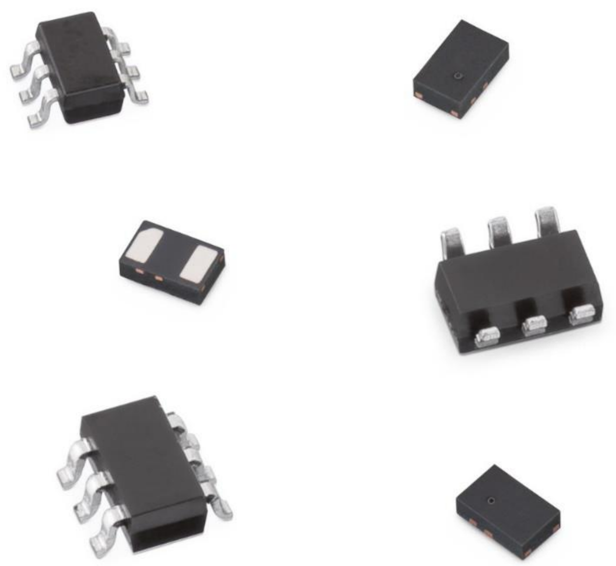


Fig. 2.185: *Comparison of the insertion loss of 0.2 pF and 3.0 pF*

Signalling		Data line		Data rate	Frequency	Rec. Capacitance for ESD device*)
Single ended signalling		RS 232		115.2 kBit/s	57.6 kHz	<56 pF
		I²C		100 kBit/s 400 kBit/s 1 MBit/s 3.4 MBit/s	50 kHz 200 kHz 500 kHz 1.7 MHz	<56 pF
Differential signalling	Communication	RS 422 RS 485		10 MBit/s 12 MBit/s	5 MHz 6 MHz	<10 pF
		CAN		1 MBit/s	500 kHz	<22 pF
		USB	1.1	12 MBit/s	6 MHz	<10 pF
			2.0	480 MBit/s	240 MHz	<2 pF
			3.2 Gen 1x1	5 GBit/s	2.5 GHz	<0.5 pF
			3.2 Gen 2x1 3.2 Gen 2x2 4 Gen 2	10 GBit/s	5 GHz	<0.35 pF
			4 Gen 3	20 GBit/s	10 GHz	<0.2 pF
		SATA	1.0	1.5 GBit/s	750 MHz	<1 pF
			2.0	3 GBit/s	1.5 MHz	<1 pF
			3.0	6 GBit/s	3 MHz	<0.6 pF
		Ethernet	IEEE 802.3u	100 MBit/s	125 MHz digital CLK 31.25 MHz (UTP	<2 pF
			IEEE 802.3ab	250 MBit/s	62.5 MHz	<2 pF
			IEEE 802.3ak	2.5 GBit/s	417 MHz	<0.2 pF
	Video	LVDS		3.125 GBit/s	1.56 GHz	<2 pF
		HDMI	1.0, 1.1, 1.2	1.65 GBit/s	825 MHz (165 MHz)	<1 pF
			1.3, 1.4	3.4 GBit/s	1.7 GHz (340 MHz)	<0.6 pF
			2	6 GBit/s	3 GHz (600 MHz)	<0.6 pF
		Display Port	1.1	1.62 GBit/s	810 MHz (162 MHz)	<1 pF
			1.1	2.7 GBit/s	1.35 GHz (270 MHz)	<1 pF
			1.2	5.4 GBit/s	2.7 GHz (540 MHz)	<0.6 pF
			1.3	8.1 GBit/s	4.05 GHz (810 MHz)	<0.6 pF

TVS DIODE

Standard, High Speed, Super Speed



Serie	$V_{ch,max}$(V)	I_{Peak}(A)	$C_{ch,typ}$(pF)
Standard	3.3-24	6-180	12-1650
High Speed	3.3-5	5-30	1.2-3
Super Speed	3.3-5	3-5	0.18-0.55

The capacitance decreases.

TVS DIODE

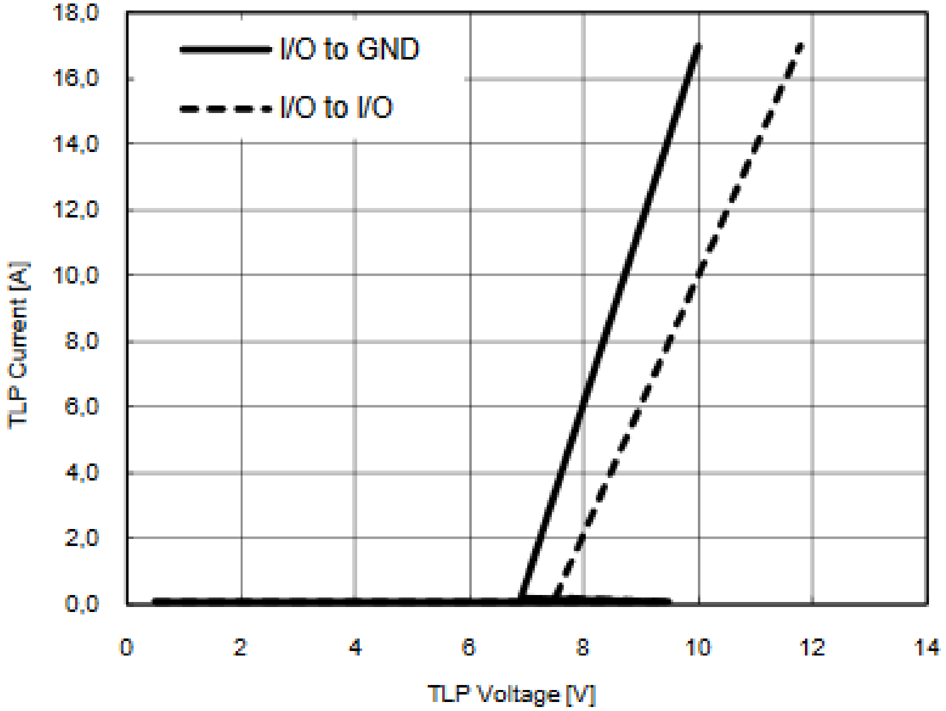
Snapback effect

- Diodes are based on **P-N junction**.

- **Snapback effect** comes from **parasitic transistor** when the voltage increases to a certain level.

- The diodes with **snapback effect** have almost **same behavior** as the normal diodes, but they have **lower clamping voltage** in the clamping area, it means a **better protection**.

- A small **disadvantage** is that the component needs **extra voltage** to activate, but this extra voltage is **not comparable** with the voltage from transient signal.

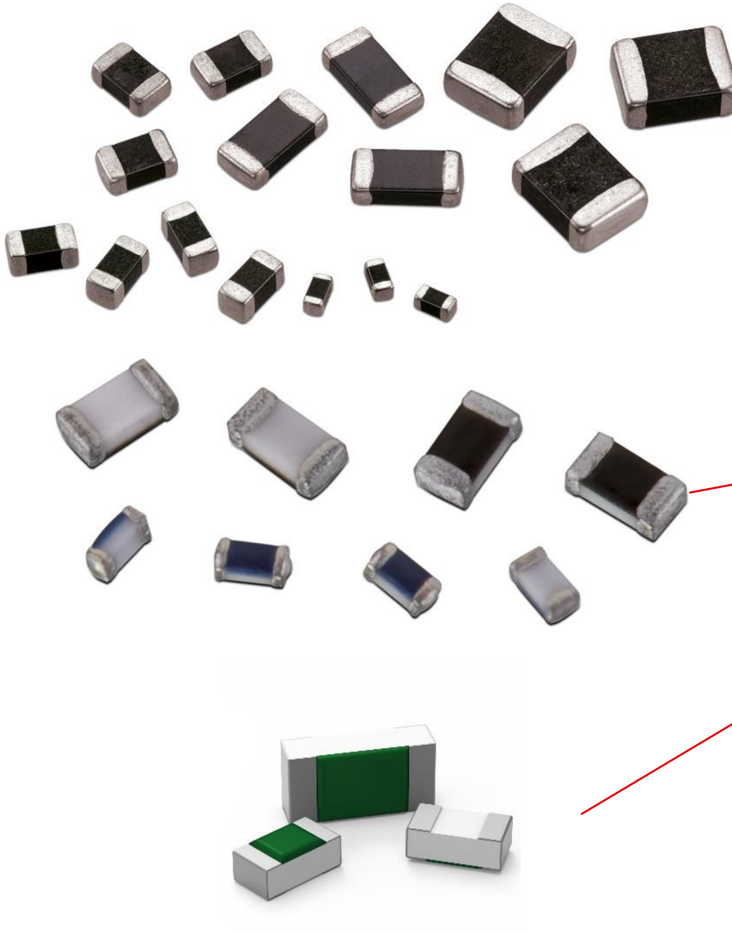


Transmission Line Pulsing (TLP) Measurement

More info about snapback effect in AppNote: [ANP143]

ESD SUPRESSOR

Standard, ULC, femtoF

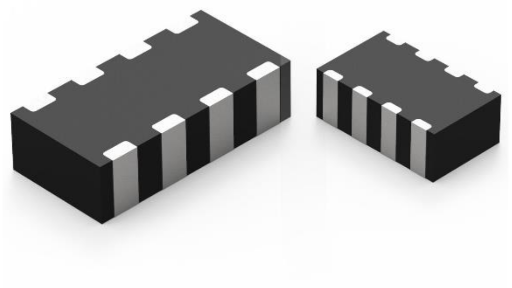


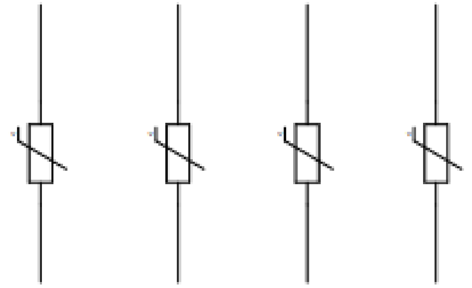
Serie	V_{DC}(V)	$C_{ch,typ}$(pF)
Standard	5-24	1-100
ULC	5-12	0.2
femtoF	6-26	0.05

The capacitance decreases

Varistors

MULTIARRAY VARISTOR





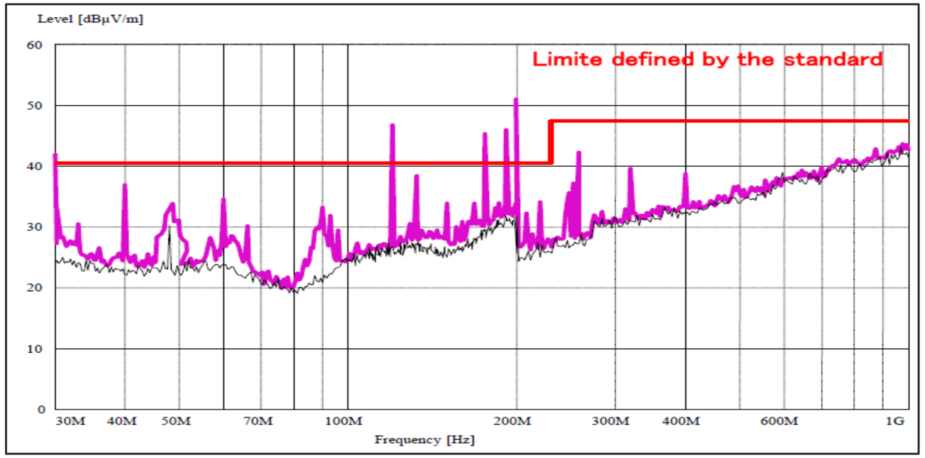
- The multiarray varistor work as **4 varistors connected in paralell**.
- Used for **compact** design of PCB.
- Depending on the design and applied technology, it is also possible to have **multiarray varistor with low capacitance value**.

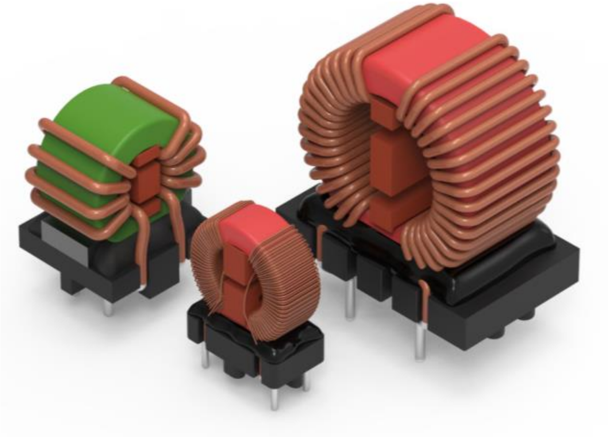
COMMON MODE CHOKES

WHY COMMON MODE CHOKES?

