SELECTING INDUCTORS AND CAPACITORS FOR EMI FILTER DESIGN

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EXTERNAL

BIOGRAPHY

- Dheeraj Jain has received his Masters in Computer and Electrical Engineering specialized in Power supply design from Concordia University, Canada. He joined Würth Elektronik in 2011 and currently hold the title of Technology Strategist. His focus is to identifying growth opportunities aligned with Company product portfolio and future market needs. He is involved in the strategic aspects to make sure that right applications and technologies are targeted. He is currently holding the Chair position for IEEE PELS/PES/IAS Dallas Chapter.

WHY AN EMI FILTER?

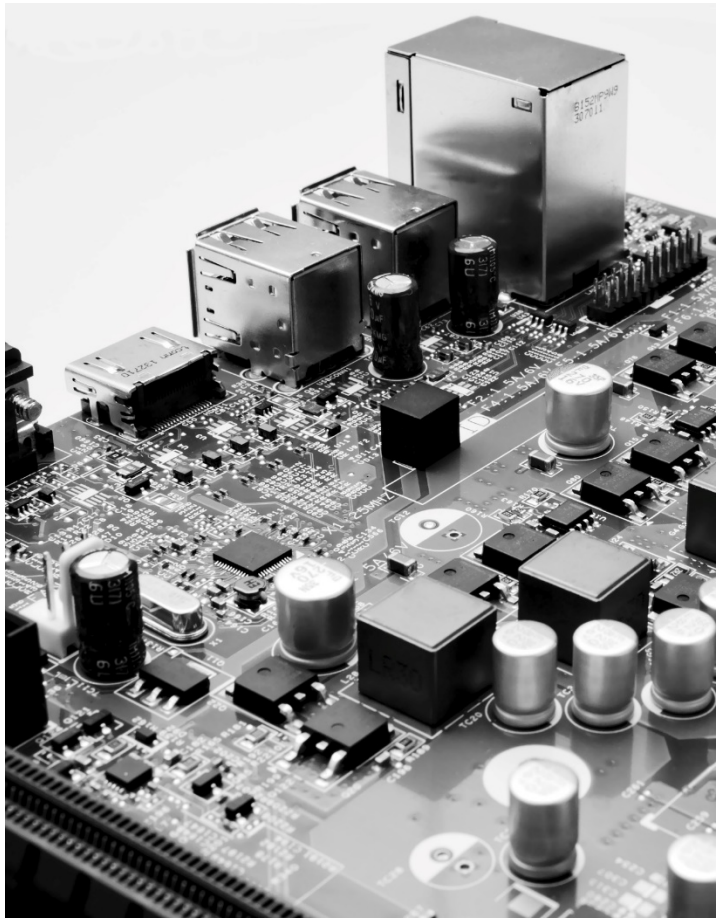
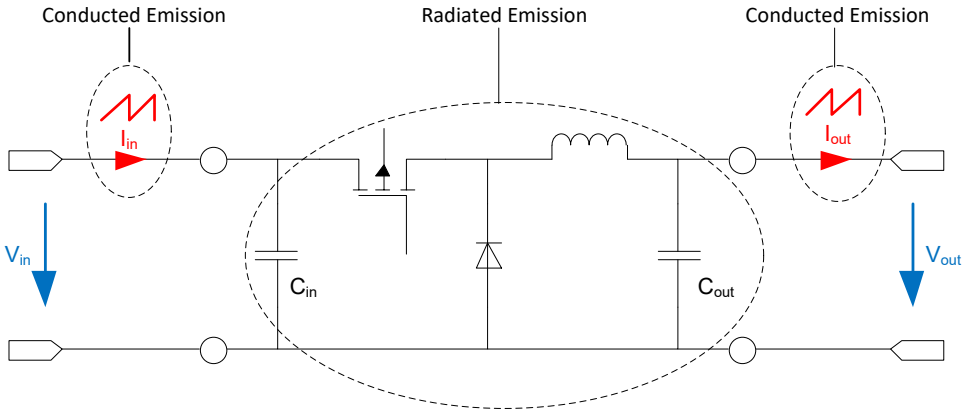
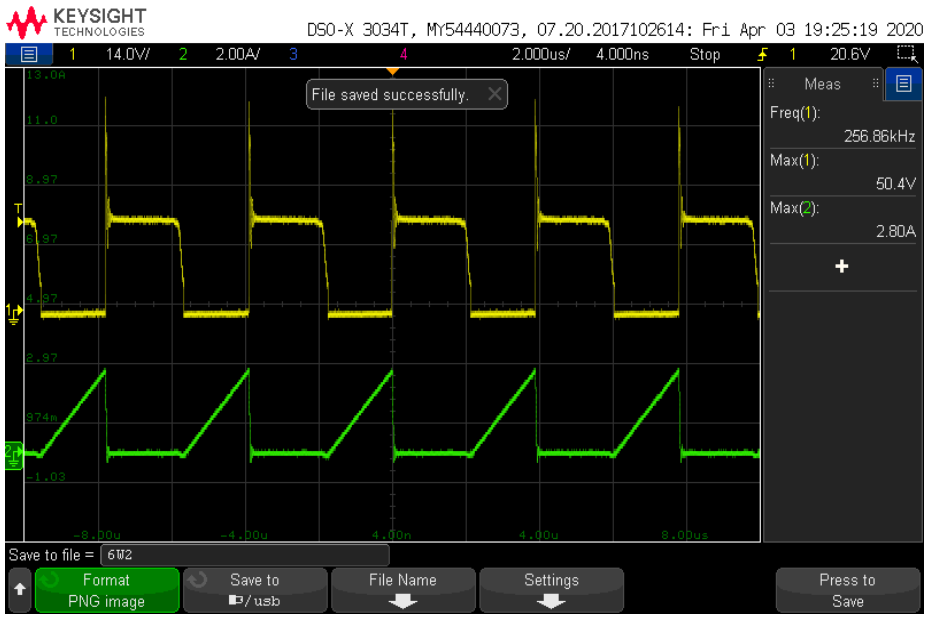


