Paris Session 2022

Negative Excitation Current

SC A1 Rotating Electrical Machines
PS1 Generation mix of the future

Question 1.3 - Have the authors considered the possibility of introducing an excitation system with the capacity to supply negative current?

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- Rectifier bridge inversion time: It is necessary to invert the field voltage (regenerative mode of the rectifier bridge); only after “zeroing” the field current, the inverse bridge must be connected. Otherwise, a short circuit between the bridges may occur.
- The thyristor that was in conduction mode “takes a long time” to go into blocking mode. Thus, it’s necessary to have a high precision in the field current measurement to ensure that the current really “zeroed” and the thyristor went into blocking. Even small current passing through the thyristor can cause a “re-ignition” and, consequently, a short circuit between the phases.
- To reduce the risk of short circuit between bridges, two excitation transformers must be used, one for the “positive” bridge and the other for the “negative” bridge.

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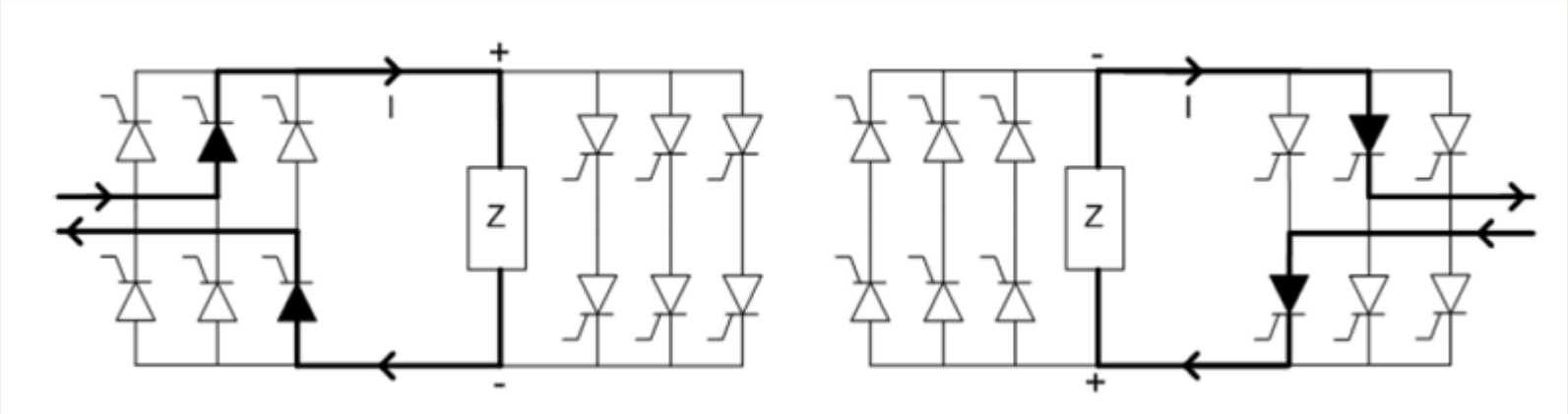

Figure 1: Connection diagram of the positive and negative bridges

Figure 2: Representation of the short-circuit between bridges, if the thyristors start conducting simultaneously.

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1. The “coupling” (magnetic stiffness) between rotor and stator will be quite weak and the load angle will fluctuate. Even considering a constant and very low active power (0.02 x MVA), variations of the load angle due to the inherent voltage variation of the electrical system are unavoidable. Consequently, (large) currents will be induced in the damper winding. The unit will remain synchronous due to reluctance, but the load angle can be large and with low damping.

2. The control must be fine tuned to determine how far the field current can be reversed. The ideal would be to invert the field current but keeping some safety margin against slipping.

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3. The excitation system needs to calculate the practical limit to limit field current reversal. If the field current is reversed too much, a slipping may occur.

4. If a frequency variation occurs during operation with negative excitation there is a risk of slipping, e.g., loss of stability. The inversion time, after “zeroing” the field current is around 200ms; thus, the risk of losing stability during a frequency variation is considerable.

5. If the system is operating with its maximum negative current (approx. -0.15 x If0), the time to “zeroing” the field current can be approx. 300ms; thus, the total time for reversal can be more than 500ms.

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Thank you!

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