Benefits

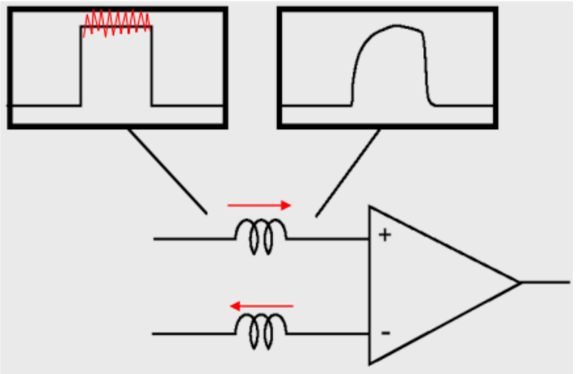
- Suppress electromagnetic interference (EMI)
- Ensure compliance with EMC standards
- Preserve signal integrity





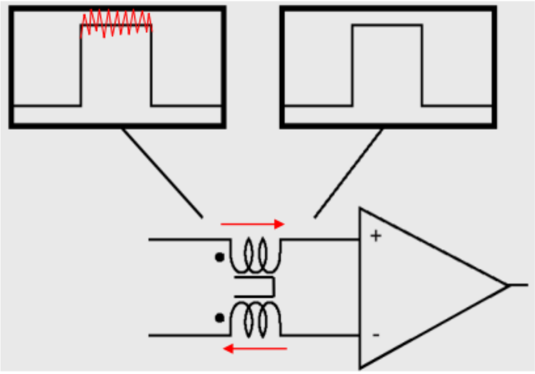
Filter with two inductors

Filter input Filter output



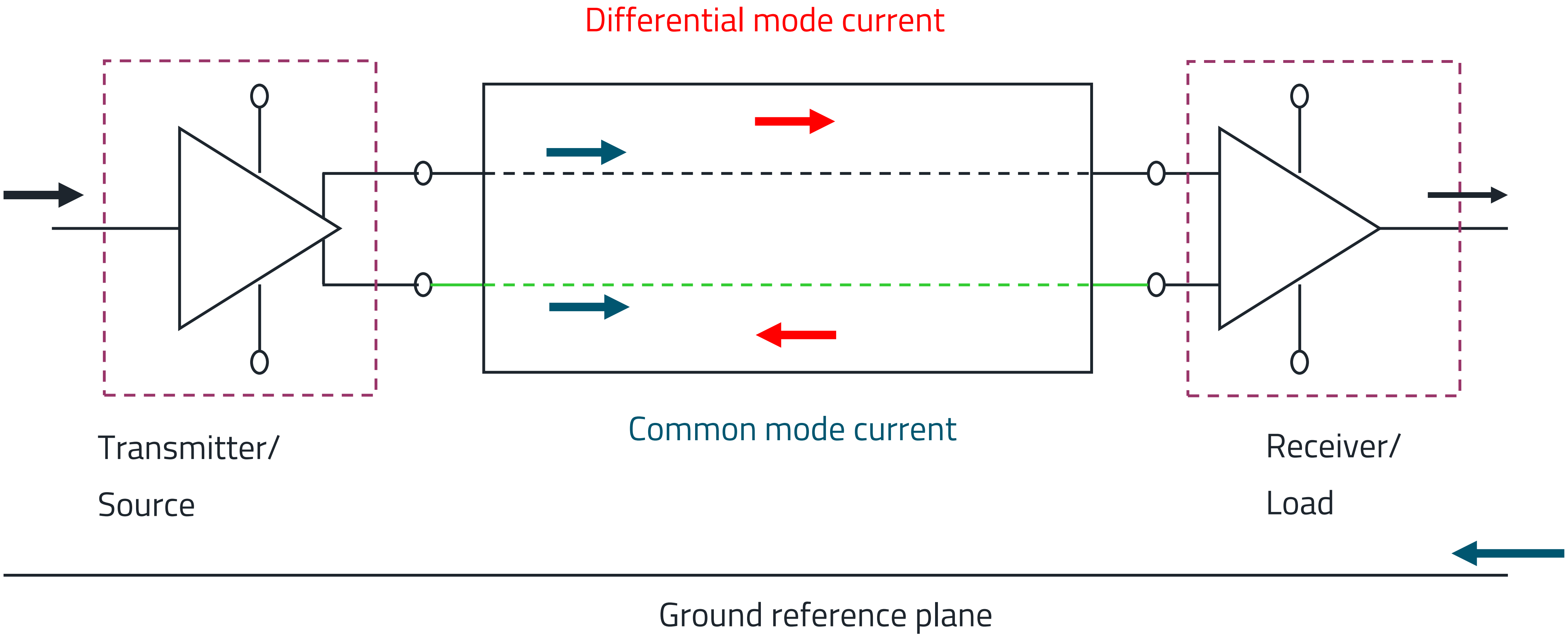
Filter with CMC

Filter input Filter output



MODE COMPARISON

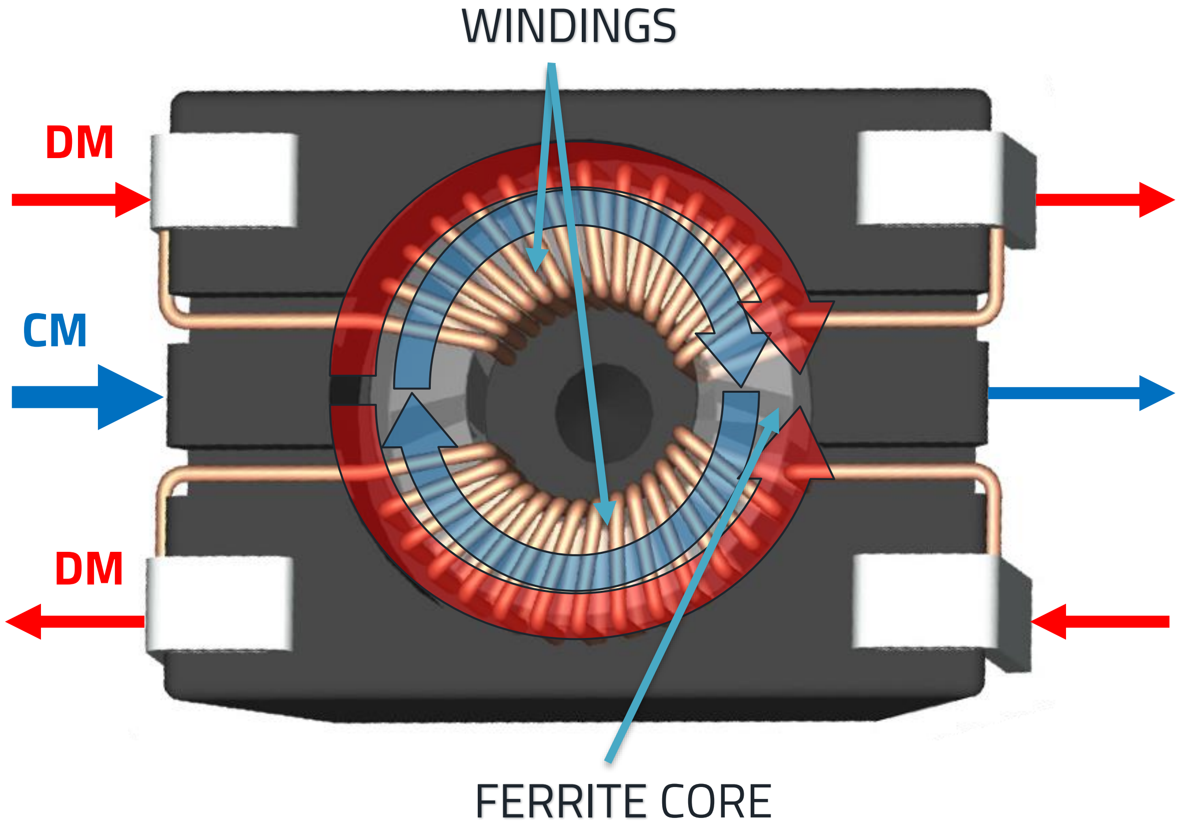
Common Mode vs. Differential Mode

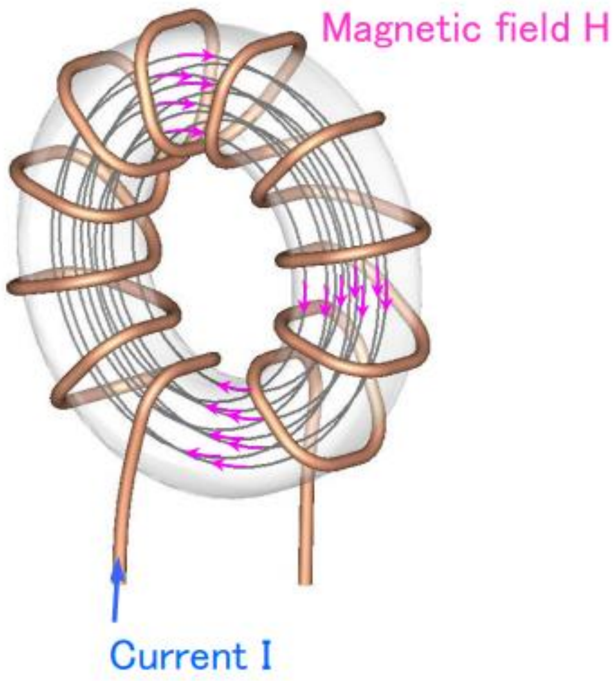


WHAT IS A COMMON MODE CHOKE (CMC)?

How it Works

- A common-mode choke suppresses common-mode noise (CM) while allowing differential-mode currents (DM) to pass with little attenuation.



