X2Y to replace a **Common Mode Choke**

1) Common mode choke – basic reminder/recap

- Ideal Common Mode Choke

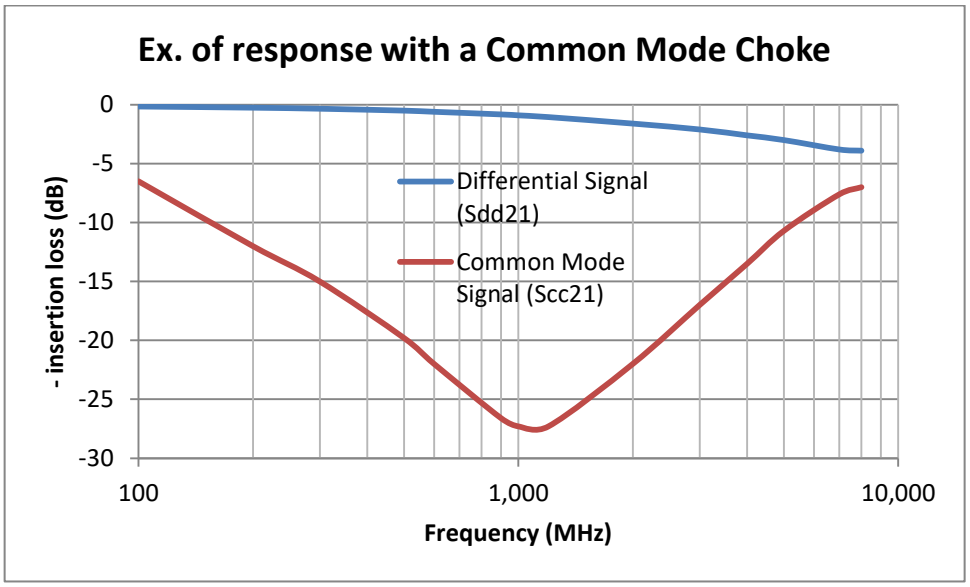
An ideal Common Mode Choke would let a differential signal go through with no attenuation, while it would completely block a common signal:

Differential signal:

Common signal:

- Advantage of a Common Mode Choke

In many cases, a Common Mode Choke can reject a common mode noise even when it is in the same frequency range as the differential signal we want to pass.



In this case, a differential signal at 1GHz would have about 1dB loss (blue curve), while a common mode signal at 1GHz would have about 27 dB rejection (red curve)

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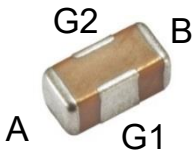
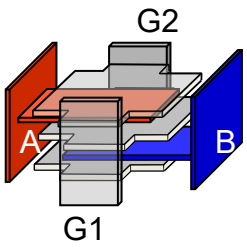
- Technical Issues with a CMC
  - The CMC is mounted in series, hence DC current limitation and power consumption.
  - Introduction of new noise due to windings that are never identical for each line.
  - Common noise rejection gets to 40 dB at the very best.
  - In most cases, need to add other components (Cy caps, Cx caps, feed-through, Pi filters, etc.) to improve performance.
  - Assembly management, especially for large sizes.

- Other issues

  High cost, long lead-time, big size, weight, sensitive to vibrations, narrow temperature range…

2) X2Y component - recap





- Field shielding
- Balanced shunt impedance
- H-field cancellation for a Common-Mode signal (lower inductance)

When properly laid out (see paragraph 4), the X2Y component provides great performances.

However, the X2Y will not be satisfactory if the differential signal is in the same frequency range as the common mode signal: Scc21 and Sdd21 are somewhat similar for an X2Y, contrary to a Common Mode Choke (see previous paragraph).

