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:
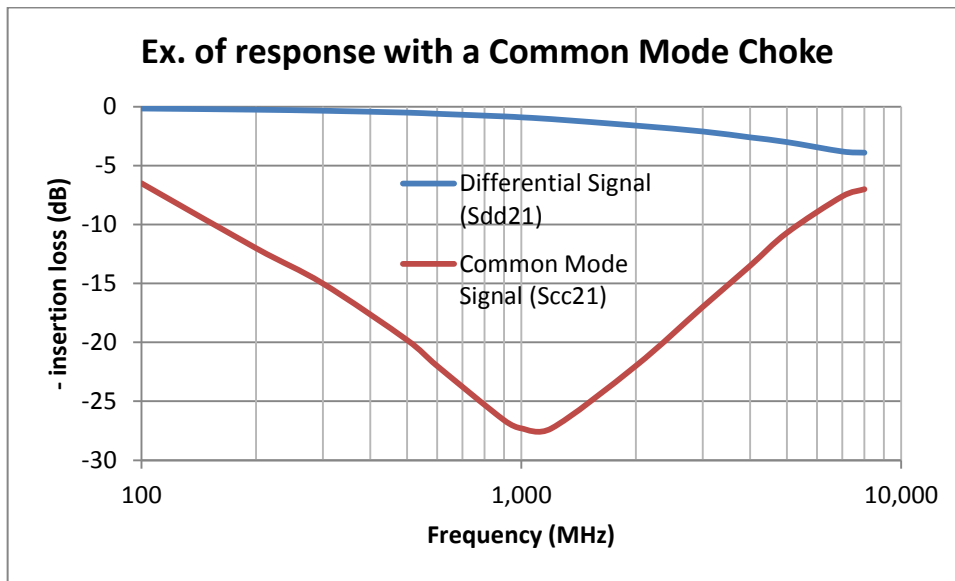
Differential signal:

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)

- 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
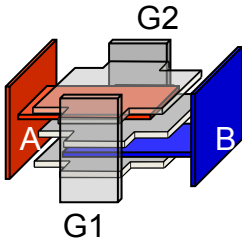
> Field shielding
> Balanced shunt impedance
> H-field cancellation (lower ESL)
> Reduction of mounted inductance*

***When properly laid out** (see paragraph 6), the X2Y component provides great performances.

However, the X2Y will <u>not</u> 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).
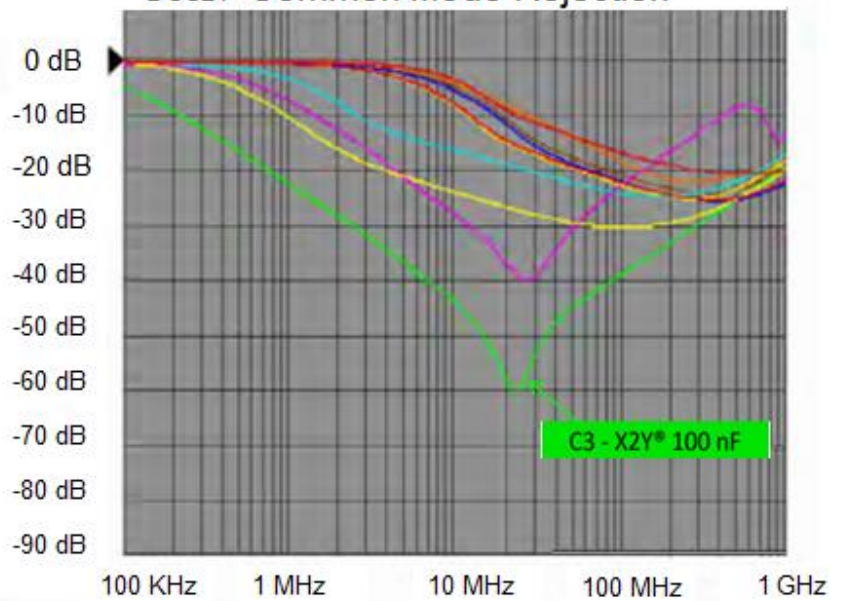
3) Performance comparison