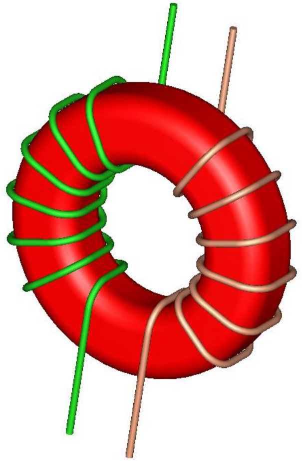


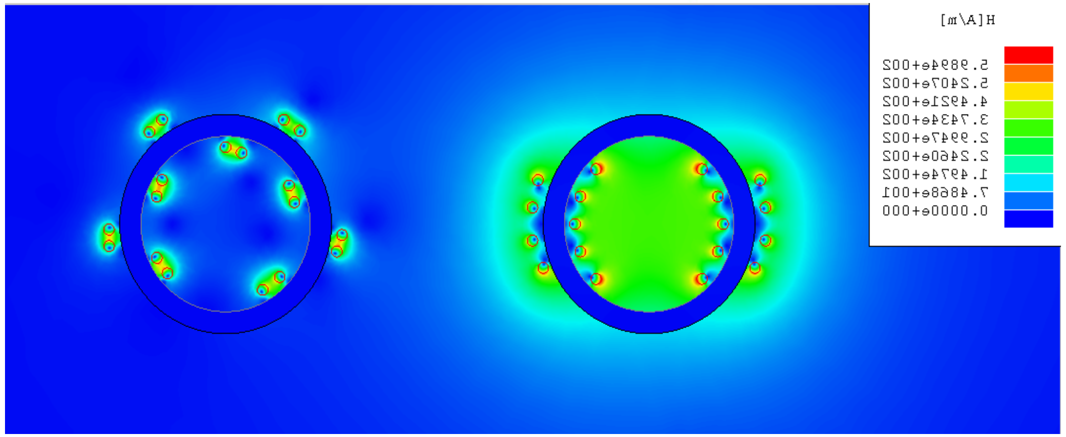
COMMON MODE CHOKES

Winding Styles

Bifilar

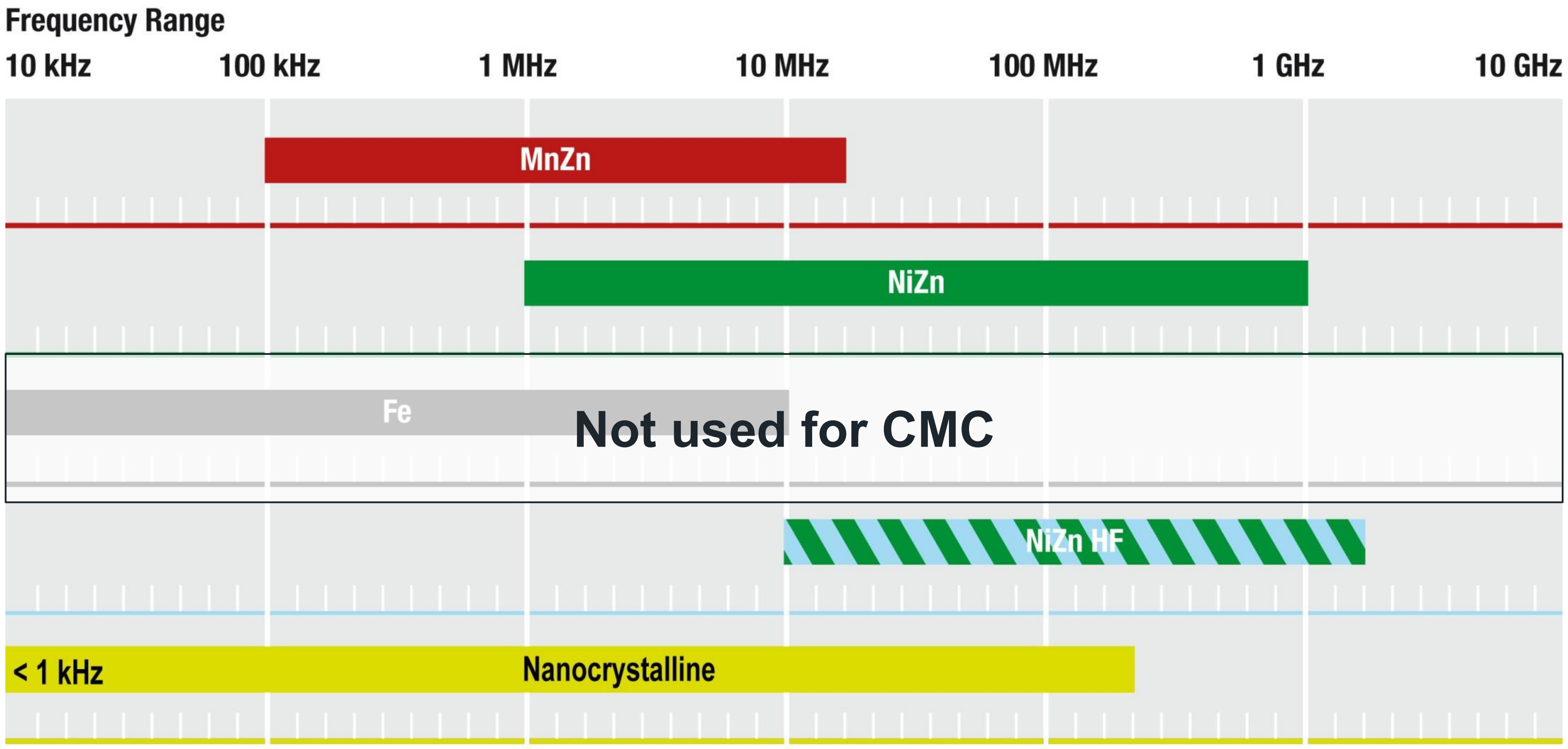
Sectional





COMMON MODE CHOKES

Core materials



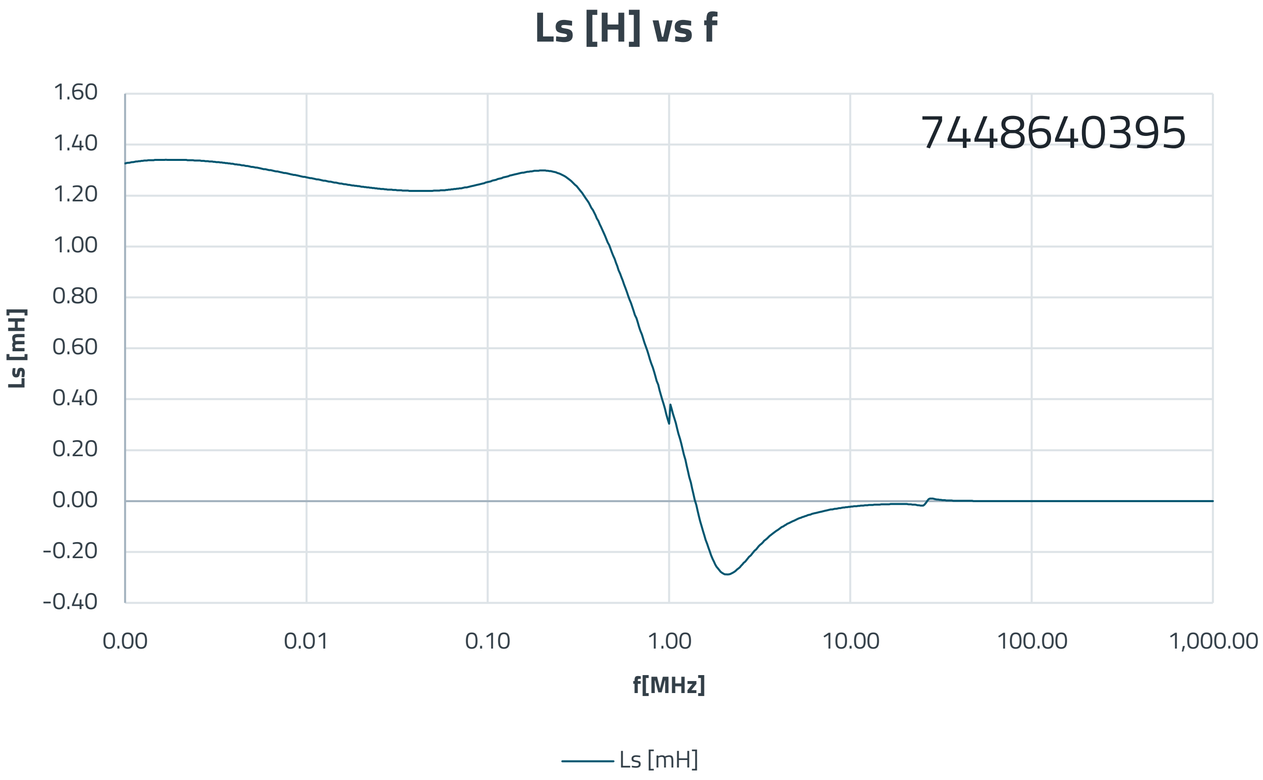
DATASHEET PARAMETERS

Comparison - Inductance

- take care of the Test Condtions

Electrical Properties:

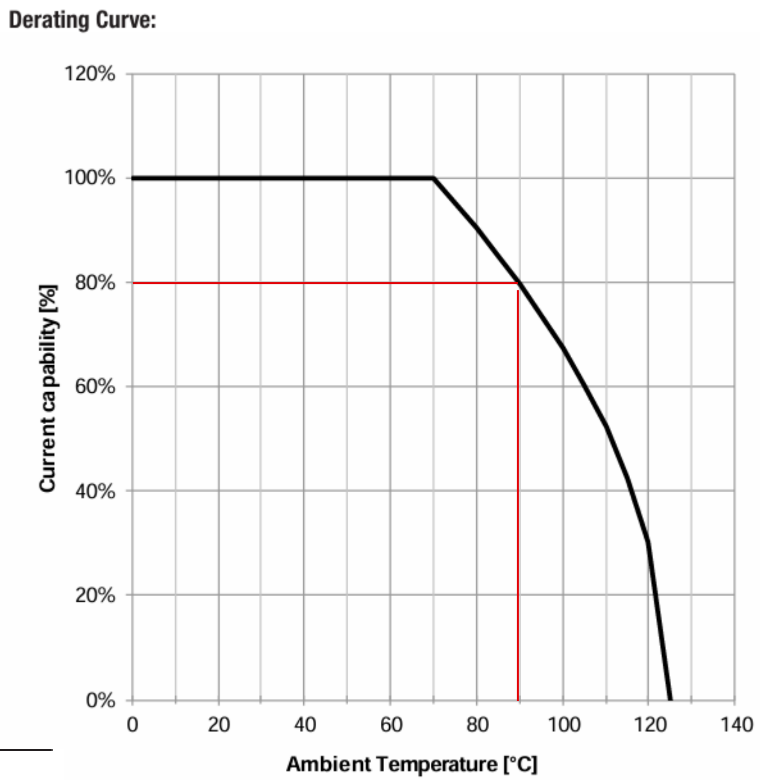
Properties		Test conditions	Value	Unit	Tol.
Number of windings	N		2		
Inductance	L	10 kHz/ 100 mV	0.82	mH	min.
Inductance	L	10 kHz/ 100 mV	1.1	mH	typ.
Leakage Inductance	L_S	100 kHz/ 100 mV	13.5	µH	typ.
Rated Current	I_R	@ 70 °C/ ΔT < 55 K	2.6	A	max.
DC Resistance	R_{DC}	@ 20 °C	0.08	Ω	max.
Rated Voltage	V_R	50 Hz	250	V (AC)	max.
Insulation Test Voltage	V_T	50 Hz/ 5 mA/ 2 sec.	2000	V (AC)	



DATASHEET PARAMETERS

Comparison Rated Current

- often different rated temperatures are used
- rated temperature → 70°C
  - maximum ambient temperature at which an inductor can carry its rated current
- temperature rise / self heating → 55K
- rated temperature + temperature rise < max. operating temperature
- Higher ambient temperature as rated temperature ?
  - derating needed



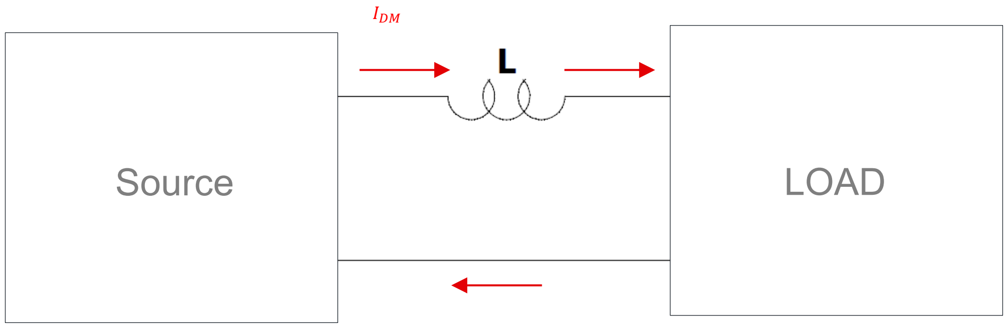
Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Number of windings	N		2		
Inductance	L	10 kHz/ 100 mV	0.82	mH	min.
Inductance	L	10 kHz/ 100 mV	1.1	mH	typ.
Leakage Inductance	L_S	100 kHz/ 100 mV	13.5	µH	typ.
Rated Current	I_R	@ 70 °C/ ΔT < 55 K	2.6	A	max.
DC Resistance	R_{DC}	@ 20 °C	0.08	Ω	max.
Rated Voltage	V_R	50 Hz	250	V (AC)	max.
Insulation Test Voltage	V_T	50 Hz/ 5 mA/ 2 sec.	2000	V (AC)	

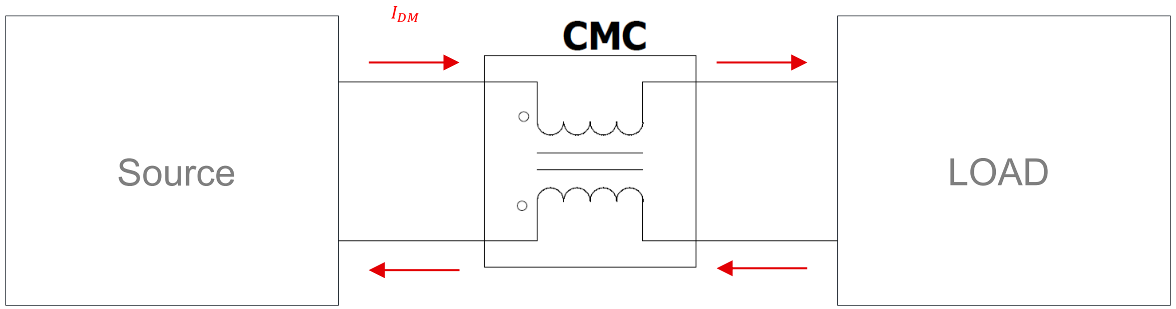
General Information:

Operating Temperature	-40 up to +125 °C
Ambient Temperature (referring to I_R)	-40 up to +70 °C
Storage Conditions (in original packaging)	< 40 °C ; < 75 % RH
Moisture Sensitivity Level (MSL)	1
Temperature Rise < 55 K	
Test conditions of Electrical Properties: +20 °C, 33 % RH if not specified differently	