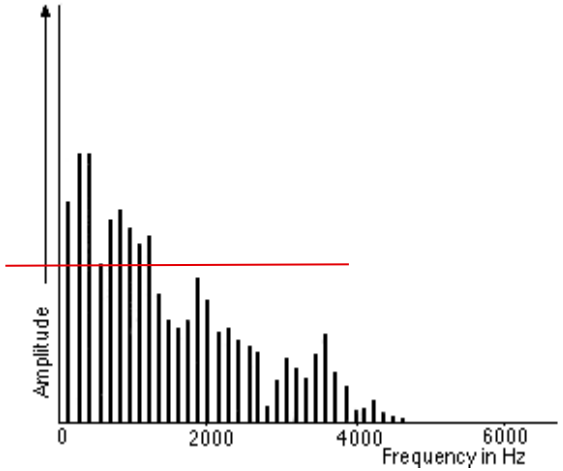
Photo by Michael Dziedzic on Unsplash





Electronic interference

- Badly working products
- Lost revenue
- Property loss
- Dangerous situations

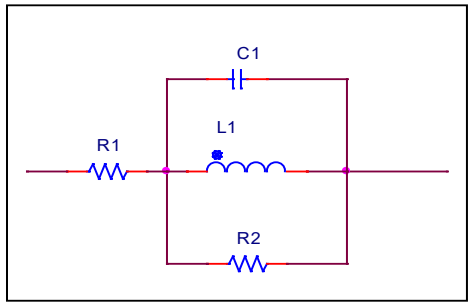


EMI FILTER DESIGN PROBLEM

Determining suitable components for a low-pass filter, to make your device EMC compliant, can be a time consuming and largely empirical process.

- $f = \frac{1}{2 \times \pi \times \sqrt{LC}}$
  - Insertion Loss may not be achieved
  - Only limited to LC filter topology
  - Impedances not considered
- Does not consider attenuation @ frequency
- Assumes ideal components
- Which actual component to select?

