MAINS FILTER GUIDE

An integrated solution for your EMI.

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

1 Single Phase Line Filter

Single-Stage:
Very compact design

Single-Stage Advanced:
Improved differential mode noise attenuation

Two-Stage:
Extreme differential and common mode noise attenuation

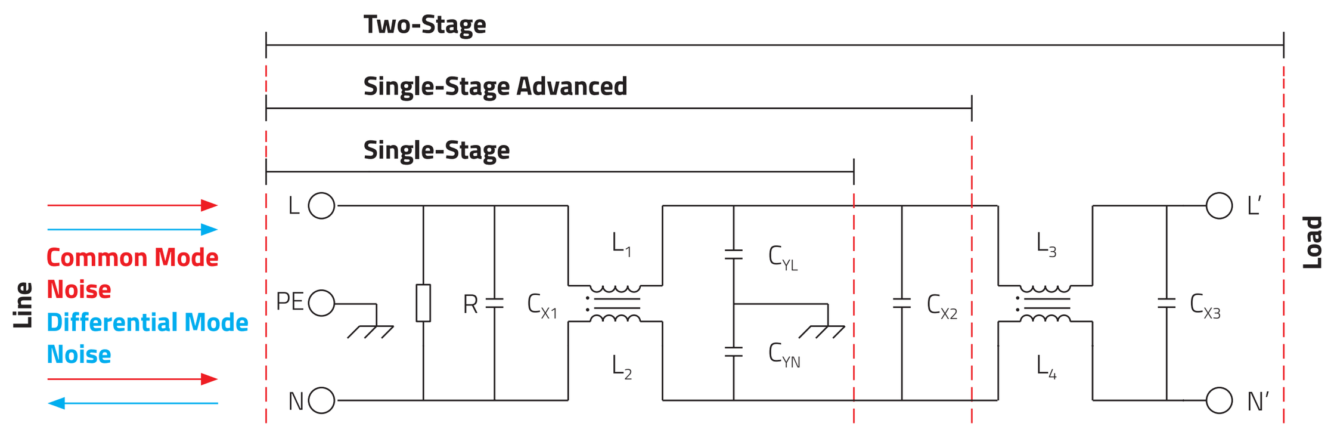
Low Leakage Version available for each of them

Size	L (mm)	W (mm)	H (mm)
Single-Stage	64	35	29
Single-Stage Advanced	75	51.8	29
Two-Stage	114.9	58.5	45

LTspice Simulation Models, Application Scenarios and more technical Information available.

More information about WE-CLFS:
www.we-online.com/we-clfs

2 Internal Schematic



Discharge Resistor R:
Discharge of capacitors. Important to fulfill safety standards.

X-Capacitor C_X:
Increases the differential mode attenuation.

Common Mode Choke L:
High common and partly differential mode attenuation, without deriving any leakage current to ground.

Y-Capacitor C_Y:
Strongly increases common and partly differential mode attenuation, driving some leakage current to ground.

3 General Information

Rated current of the mains filter :
Must be equal to or greater than the current requirements of the connected devices.
For ambient temperatures above 40 °C, the following derating curve applies.