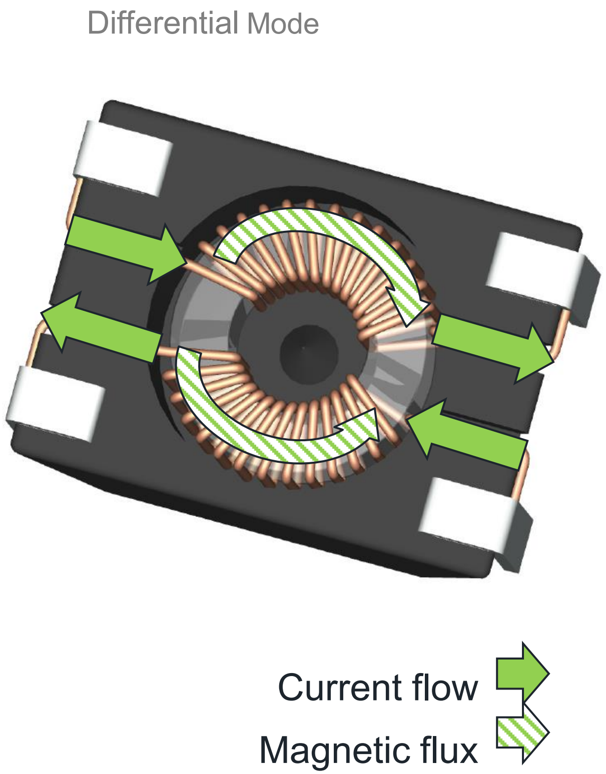
SATURATION



I_{DM}
L
Source
LOAD

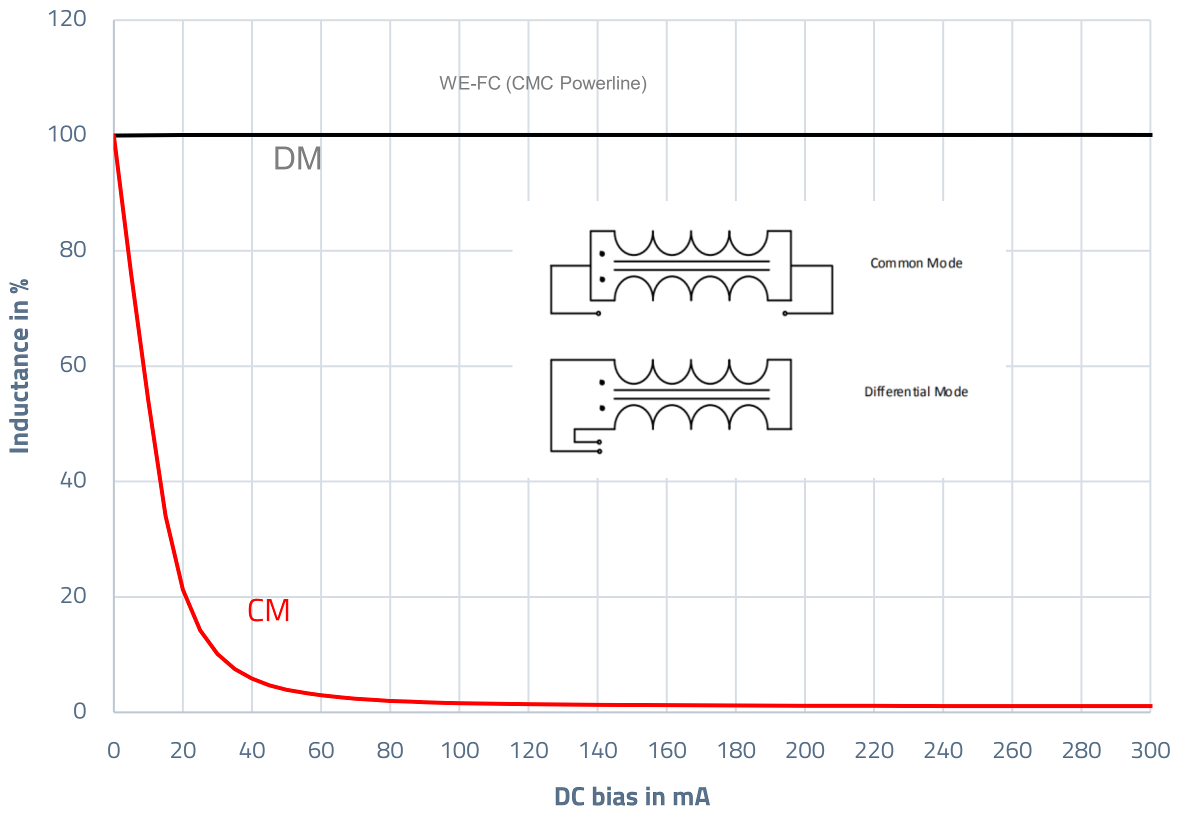


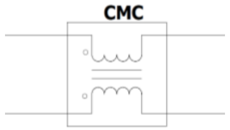
I_{DM}
CMC
Source
LOAD



Differential Mode
Current flow
Magnetic flux

SATURATION



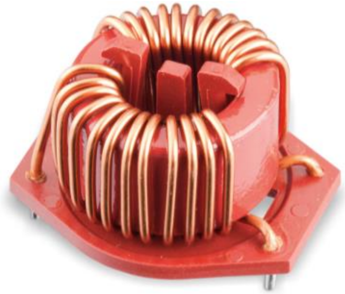


Inductance	L	10 kHz/ 100 mV	10	mH	min.
Inductance	L	10 kHz/ 100 mV	13	mH	typ.
Rated Current	I_R	@ 70 °C/ ΔT < 55 K	0.8	A	max.

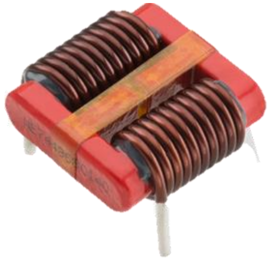
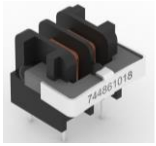
COMMON MODE CHOKES

Mains Power Line Applications

- Safety requirements – IEC 60938
  - Creepage distance
  - Clearance distance
- Winding Styles
  - (only) sectional
- Leakage Inductance
- Core materials
- Designs



SAFETY REQUIREMENTS

IEC 60938 – (2021) Fixed inductors for electromagnetic interference suppression

- Clearance Distances
  - shortest distance in air between two conductive parts

		Mains supply nominal voltage line-to-neutral			
	AC voltage	150 V	300 V	600 V	1000 V
	DC voltage	250 V	450 V	900 V	1500 V
Between live parts of different polarity		1,5 mm	2,5 mm	3,0 mm	5,5 mm

- Creepage Distances
  - shortest distance between two conductive parts
  - depending on Pollution degree and Material group of the insulation material

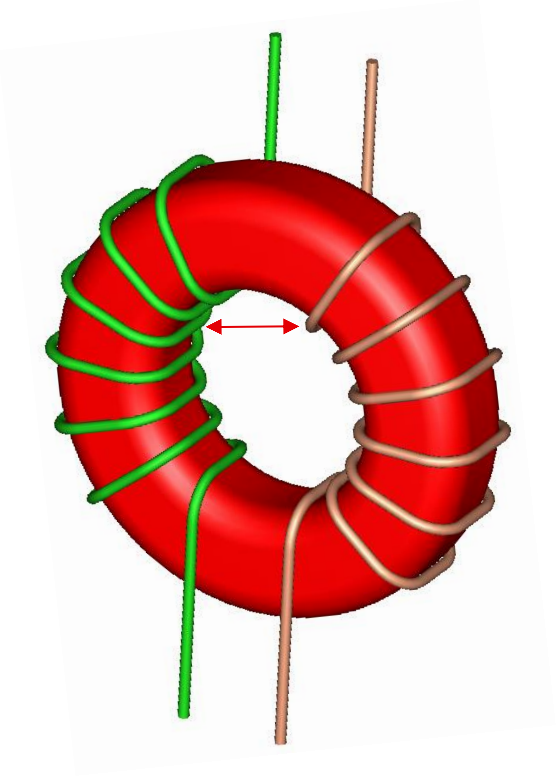
Source: IEC 60938-2

SAFETY REQUIREMENTS

Winding Style

- Mains Power Line Application – 230 V AC
  - Clearance distance → 2,5 mm
  - Creepage distance → 1,25mm – 4mm (Pollution degree 2-3)

Sectional Winding Style



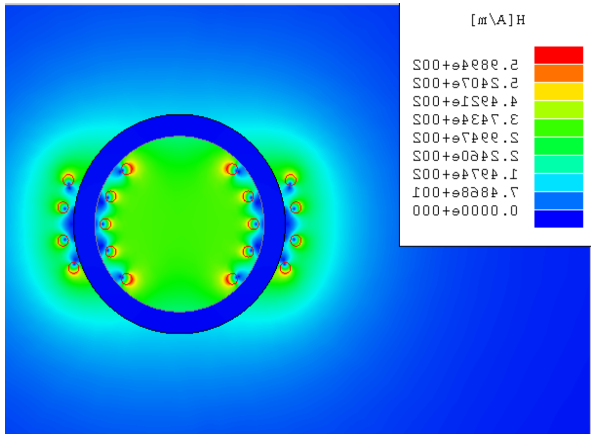
LEAKAGE INDUCTANCE

Differential Mode Impedance

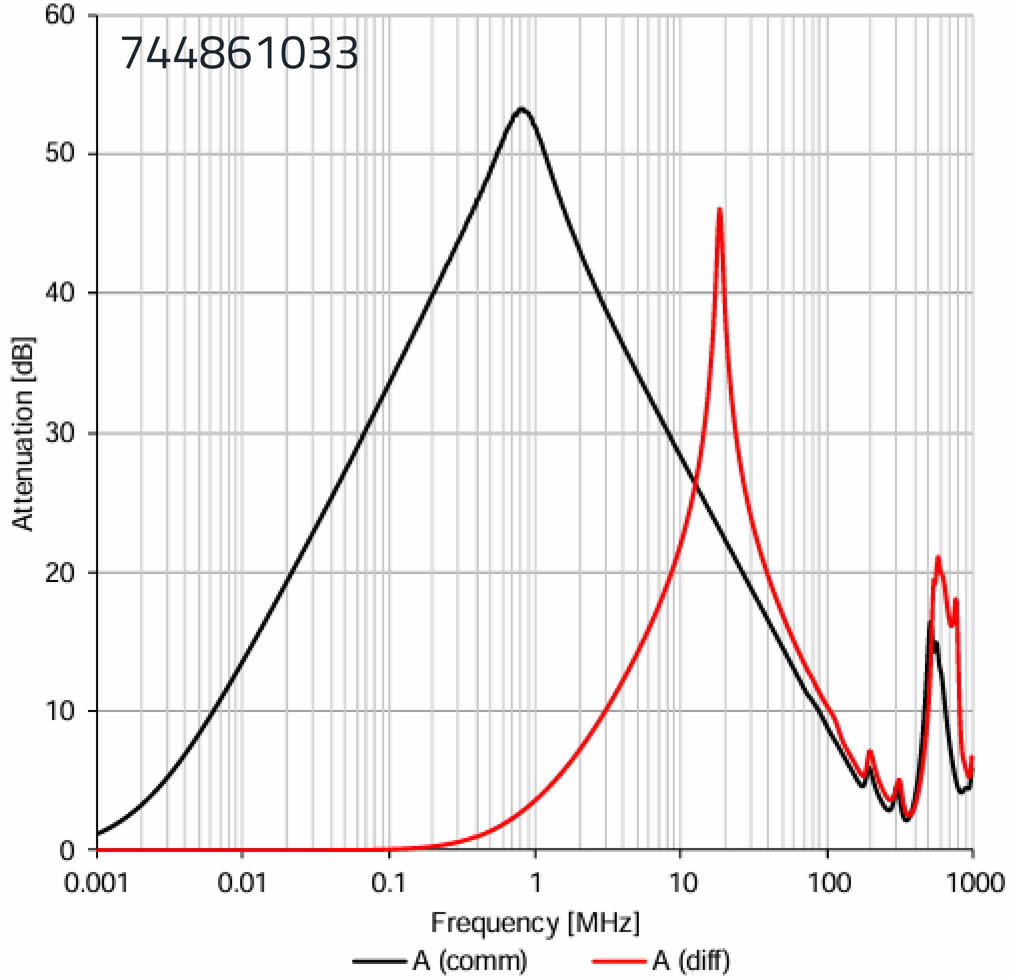
- Sectional Winding
  - ➢ High leakage inductance
    - ➢ High differential mode attentuation

- Power Line Signal – influenced?
  - 50 / 60 Hz
  - No attenuation at the intended signal