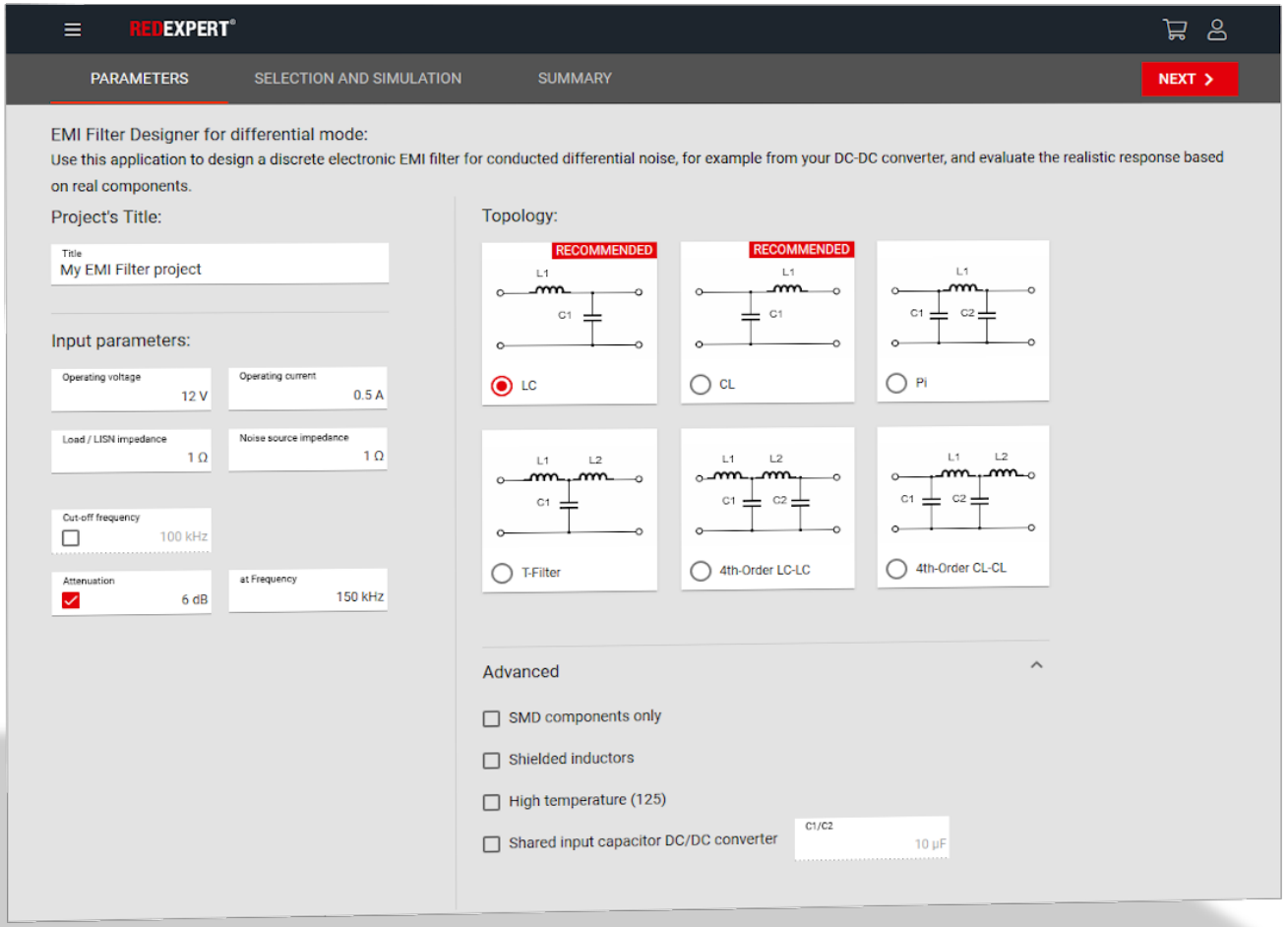
Simple Equivalent Circuit - Inductor



REDEXPERT® EMI FILTER DESIGNER

Benefits

- Takes out guess work
- Reduces time & costs
- Low entry and easy to use
- First filter tool from component manufacturer
- Design and simulate 4 component subsystem circuit from scratch