PCB: 60-mil thick FR4

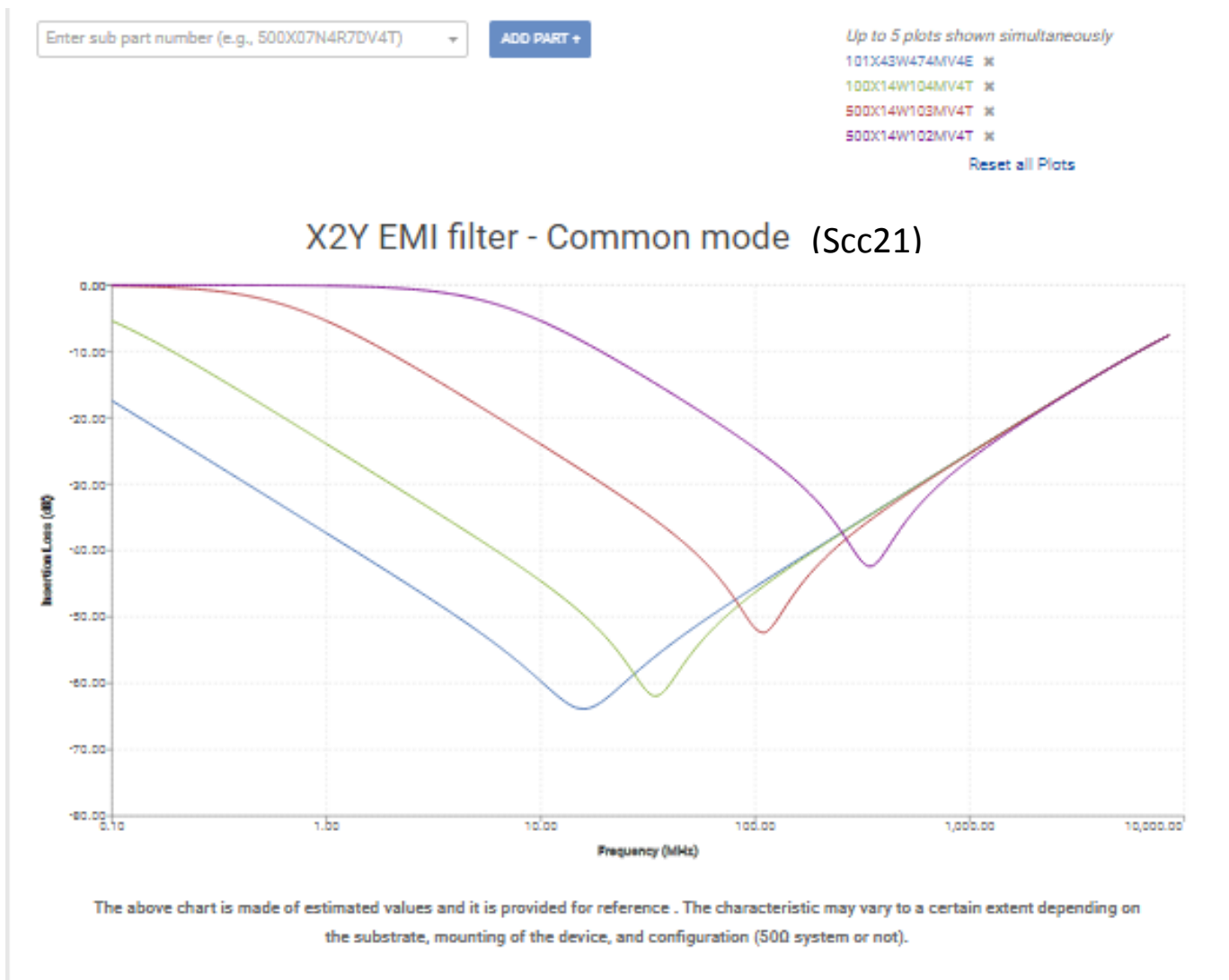|	Type	Size (mm)			Max DC Current Rating (A)	Max DC Resistance (Ω)
		W	L	T		
C3	X2Y	3.2	1.6	1.27	N/A	0
L1	DC choke	7	6	3.5	4	0.015
L2	DC choke	12	11	6	8	0.06
L5	DC choke	12	11	6	6	0.014
L6	DC choke	5	5	4.5	1.4	0.85
L7	DC choke	9	7	4.5	5	0.01
L8	DC choke	4.7	4.5	2	2.6	0.05
L9	DC choke	15	13	6	10	0.004
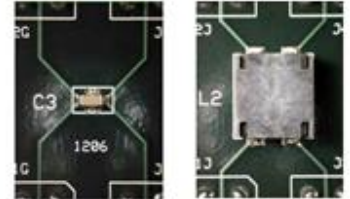
S_{CC21} Common Mode Rejection

