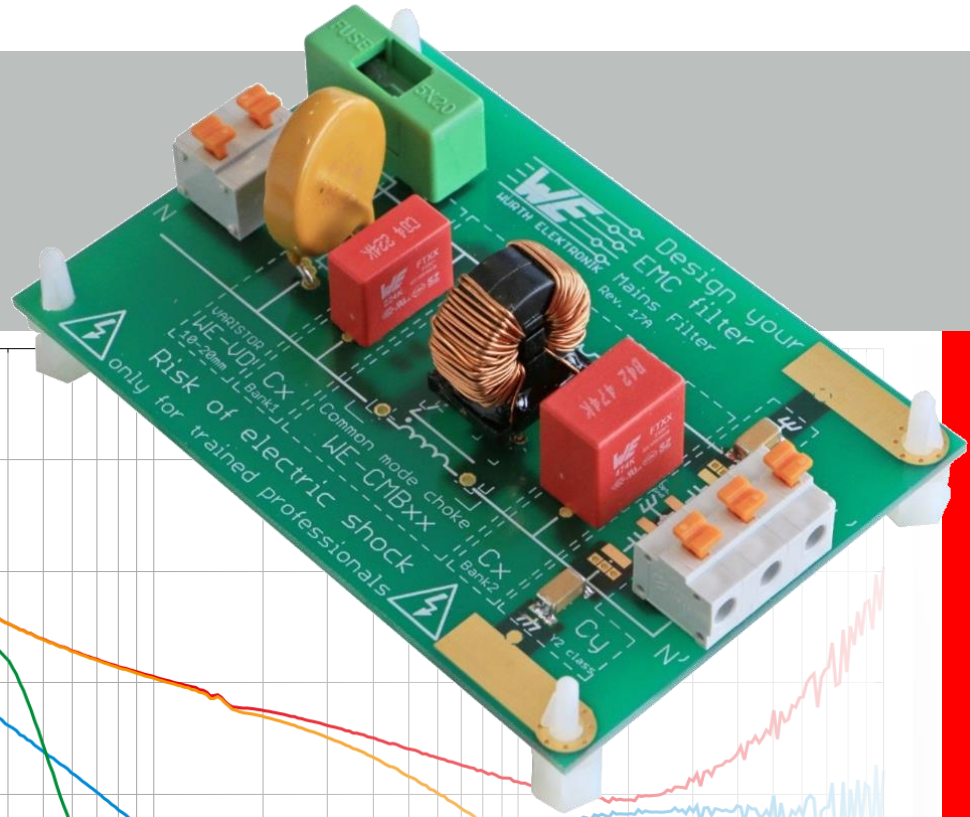
TECHNICAL ACADEMY

WÜRTH ELEKTRONIK

LE FILTRAGE SECTEUR

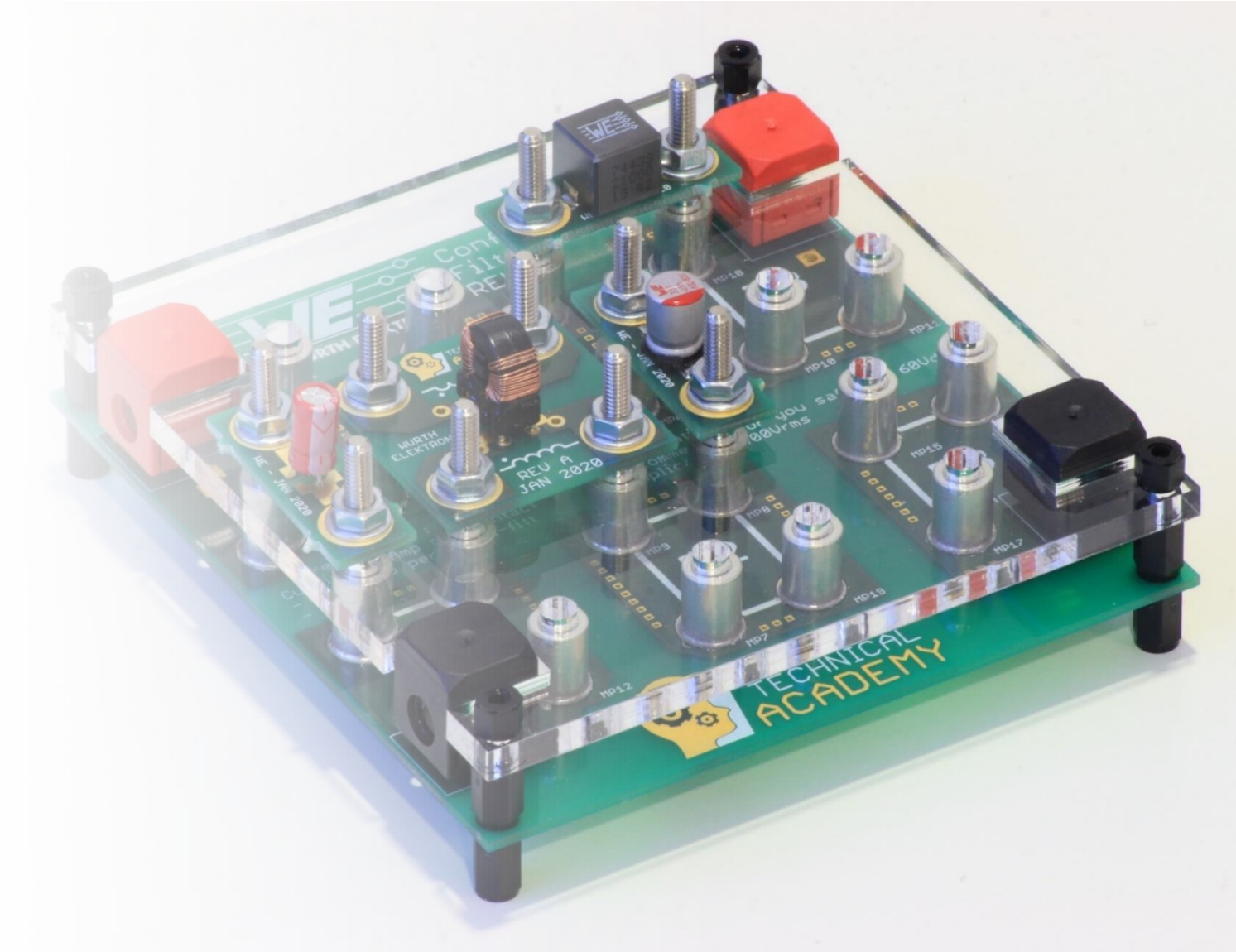


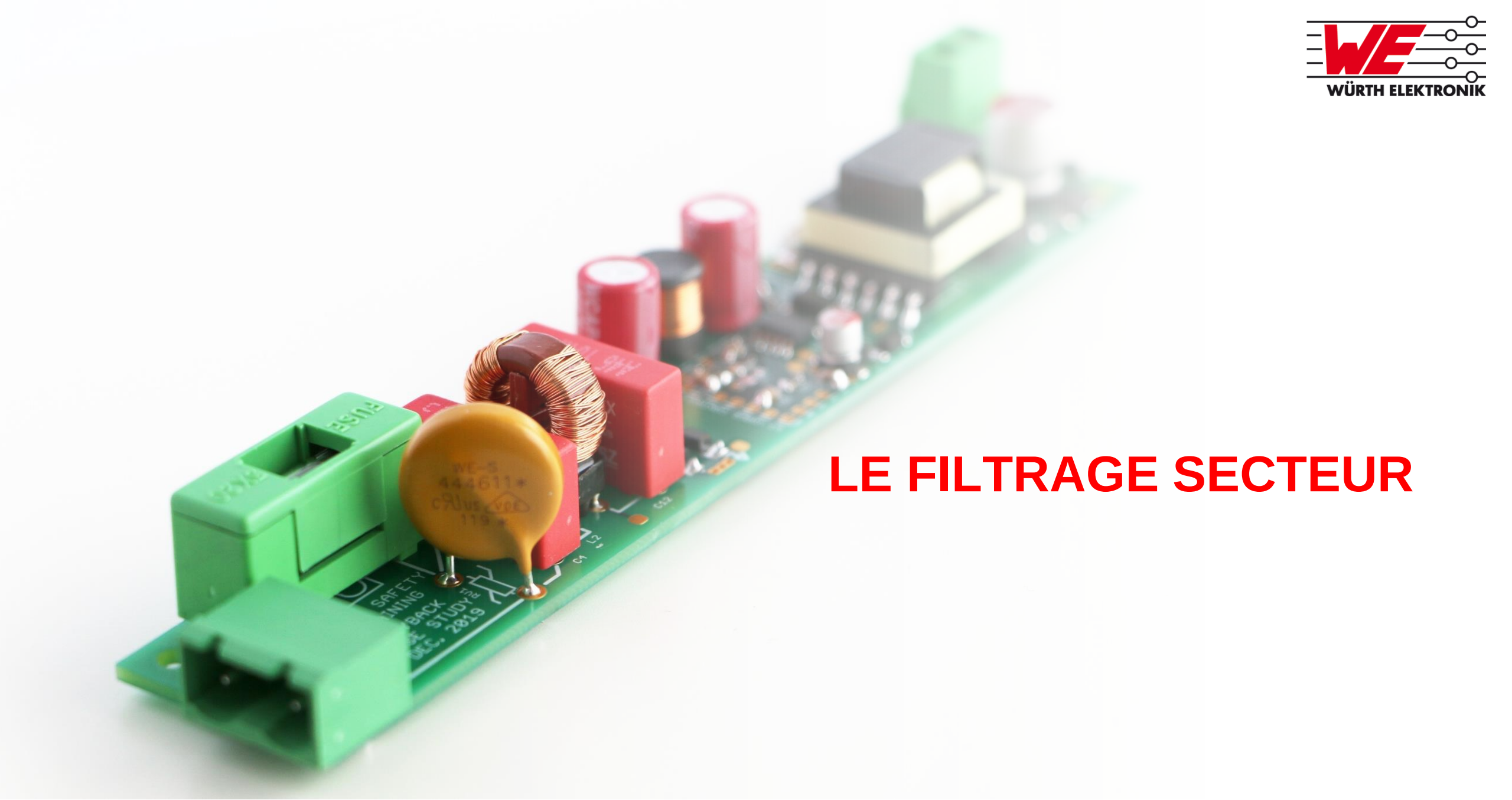
Sylvain LE BRAS

Wurth Elektronik eiSos

Webinaire : le filtrage secteur

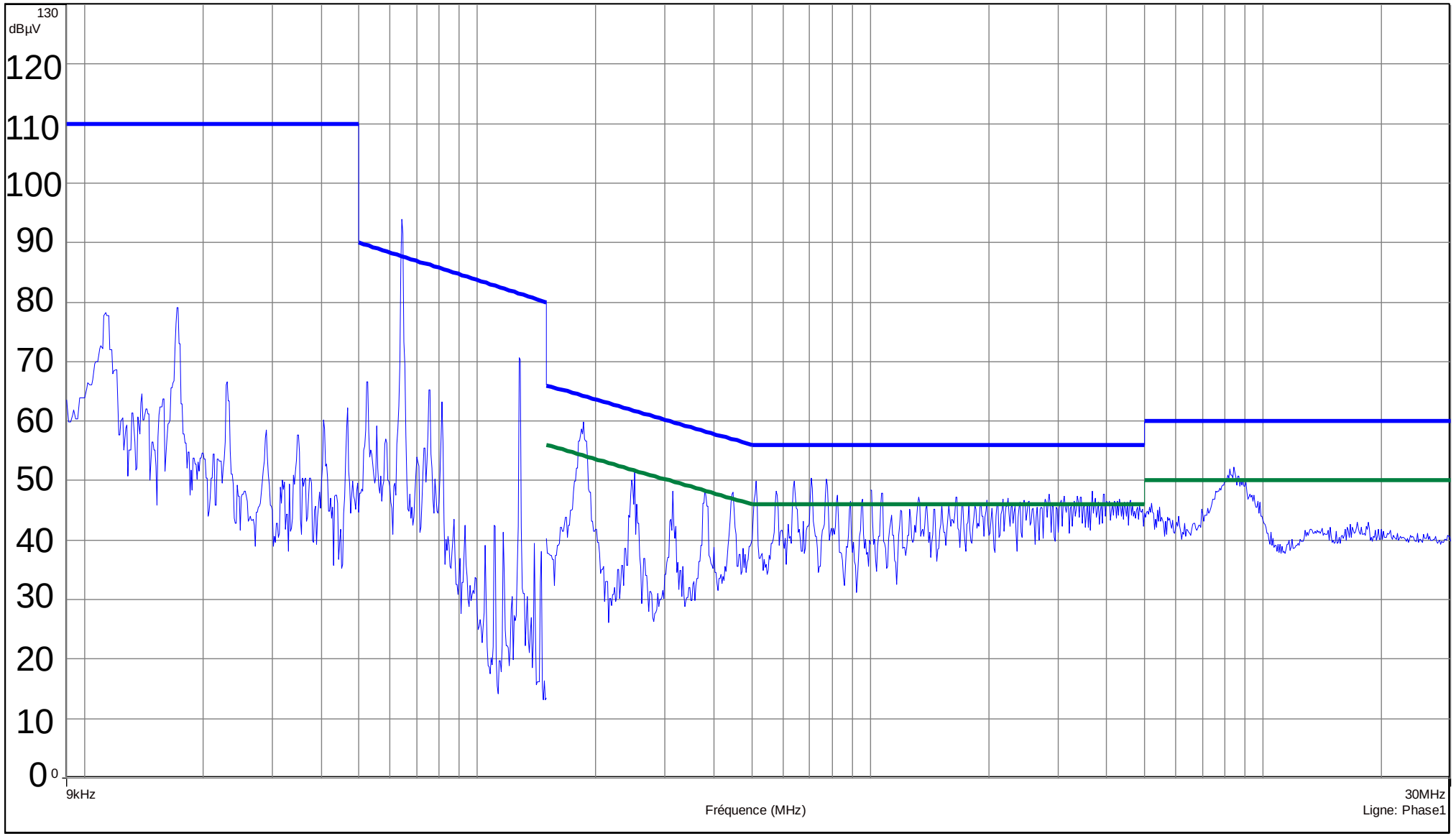
- Emissions conduites
  - La mesure CEM conduit
  - Le systeme d’impédance
  - Rappels théoriques sur le filtrage
  - Mode commun / différentiel
  - Cas pratiques
- Emissions rayonnées
- Immunité conduite
  - Dualité emission / immunité
  - Essais de surtension



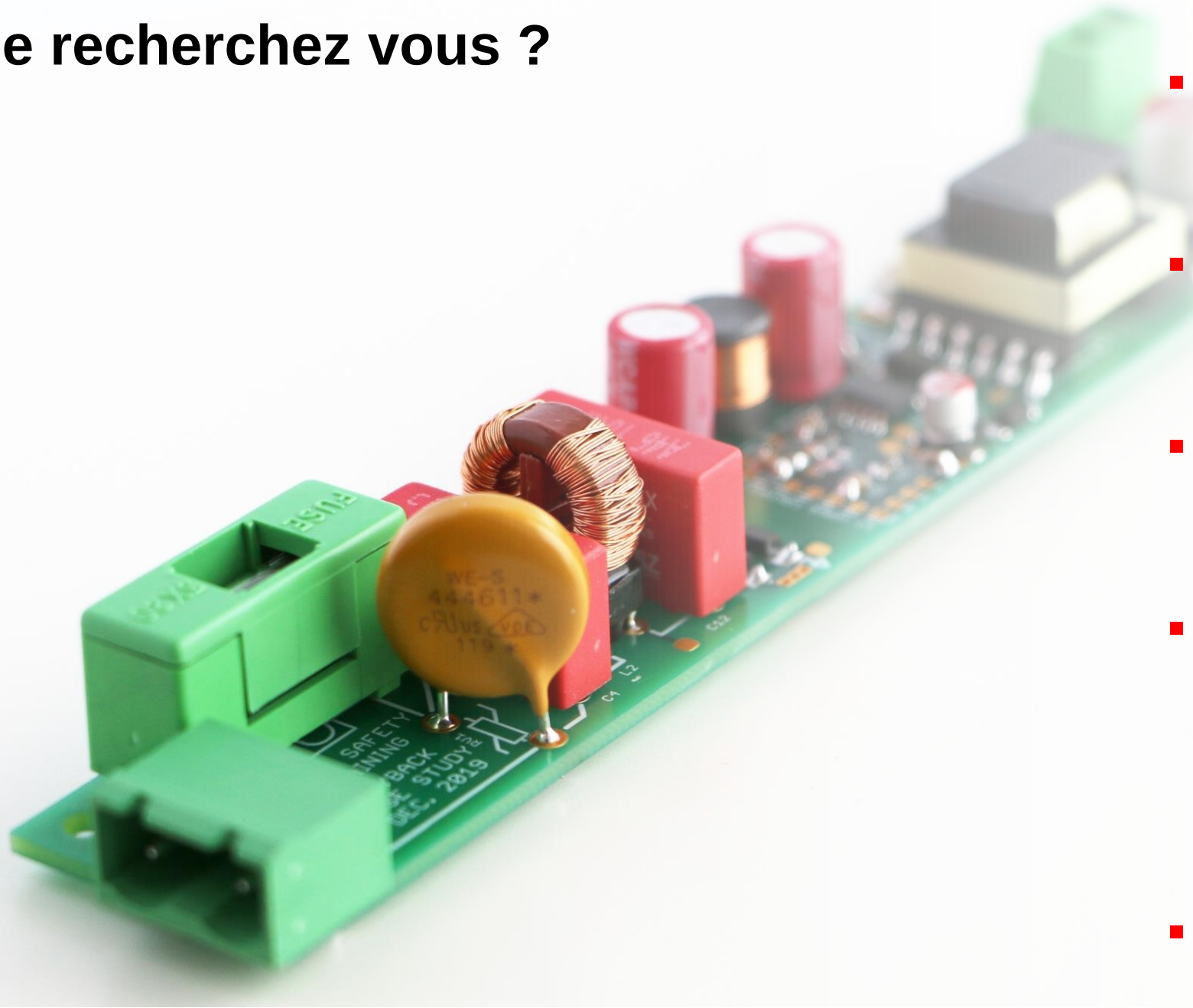


LE FILTRAGE SECTEUR

Que recherchez vous ?

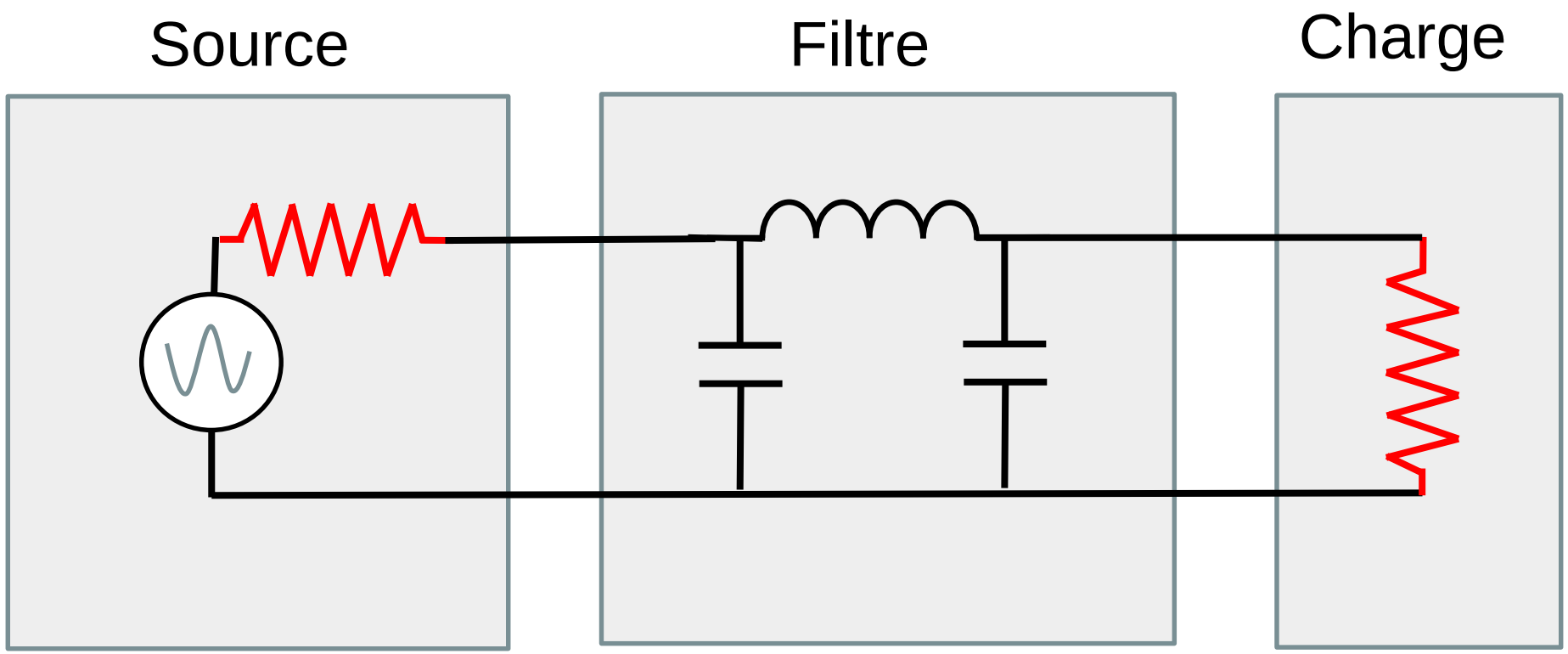


Que recherchez vous ?