- Best case – save an additional DM Filter Choke



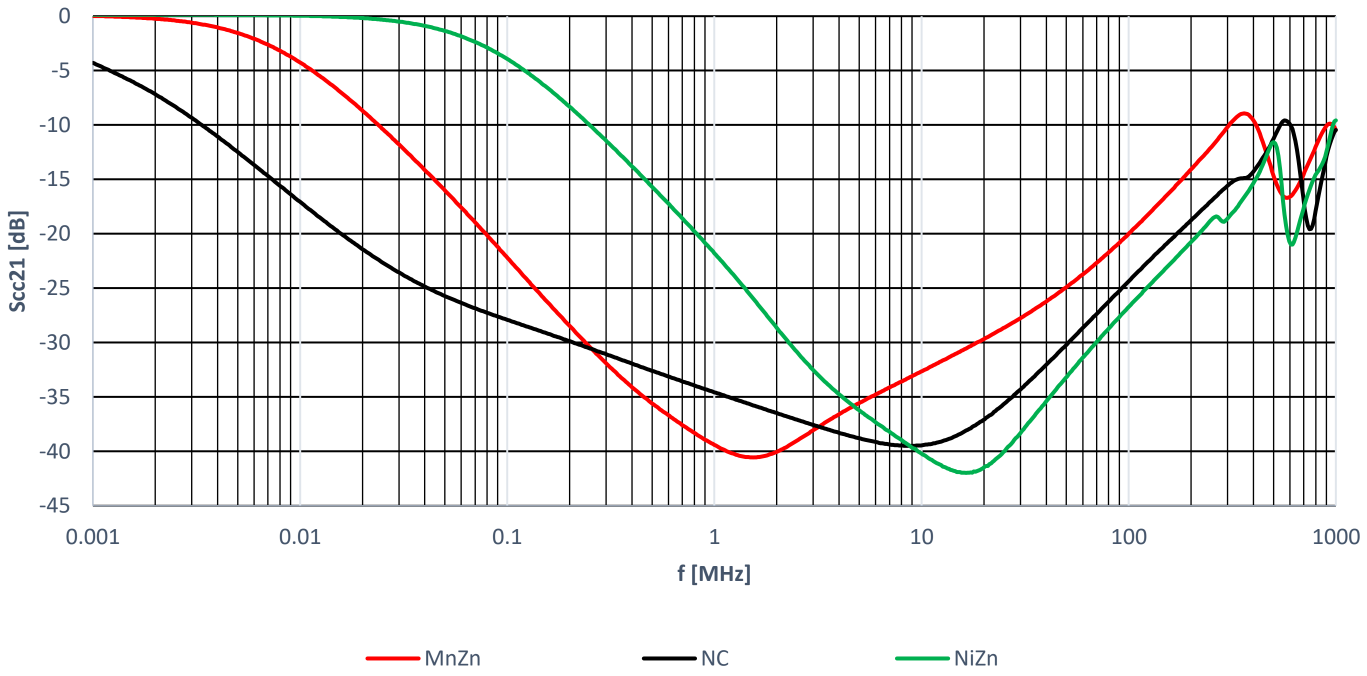
Typical Attenuation:



COMPARISON TOROIDAL CORE MATERIALS

MnZn/NC/NiZn

- Coresize S
  - Sizes are similar
- Same/similar turns
- Same/similar wire diameter



Corematerial	Number of turns	Wirediameter in mm	Inductance in mH
MnZn	12	0,6	1,00
Nanocrystalline	13	0,5	5,00
NiZn	13	0,5	0,11

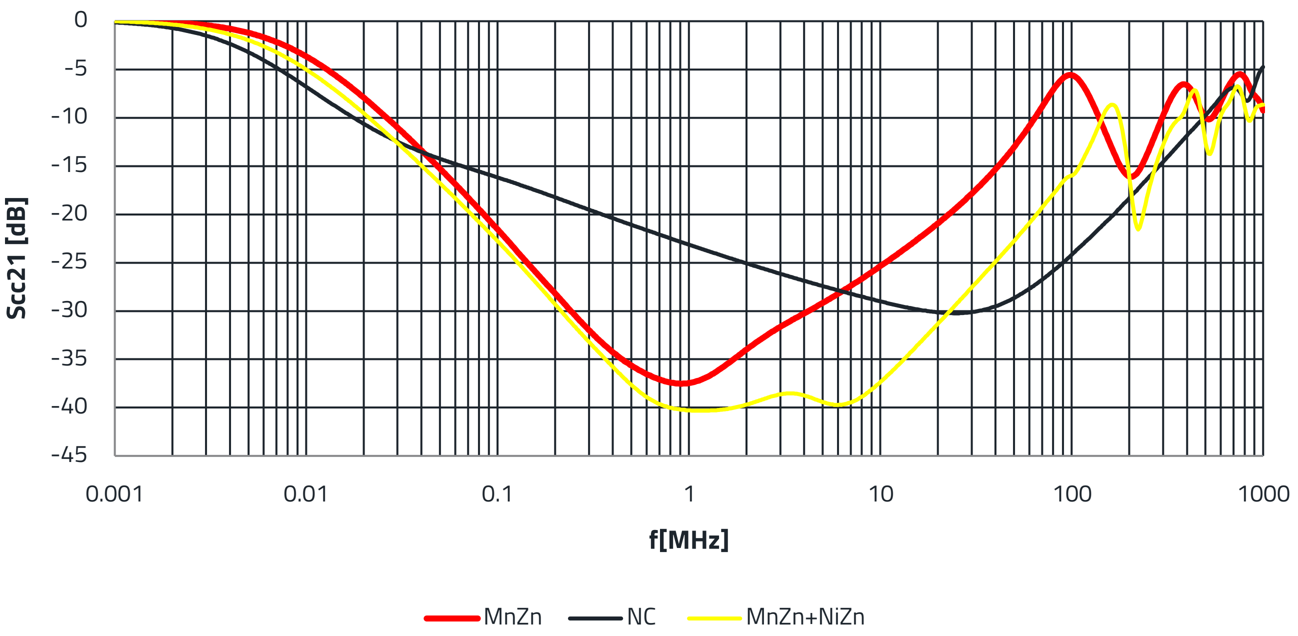
COMPARISON TOROIDAL CORE MATERIALS

MnZn/NC/MnZn+NiZn

- Coresize L
  - Sizes are similar
- Same inductance of 1 mH

➡ Different Attenuation

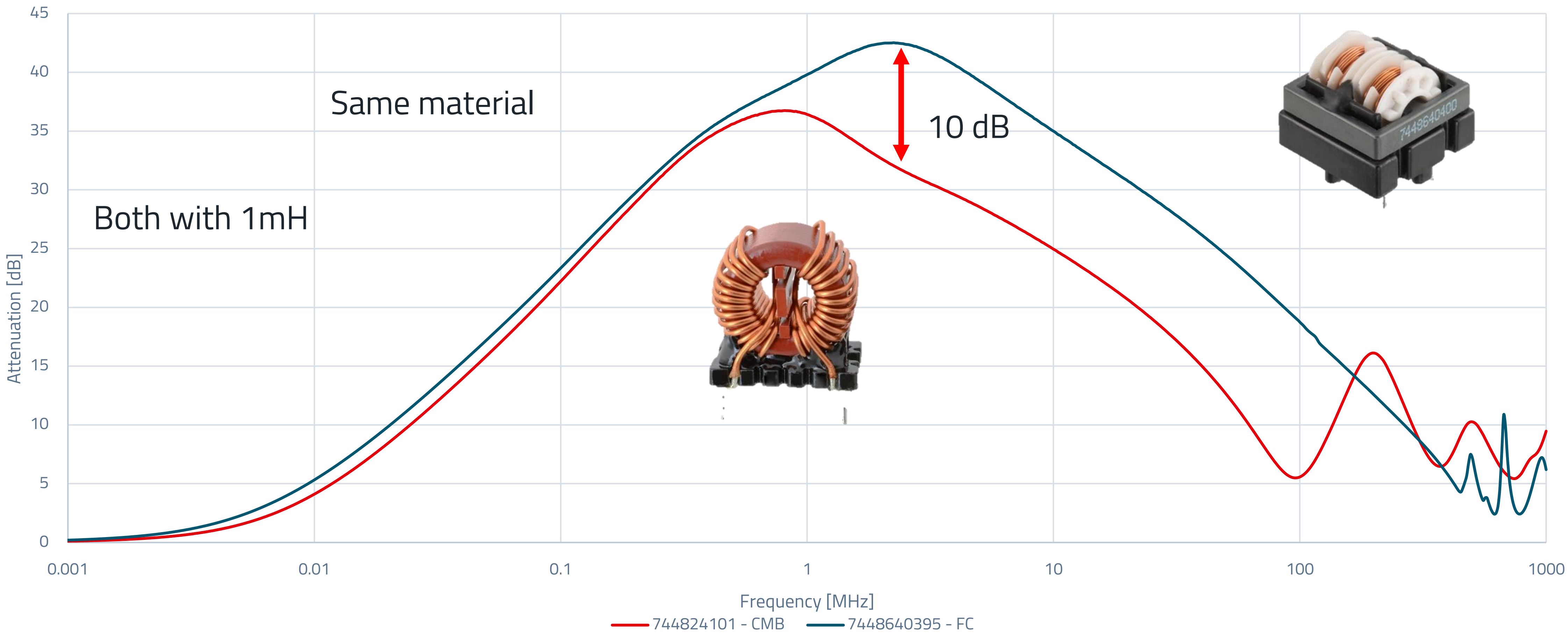
➡ Different number of turns needed



Corematerial	Number of turns	Wirediameter in mm	Inductance in mH
MnZn	11	1,4	1,00
Nanocrystalline	5	1,6	1,00
MnZn + NiZn	19	0,7	1,00