Operating Voltage:
250 V_{AC} 50/60 Hz
250 V_{DC}

Operating Temperature:
-25 °C – +100 °C

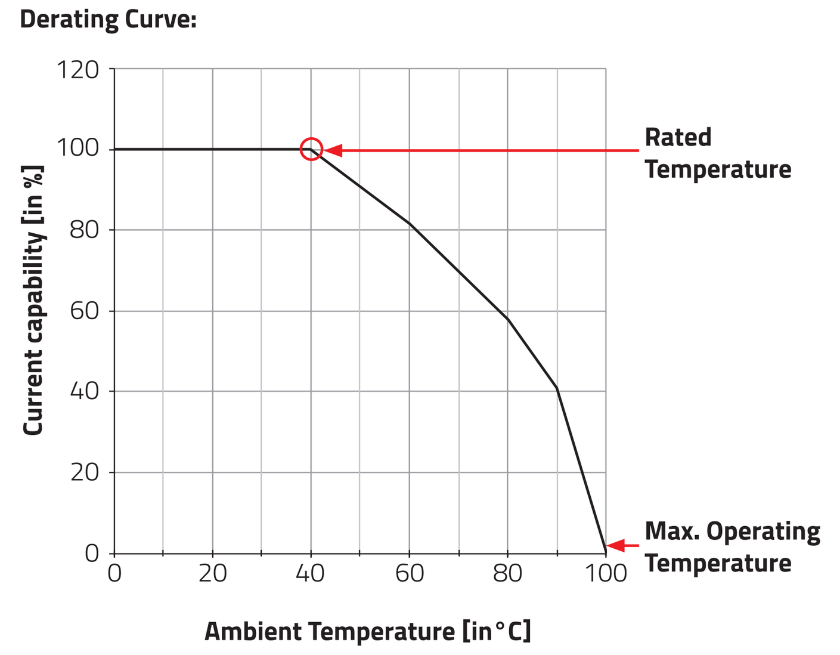
Climatic Category:
25/100/21

Rated Current:
Up to 20 A

Certifications:

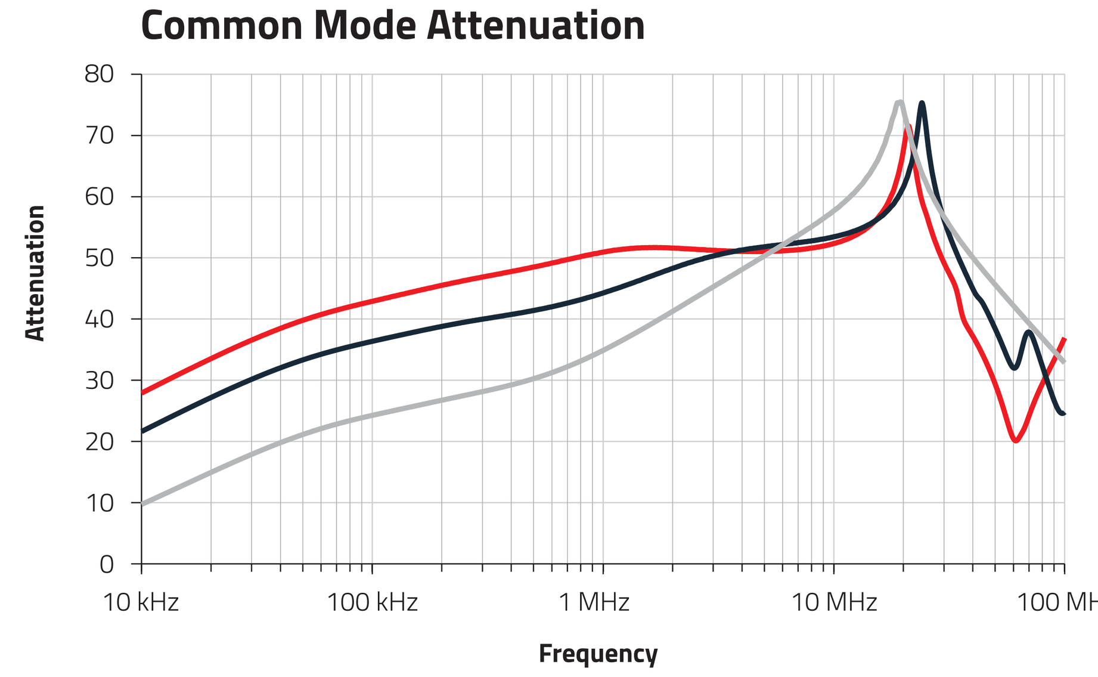
RoHS COMPLIANT
REACh COMPLIANT

Derating Curve:

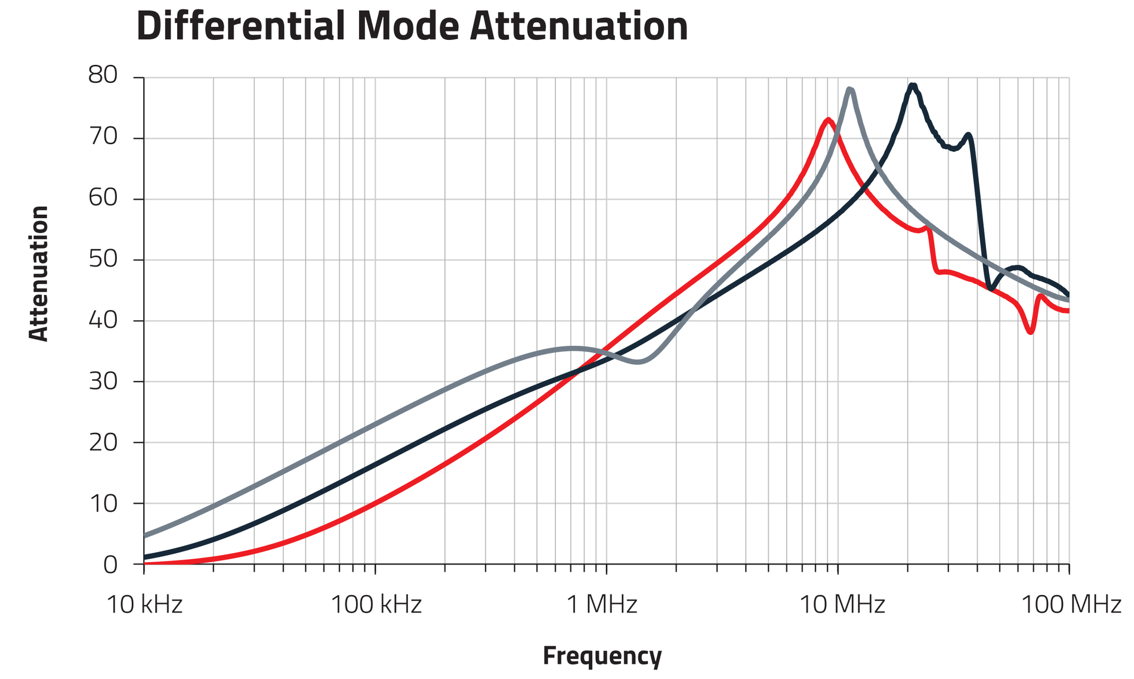


4 ATTENUATION FOR DIFFERENT INDUCTANCE VALUES AND TOPOLOGIES:

Common Mode Attenuation



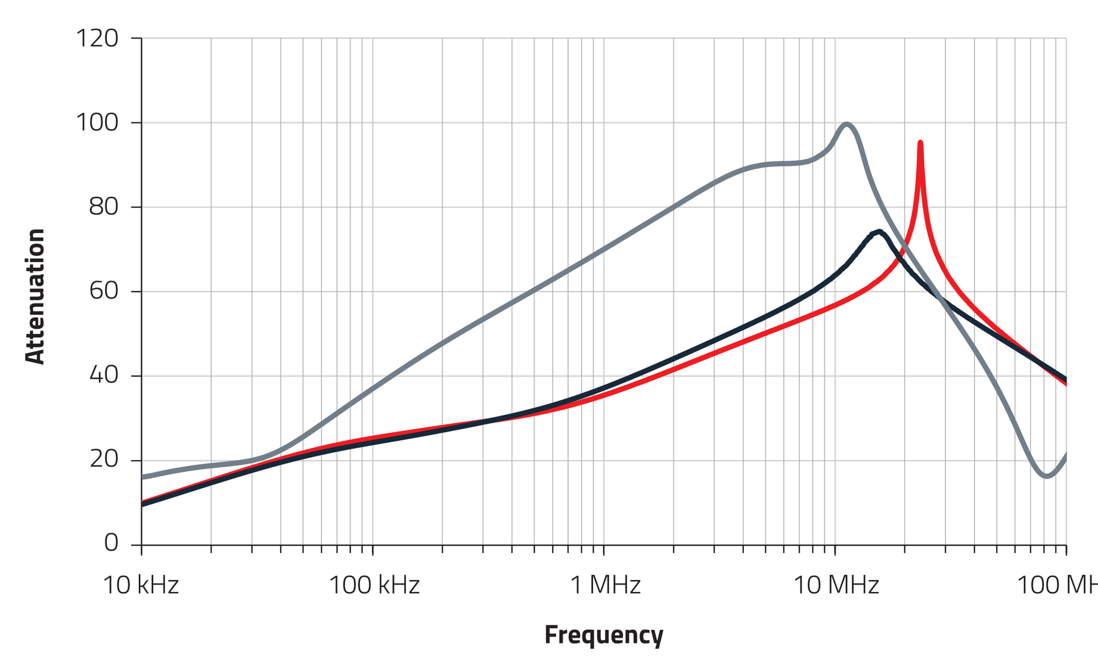
Differential Mode Attenuation



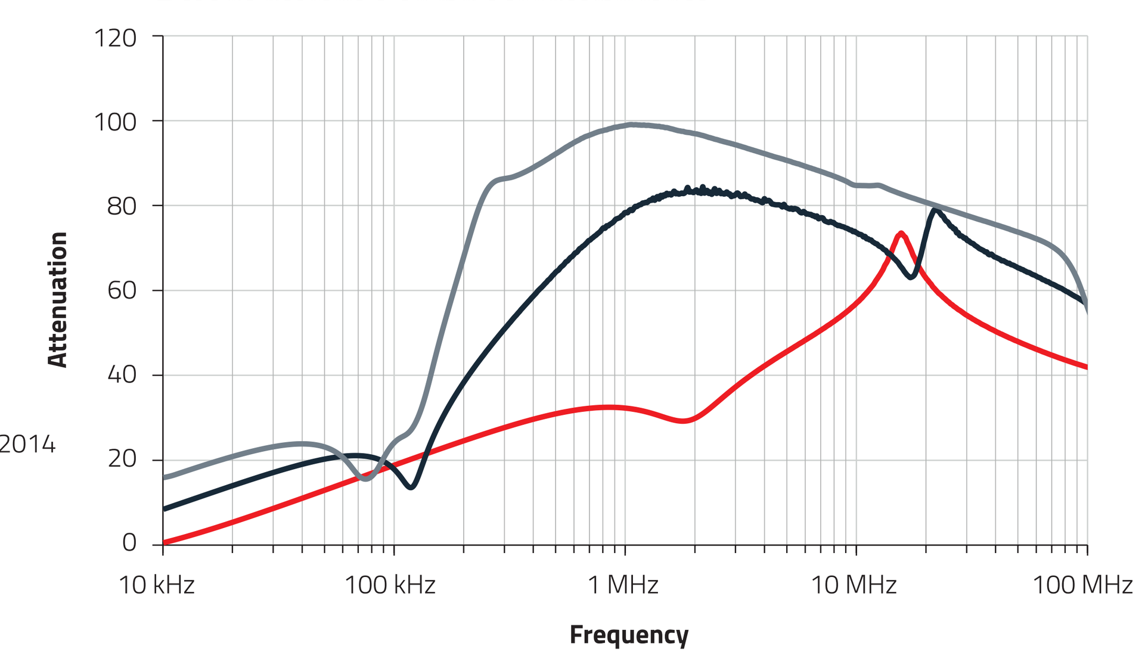