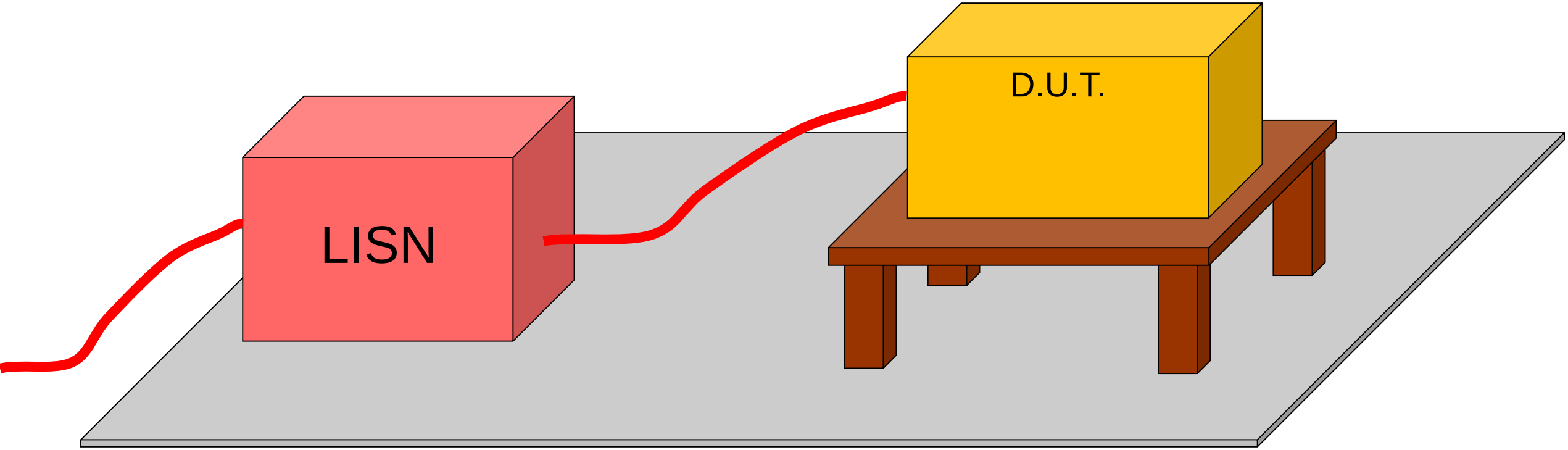


- Attenuation
  - Mode commun
  - Mode différentiel
- Système d’impédance
  - Source
  - Charge
- Tension
  - AC / DC
  - Tenue aux surtensions
- Courant
  - Nominal
  - Rms / Crête
  - En défaut
  - De fuite ?
- Sécurité
  - UL / CSA / VDE / EN

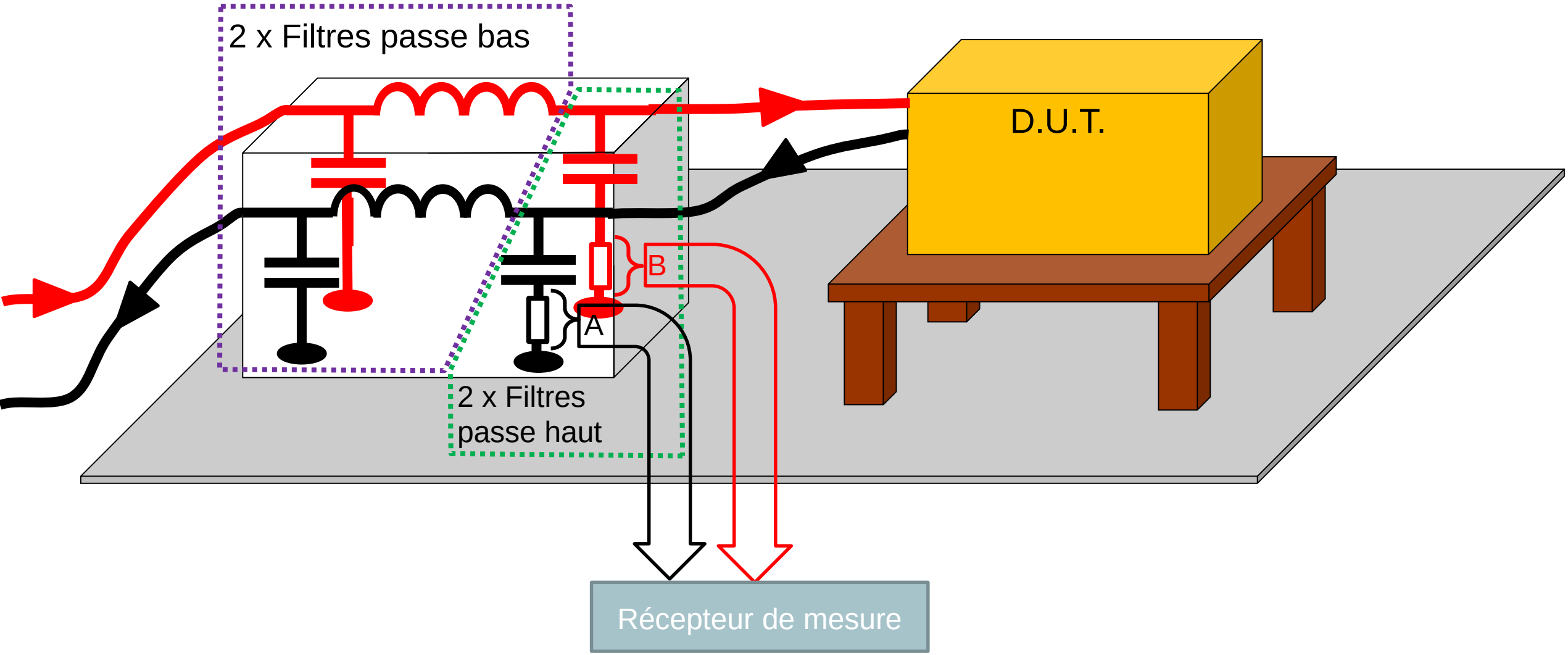
Système d’impédance ?



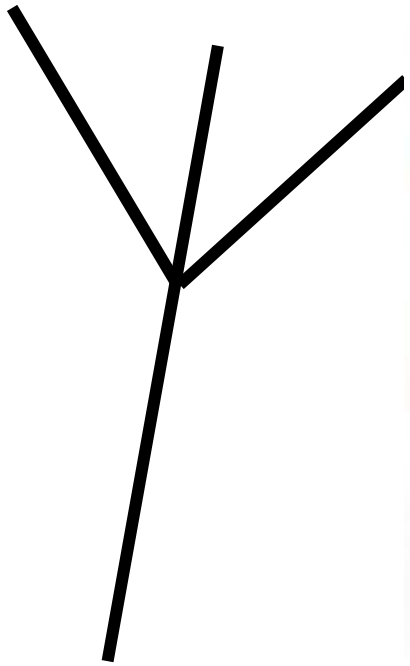
Mesure des émissions conduites

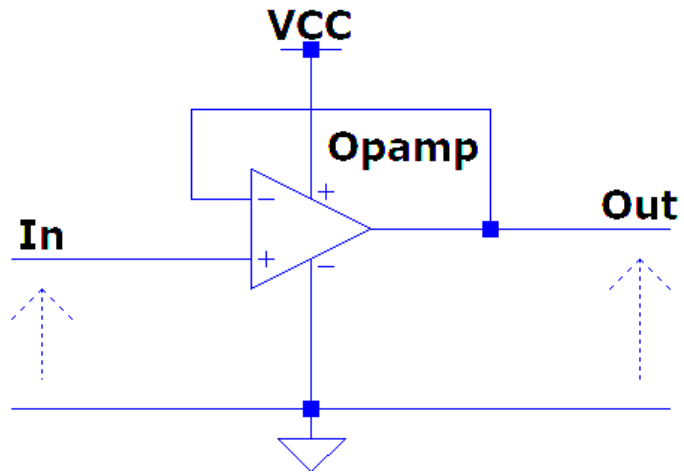


Mesure des émissions conduites



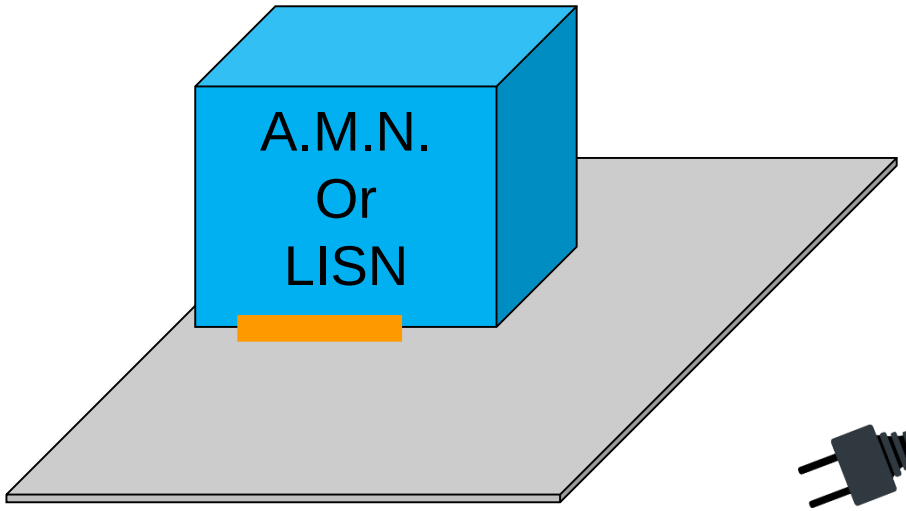
Votre système d’impedance ?



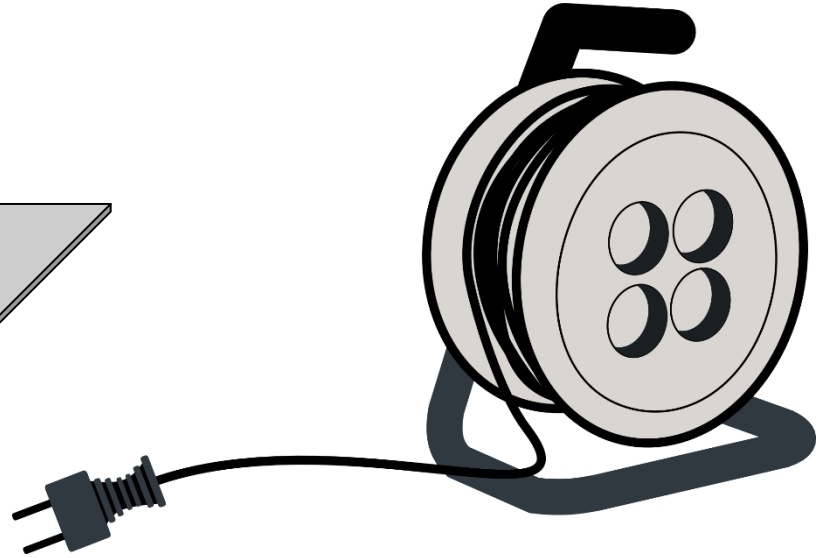


Low High Low High Low

Votre système d’impedance ?



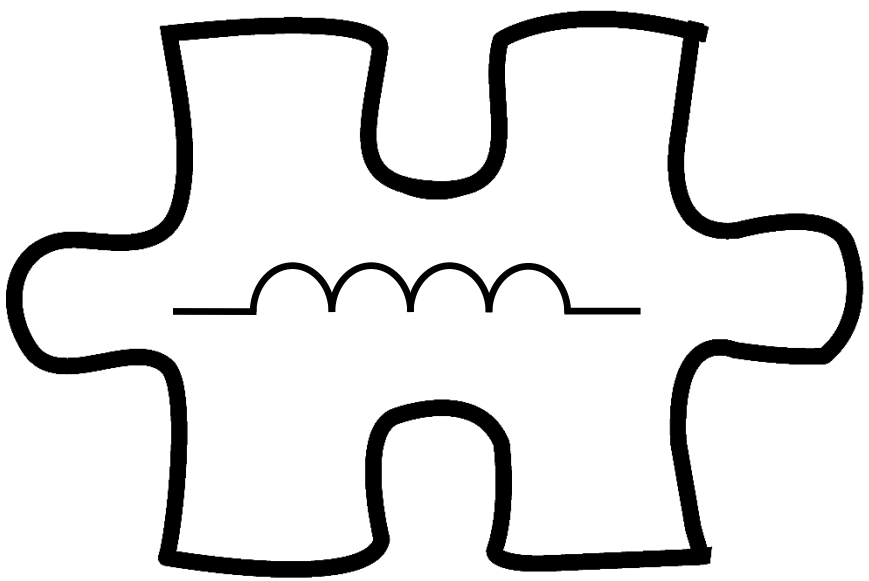
High and Low

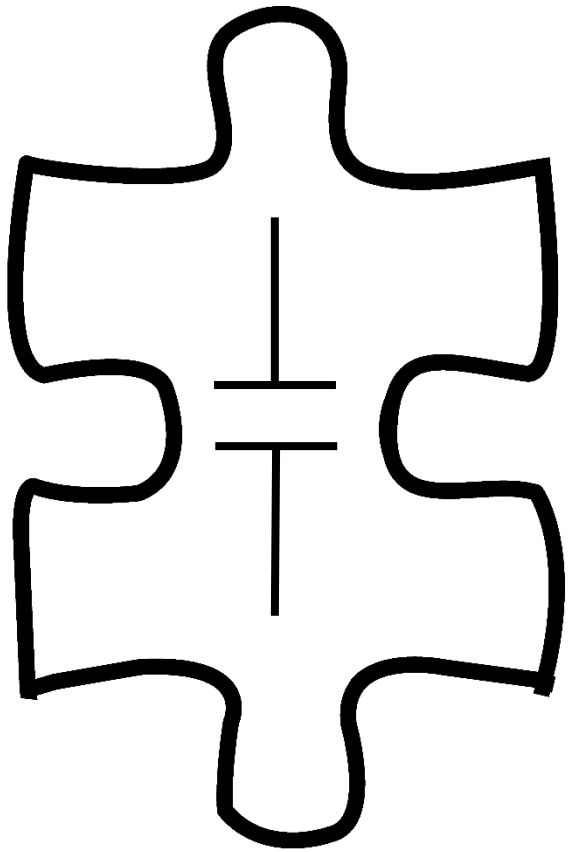


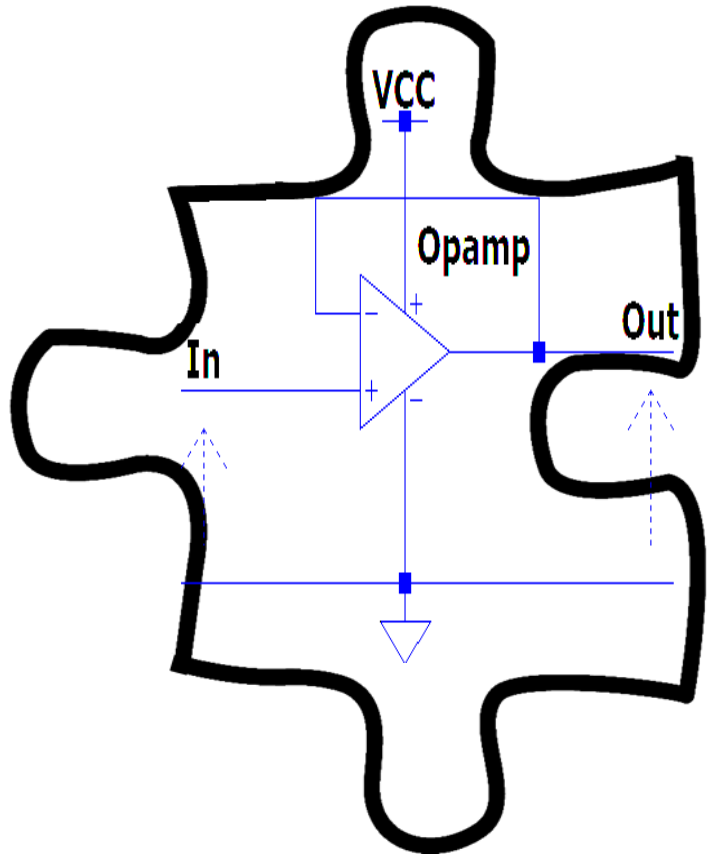
Low to High

High

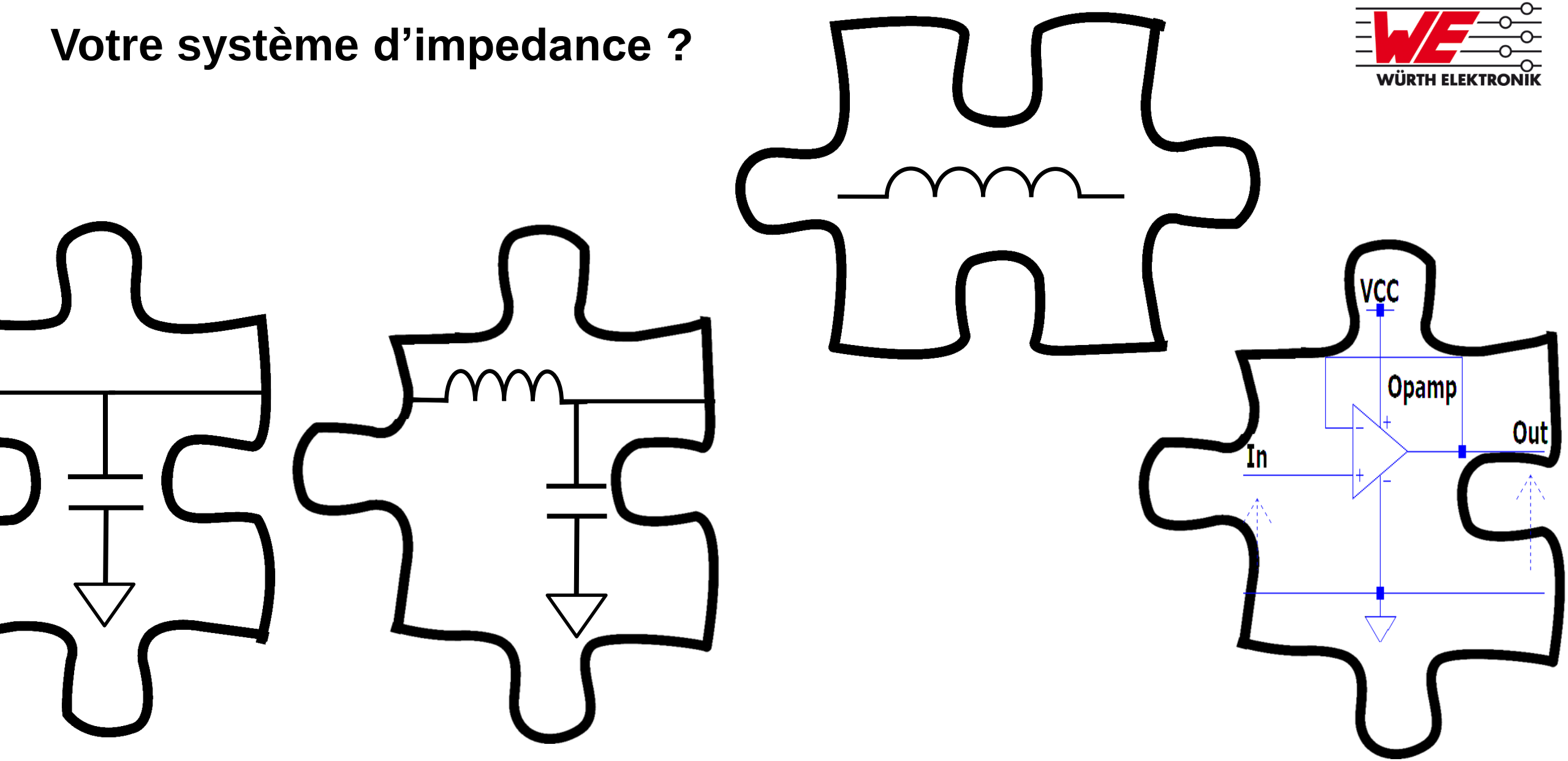
Votre système d’impedance ?



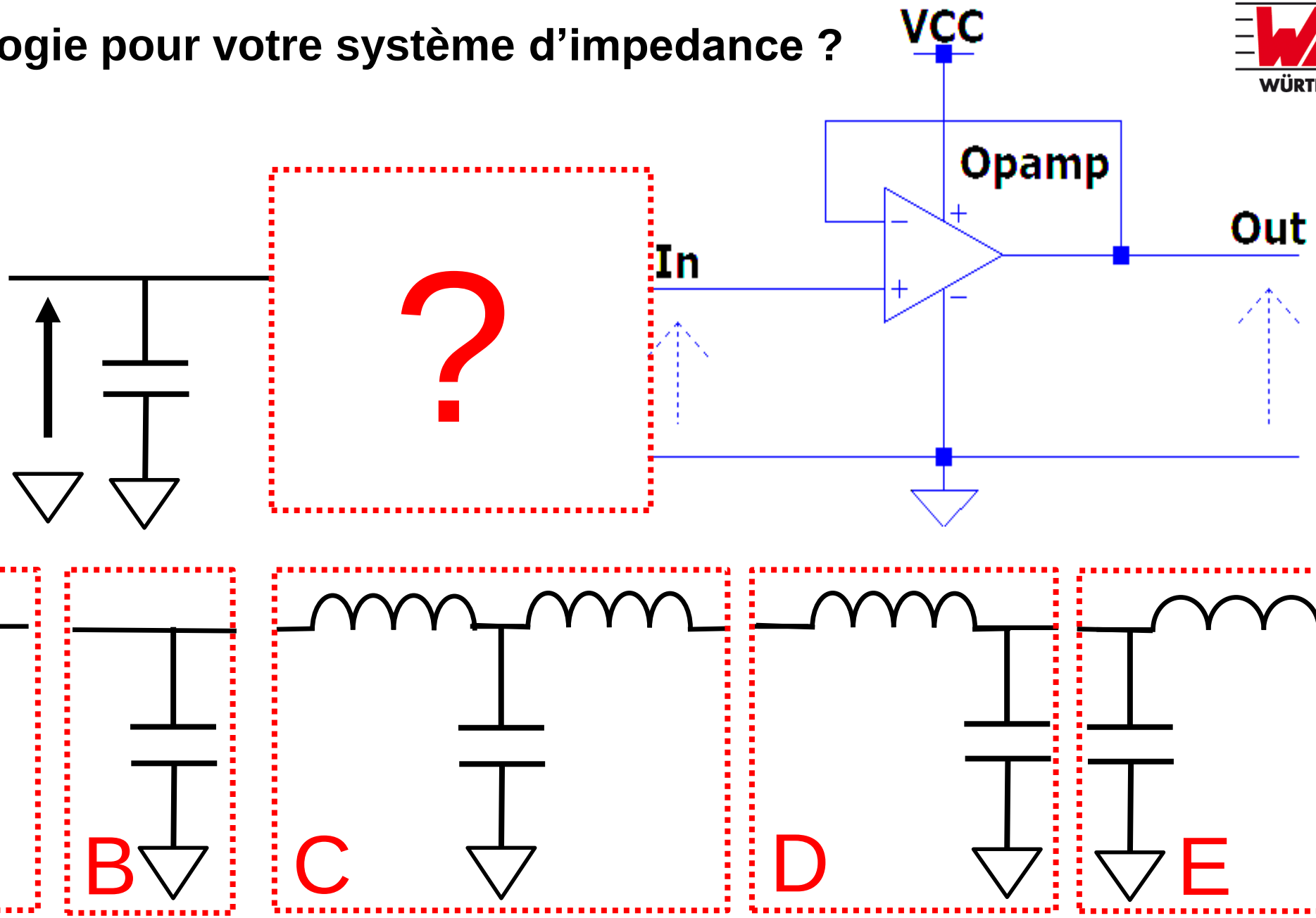




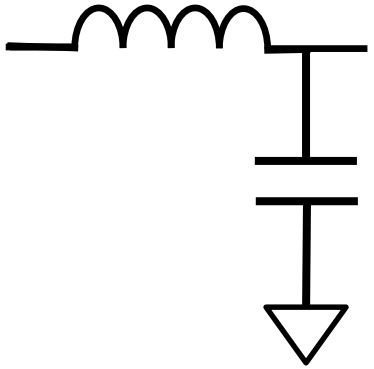
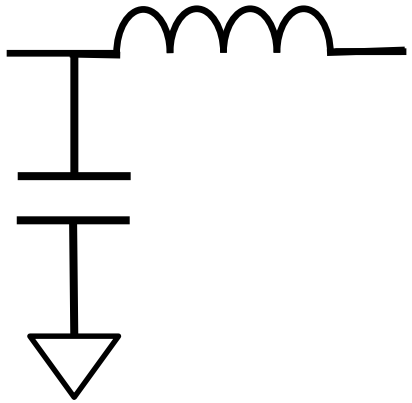
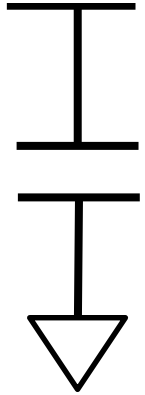
Votre système d’impedance ?