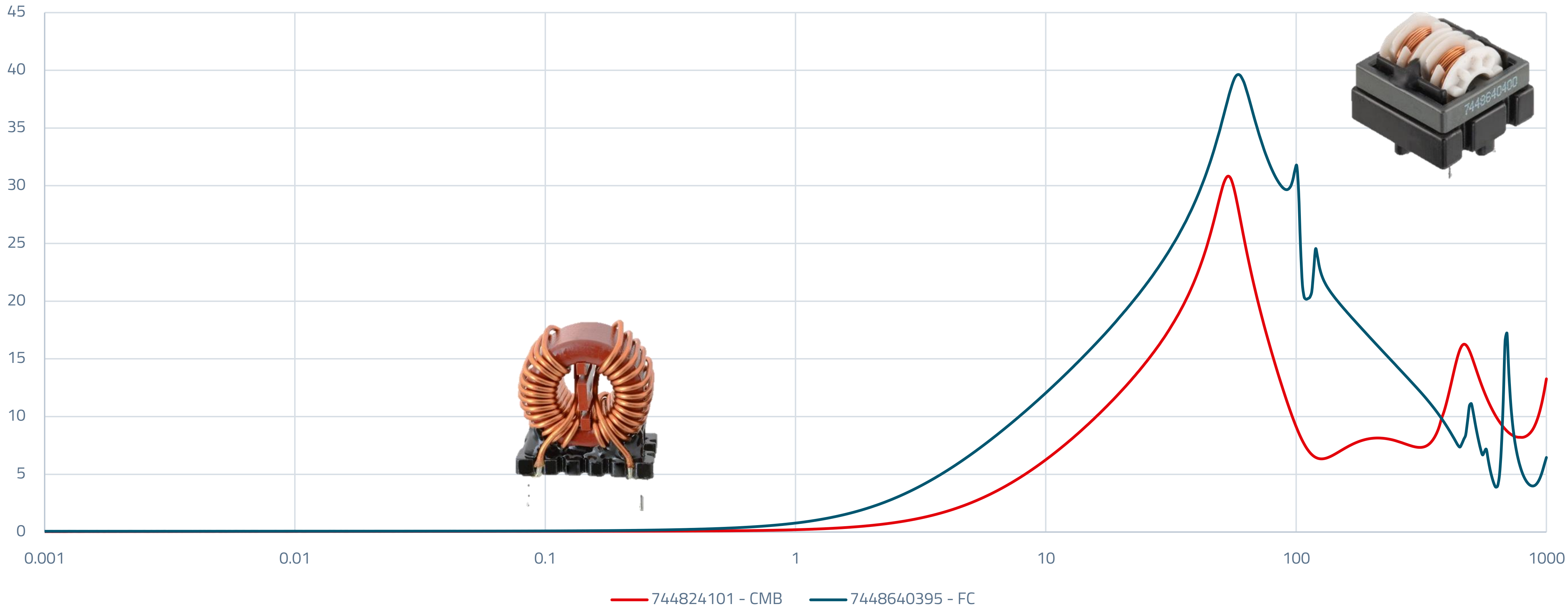
DIFFERENT SHAPE/DESIGNS

Common Mode Attenuation



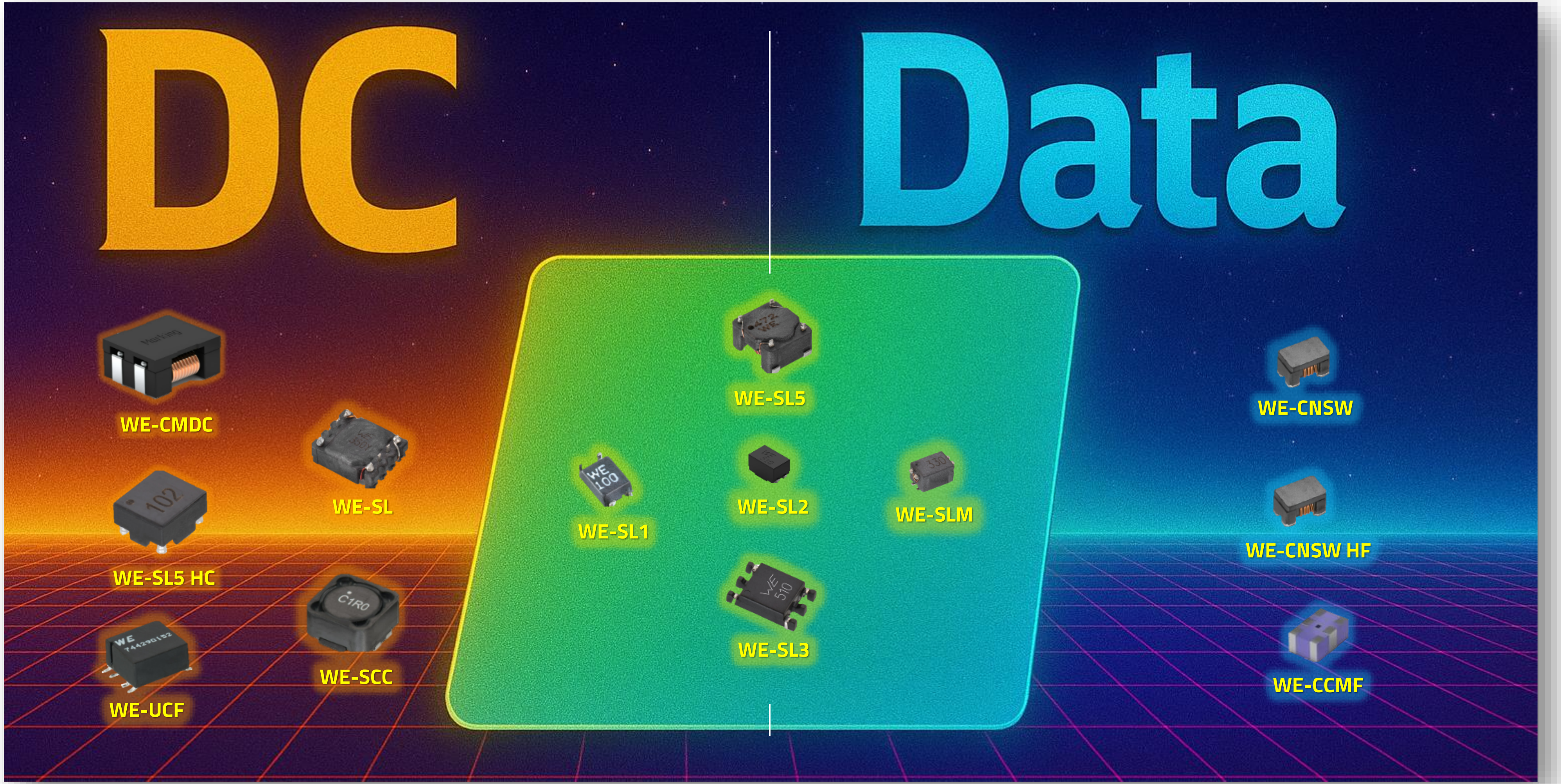
DIFFERENT SHAPE/DESIGNS

Differential Mode Attenuation



WÜRTH ELEKTRONIK PORTFOLIO

Understanding the Product Series



WHY COMMON MODE CHOKES?

Comparison With Alternative Solutions

Series	CMDC	CNSW	SCC	SL2	CBF, RFI, PBF	STAR, AFB, SAFB
Function	Common Mode Choke	Common Mode Choke	Common Mode Choke	Common Mode Choke	Ferrite bead	Snap ferrites
Figure						
Application	Filtering DC Power Supply paths in the low voltage range. High Ir	Filtering Signal Data Lines, also for high transfer rates	Filtering DC Power Supply paths in the low voltage range	Filtering DC and Data lines	Attenuating differential interference signals in the HF range	Attenuating CM interference in HF Range on Cables
Advantages	Low parasitic capacitance, ferrite loss R < typ. 5 MHz	High Symmetry, low losses	High inductance values, high leakage inductance	Very wide value range between 10 uH to 20 mH	Frequency selective measure are possible	Can be subsequently assembled on cables

EMC Products overview for informed and effective selection

- **ANP 146** | Theoretical Insights and Practical Applications of the WE-CMDC Series Common Mode Chokes

WHY COMMON MODE CHOKES?

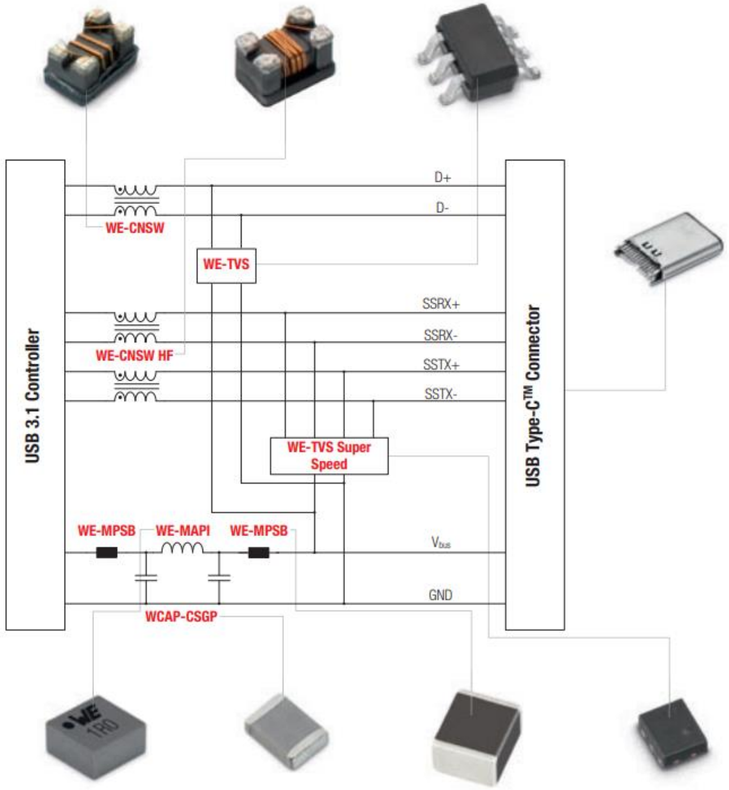
Most Common Noise Sources and Characteristics

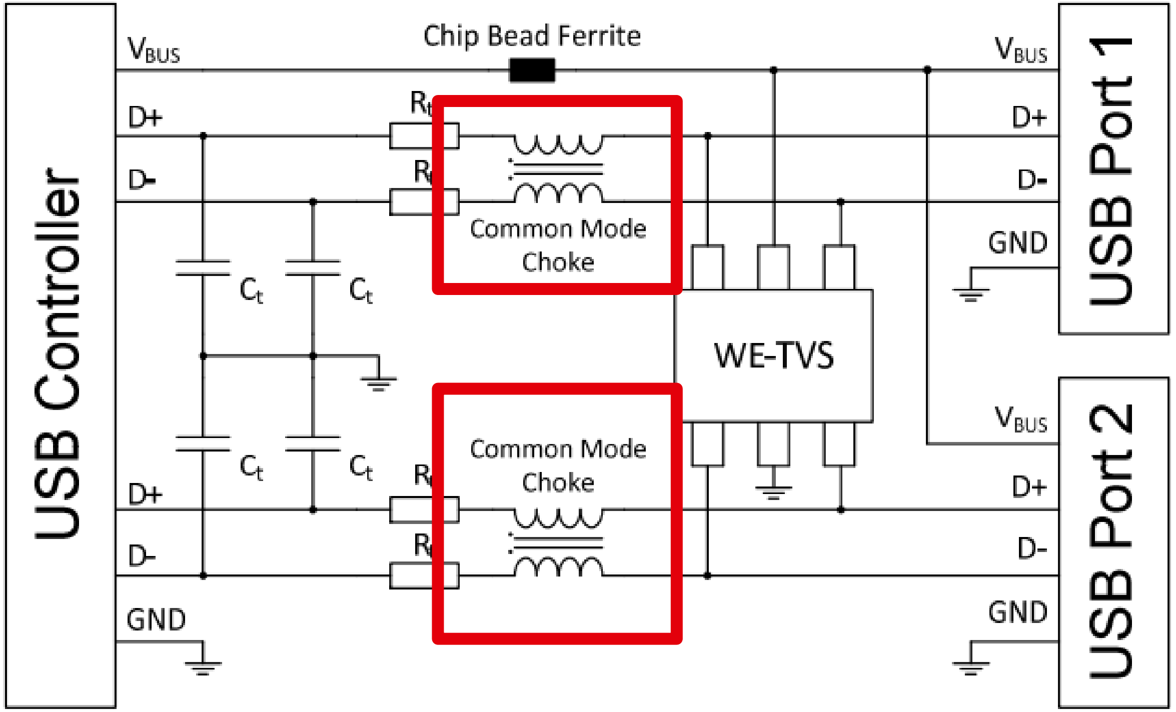
Applications	Probable Noise Source	Main Frequency (reference)	CMC benefit
Power supplies, IoT, LED drivers	Active Switching	100 kHz – 1 MHz	Blocks CM Noise along cables
Cameras, robotics, PoE	Inrush / Capacitive Load	< 1kHz	Dampens overshoot and ringing
Instrumentation	Ground loop or floating reference	500 kHZ – 50 MHz	Suppresses CM
Power + Data	Fast buses: USB, WiFi, CAN	10 MHz – 500 MHz	Reduces Common mode coupling of digital signals on DC line
Industrial	EMI from Motors/ Relays	10 kHZ – 5 MHz	Isolates DC line from inductive noise sources