Attenuation comparison of different filter inductance values for a single-stage filter.

- 20 mH / 810911001
- 10 mH / 810911003
- 2.2 mH / 810911006

Common Mode Attenuation



Differential Mode Attenuation



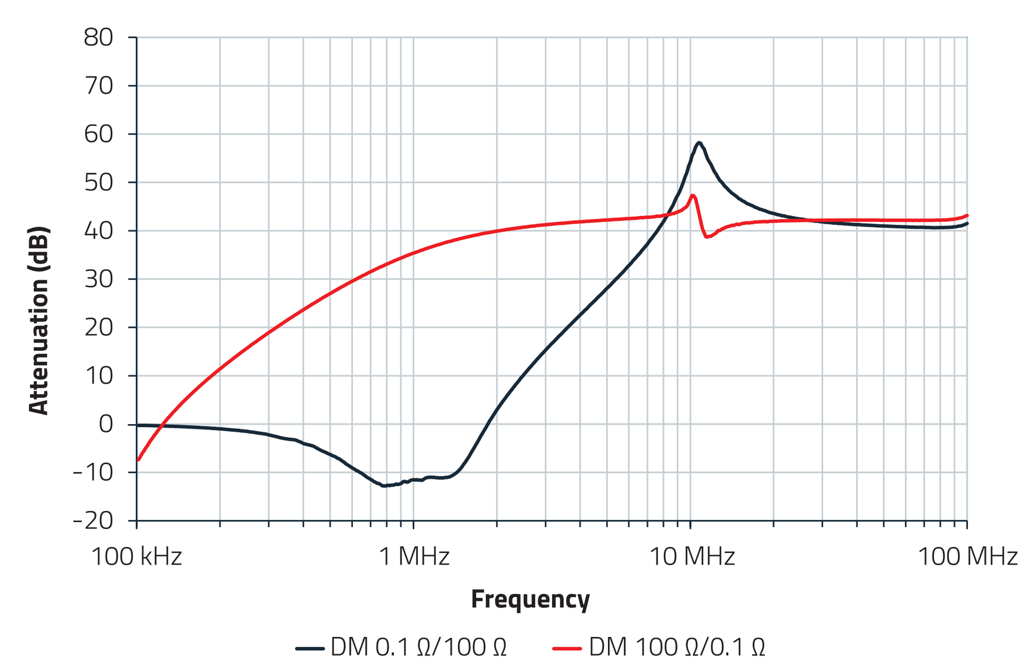
Attenuation comparison of different topologies with a filter inductance of 2.2 mH