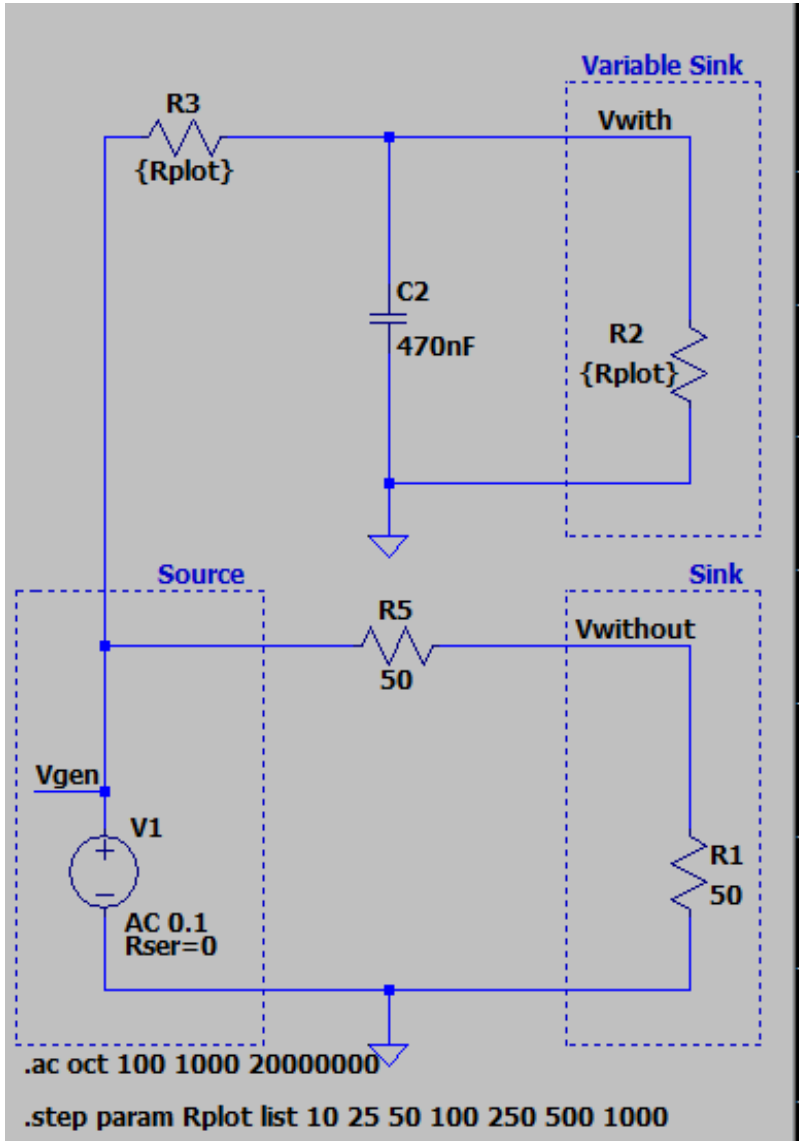
Quelle topologie pour votre système d’impedance ?

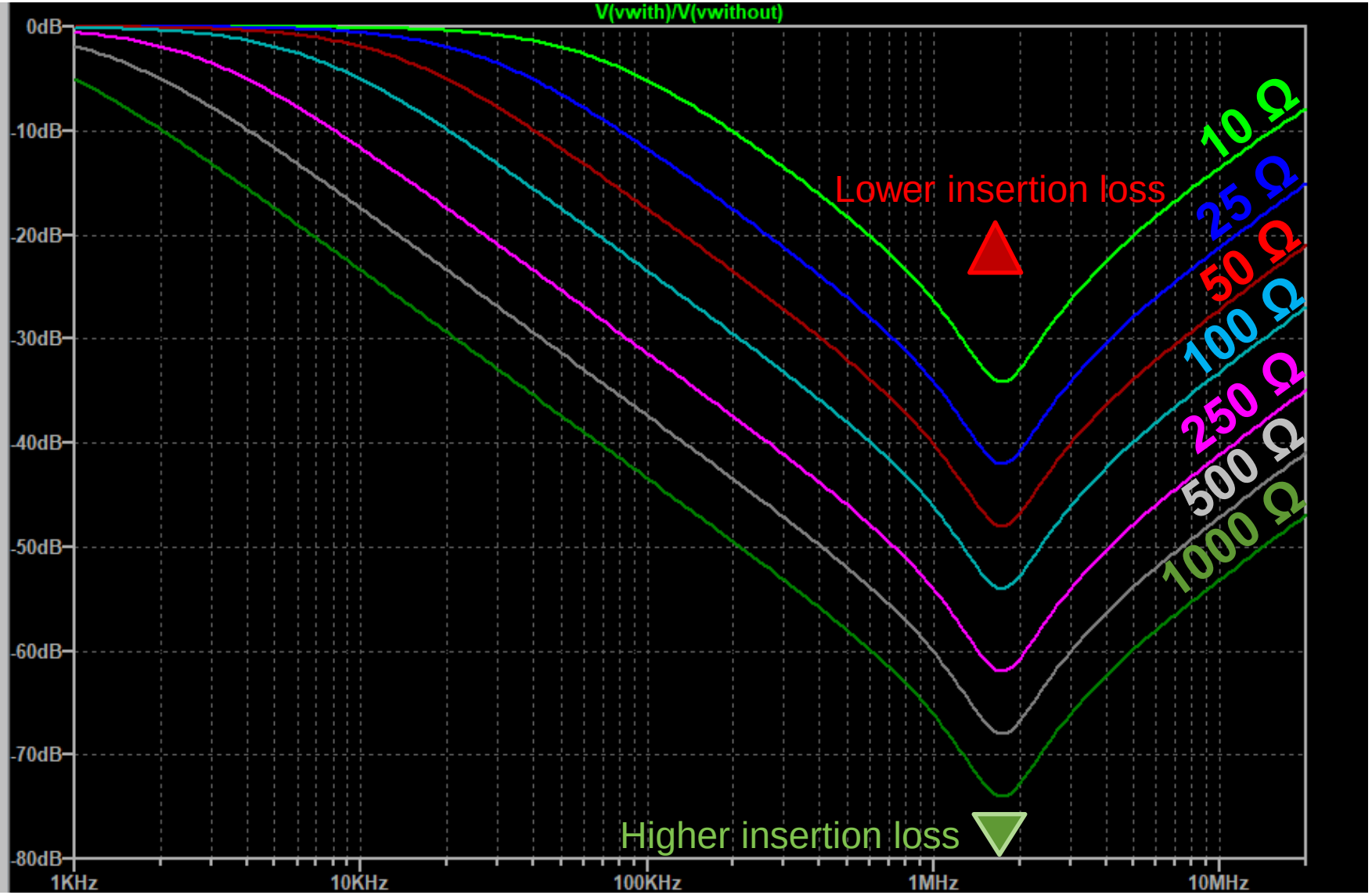


Quelle topologie pour votre système d’impedance ?

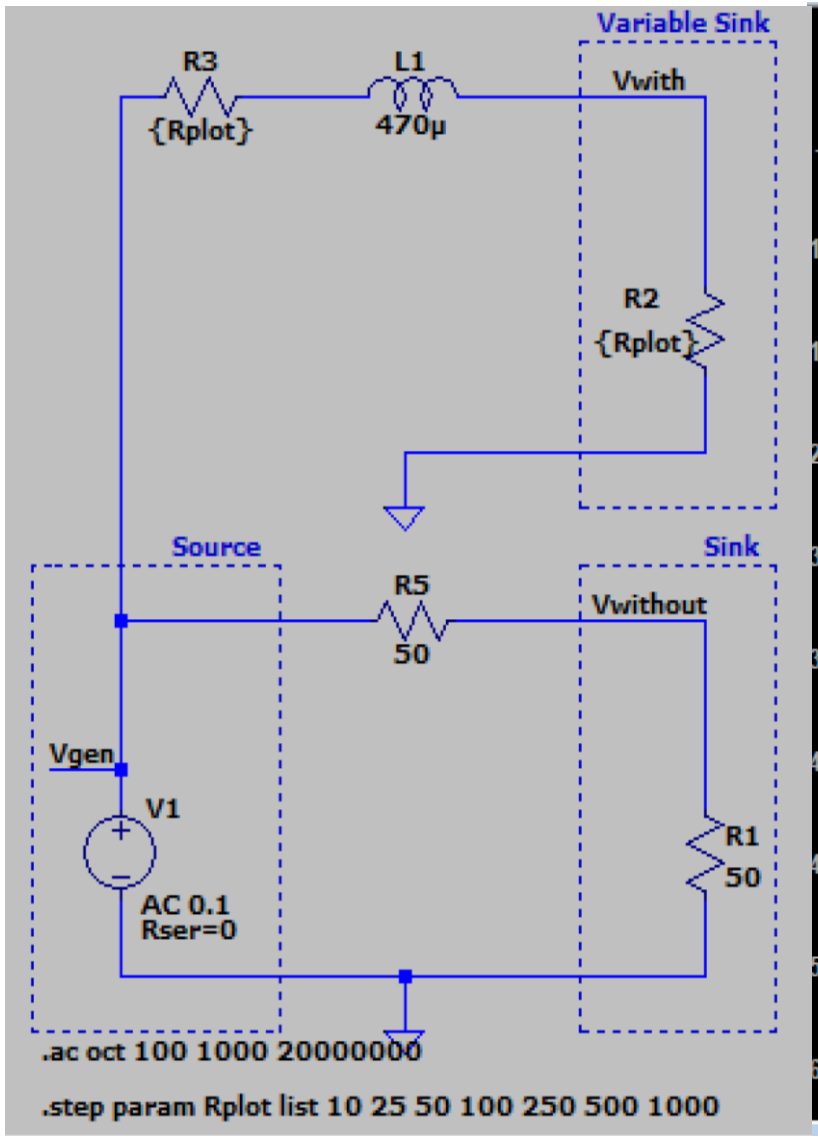
Load |Z| / Source |Z|	**Low**	**High**
Low		
High		

Impact du système d’impedance ?

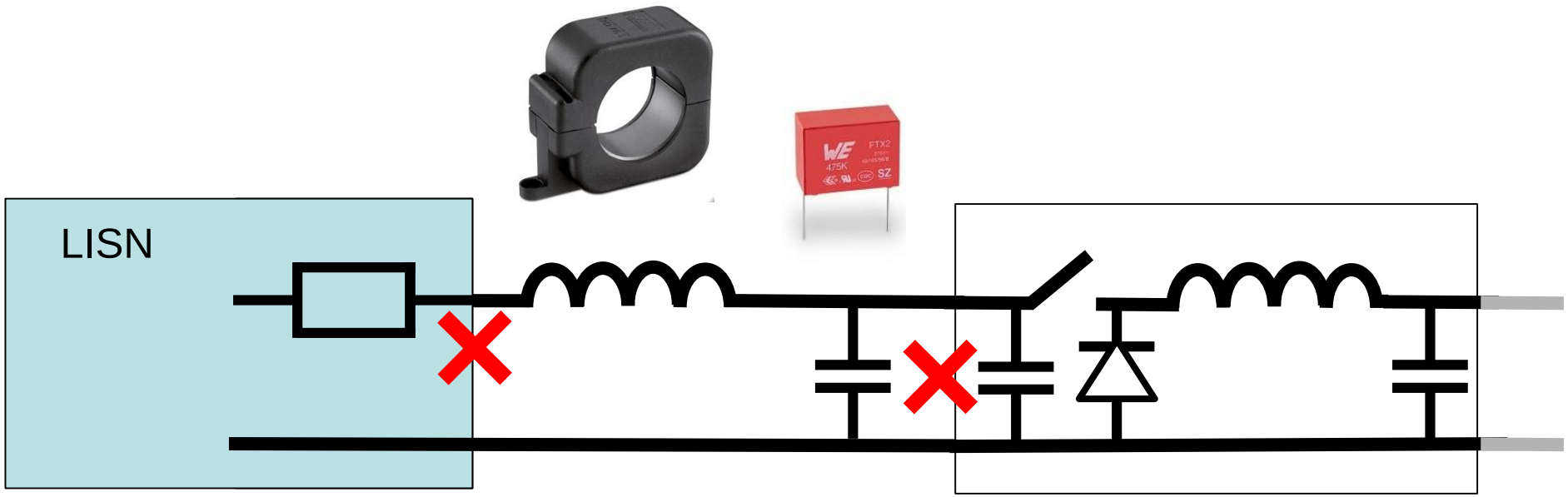




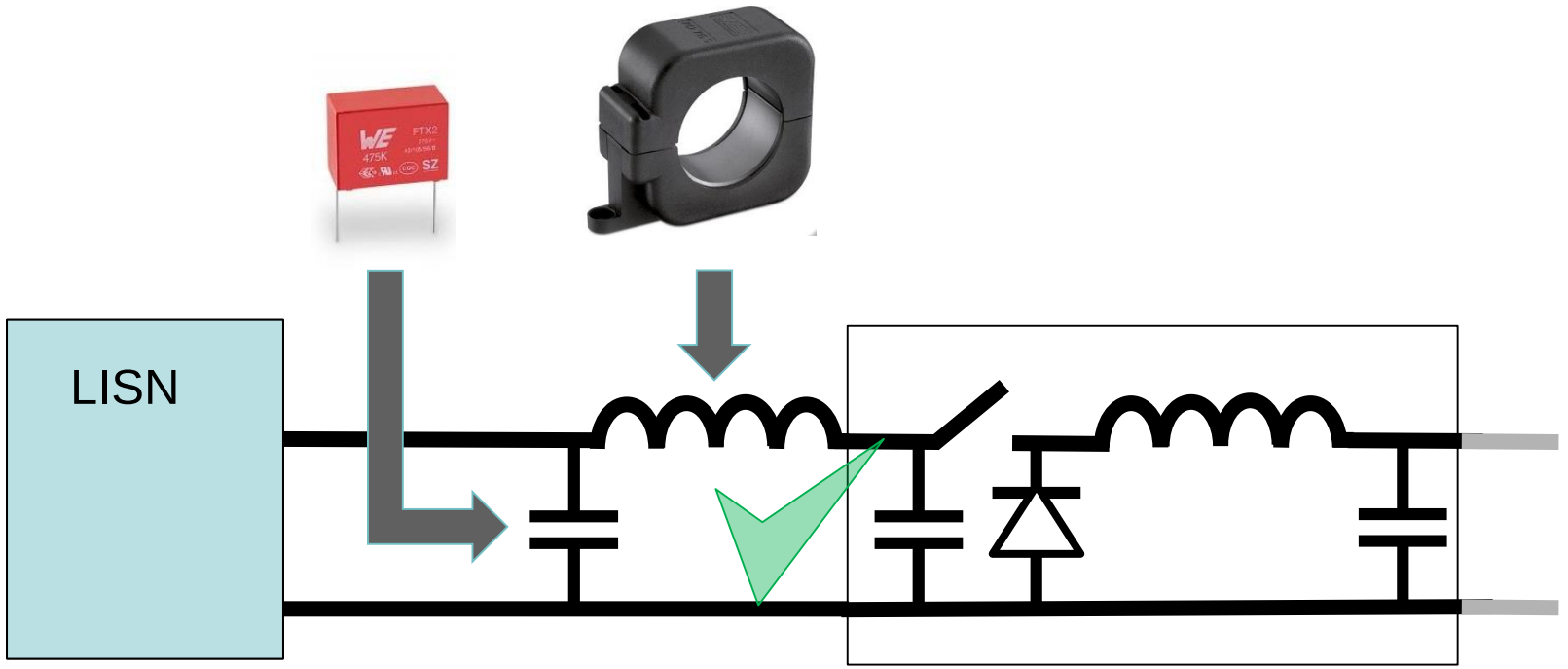
Impact du système d’impedance ?



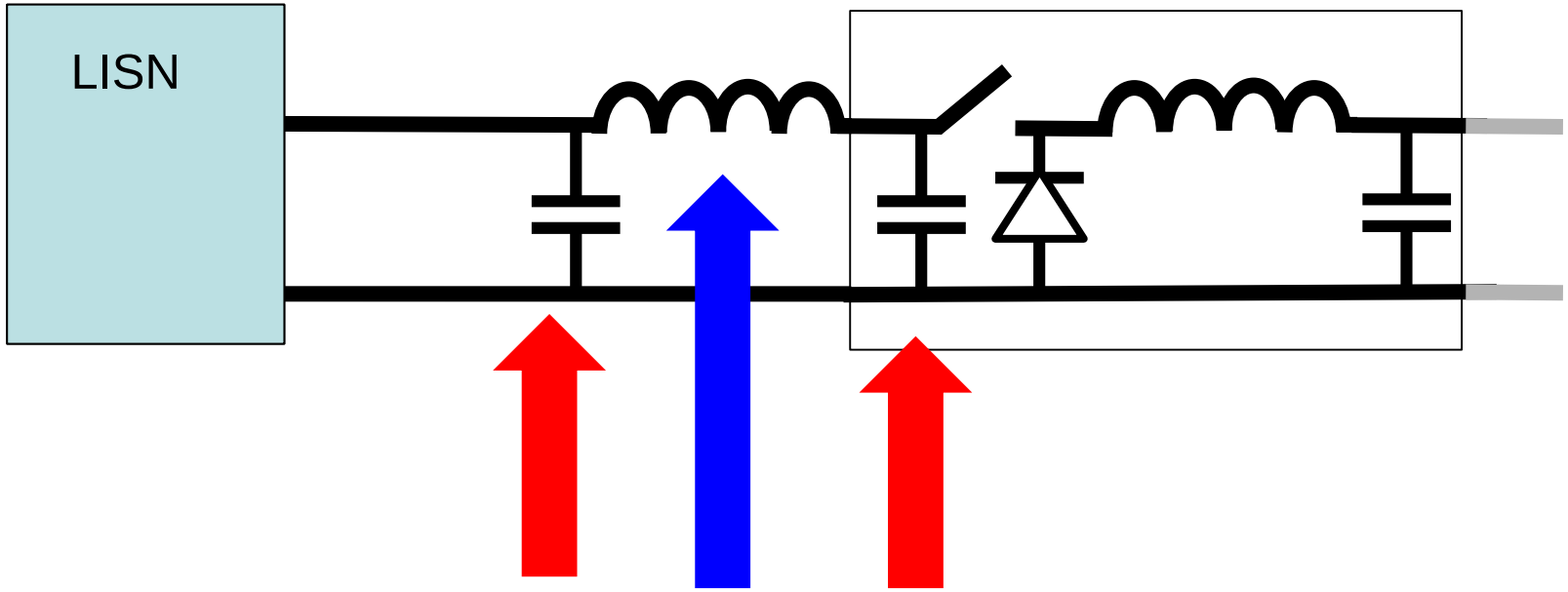
La mauvaise méthode pour les bons composants



La bonne méthode pour les bons composants



Mnémotechnique du “block and bypass”

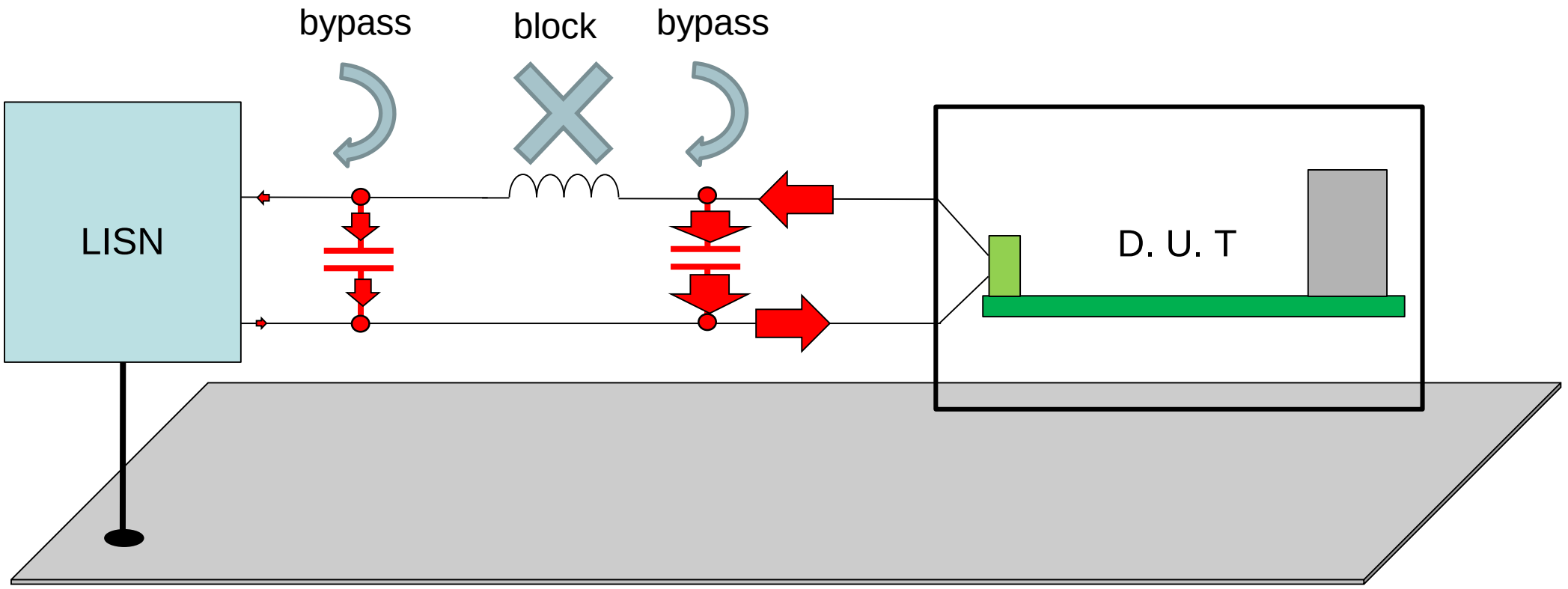


Solution CEM = Inductive + Capacitive

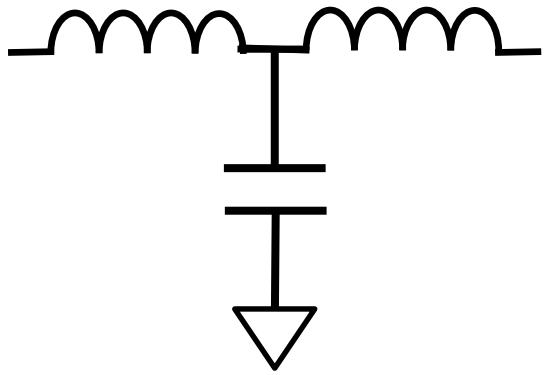
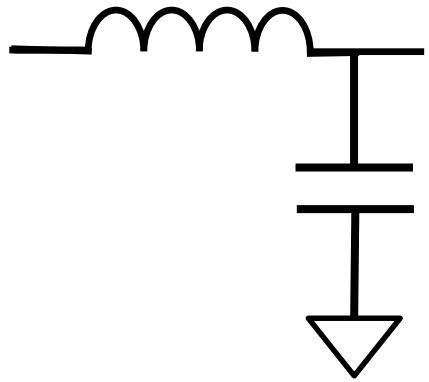
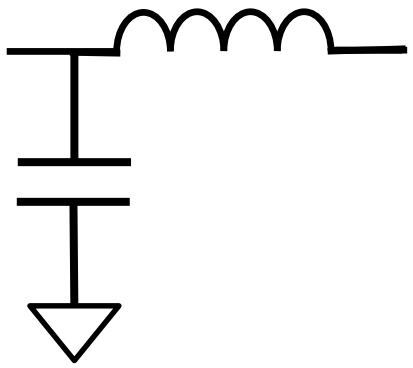
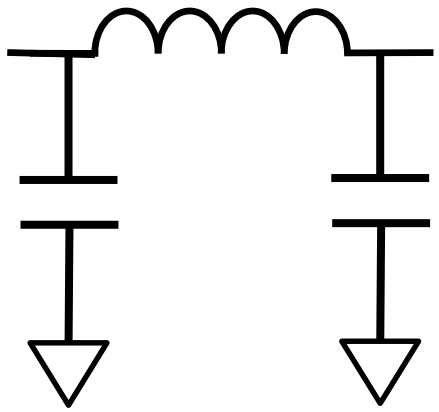
En série

