

Paris Session 2022



Experience with specification and thermal sizing of transformer for photovoltaic plant application

SC A2 PS1

Q1.2: What design and operation considerations should be included to optimize the selection of transformers for photovoltaic plant applications?

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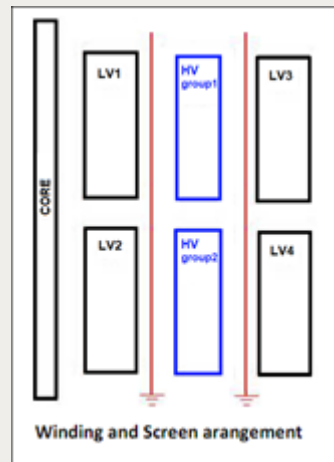
Specifications

– Transformer rating

50Hz , 3 Phase	HV	LV1	LV2	LV3	LV4
Rated Power (MVA)	85	21.25	21.25	21.25	21.25
Connection	Y	d5	d5	d5	d5
Line-Line Voltage (kVrms)	116	6.4	6.4	6.4	6.4

- 5 Windings : 1HV (AC side) and 4 LV (Convertor side)

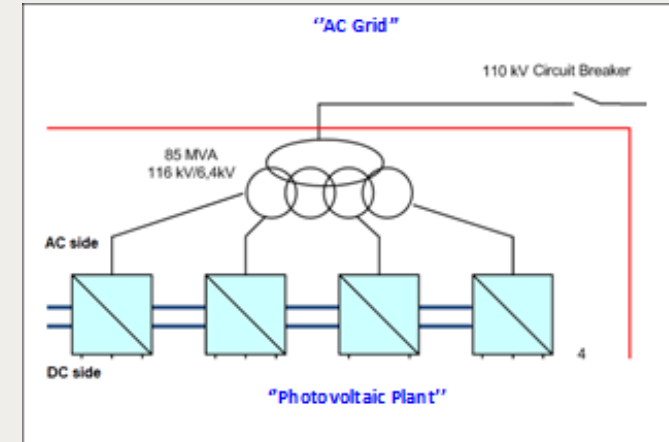
– Windings geometry arrangement



- Double-tier, double concentric
- Earth screen shields are specified to avoid capacitively transferred surge from HV to convertor side