- Single-Stage / 810911008
- Single-Stage Advanced / 810912014
- Two-Stage / 810913020

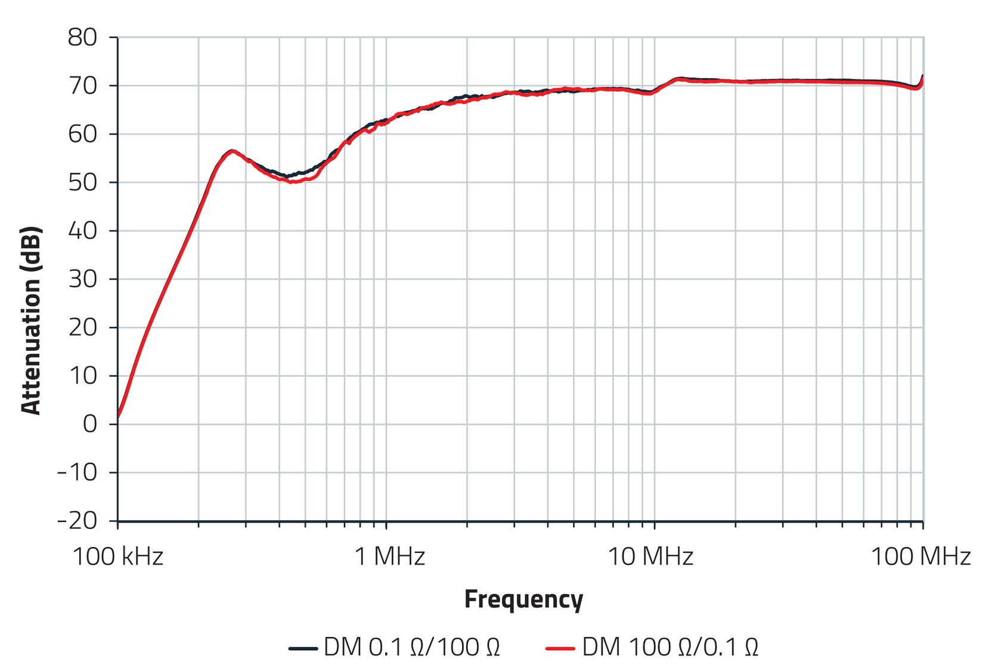
Attenuation plots for the examined filters with **system impedances of 50 Ω and 50 Ω**. You can simulate these plots and many more with our **REDEXPERT** online tool.

5 Influence of the System Impedances

Single-Stage Filter: (810911001)



Two-Stage Filter: (810913006)



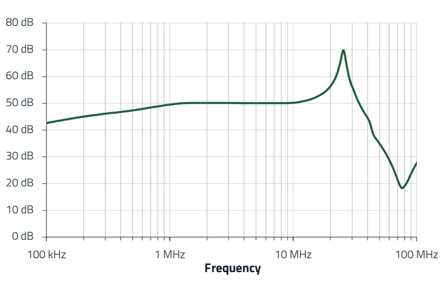
- **Single-Stage Filter:**
  Attenuation of filter is strongly depended on system impedances (especially up to approx. 10 MHz).
- **Two-Stage Filter:**
  Much less system impedance dependence.
  Filters with two or more stages have a decoupled impedance node.
- **Impedances** of your system **may vary** and influence the attenuation of your filter. Therefore the two shown „worst case methods" are defined in CISPR 17 to show system impedance influence:
  - $Z_{IN} = 0.1\ \Omega$, $Z_{OUT} = 100\ \Omega$
  - $Z_{IN} = 100\ \Omega$, $Z_{OUT} = 0.1\ \Omega$

6 Filter Selection with REDEXPERT

Selection Guide:
- Choose rated current
- Check frequency range of the noise
- Check attenuation in this frequency range
- Choose maximal allowed leakage current

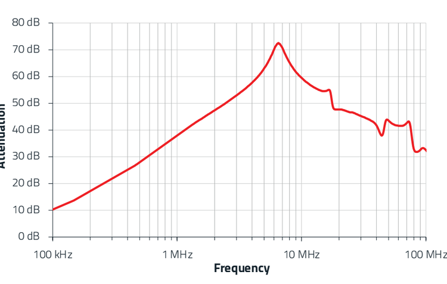
Take the different system impedances in consideration.

