



Advanced Conversion Integrated DC Link Solutions

Grid PACE Annual Meeting
Session 4 MVDC Supply Chains

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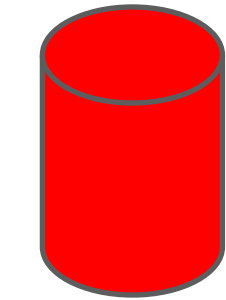
Technology Summary

- Unique annular form factor winding provides the highest possible A/uF rating for any film
- Integrate high-performance windings with optimized terminals and surface mount windings on bus structures
 - DC link as a solution not discrete components
- In house bus design and prototyping
- For more information see <https://advanced-conversion.com/technology/technical-papers/>

Film versus Form Factor

Consider two windings with the same capacitance value and different form factors

1. Higher electrode losses
2. Higher thermal resistance
3. Same dielectric loss
4. Lower peak current
5. Easy to wind on standard equipment



“Can” style capacitor

Same film better form factor



“Ring” style annular capacitor

10x lower electrode ESR
10x lower R_{th}

1. Lower electrode losses
2. Lower thermal resistance
3. Same dielectric loss
4. Higher peak current
5. Proprietary technology and winding
6. Lighter metallization supports higher voltage stress with no ESR penalty

Lower performance, capacitor is not the limit

Higher performance, capacitor enables system level win

DC Link Implementation

Good

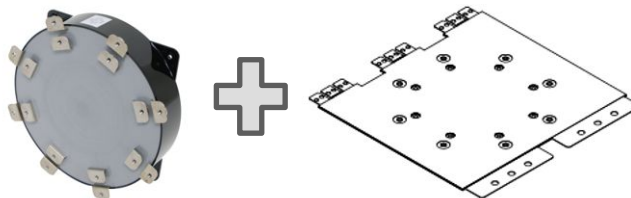
ESL $< 5\text{nH}$ for the capacitor if properly connected



Standard discrete capacitor with distributed parallel terminals

Better

ESL $3\text{-}5\text{nH}$ for cap/bus, module connection is the limit, $8\text{-}12\text{nH}$



Discrete capacitor with a “universal busbar” that provides DC input and optimized module connections

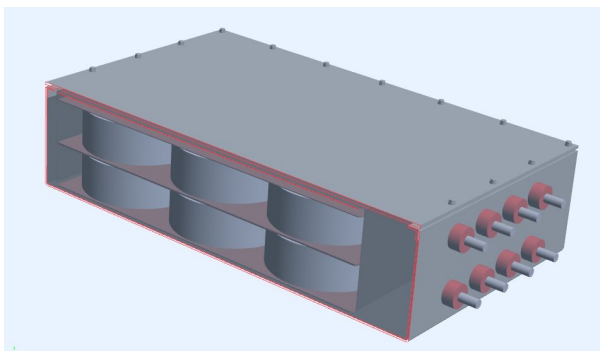
Best

ESL $2\text{-}3\text{nH}$ for cap/bus, module connection is the limit, $4\text{-}10\text{nH}$



Integrated test kit with windings “surface mounted” on the bus eliminates duplicate copper and reduces height. Optimized DC input and module connections.

HVDC Capacitors



The dielectric dissipation losses are the same as conventional part

Electrode ESR can be reduced by up to 3x with optimized form factor windings



Path forward for reduced ESL...
Windings surface mounted on a bus that extends over switch modules