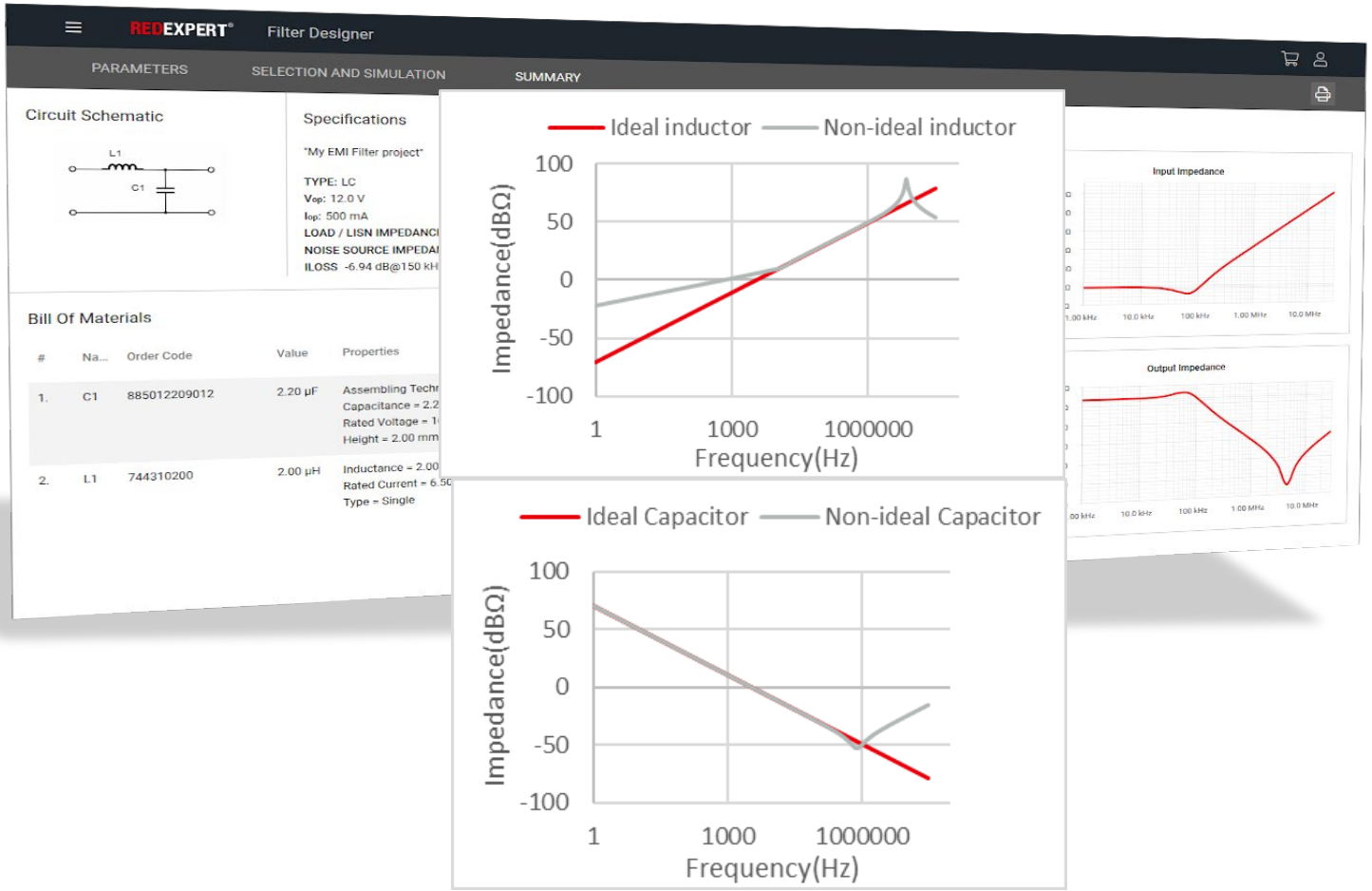


REDEXPERT® EMI FILTER DESIGNER

Features

REDEXPERT EMI Filter Designer, for **conducted differential noise**, provides component selection and accurate frequency response for up to 4th order.

- Topology recommendation based on the impedance, insertion loss & cutoff frequency
- Component recommendation considering noise source and load impedance, cut off frequency, parameters
- Source and load impedances are considered to recommend appropriate filter topology, and L and C values for all available topologies
- The Input and output impedance graphs of the selected filter are shown: useful in analyzing the stability of and electronic system
- Auto-selects from combinations of thousands of parts
- Shows insertion loss and input/output impedance
- Non-ideal components simulation



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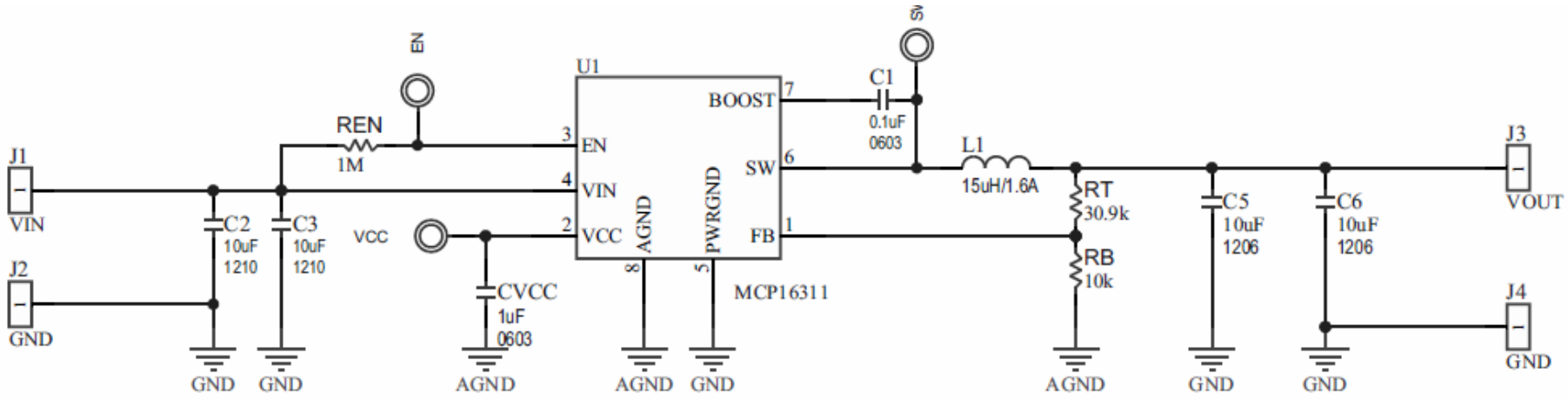
- **EXAMPLE: MCP16311/2 Synchronous Buck Converter**
- Specifications: Vin = 12 V, Vout = 3.3 V, Iout = 1 A, Fsw = 500 KHz
- Load impedance is LISN impedance: 50 Ω
- Noise source impedance: ESR of input capacitors: 2.2 mΩ