En parallèle

“Block and Bypass”



Les filtres d’ordre supérieur

Load |Z| / Source |Z|	**Low**	**High**
Low		
High		

1st Order filter

-20dB per Decade ?

$$10^{\left(\frac{-20}{20}\right)} = 1/10$$

Amplitude / 10

Frequency * 10

-6dB per Octave

$$10^{\left(\frac{-6}{20}\right)} \approx 0{,}5 \approx 1 / 2$$

Amplitude / 2

Frequency * 2

2nd order filter

-40dB per Decade

$10^{\left(\frac{-40}{20}\right)} = 10^{-2} = 1/100$

Amplitude / 100

Frequency * 10

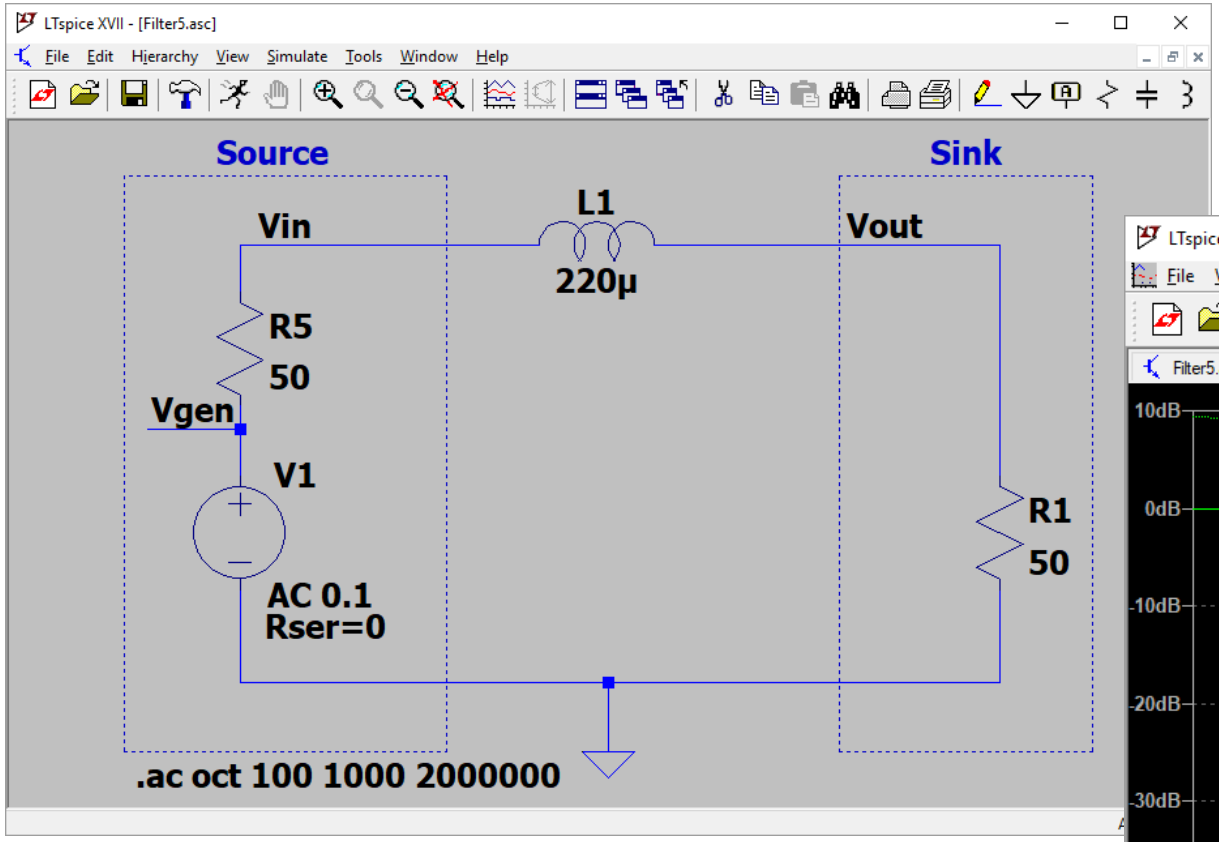
-12dB per Octave

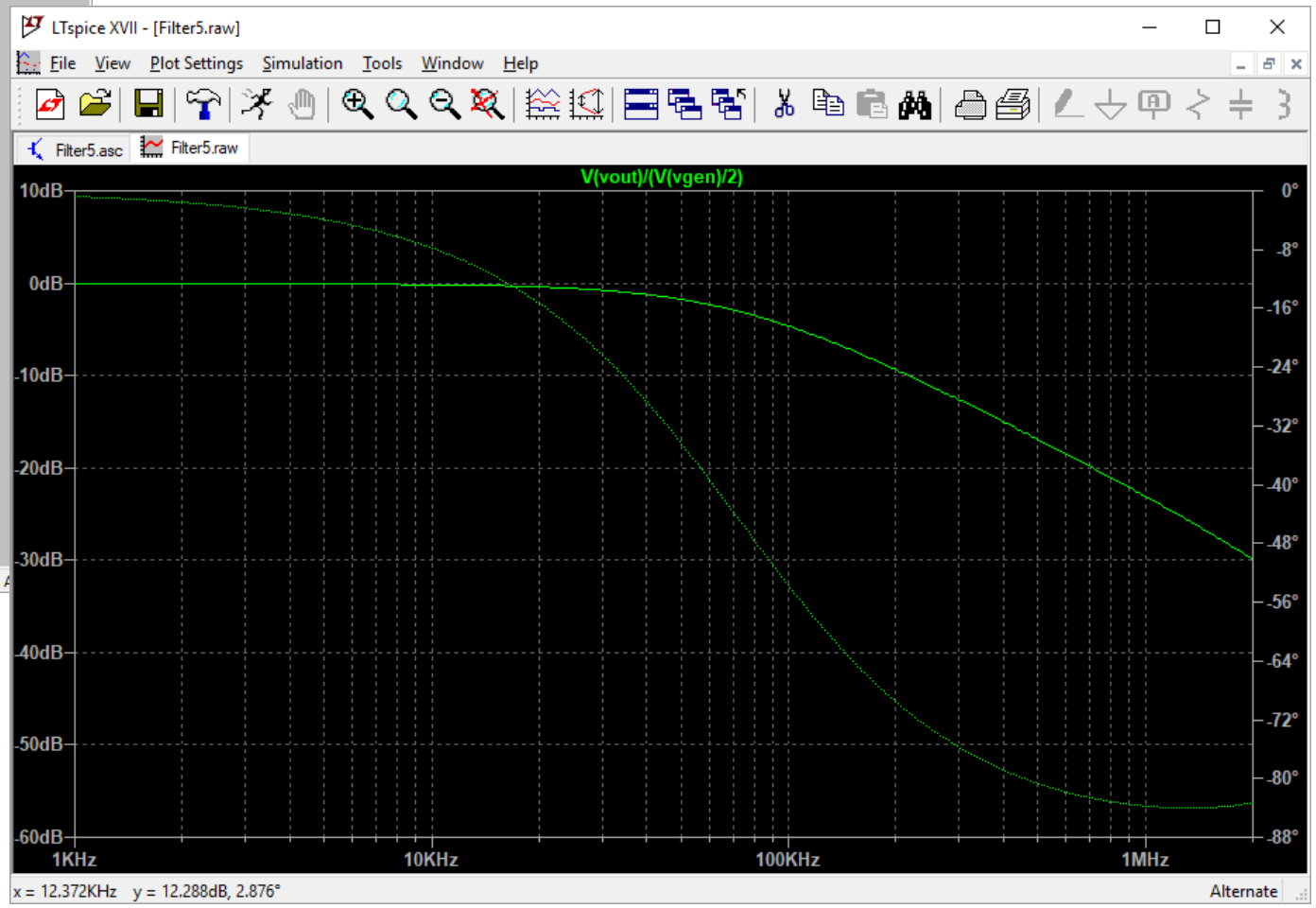
$10^{\left(\frac{-12}{20}\right)} \approx 0{,}25 \approx 1 / 4$