Common Mode Insertion Loss



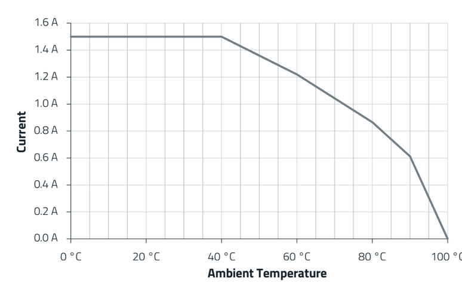
Single-Stage Filter
20 mH / 810911001

Differential Mode Insertion Loss



Single-Stage Filter
20 mH / 810911001

Temperature Derating



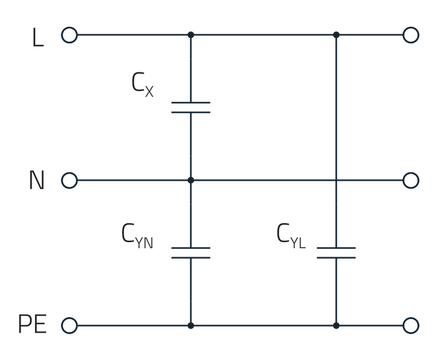
Single-Stage Filter
20 mH / 810911001

REDEXPERT is for simulation and selection

www.we-online.com/redexpert-emc-filters

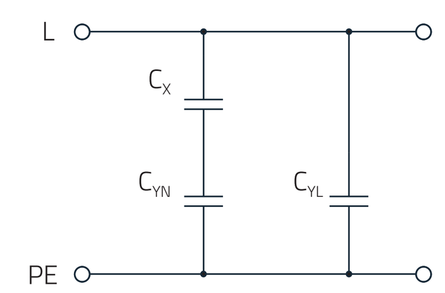
7 Interesting: Leakage Current

Leakage current calculation during regular operation:



$I_{LK} = 2\pi \cdot f \cdot U \cdot C_{YL}$ **see also IEC 60939-1:2010**

Worst case operation: Neutral line interruption



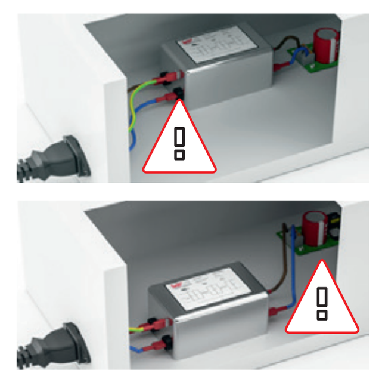
$I_{LK} = 2\pi \cdot f \cdot U \cdot C_{eq}$

$$C_{eq} = C_{YL} + \frac{C_{YN} \cdot C_X}{C_{YN} + C_X}$$

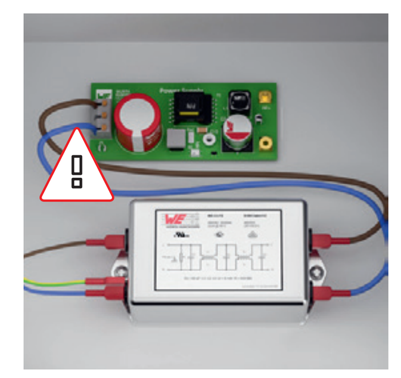
For low leakage requesting applications, we offer a low leakage version without Y capacitors.

8 Placement and Grounding

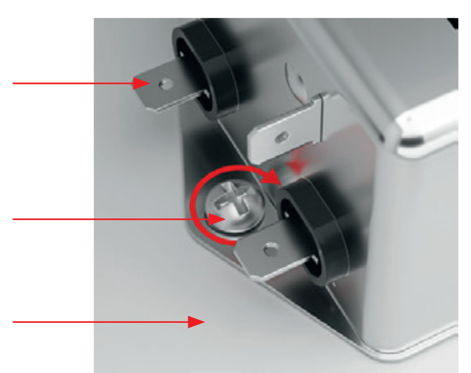
Short Connections



Minimize Crosstalk



Good Placement



Properly placing the filter optimizes its performance and prevents unintentional bypassing of it.

Ensure that the filter housing have a wide connection area to the ground plane: Remove paint and dirt.

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