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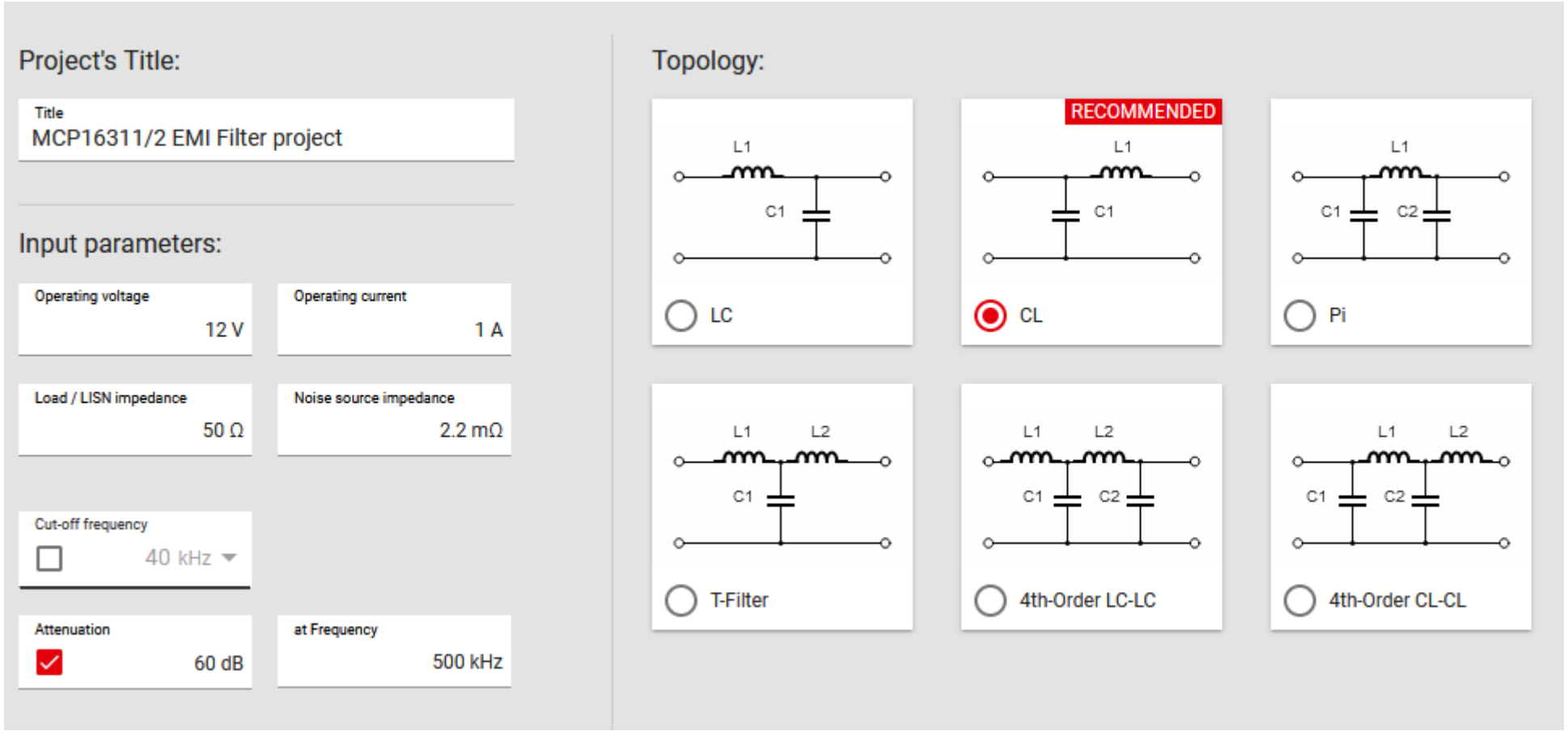
- EXAMPLE: MCP16311/2 Parameters selection



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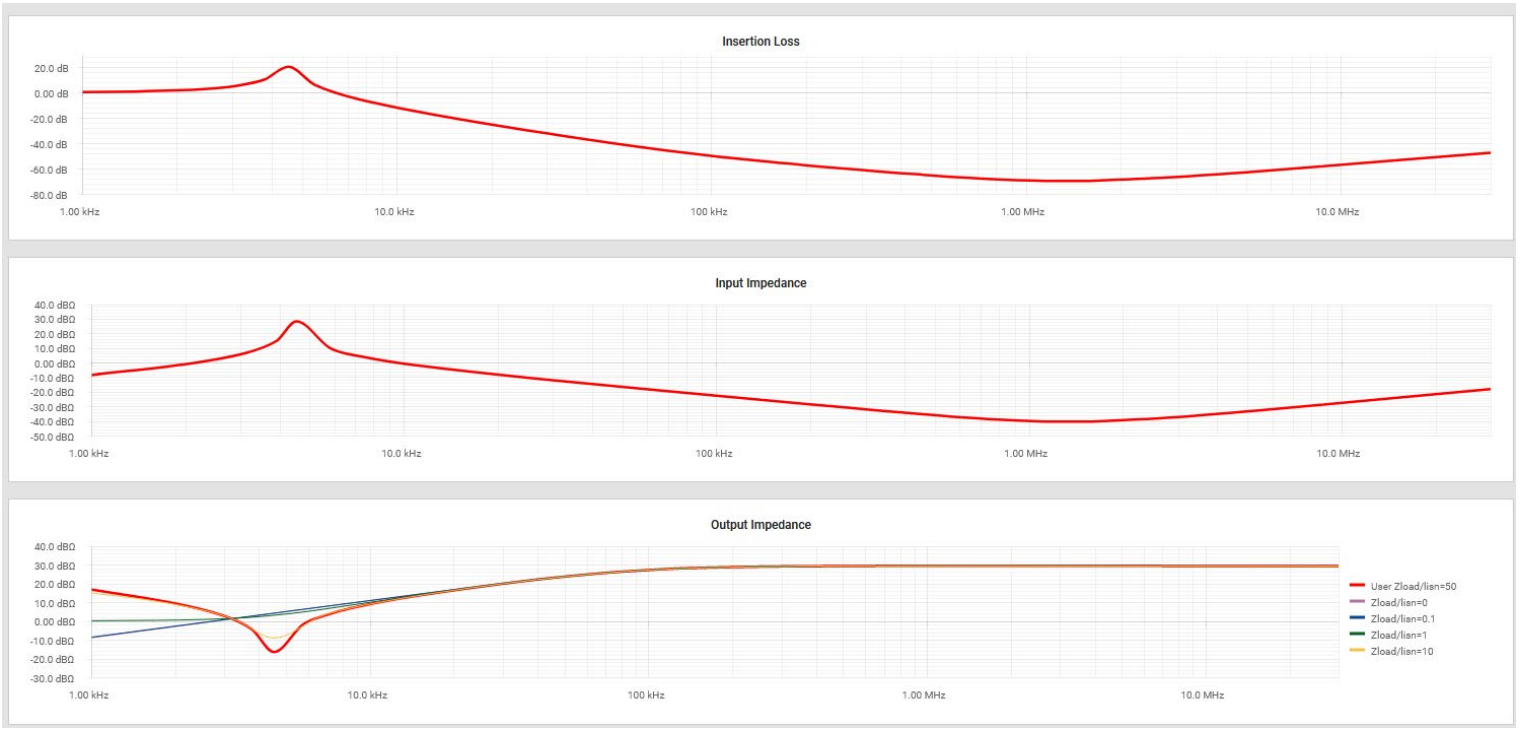
- **EXAMPLE: MCP16311/2 Components selection**
- The component selection is based on the ideal component model.
- The filter details and response charts include parasitics of the real component equivalent model.
- **Tip**: If the required attenuation is not achieved, reduce the cutoff frequency, select the next bigger component value or manually select a component.



