

SRCG 16th January 2018



Filter components and grounding at the PCB level

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Outline



- How to configure a filter
- Practical component limitations
- Demonstrating the effect of real components and real impedances
- Modelling the predicted attenuation of a filter
- The impact of ground impedance on the attenuation

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Filter configuration

One component

- Series inductor (L): Low impedance at both Z_S and Z_L .
- Parallel capacitor (C): High impedance at both Z_S and Z_L .

Two component, L

- Series inductor (L) and parallel capacitor (C): Low impedance at Z_S , High impedance at Z_L .
- Parallel capacitor (C) and series inductor (L): High impedance at Z_S , Low impedance at Z_L .

Three component, π or T

- π network (two parallel capacitors and a series inductor): Medium-high impedance at Z_S and Z_L .
- T network (two series inductors and a parallel capacitor): Medium-low impedance at Z_S and Z_L .

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Component imperfections

Parasitic parallel capacitance and series resistance

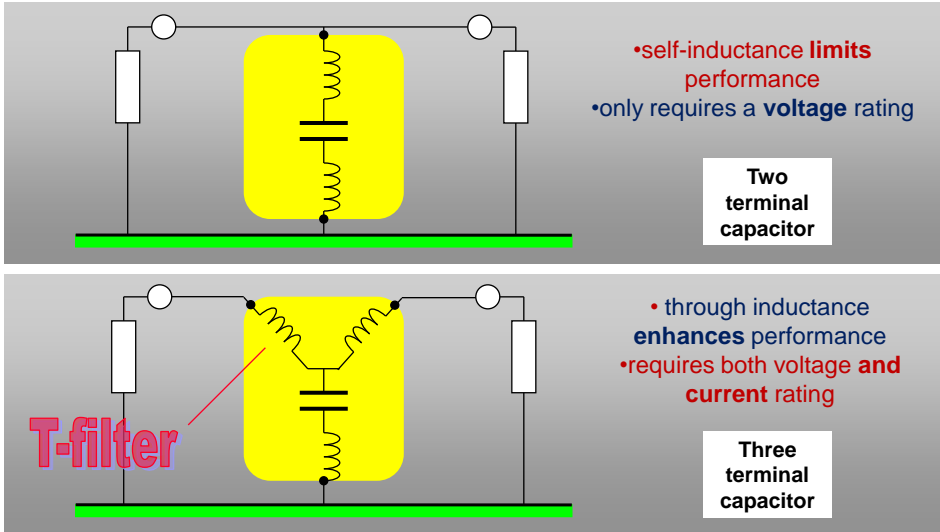
Parasitic series inductance and resistance

Graph showing attenuation (dB) vs. frequency:

- The graph shows two curves: a smooth curve for a "perfect component" and a curve with a sharp dip for a "real component".
- The dip in the "real component" curve is labeled "self-resonance".
- The depth of the self-resonance dip is indicated to depend on the resistance.

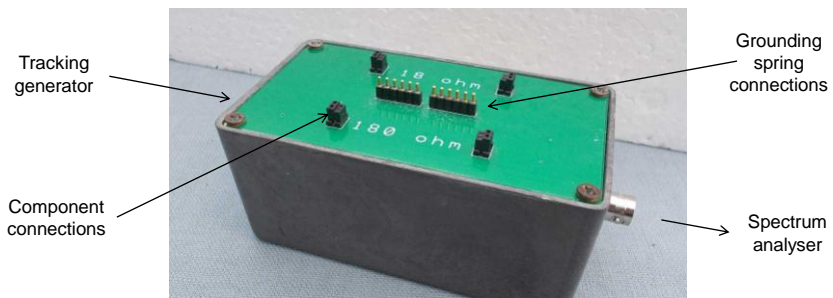
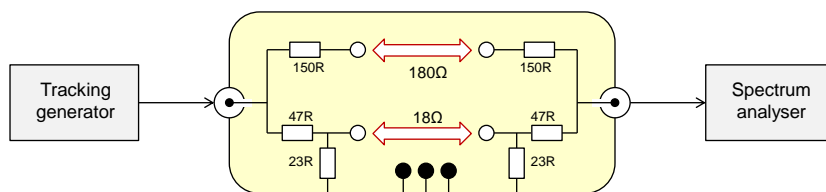
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Three-terminal capacitors