C3 - X2Y® 100 nF
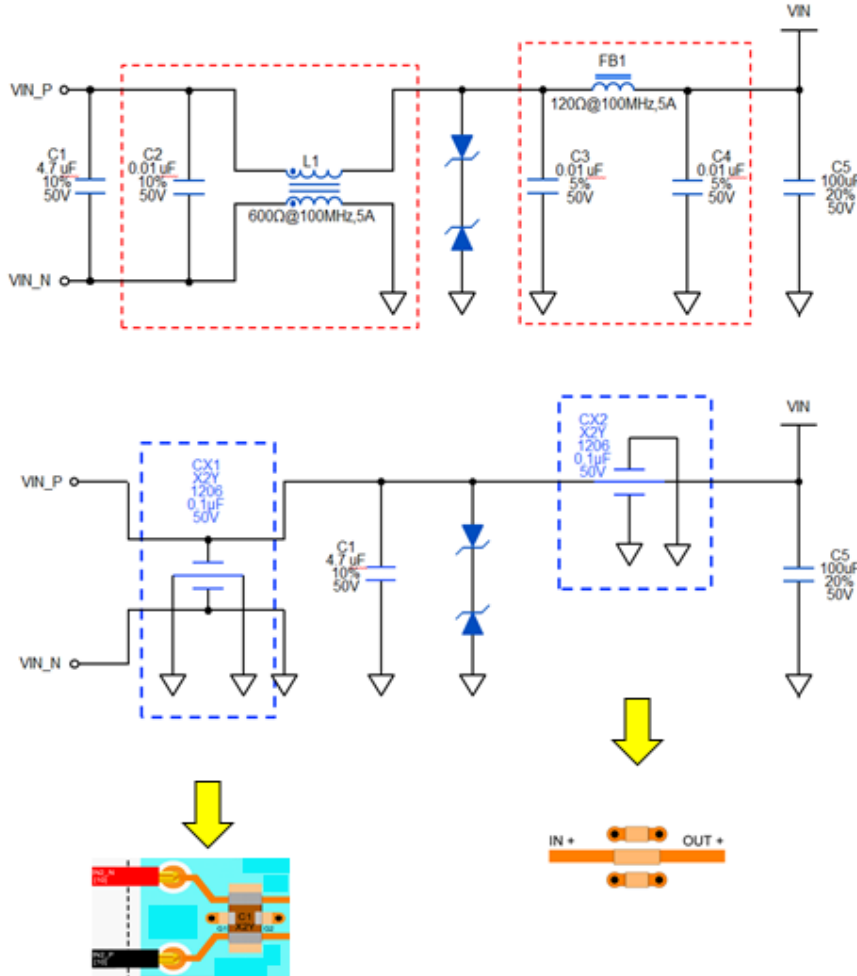
4) Selection of the value of X2Y

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/

Enter sub part number (e.g., 500X07N4R7DV4T) ▾   ADD PART +

Up to 5 plots shown simultaneously
101X43W474MV4E ✕
100X14W104MV4T ✕
500X14W103MV4T ✕
500X14W102MV4T ✕

Reset all Plots

X2Y EMI filter - Common mode (Scc21)

The above chart is made of estimated values and it is provided for reference . The characteristic may vary to a certain extent depending on the substrate, mounting of the device, and configuration (50Ω system or not).

5) Example: replacement of CMC + Pi filter with X2Y

6) Layout guidelines

To get the best performances of the X2Y component, it is important to follow our layout recommendations:

https://www.johansondielectrics.com/downloads/jdi-x2y-pcb-design-guide.pdf