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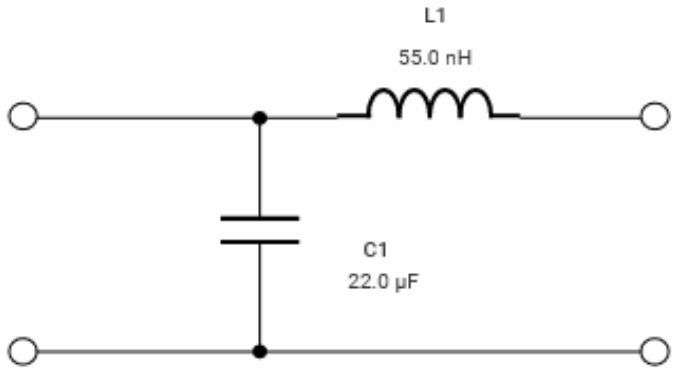
- **EXAMPLE: MCP16311/2 Components selection**
- The user also has the freedom to pick any component from the Würth Elektronik database where thousands of components are available.

PARAMETERS | SELECTION AND SIMULATION | SUMMARY

HIGHLIGHTED ITEM REPLACES C1 — ADD MORE

	C	Assy	ESR	V_R	Series	Footprint	H	T_{MAX}	T_{MIN}
☑	22.0 µF	SMT	9.46 mΩ	16.0 V	WCAP-PHET	31.4 mm²	1.90 mm	125 °C	-55.0 °C
☐	15.0 µF	SMT	12.2 mΩ	16.0 V	WCAP-PHET	31.4 mm²	1.90 mm	125 °C	-55.0 °C
☐	10.0 µF	SMT	2.23 mΩ	16.0 V	WCAP-CSGP	8.00 mm²	2.00 mm	125 °C	-55.0 °C
☐	10.0 µF	SMT	3.03 mΩ	16.0 V	WCAP-CSGP	5.12 mm²	1.60 mm	125 °C	-55.0 °C
☐	10.0 µF	SMT	2.61 mΩ	25.0 V	WCAP-CSGP	8.00 mm²	2.00 mm	125 °C	-55.0 °C