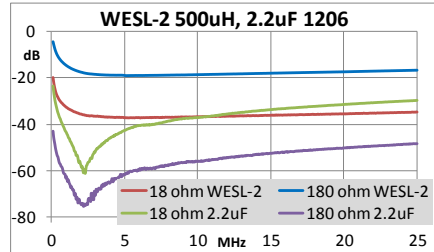
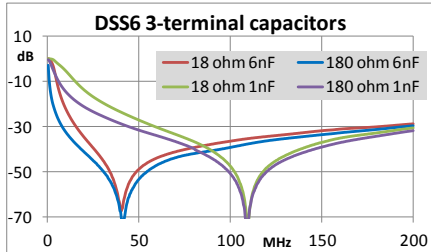
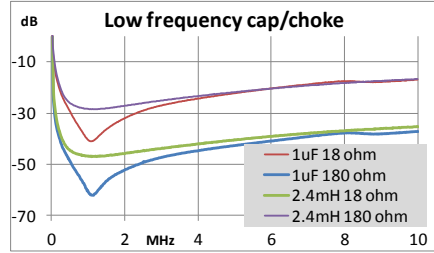
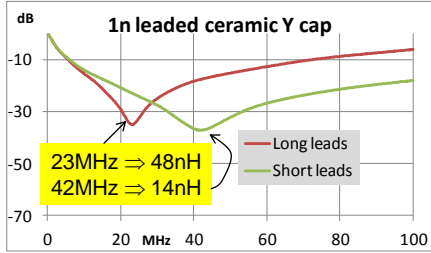
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Demo: the jig



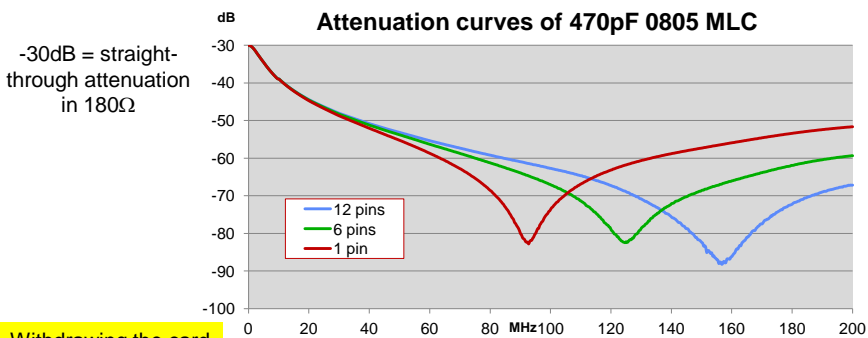
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Demo: some example components

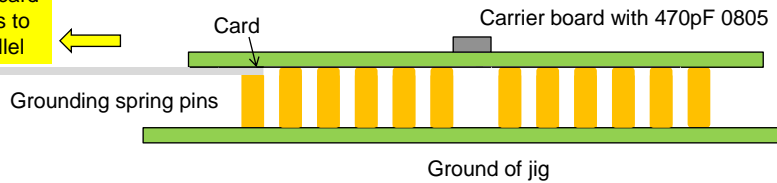


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Demo: the business card trick

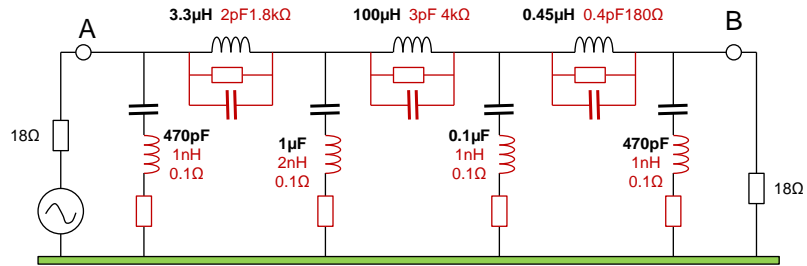


Withdrawing the card allows more pins to connect in parallel

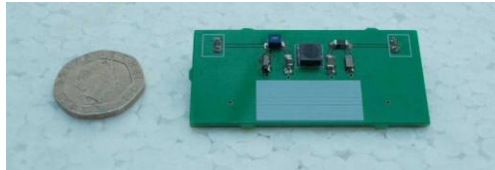


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An example cascaded filter schematic