Amplitude / 4

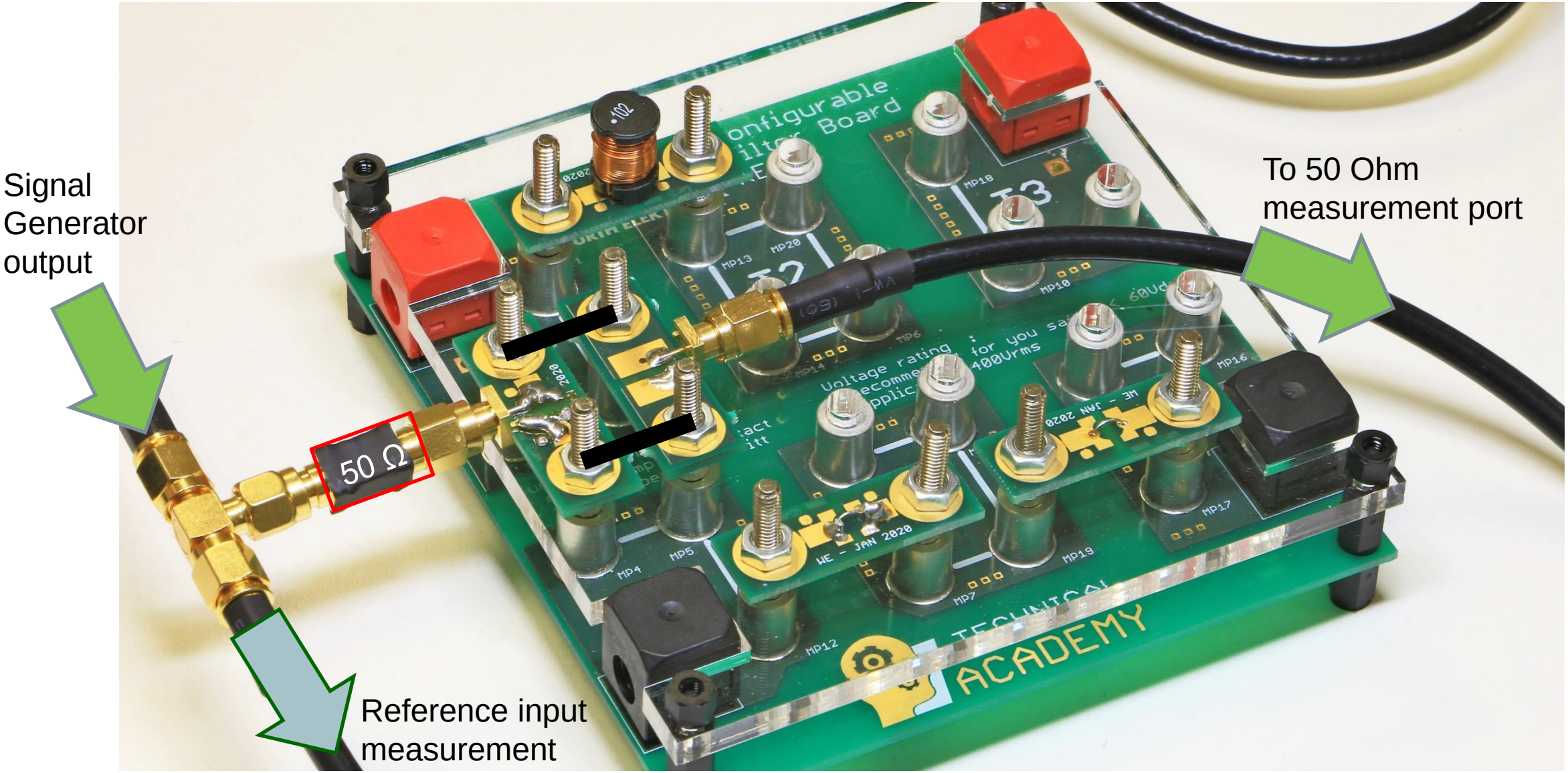
Frequency * 2

Simuler un filtre

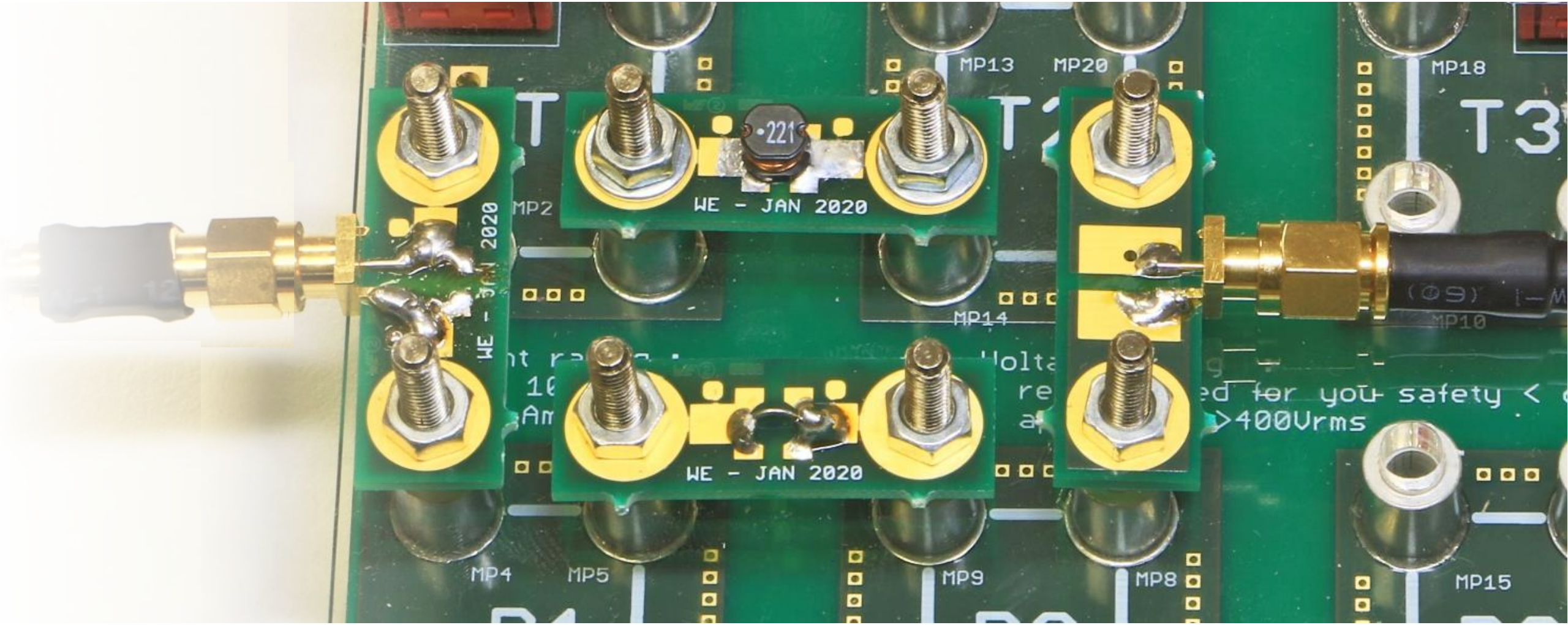




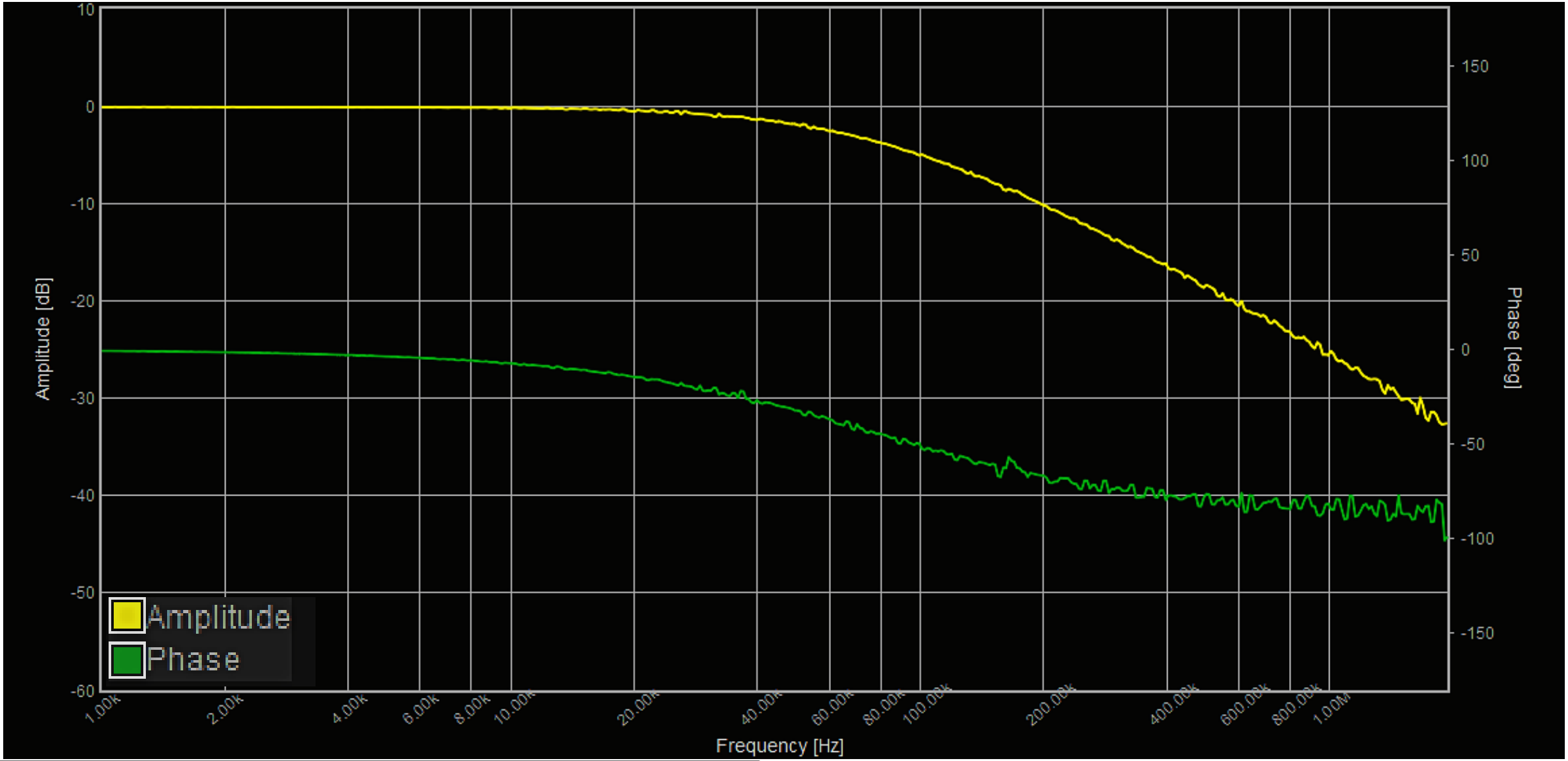
Mesurer un filtre



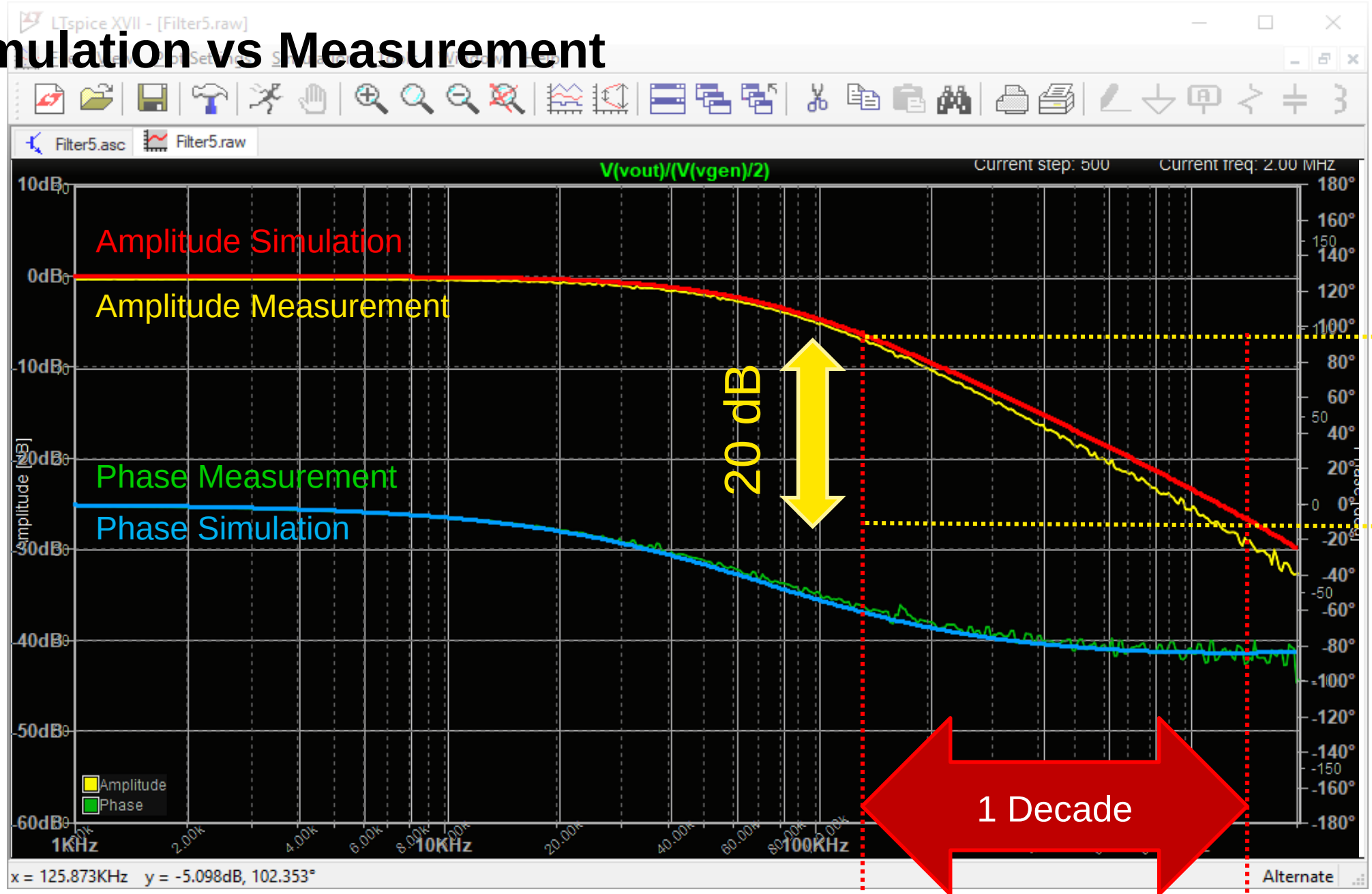
Mesurer un filtre



Mesurer un filtre

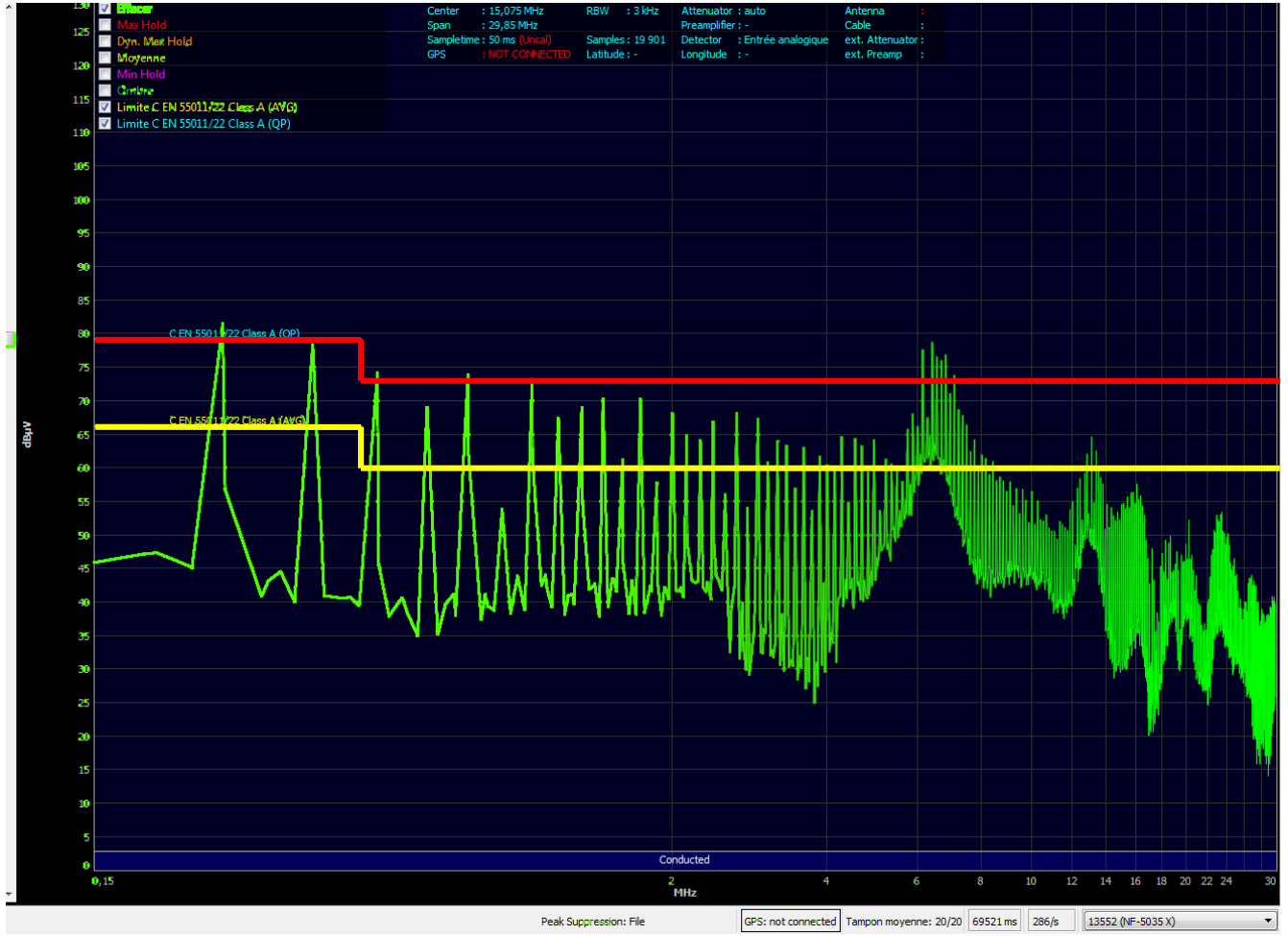


Simulation vs Measurement

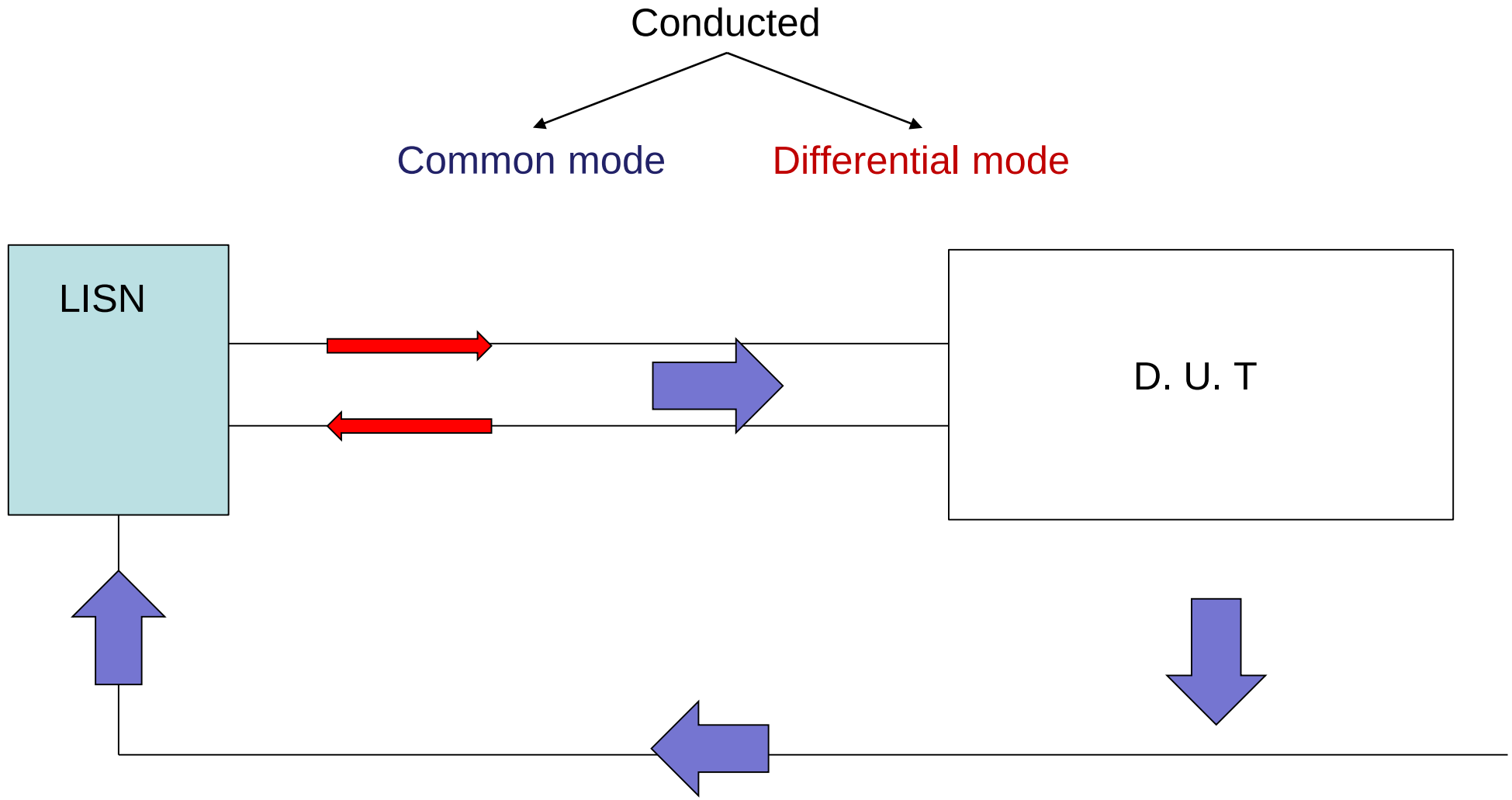


La mesure en CEM

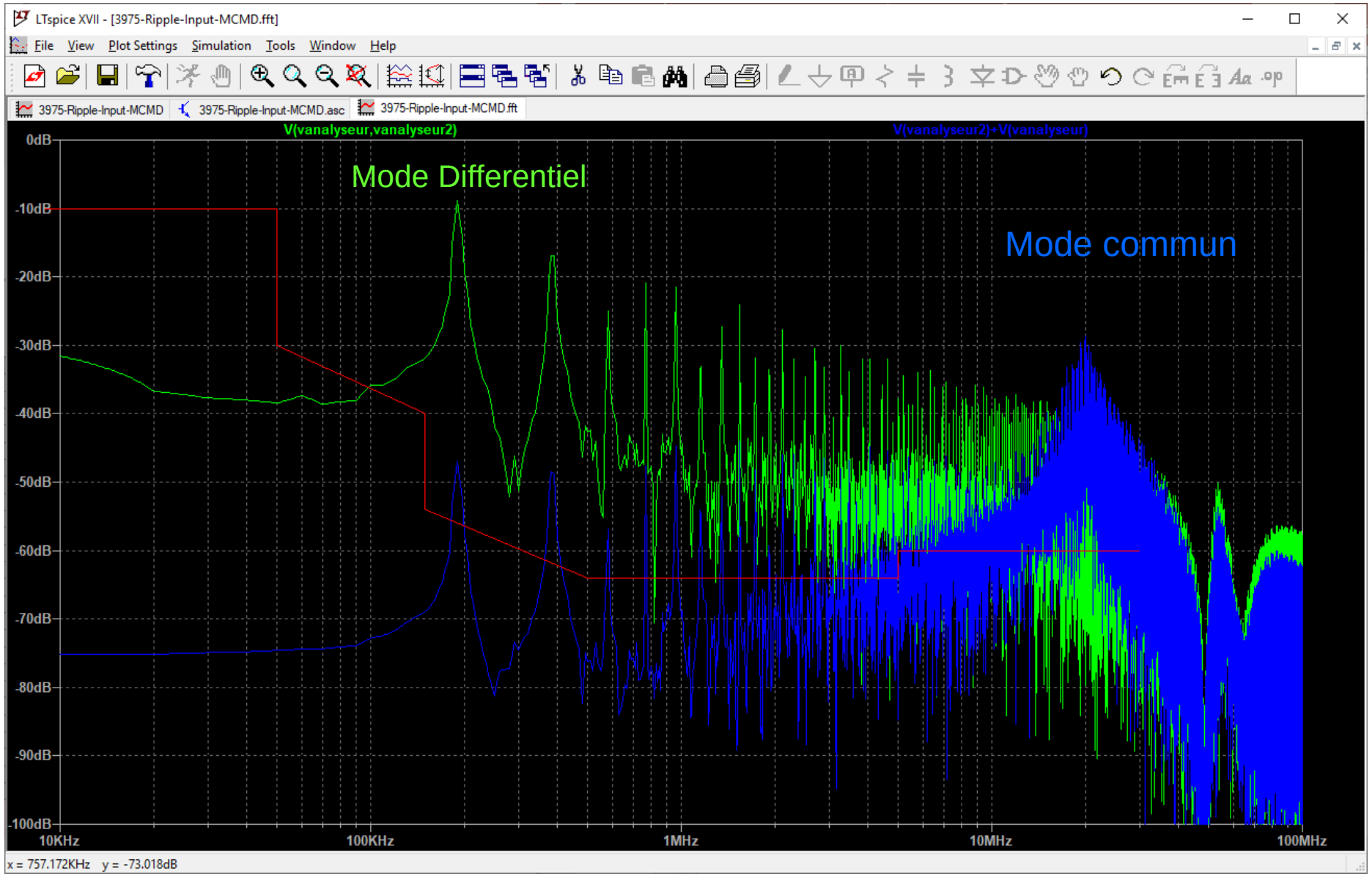
Courbe = ∑ (Mode Commun + Mode Differentiel)



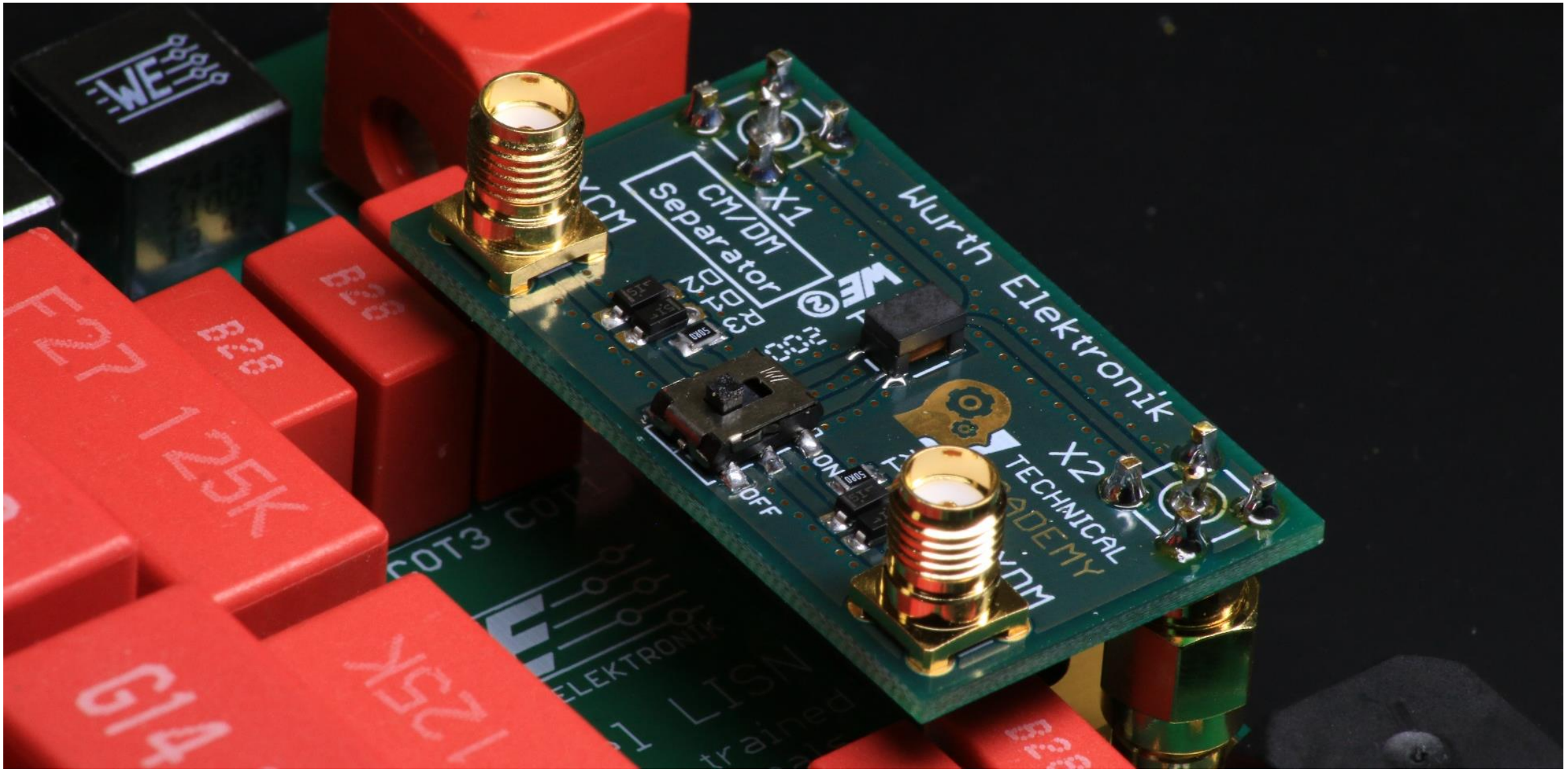
Mode commun et mode différentiel



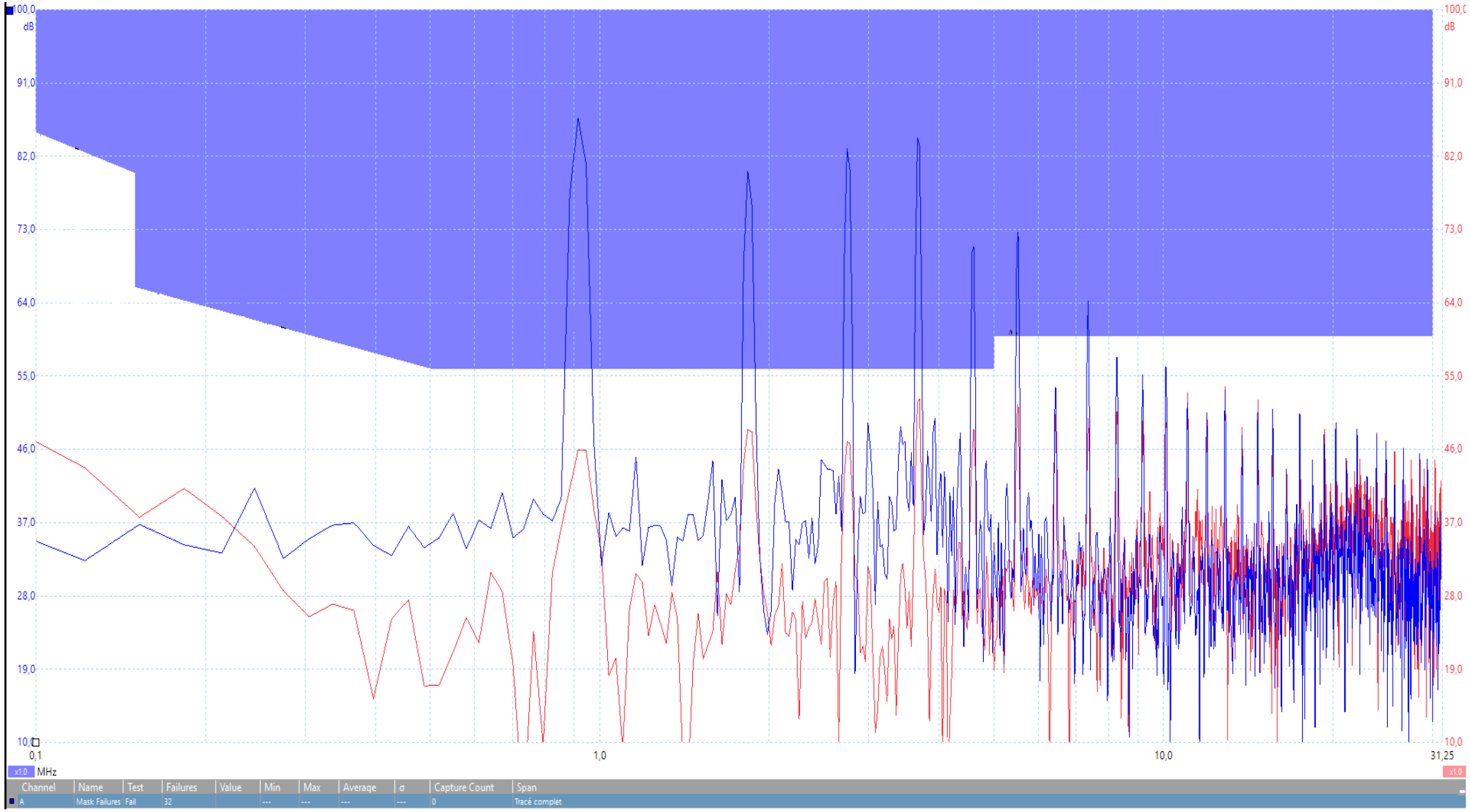
Séparation mode commun mode différentiel ?



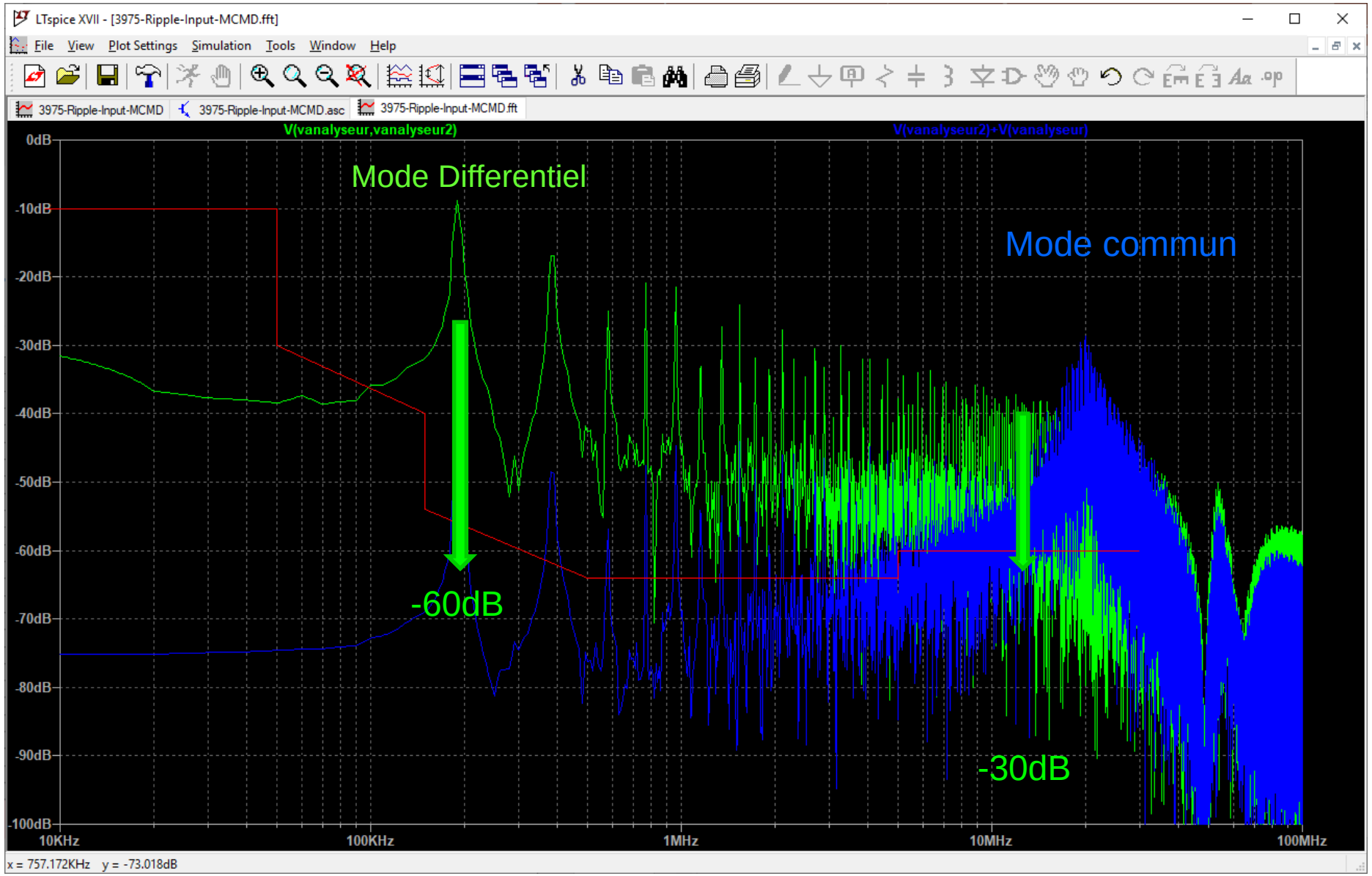
Séparation mode commun mode différentiel ?