MCP16311/2 EMI Filter project



C1	22.0 µF	16.0 V	9.46 mΩ	⇄
L1	55.0 nH	27.0 A	0.270 mΩ	⇄

Details

Calculated C1 Capacitance: 6.47 mF

Insertion Loss: -65.4 dB@500 kHz

Calculated L1 Inductance: 15.7 nH

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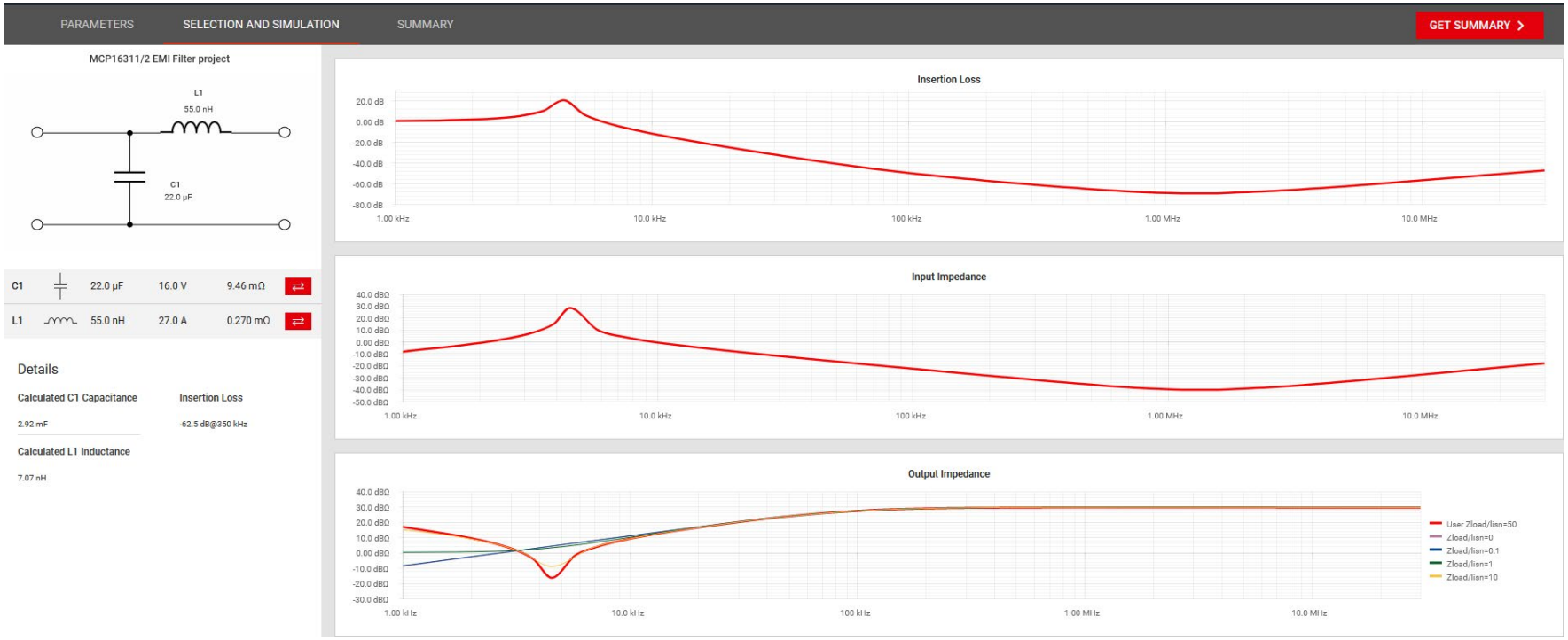
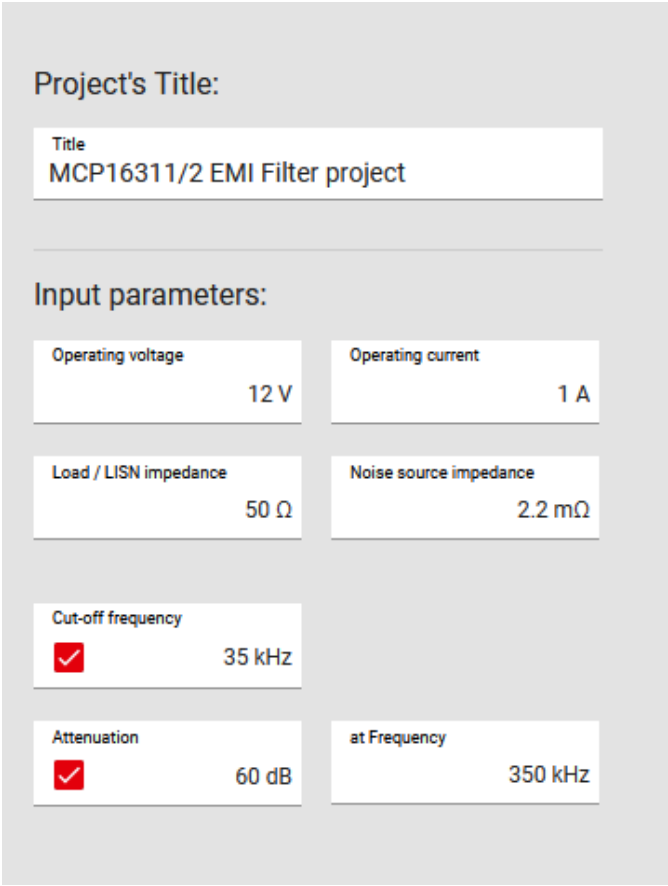
- **EXAMPLE: MCP16311/2 Cut-off frequency**
- If the cut-off frequency is not selected, you must know the order of the filter that will get desired attenuation or you can manually change the order of the filter accordingly.
- To get more precise recommendation, one needs to enter a cut-off frequency and for the same specifications, the filter calculations will change.