CMC IN DATA LINES

Applications: USB | Ethernet

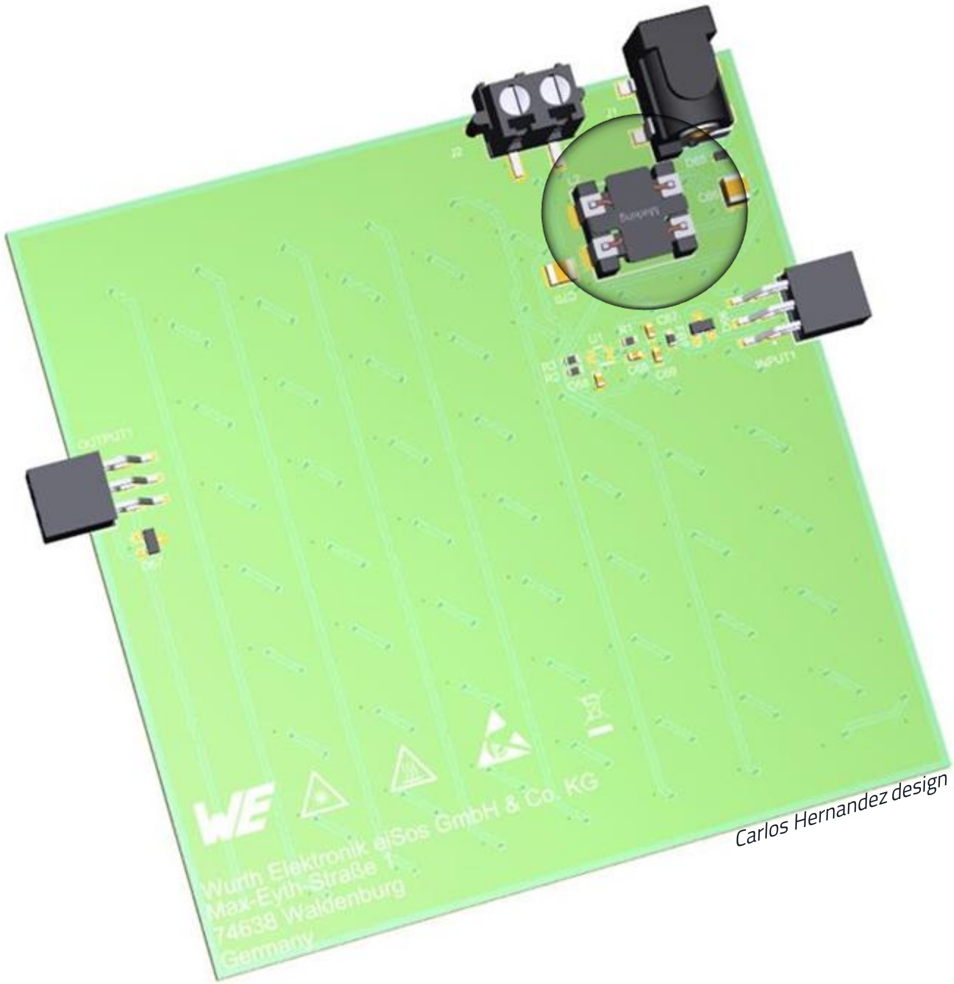
- Ethernet 100/1000BASE-T



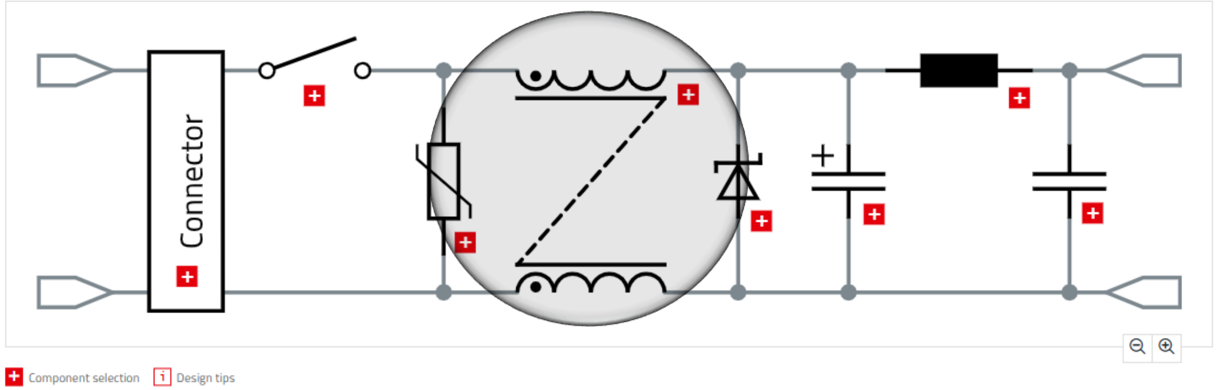


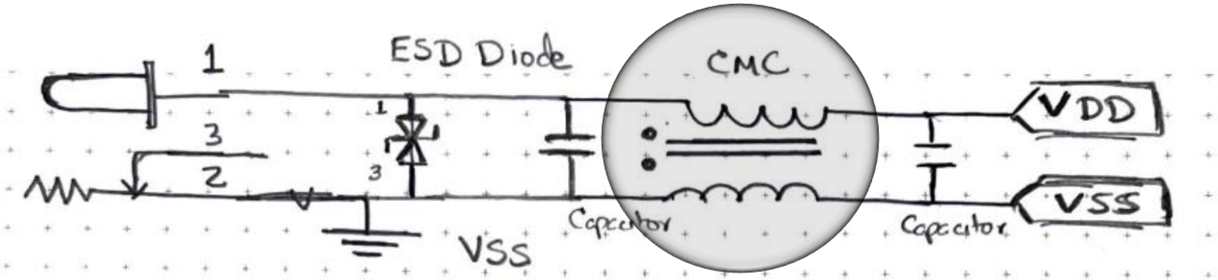
CMC IN DC LINES

Applications: DC Filter



Carlos Hernandez design

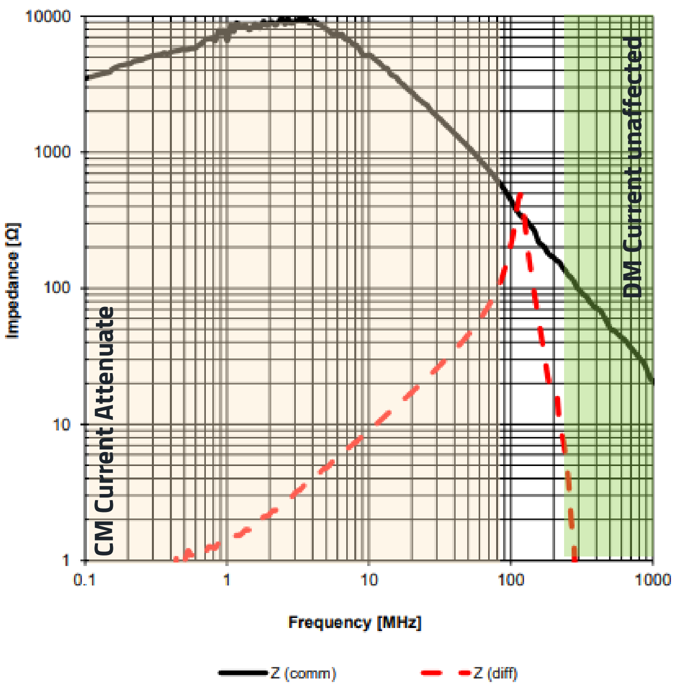




CMC IN MIXED APPLICATIONS (DC+DATA)

Applications: “mixed”

- The LAN-PoE Connection



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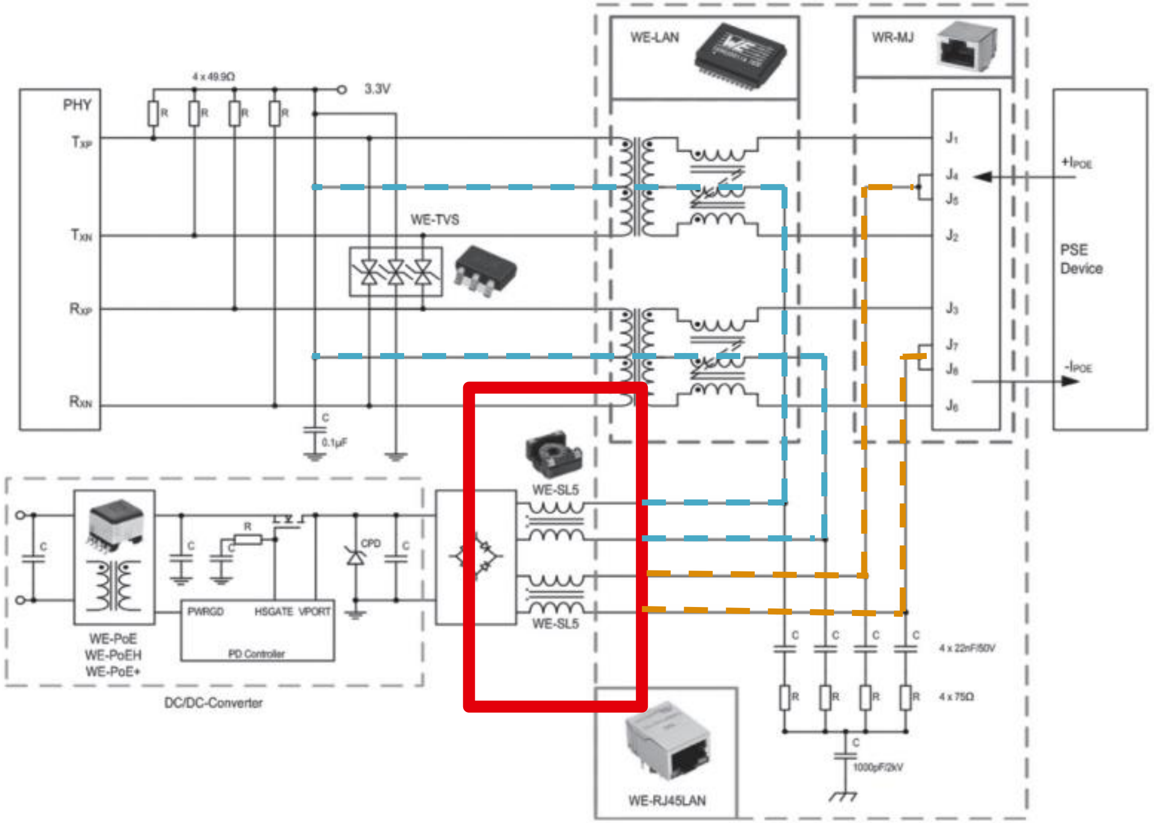
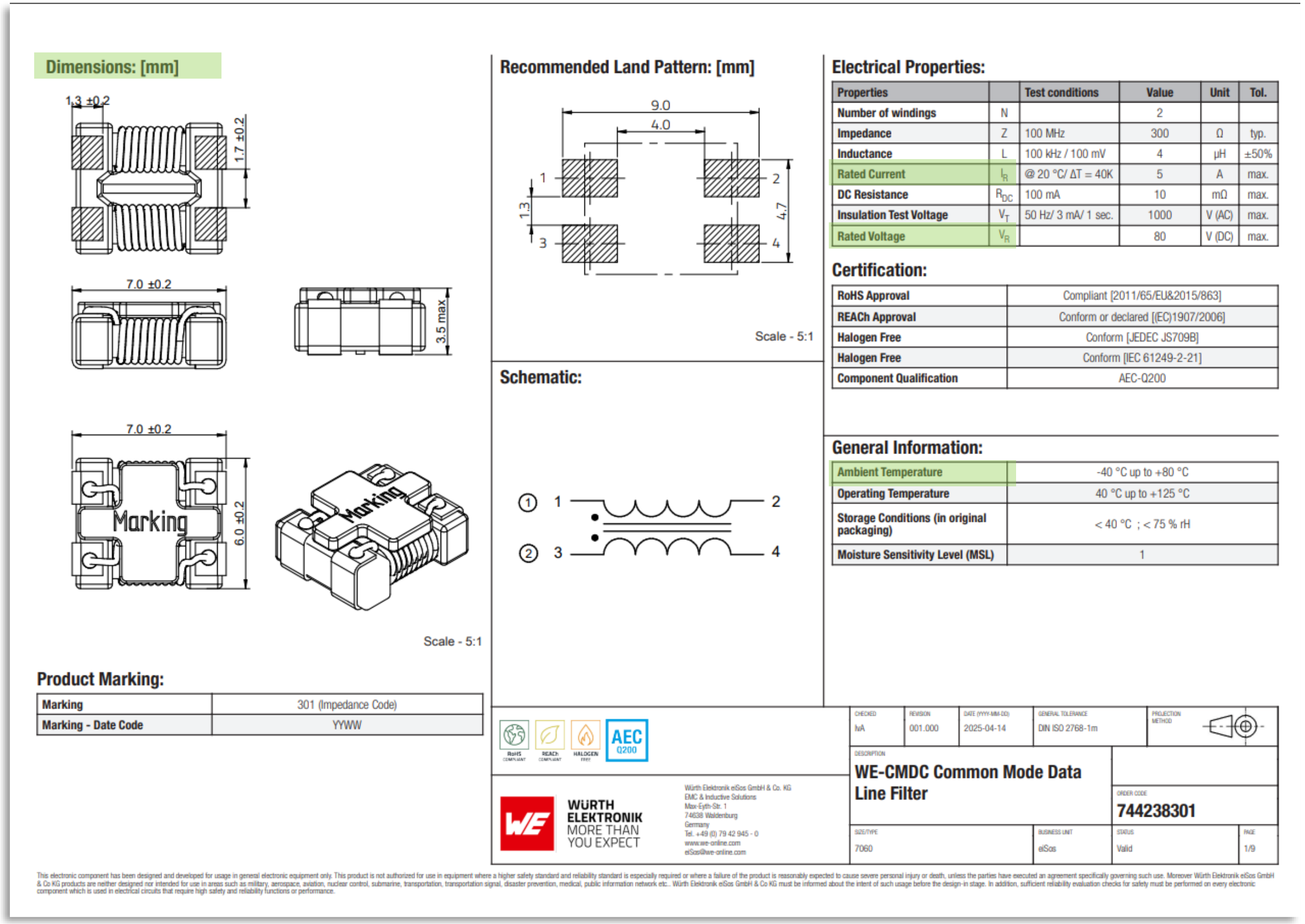


SELECTION CRITERIA

Process

1. Define Design Constraints	
Working Current	Rated Current **[IR]**
Working Voltage	Rated Voltage **[VR]**
Available Space	Dimensions **[mm]**
Environment conditions	Ambient temperature **[°C]**



Dimensions: [mm]

Product Marking:

Marking	301 (Impedance Code)
Marking - Date Code	YYWW

Recommended Land Pattern: [mm]

Schematic:

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Number of windings	N		2		
Impedance	Z	100 MHz	300	Ω	typ.
Inductance	L	100 kHz / 100 mV	4	µH	±50%
Rated Current	I_R	@ 20 °C/ ΔT = 40K	5	A	max.
DC Resistance	R_{DC}	100 mA	10	mΩ	max.
Insulation Test Voltage	V_T	50 Hz/ 3 mA/ 1 sec.	1000	V (AC)	max.
Rated Voltage	V_R		80	V (DC)	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

General Information:

Ambient Temperature	-40 °C up to +80 °C
Operating Temperature	40 °C up to +125 °C
Storage Conditions (in original packaging)	< 40 °C ; < 75 % rH
Moisture Sensitivity Level (MSL)	1

RoHS COMPLIANT REACh COMPLIANT HALOGEN FREE AEC Q200

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

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EMC & Inductive Solutions
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74638 Waldenburg
Germany
Tel. +49 (0) 79 42 945 - 0
www.we-online.com
eiSos@we-online.com

CHECKED	REVISION	DATE (YYYY-MM-DD)	GENERAL TOLERANCE	PROJECTION METHOD
IvA	001.000	2025-04-14	DIN ISO 2768-1m	

DESCRIPTION
WE-CMDC Common Mode Data Line Filter

ORDER CODE
744238301

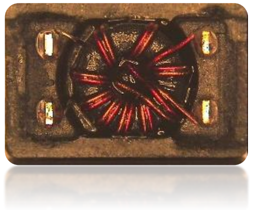
SIZE/TYPE	BUSINESS UNIT	STATUS	PAGE
7060	eiSos	Valid	1/9

SELECTION CRITERIA

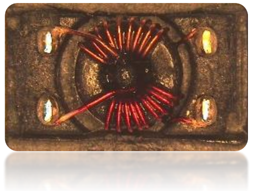
Process

2. Application Type	
Data Line	Winding Style: Bifilar
DC Line	Winding Style: Sectional

- **Bifilar winding**
  - Higher symetry between wires
  - Lower leakage inductance
  - Lower differential mode impedance



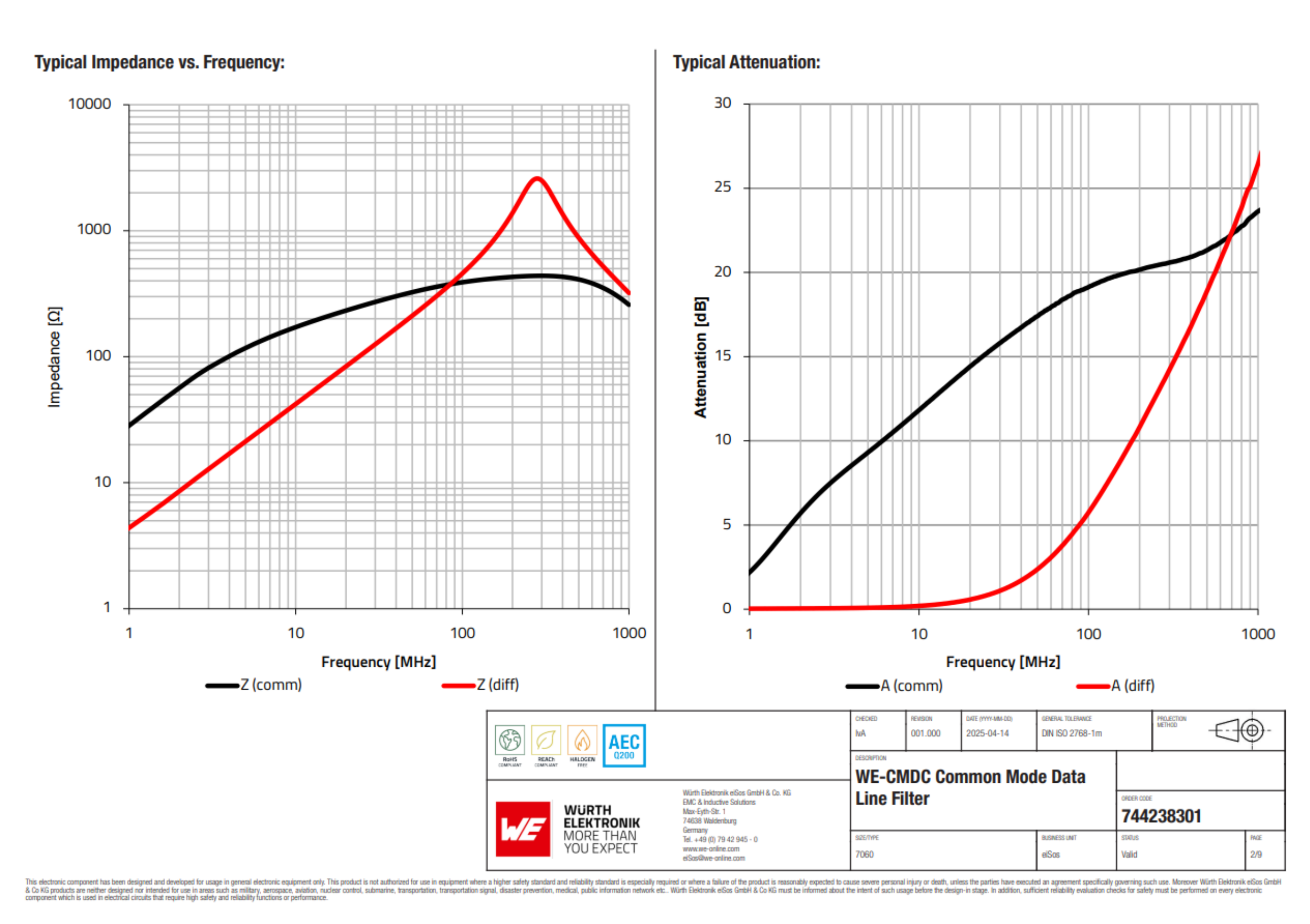
- **Sectional winding**
  - Less symetry between wires
  - Higher leakage inductance
  - Higher differential mode impedance



SELECTION CRITERIA

Process

3. Frequency Performance	
Digital Signal Must pass unaffected	DM Impedance DM Attenuation
Attenuate Noise and Harmonics	CM Impedance CM Attenuation



SELECTION CRITERIA

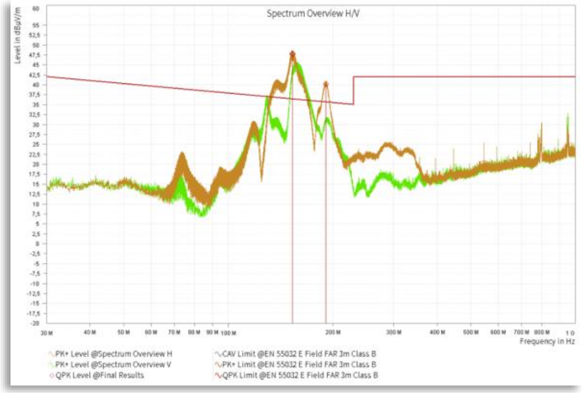
Process

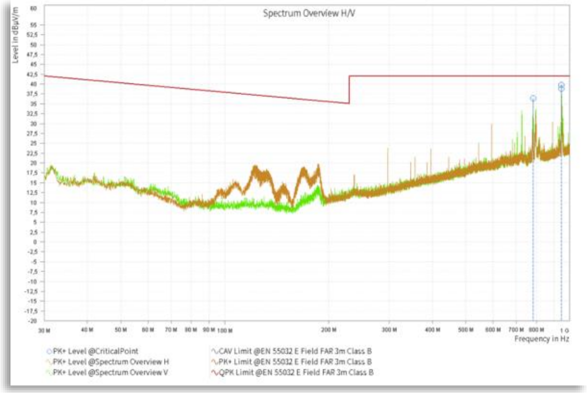
4. Design Tips and	
Check the voltage Drop	DC Resistance **[Rdc]**
Place CMC Close to connector	
Design Filter adding a capacitor if needed	Inductance

5. Measure and iterate

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Number of windings	N		2		
Impedance	Z	100 MHz	300	Ω	typ.
Inductance	L	100 kHz / 100 mV	4	µH	±50%
Rated Current	I_R	@ 20 °C/ ΔT = 40K	5	A	max.
DC Resistance	R_{DC}	100 mA	10	mΩ	max.
Insulation Test Voltage	V_T	50 Hz/ 3 mA/ 1 sec.	1000	V (AC)	max.
Rated Voltage	V_R		80	V (DC)	max.





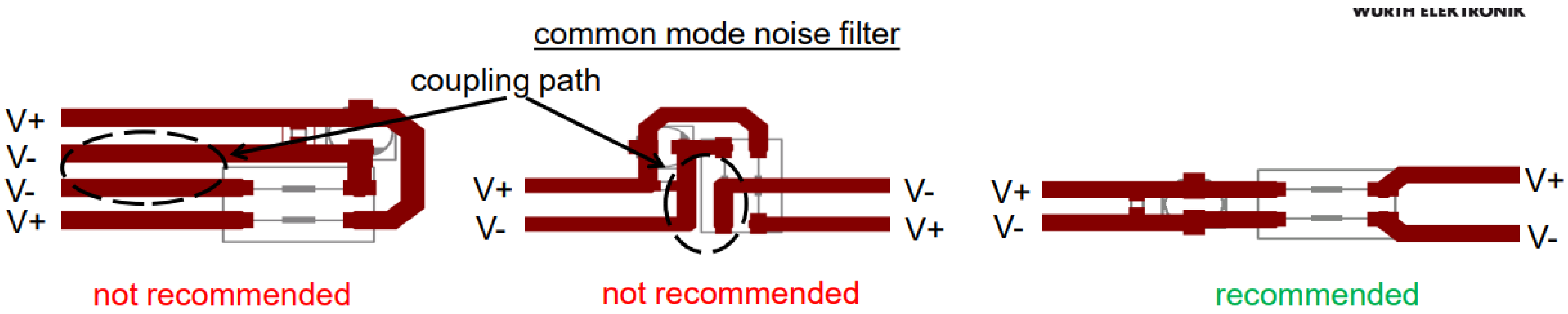
CMC GUIDELINES

Design phase

- Prioritize high speed or power (small size and less losses or high current capability)

- Detect and define correctly the noise frequency

- Board placement
  - Close to IN or connector to avoid noise distribution
  - Keep symmetry between traces to avoid mode conversion and signal integrity
  - Minimize return loops and define continuous planes
  - Metal planes beneath the CMC could alter inductance and increase losses.



NEW UPDATES OVERVIEW

NEW RELEASES

New on catalogue!

- **WE-CMDC** Series expansion: sizes 7060, 9070 and 1513!
- **WE-CNSW** Series Expansion: size 1210!

COMING SOON

WE-CMB HV

- ***CMB-HV:***
  - Expansion with higher Voltage rating up to 1000 V_{AC} or 1250 V_{DC}
  - VDE and ENEC approval according to IEC 60938-2

NEW UPDATES OVERVIEW

WE-VD: Update maximum operating temperature to 105 °C

Product/Process Change Notice (PCN)

☒ Major Change
☐ Minor Change

PCN Number:	PCN_VarVD_20250210
Affected Series:	WE-VD
Affected Part Number:	see table below
PCN Date:	2024-11-11 (YYYY-MM-DD)
Effective Date:	2025-02-10 (YYYY-MM-DD)
Contact:	Product Management
Phone:	+49 (0) 7942 - 945 5001
Fax:	+49 (0) 7942 - 945 5179
E-Mail:	pcn.eisos@we-online.com

Change Category:
☐ Equipment/Location
☒ General Data
☐ Material
☐ Process
☐ Product Design
☐ Shipping/Packaging
☐ Supplier
☐ Software

Datasheet Change: ☒ Yes ☐ No

Attachment: ☐ Yes ☒ No

DESCRIPTION OF CHANGE:

To meet current customer demands, Würth Elektronik eiSos will increase the operating temperature to 105 °C.

There will be no change in form, fit, function or quality of the product.

Affected part numbers see details of change.

WE-VS: Update to lead-free version

Product/Process Change Notice (PCN)

☒ Major Change
☐ Minor Change

PCN Number:	PCN_VarVS_20250523
Affected Series:	WE-VS
Affected Part Number:	please see table below
PCN Date:	2025-02-21 (YYYY-MM-DD)
Effective Date:	2025-05-23 (YYYY-MM-DD)
Contact:	Product Management
Phone:	+49 (0) 7942 - 945 5001
Fax:	+49 (0) 7942 - 945 5179
E-Mail:	pcn.eisos@we-online.com

Change Category:
☐ Equipment/Location
☐ General Data
☒ Material
☐ Process
☐ Product Design
☐ Shipping/Packaging
☐ Supplier
☐ Software

Datasheet Change: ☒ Yes ☐ No

Attachment: ☐ Yes ☒ No

Description of Change:

To enhance environmental protection and ensure compliance with regulatory requirements, Würth Elektronik eiSos is transitioning the WE-VS Series to a lead-free design.

There will be no change in form, fit, quality or reliability of the product.
The new revision of the affected part numbers will be sent out after the previous revision is out of stock (according to FIFO - first-in, first-out).

THANKS FOR THE TIME

QUESTIONS?