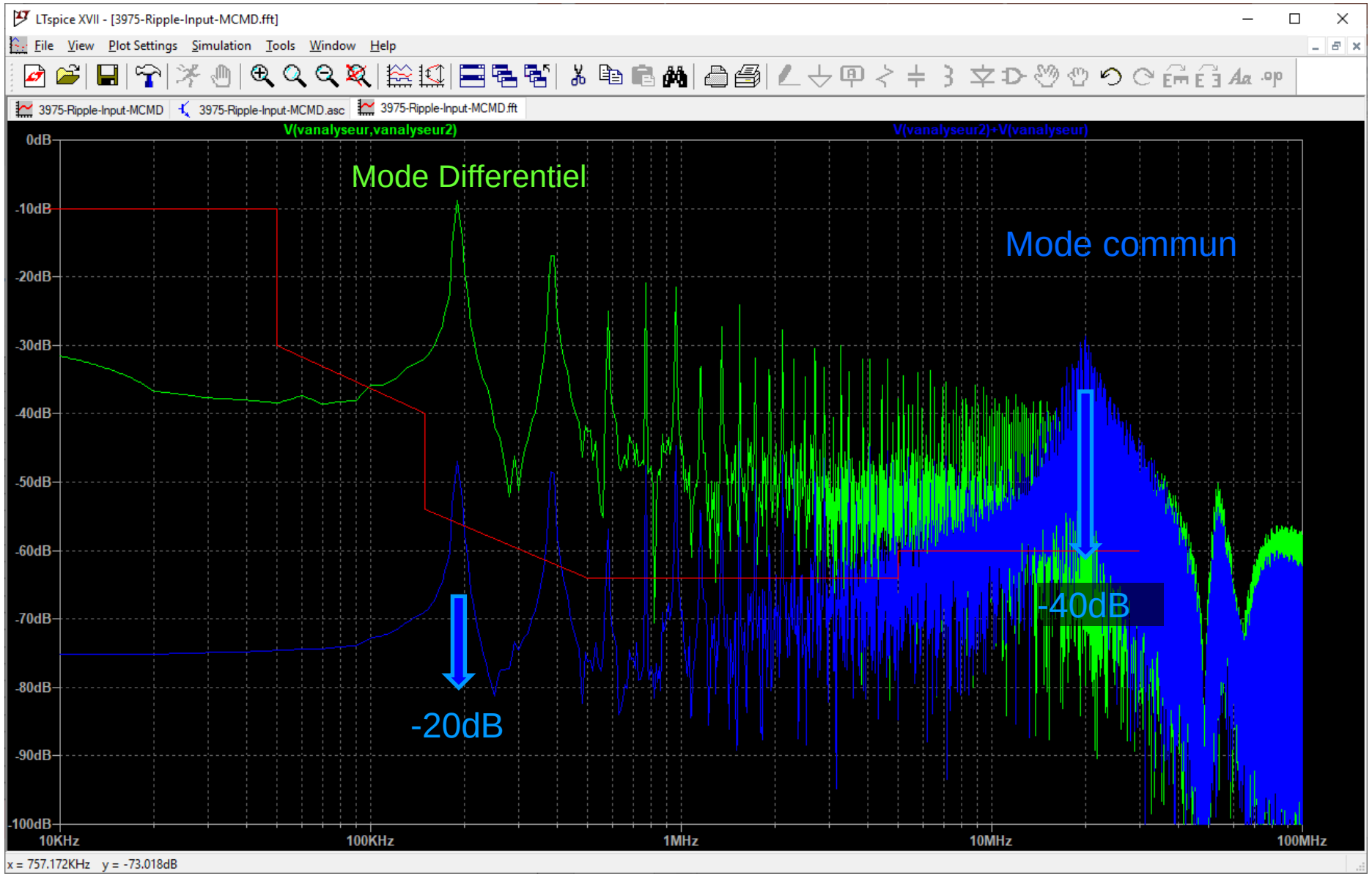
Séparation mode commun mode différentiel ?



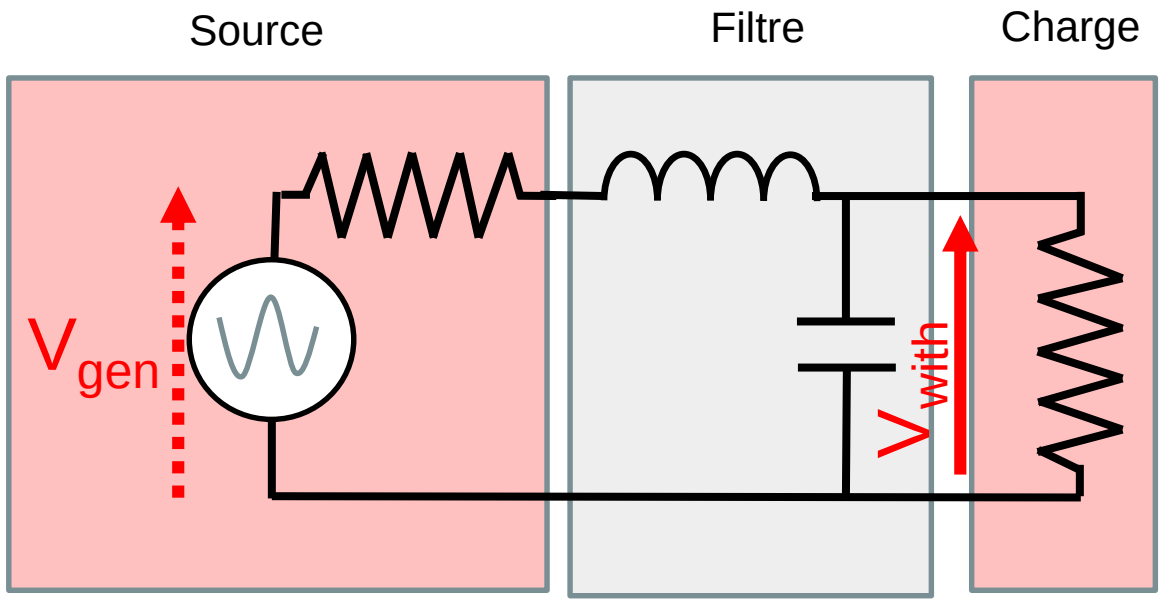
Cahier des charges en fonction du mode

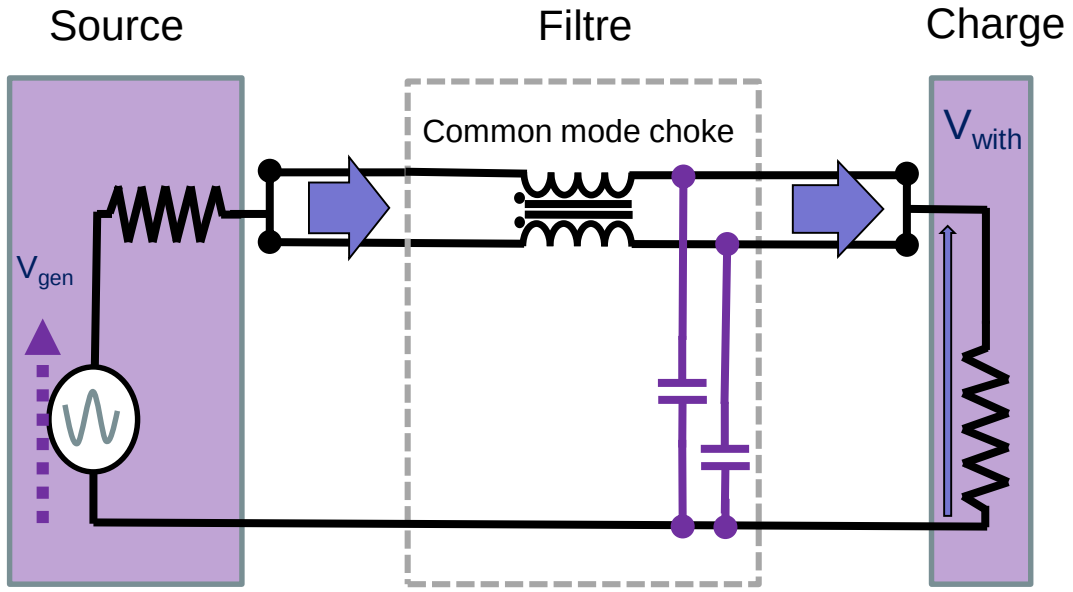


Cahier des charges en fonction du mode



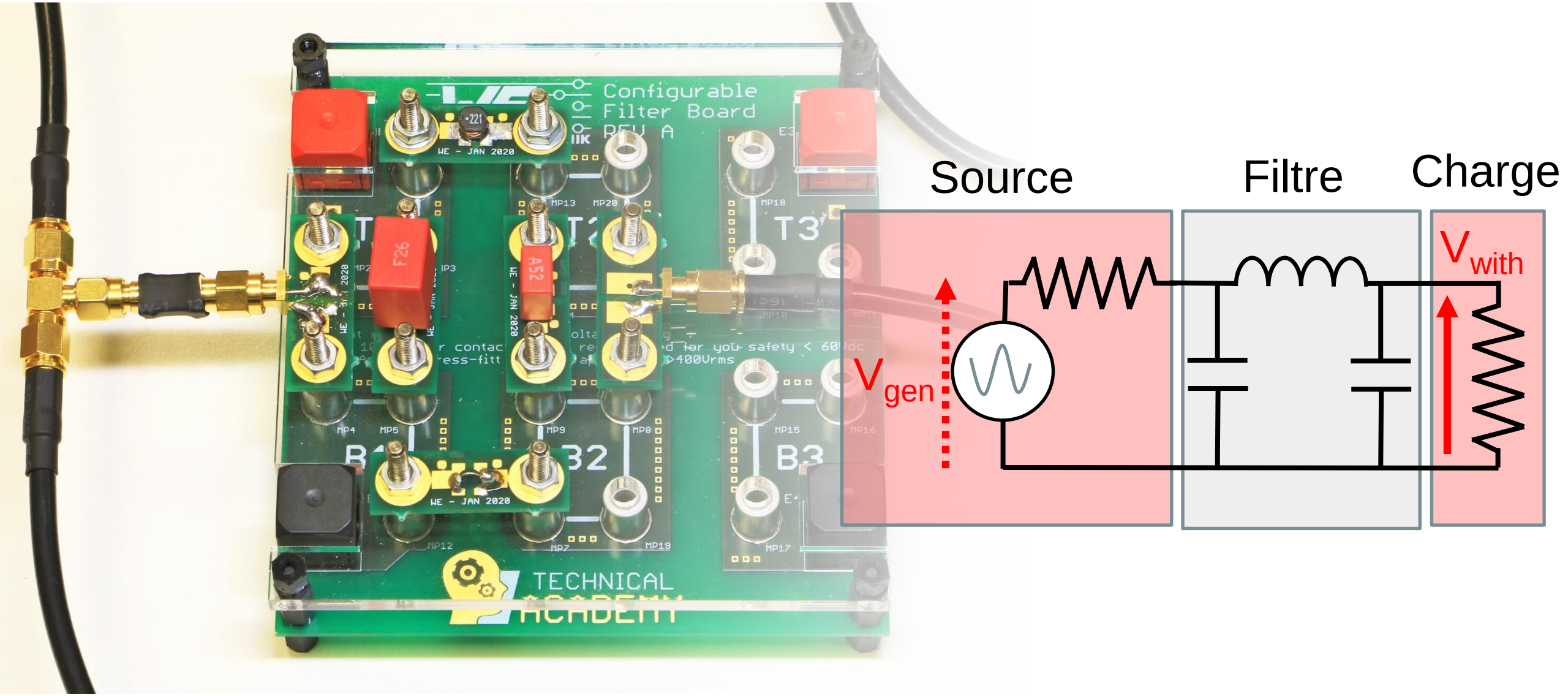
Filtre de mode différentiel / mode commun