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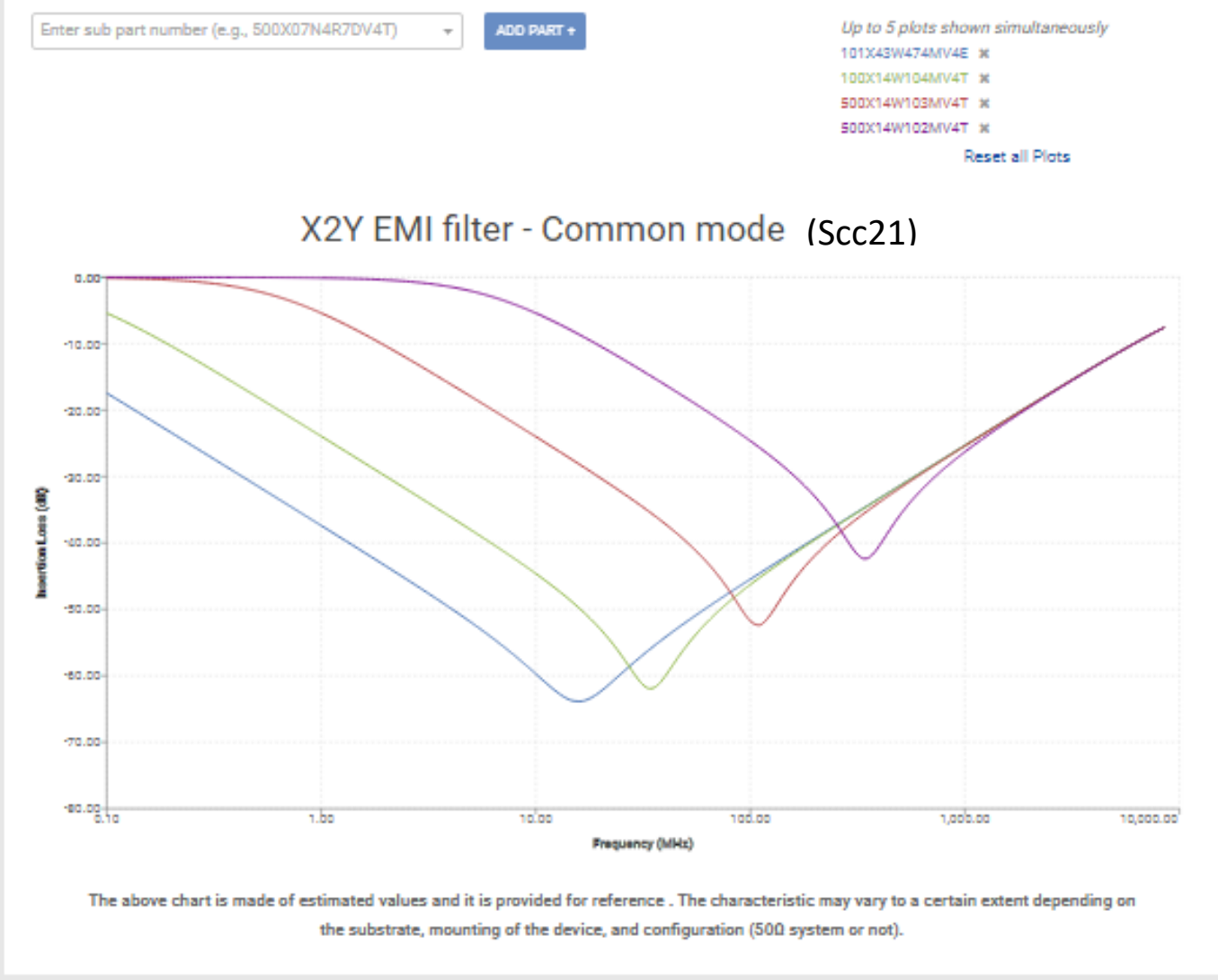
3) Selection of the value of X2Y

X2Y component can be easily selected to filter EMI, based on:

- Required signal pass-band => sets maximum cap. Value
- Required noise stop band and minimum rejection => sets min value

https://s21plotter.johansondielectrics.com/



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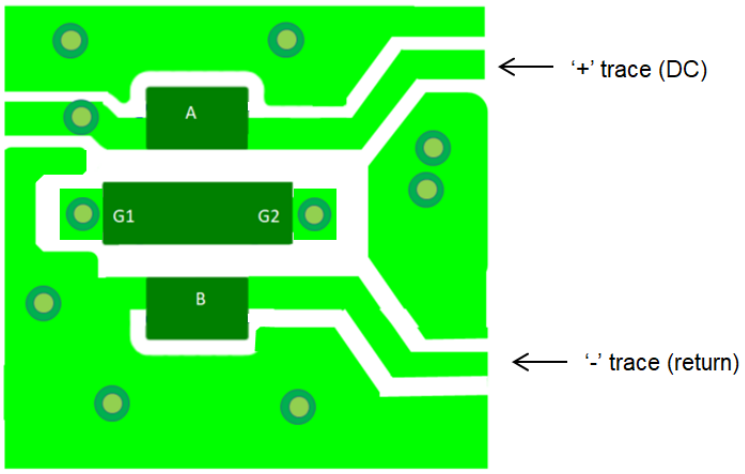
4) Replacement of a DC-Common-Mode Choke -- Example of layout



The following layout recommendations should be followed:

- When used in differential configuration, the X2Y should be placed as close as possible to the noise source.
- The two middle terminations (G1 and G2) should be connected to the reference plane (separate "ground") with vias and there should be a continuous trace (unbroken) from G1 to G2. The traces should be short and wide to minimize the mounted inductance.
- The routing of the two traces (+ trace and – trace) between noise source and X2Y should be kept symmetrical, if possible.
- The traces connected to the end terminations (A and B) should be routed to the most inner edge of the pads.

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