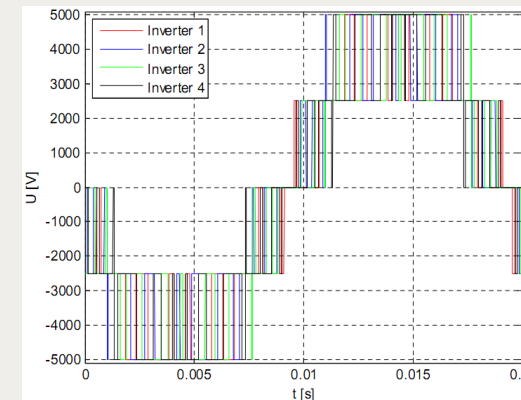
Group Discussion Meeting

– Converter



- 4 Levels PWM inverter

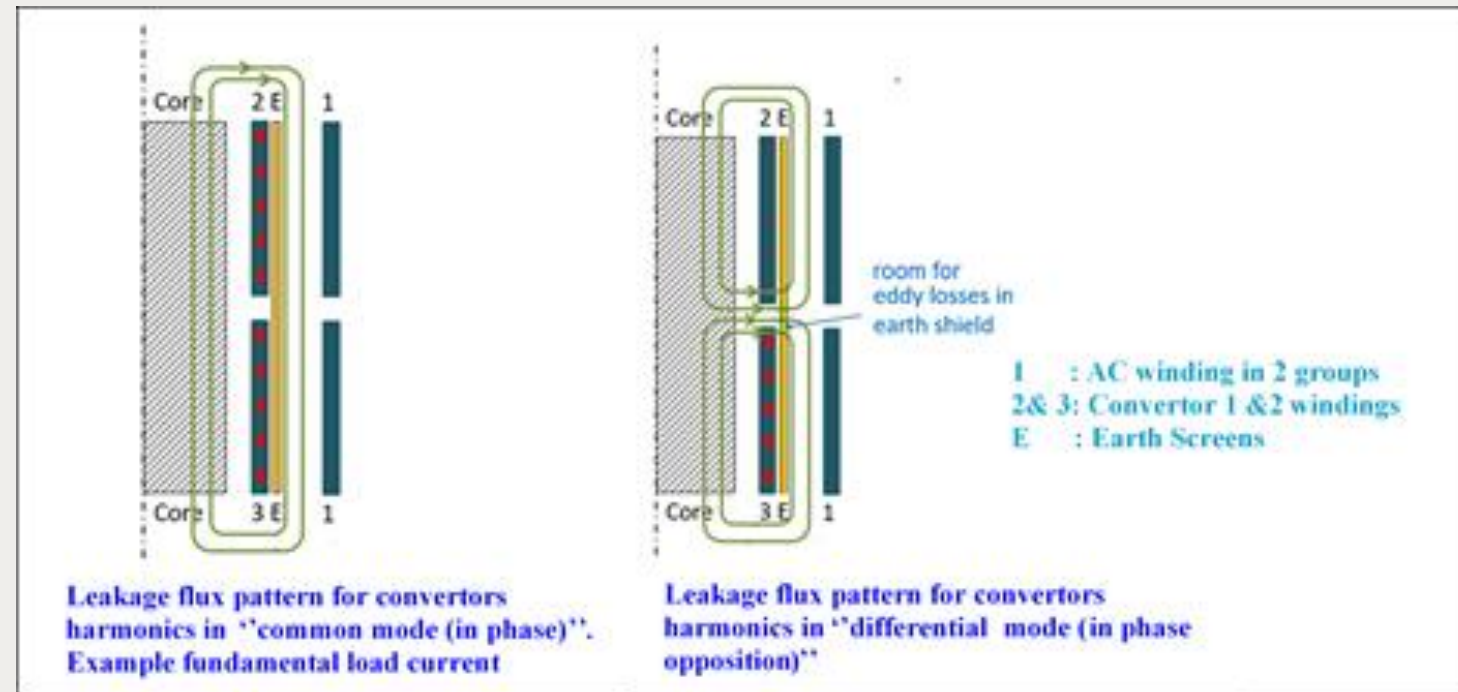
– Typical voltages profile at convertor side



- Converter side voltages are interlaced (pulse shifting)

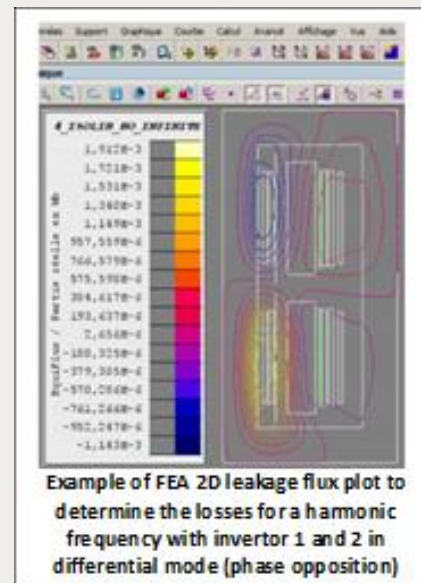
Special considerations/concerns

- Repetitive voltage dv/dt with a certain rate, resulting from the PWM convertor commutations
- Thermal sizing of windings and earth screens due to harmonics.
 - Thermal sizing of earth screens more focused. The User had experience of transformer failure associated earth screen overheating, likely due to convertor's "differential mode" operation (convertor's harmonics in phase opposition)



Thermal Design studies related to harmonics exposure

- Strong collaboration with the User for the most effective definition of voltages/currents harmonics and how to apply in models for thermal sizing.
- FEA magnetic studies of the leakage flux for the varying harmonics to determine windings extra loss following methods in IEC61378 standard on converters transformers, leading to related thermal sizing.
- Same FEA studies used to determine the losses and to define the earth screens thermal sizing.



Conclusion

Experience with operation and design considerations in the specification of a large power transformer for photovoltaic plant application has been presented. Collaboration with the User for the most effective specification of the harmonics was key to satisfactorily addressing at design stage, the concerns raised by exposure to harmonics in the varying convertor's operating configurations.

Thank you for your attention !