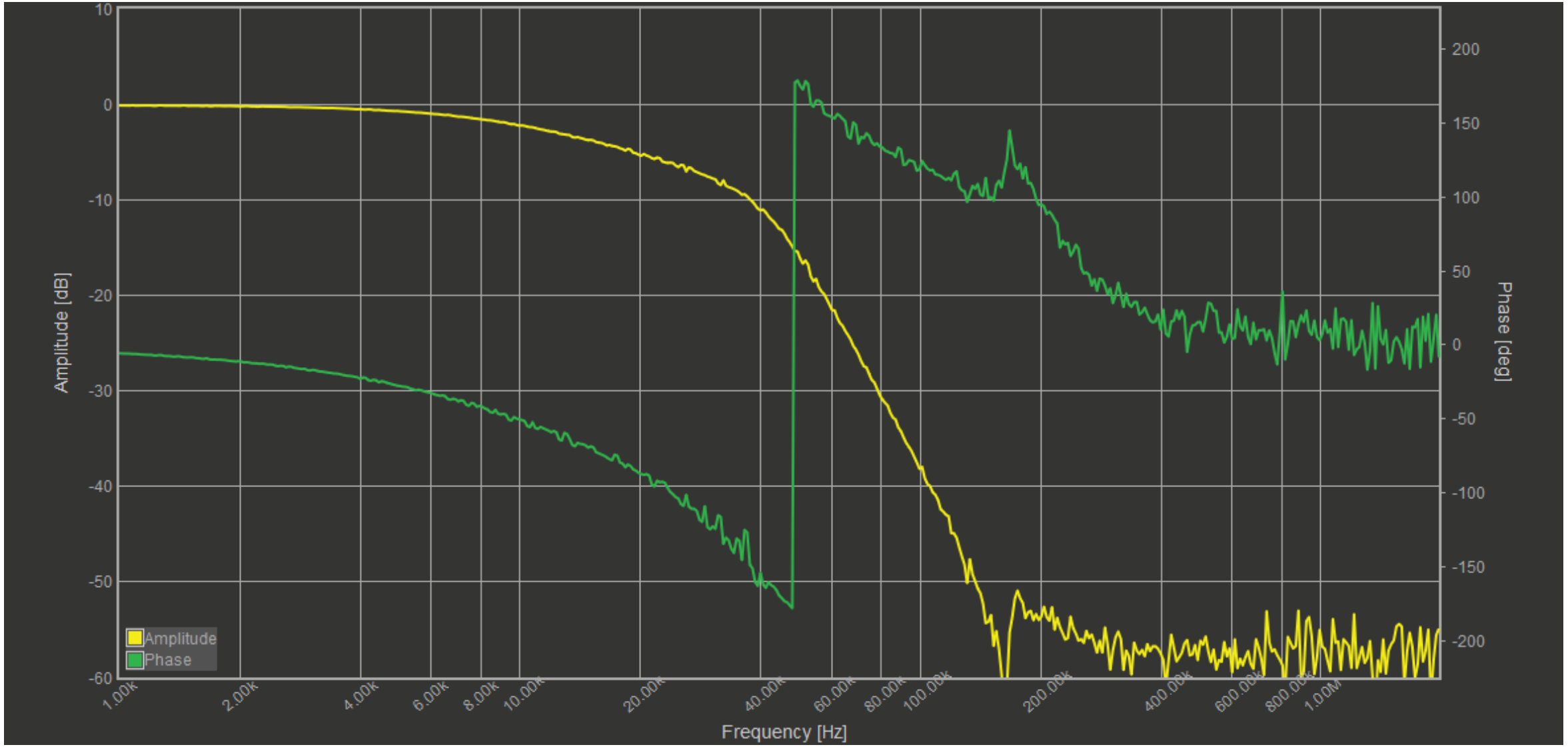
Exemple de filtrage différentiel

Filtre du troisième ordre – Condensateur / Inductance / Condensateur



Exemple de filtrage différentiel

Filtre du troisième ordre – Condensateur / Inductance / Condensateur



3rd order filters

-60dB per Decade

$10^{\left(\frac{-60}{20}\right)} = 10^{-3} = 1/1000$

Amplitude / 1000

Frequency * 10

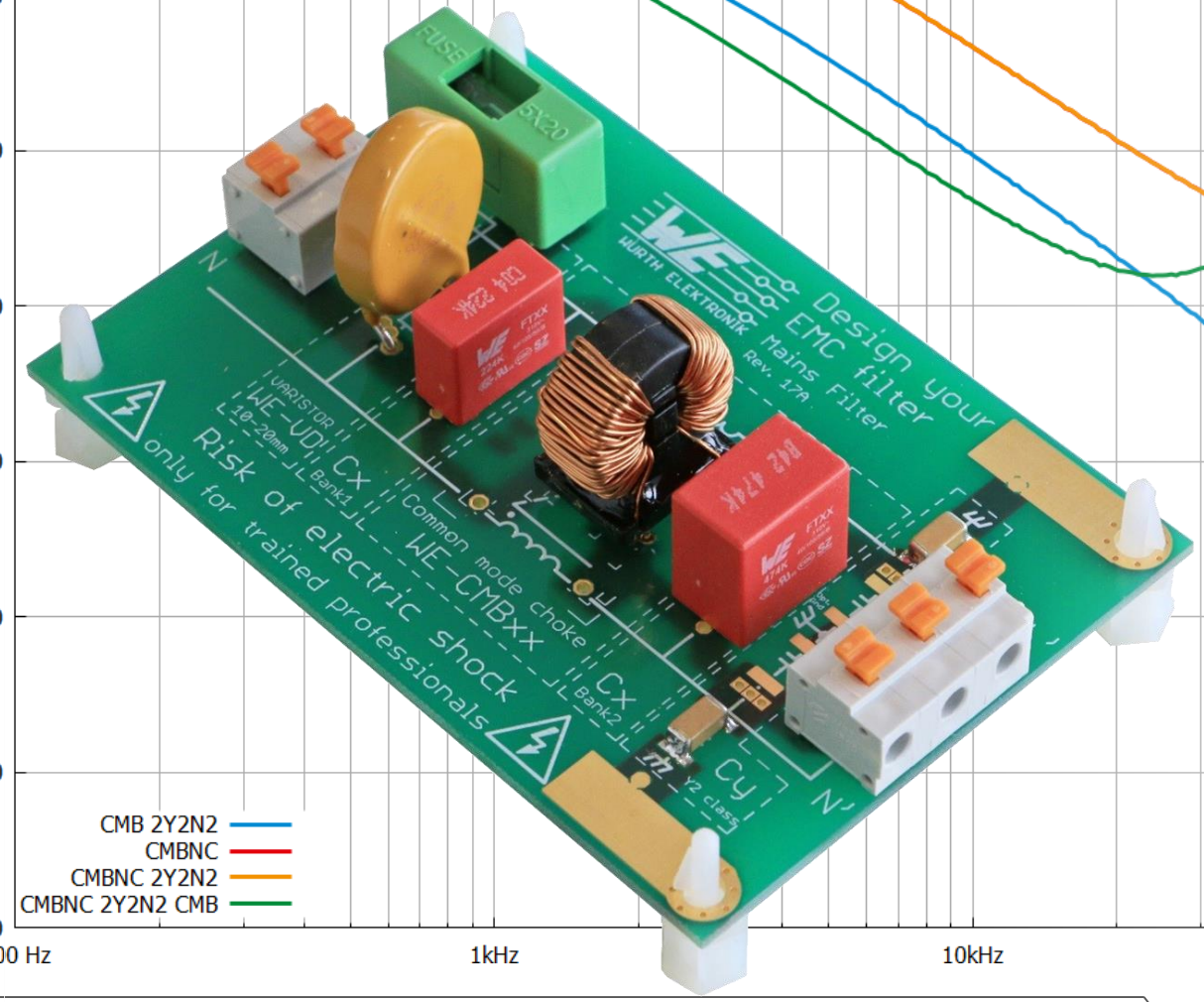
-18dB per Octave

$10^{\left(\frac{-18}{20}\right)} \approx 0{,}125 \approx 1 / 8$

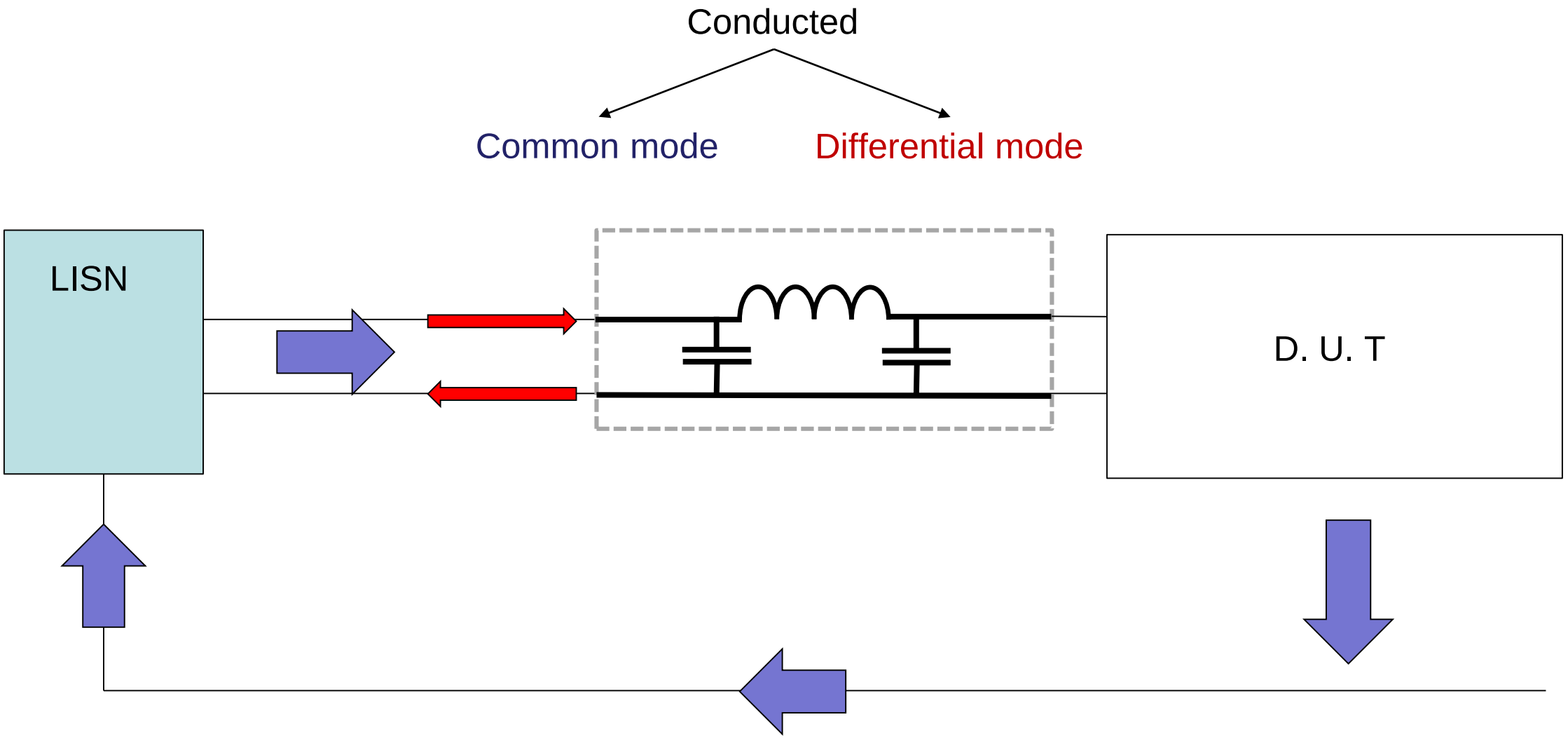
Amplitude / 8

Frequency * 2

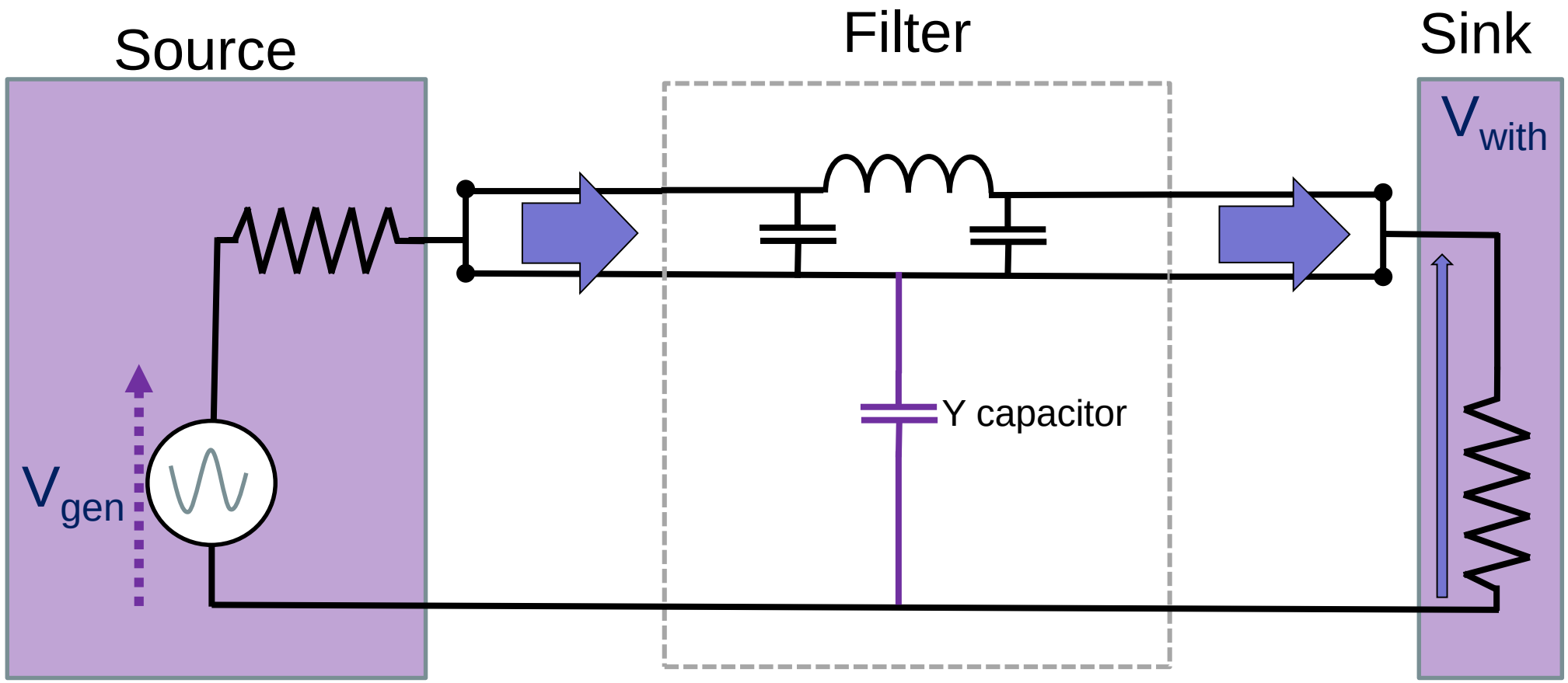
FILTRAGE DE MODE COMMUN



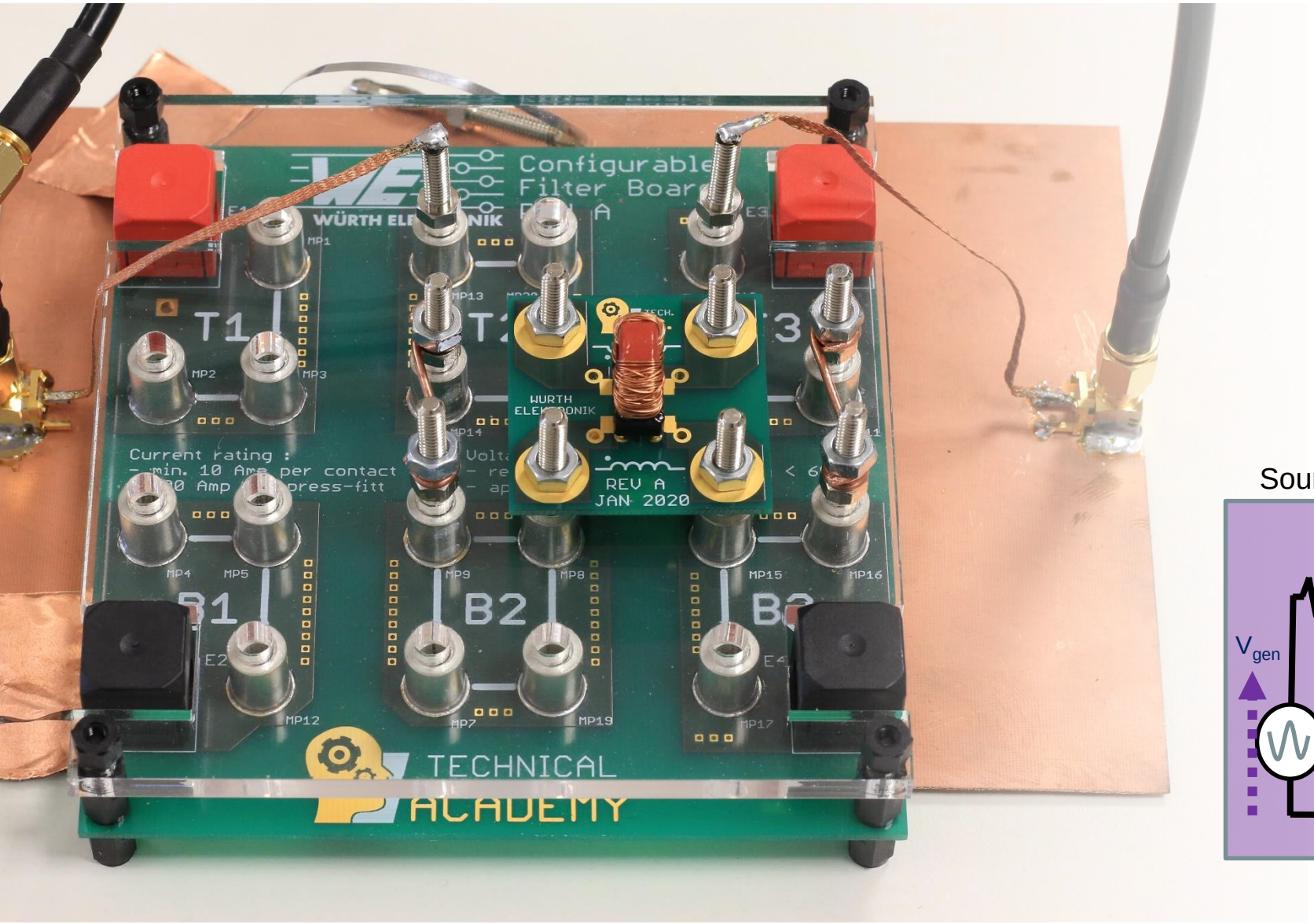
Filtre de mode différentiel/commun

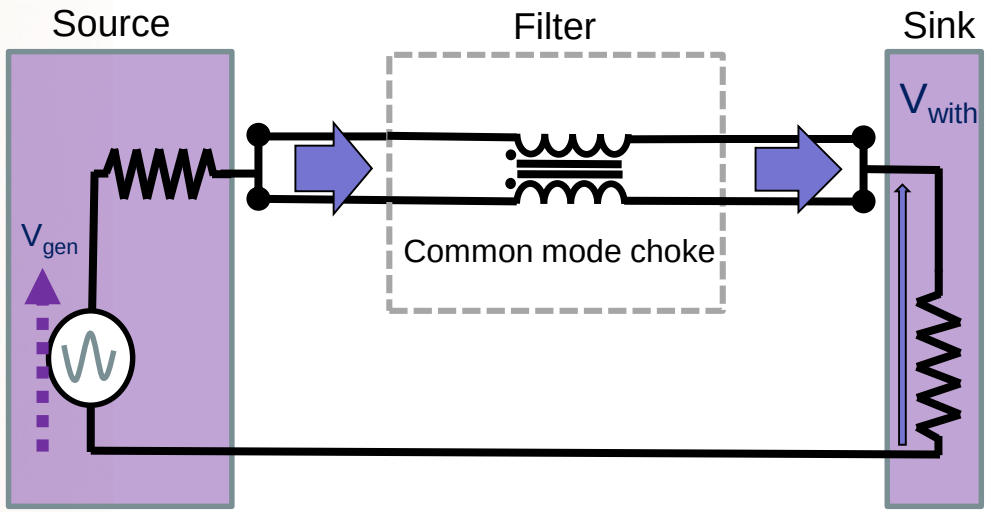


Filtre de mode commun

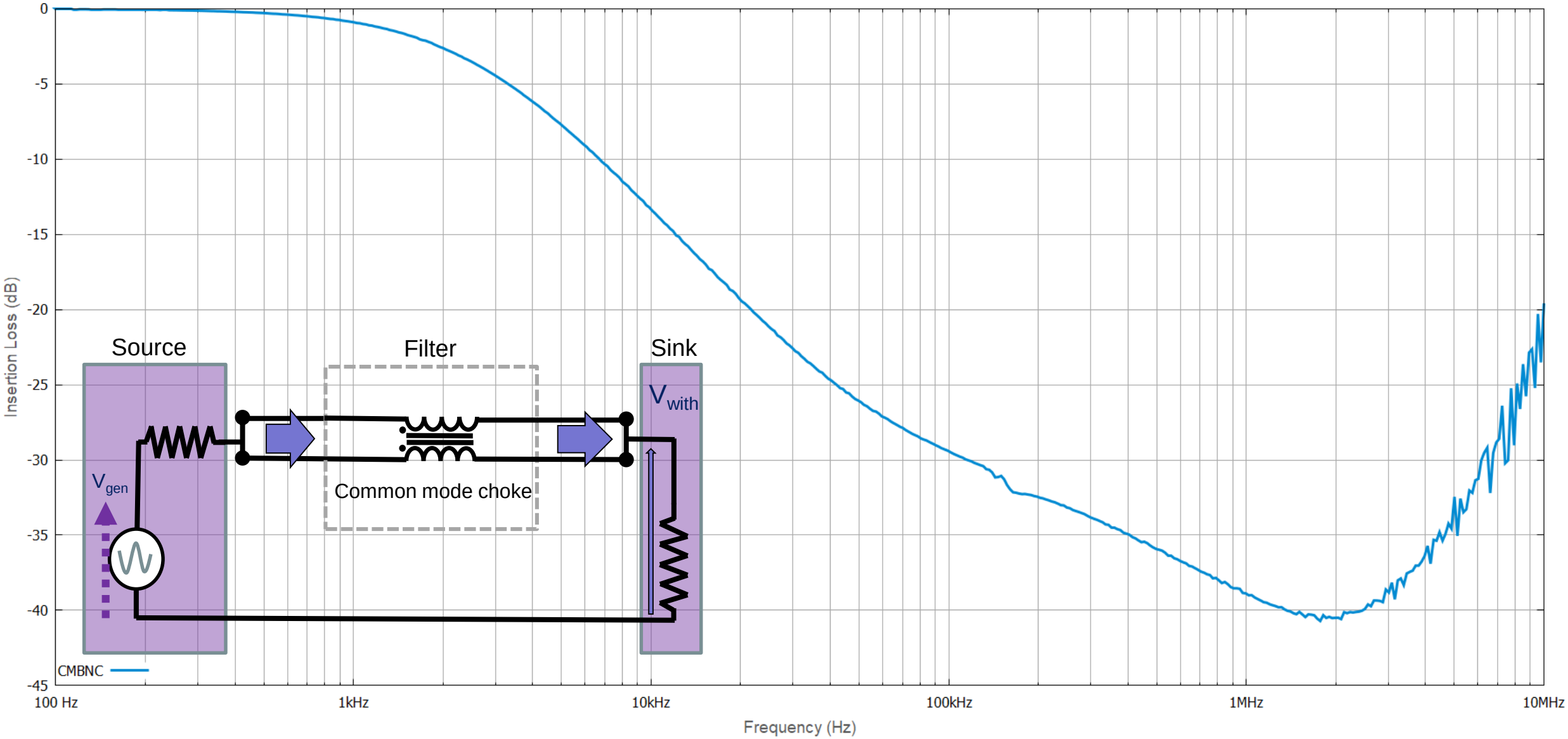


La mesure d’un filtre de mode commun

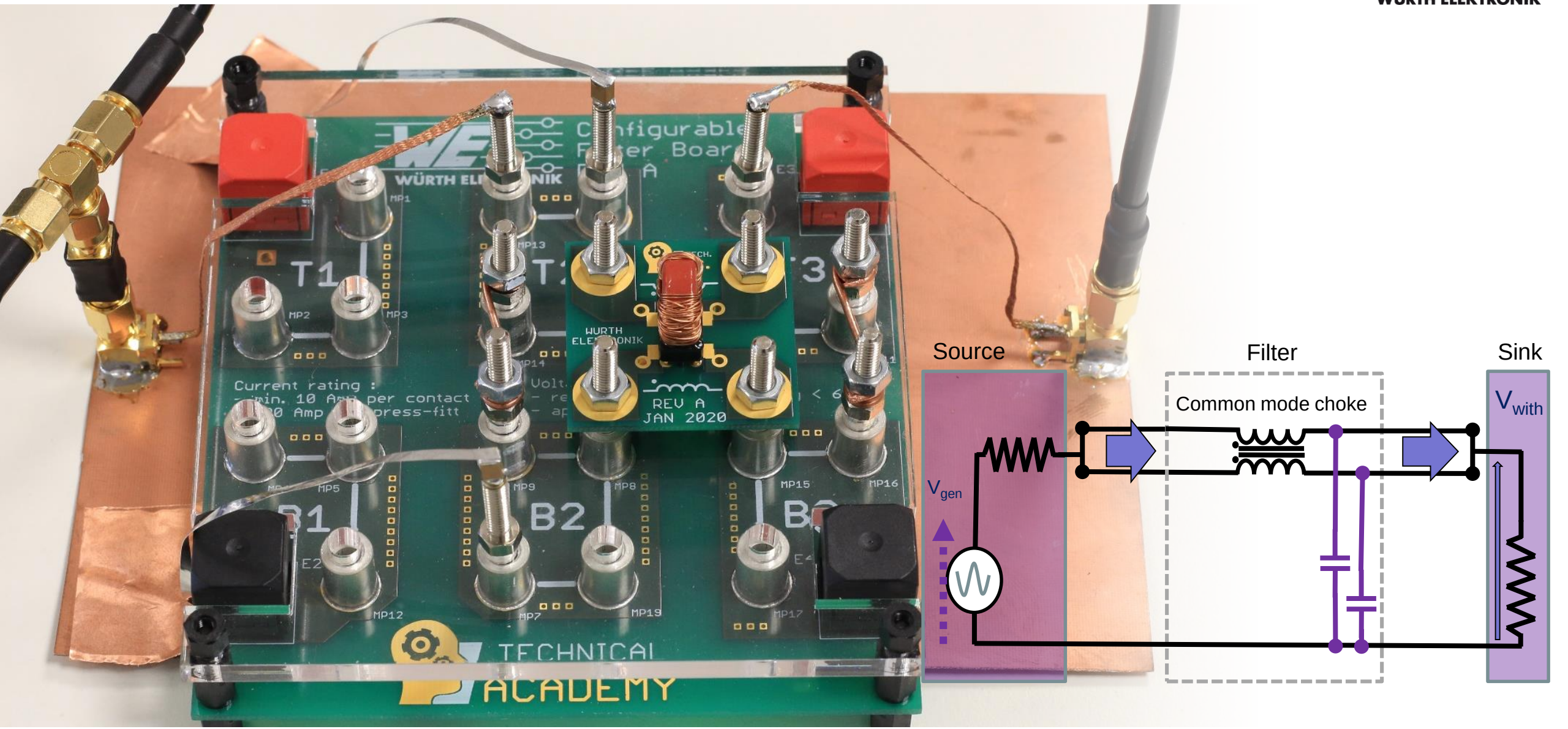




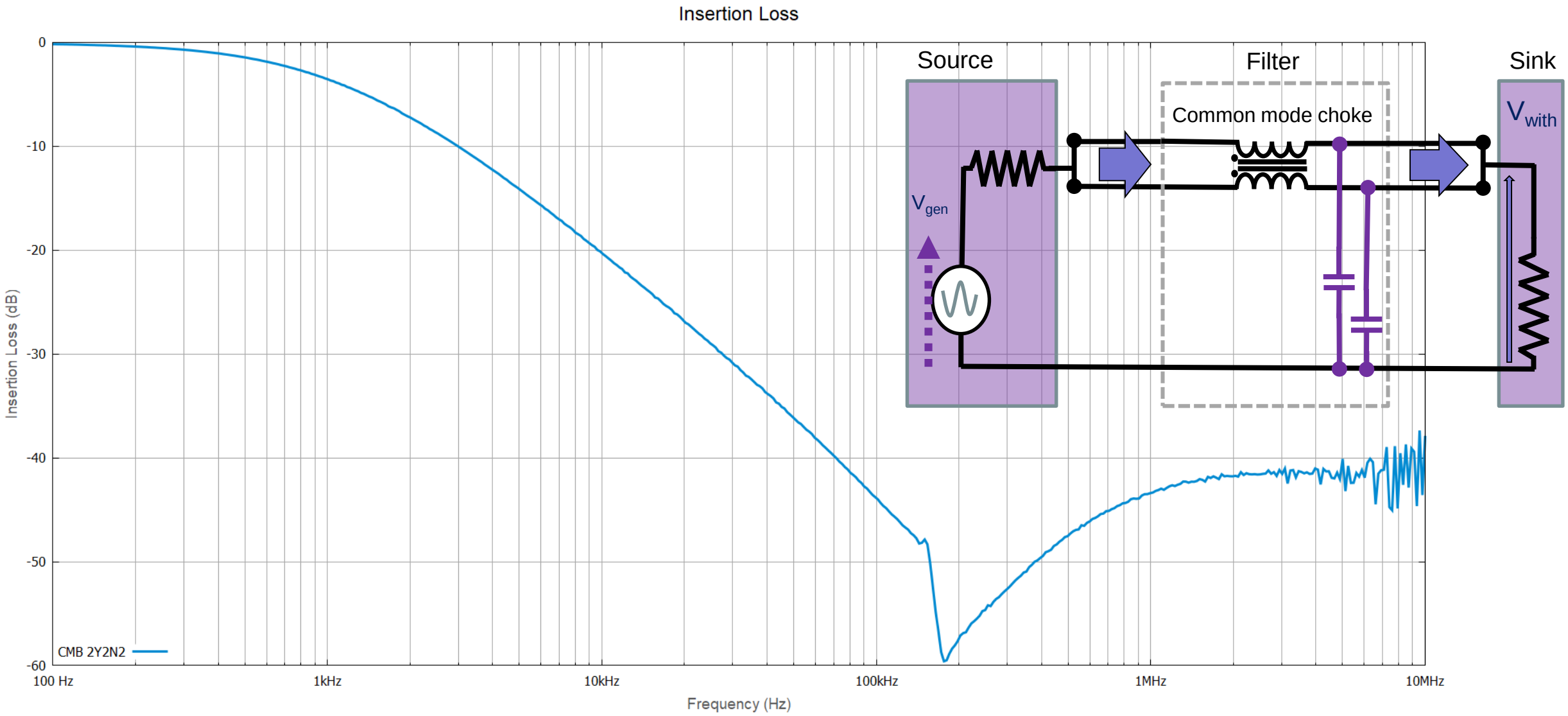
La mesure d’un filtre de mode commun



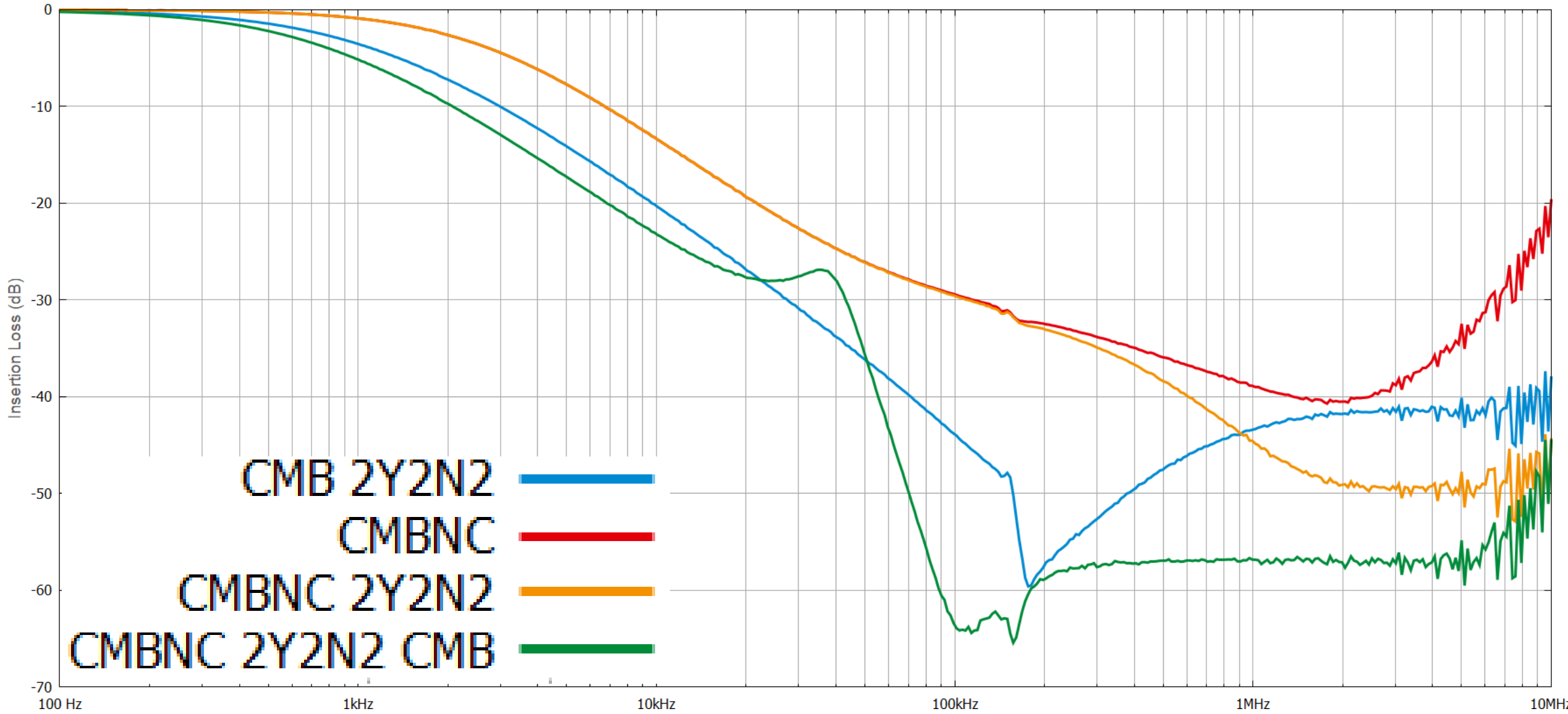
La mesure d’un filtre de mode commun : filtre en π



