Validation of cmc with **BsT-pulse**

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psma magnetics workshop  
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JC and his...

- physicist & engineer
- make and design ferrite 3Cx and 3Fx
- sales amorphous metals 2605/2714/2705
- marketing nanocrystalline 500F components
- Bs & T Frankfurt am Main GmbH
• emi choke (common & differential mode)
• Validation of choke is problem
• BsT-Pulse damping oscillation delivers the choke feature
• Example (nanocrystalline common mode choke)
• Conclusion
• Annex (alloyed cored differential mode choke)
### Sinus Magnetization AC
- **High excitation**
- **Low excitation**
- **IEC 62044-3**
- **IEC 62044-2**
- **Loss, $\mu_a$** driven by B mode
- **$B_{\text{peak}}$, loop driven by H mode**
- **DC superposition**

### Pulse Magnetization
- **Fast transit of magnetic state**
- **$dB/dt$**
- **IEC 60367-1 Annex G (393 IEEE)**

### BsT-Pro
- **Loss map** $(f, B, T, H_{\text{DC}})$
- **$\mu_{\text{rev}}$** $(f, B, T, H_{\text{DC}})$
- Major, and biased minor loop

### BsT-Pulse
- **Differential and amplitude L**
- **Energetic L, power loss i.e. Q factor**
Pulse Magnetization

fast transit of magnetic state

dB/dt

Square Wave

bipolar pulse magnetization

BdT-Pulse

differential and amplitude L

energetic L, power loss

Bs&T-Pulse
Filter – choke – common/differential mode – magnetics

Common Mode (asymmetric)
- strong "common-mode" attenuation
- $\mu$ and $B_s$ must be safe against unbalanced currents!

Differential Mode (symmetric)
- slight "differential mode" attenuation

Typical values:
- $C_x = 0.1 \ldots 1 \mu F$, $C_y = 1 \ldots 10 nF$
- $L_1 = 3 \ldots 50 mH$, $L_{stray} = 5 \ldots 50 \mu H$
- $Z_1 \neq Z_2 \approx 50 \Omega$ or $\neq 50 \Omega$
Model of choke

Insertion loss $a_E$

$|Z| = \sqrt{(\text{Re}(Z))^2 + (\text{Im}(Z))^2} \approx \sqrt{R_{s,\text{core}}^2 + (\omega L_{\text{core}})^2}$

$\mu'' f\mu' f$
Requirement of a 3+1Ø common mode choke $35A_{rms}$

- **Core:**
  *High* (*tunable*) permeability

- **Wire:**
  *High* rated current (>25A) of interest

- **Choke performance:**
  *High* frequency performance defined by mechanical terminals for fixed parasitic performance

- **Safety:**
  *No* isolation problem with safety margin in creepage distance
Validation of CMC is a challenge

• Material based core specification like $\mu_3$ of nanocrystalline tape wound core does **not** reflect application feature: $A_L$ as singulary nominal value has large tolerance like -30~+50%

• **cmc:** inductance (core&leakage $\mu$), enough flux linkage ($B$) and insertion loss ($a_E$)

All cmc specs. needs is a energetic impulse short with **Bst-pulse**
Physic principle & device damped oscillation
Voltage and current decay ($L_{\text{core}&\text{leak}}$)
**B_s and insertion loss and more**

- Flux linkage (~B_s) regardless the *effective* core geometry specification
- Insertion loss a_E* can be calculated with damping coefficient
- It may detect the isolation failure, safety margin

*Further reading: JC Sun BodoPower 10/2020
Damp-Oscillation Solution for Validation of the Nanocrystalline Core for Common Mode Choke
conclusion

• Damped oscillation principle* enables characterization and validation of common mode choke, fast easy and accurate, compliant ieee 389 mod. ✓ ✓ ✓

Core and leakage inductance ✓
flux linkage of absorption capability of noise energy and insertion loss ✓
wire isolation w/o corona effect ✓

• Same effective to differential mode choke see annex

*future reading: JC Sun IEEE power Magazine 060/2021
Recent Development in Measuring Technology of soft magnetic components for High Power Applications
Annex with an example for Different mode choke

• dmc: cored with material & shape HS1016 (CSC) 2x wound with edge wire with N=53
• Voltage load: 400V
• Capacitor: 430 µF
• Device: BsT-Pulse 1k3k Typ SN0001b
Voltage and current decay

PSMA workshop magnetics  Damp-Oscillation BsT-pulse
Curve & Loop via parameter fitting [Rivas]

further reading: JC Sun BodoPower 09/2020
Damp-Oscillation Solution for Validation of the Metal Alloyed Powder Core