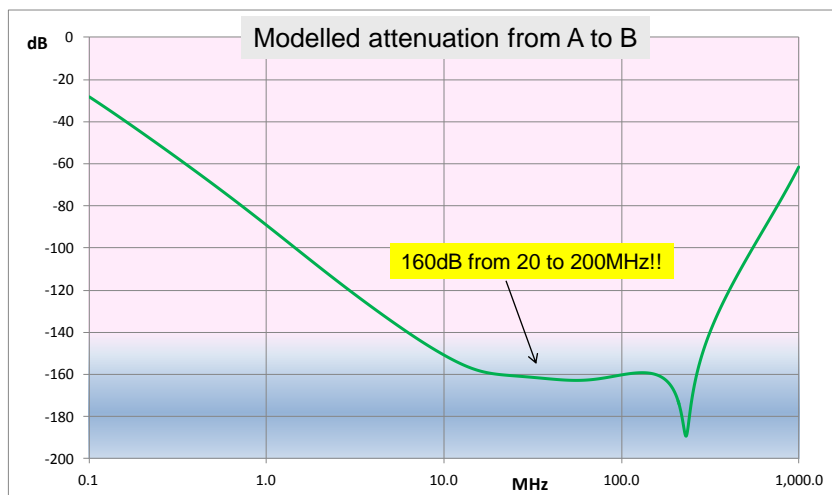


Black = main value
Red = parasitic



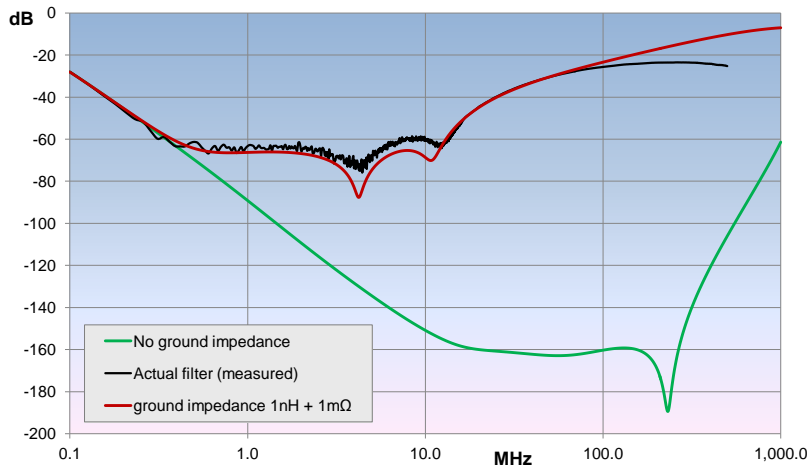
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The predicted attenuation versus frequency



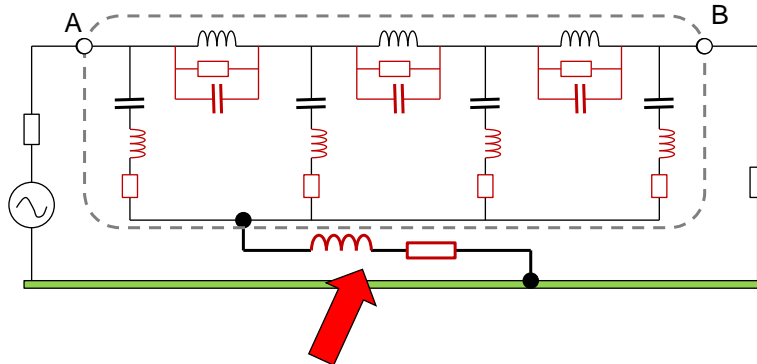
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Demo: the actual attenuation



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Respecting the ground impedance



- Adding the true ground impedance* of approx. 1nH and 1mΩ reduces the model attenuation by 120dB!

* due to the carrier-board-to-jig-ground connection

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THE END
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Thanks for your attention!