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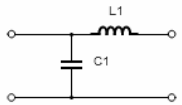
- EXAMPLE: MCP16311/2 Summary

PARAMETERS | SELECTION AND SIMULATION | SUMMARY

Circuit Schematic



Specifications Edit

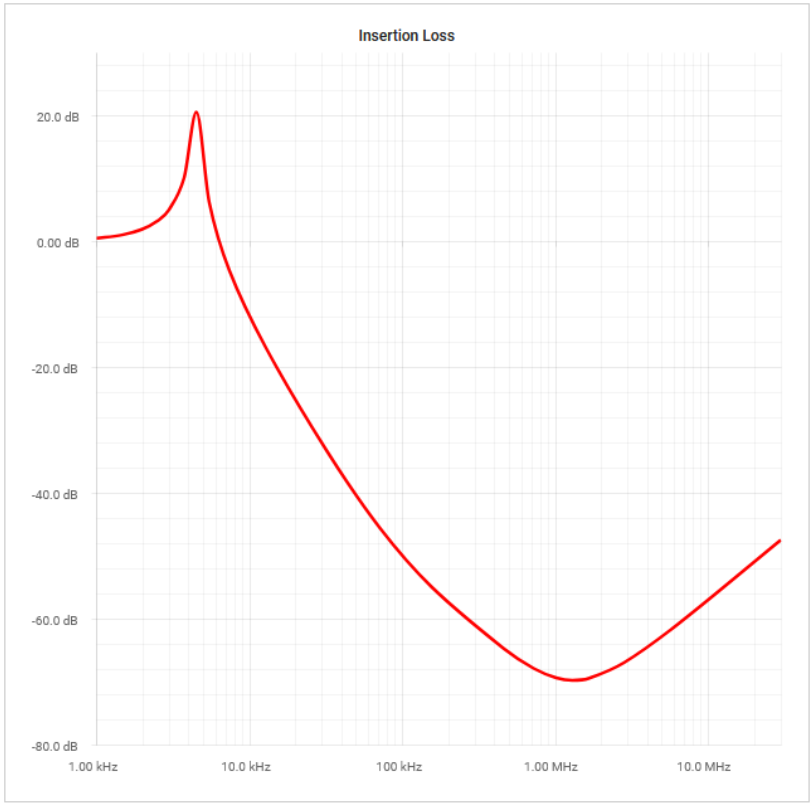
"MCP16311/2 EMI Filter project"

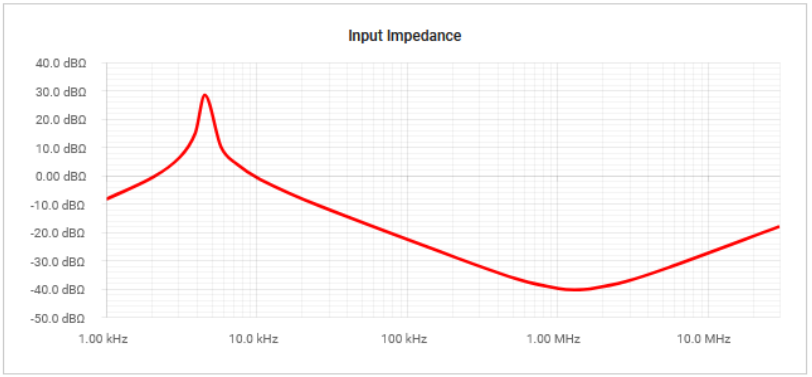
TYPE: CL
V_{op}: 12.0 V
I_{op}: 1.00 A
LOAD / LISN IMPEDANCE: 50.0 Ω
NOISE SOURCE IMPEDANCE: 2.20 mΩ
ILOSS -62.5 dB@350 kHz

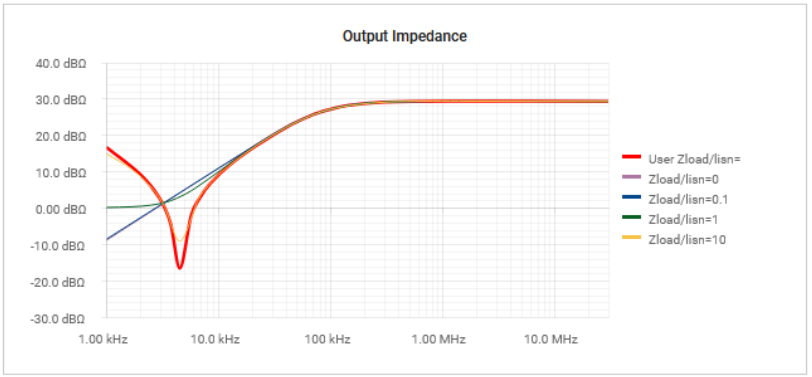
Bill Of Materials ADD

#	Na...	Order Code	Value	Properties	Qty
1.	C1	875135319007	22.0 µF	Assembling Technology = SMT Capacitance = 22.0 µF Rated Voltage = 16.0 V Height = 1.90 mm	1
2.	L1	744340300055	55.0 nH	Inductance = 55.0 nH Rated Current = 27.0 A	1

Simulation Responses







Thank you!