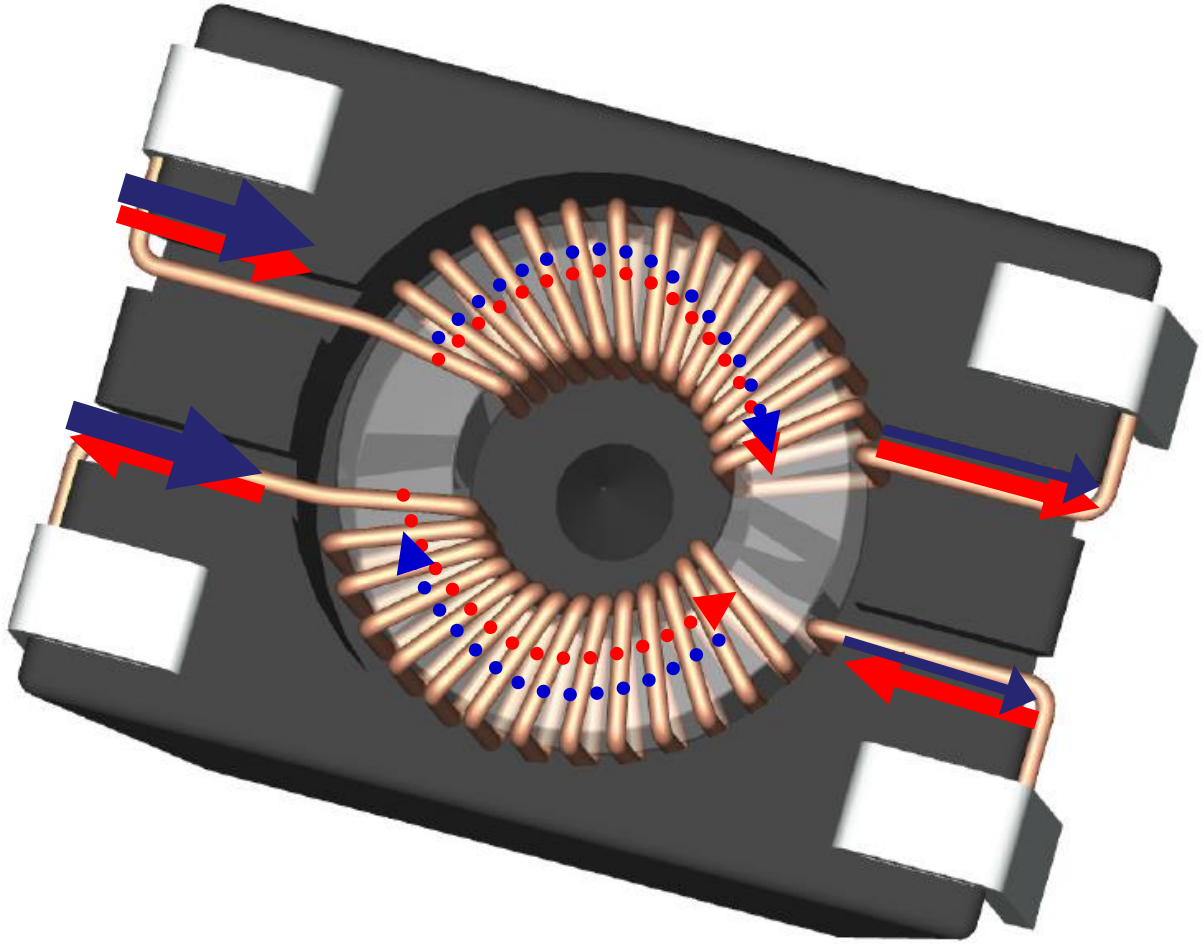
Extension to common mode filtering : π-filter



Extension to common mode filtering : L/π/Dual Stage filters



Exploiter l’inductance de fuite d’une self de mode commun



Exploiter l’inductance de fuite d’une self de mode commun

Self de mode commun parfaite

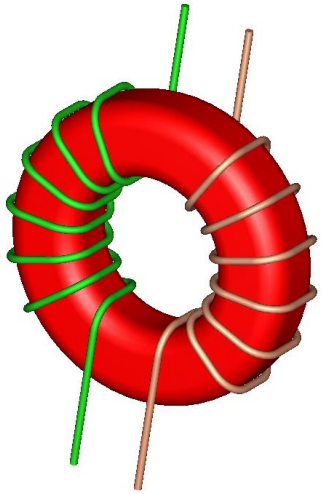
Inductance de fuite

100% Lnom

0,01 – 4 % de Lnom

Action en mode commun uniquement

Action en mode différentiel



<1%

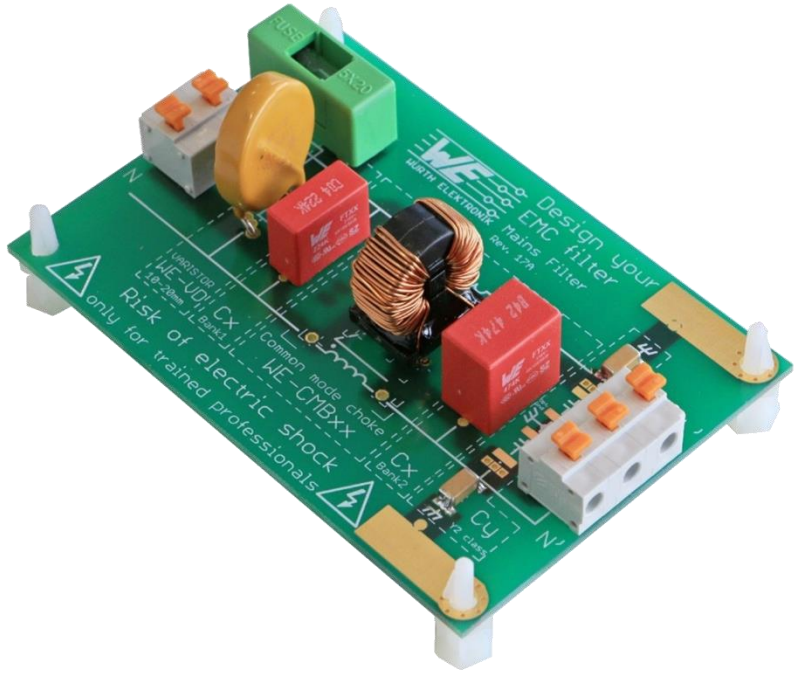
1 à 2 %

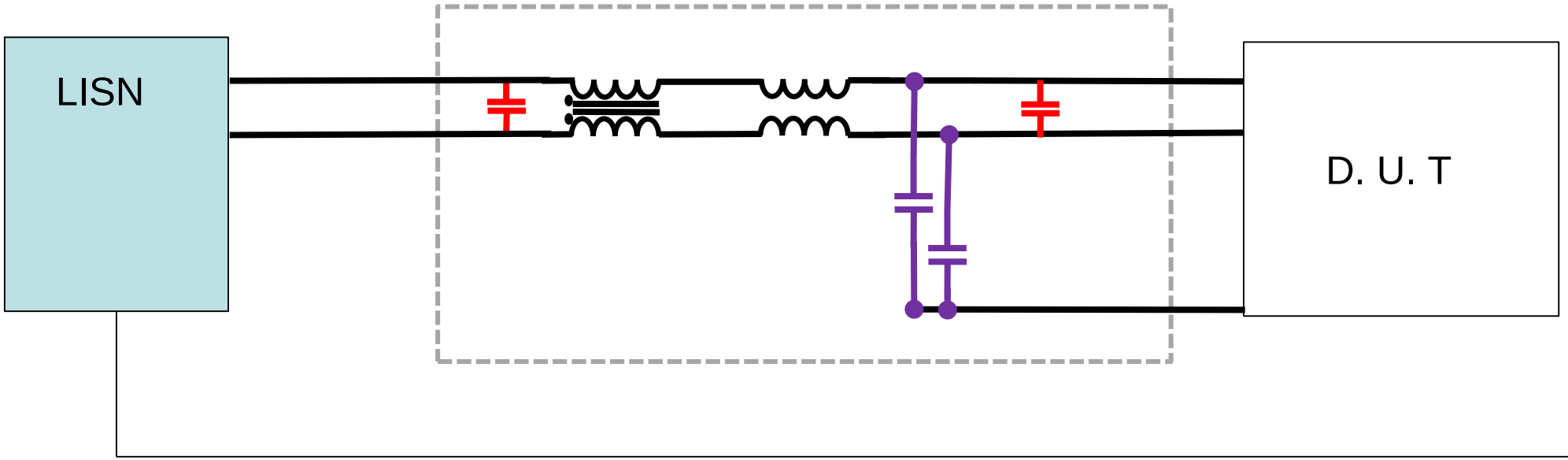
> 2 %

Intégrité du signal

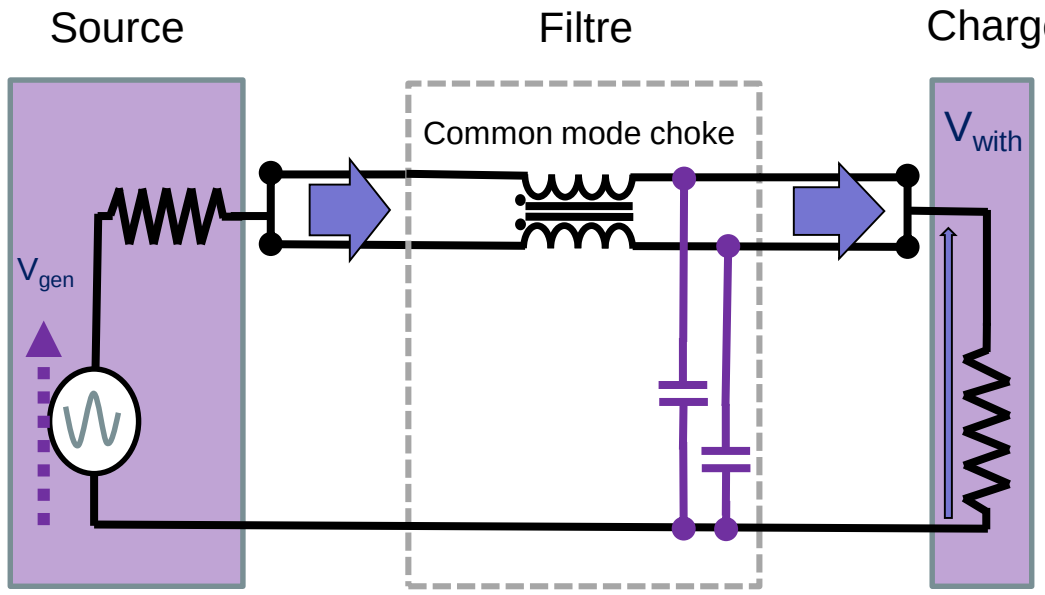
Filtrage différentiel

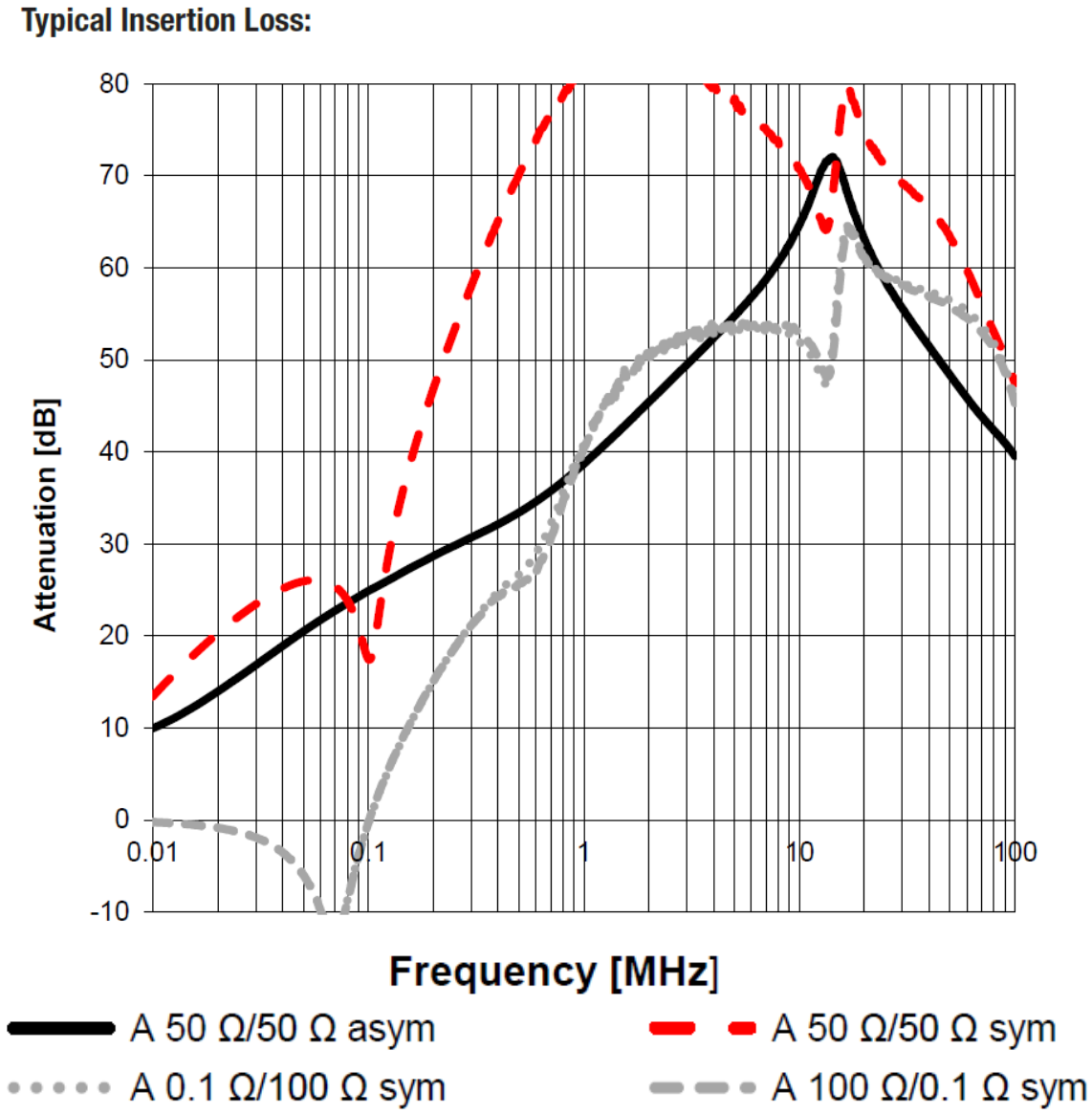
Exemple de filtre



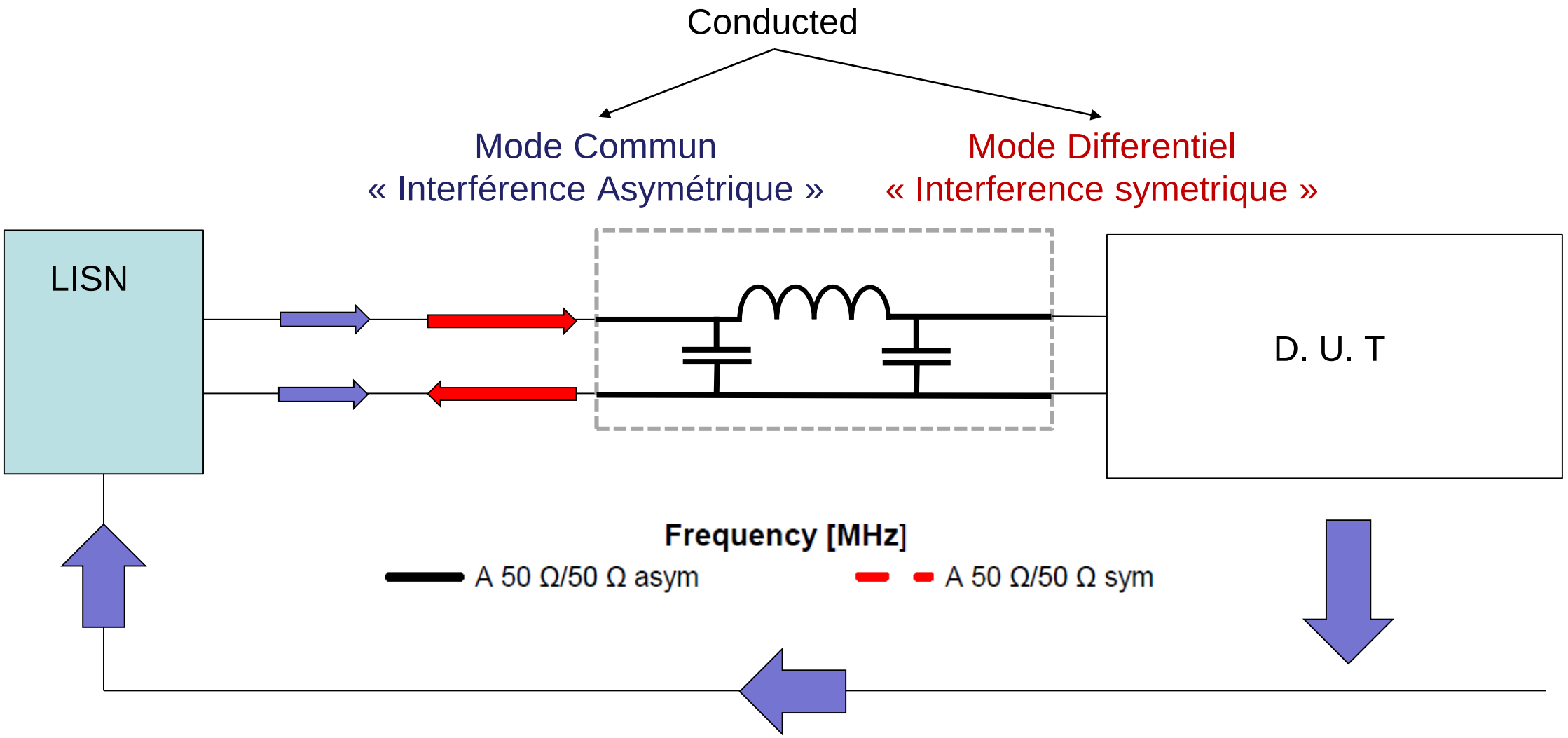


Lire les courbes de perte d’insertion

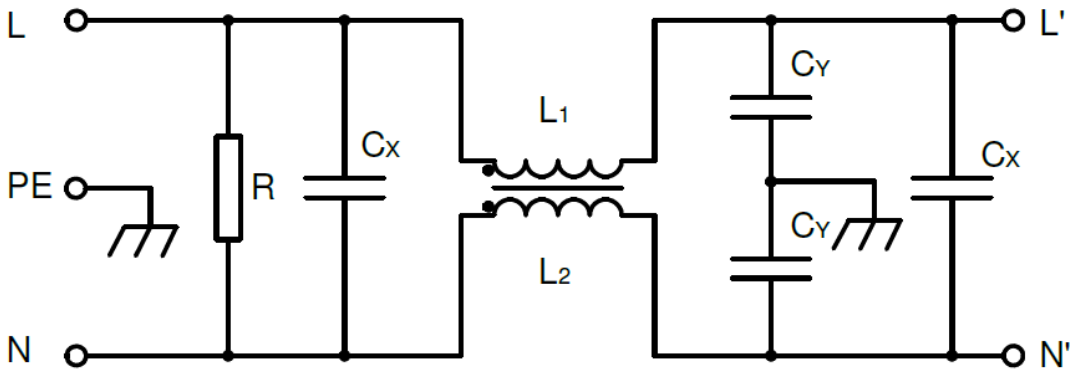




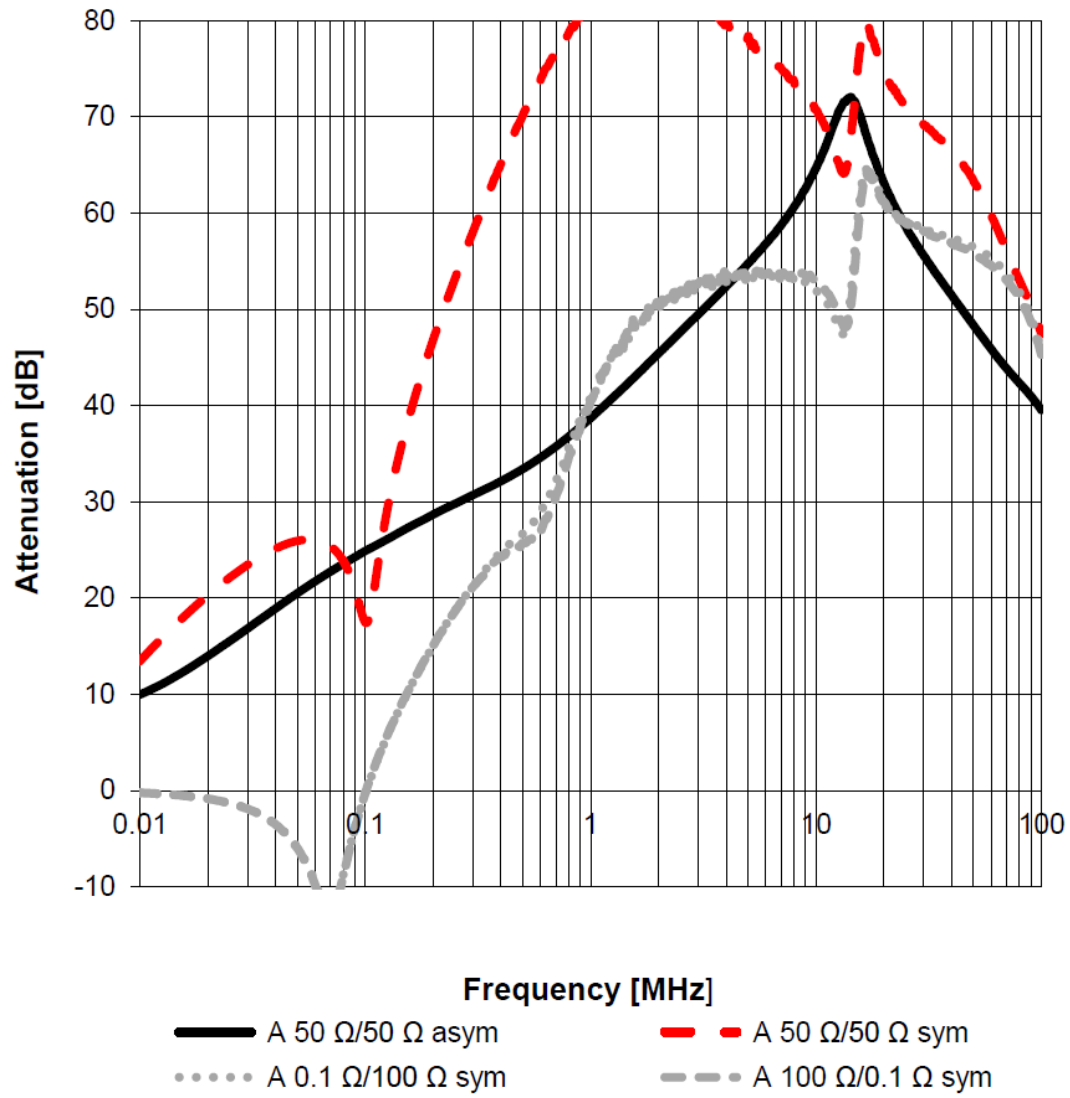
Filtre de mode différentiel/commun



Filtre de mode différentiel/commun



Typical Insertion Loss:




Thank
You!