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Study Committee B4

DC Systems & Power electronics

Paper ID_10408

Dynamic Demand Control Applied to Synchronous Grid forming Controlled HVDC

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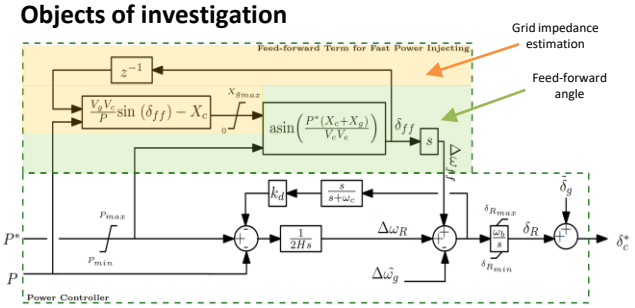
Motivation

- With the reduction in synchronous machine power generation in favour of power electronic interfaced renewable generation the need to compensate for the loss of electrical power system frequency and AC voltage stability is foreseen
- Synchronous Grid Forming (SGFM) applied at a HVDC converter can help frequency and voltage support
- SGFM inertia can impact on the converters ability to track an active power ramp or rapid active power recovery after a fault
- HVDC controllability means that with auxiliary control features the inertia response can be modified to give improved performance over synchronous generation

Objects of investigation



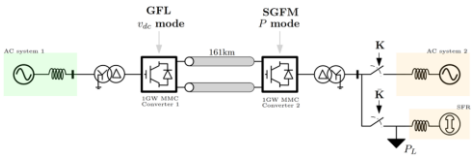
The basic Inertia controller was first enhanced with a power angle feed-forward term which drives the converter operating angle when the power order is changed. However, under weak grid conditions the power order change may not be accurately tracked so a further compensation term has been added.

For very weak systems the weak grid compensation can be automatically disabled to avoid over-stressing a very weak grid.

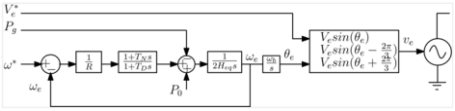
Discussion

- Results show that with the additional controllers the HVDC converter, operating in a SGFM control mode, operator power ramps can be accurately tracked
- These same additional controllers, in combination with the AC fault anti-windup arrangement also significantly improves AC fault recovery times

Experimental setup & test results



Symmetrical monopole test circuit



SFR model, $R = 1\%$, $H_{eq} = 4$ s, $T_N = 3$ s and $T_D = 8$ s. The base power of the AC source is $S_{g_{base}} = 2500$ MW

Method / Approach

- EMT simulation was used to investigate the performance of an additional feed-forward element added to the inertia controller

Conclusion

- It has been shown that a potential problem of SGFM controlled HVDC converters (and other power electronic connected energy sources) can be overcome with the addition of auxiliary controllers in the form of a feed-forward controller in parallel with the basic inertia controller
- This means that, as well as being able to provide an inertia response to the grid under dynamic AC grid conditions the converter can also provide fast, inertia independent responses to power ramps and AC fault recoveries

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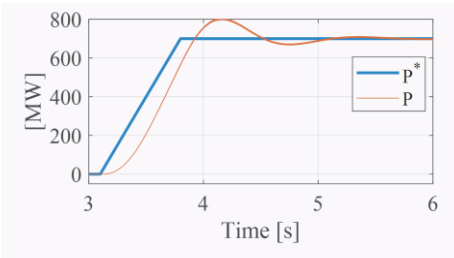
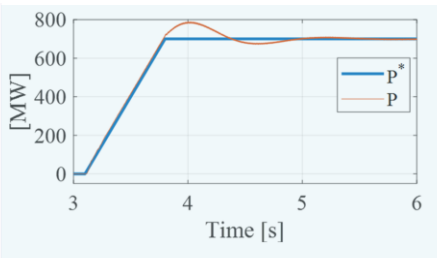
Active power dynamics during active power change (config. 1)

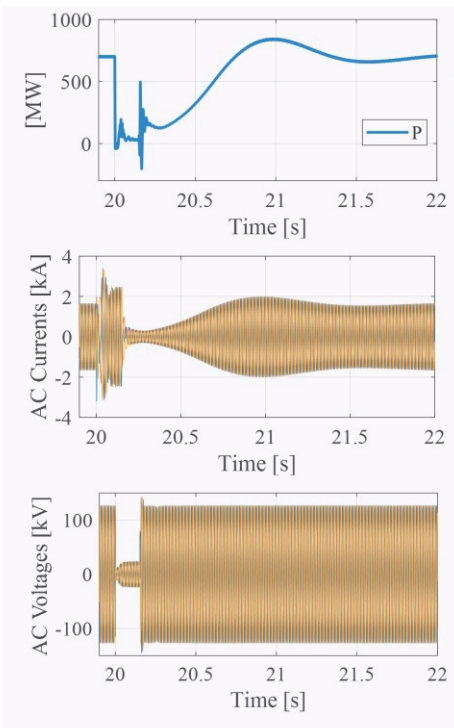


Without feed-forward controller

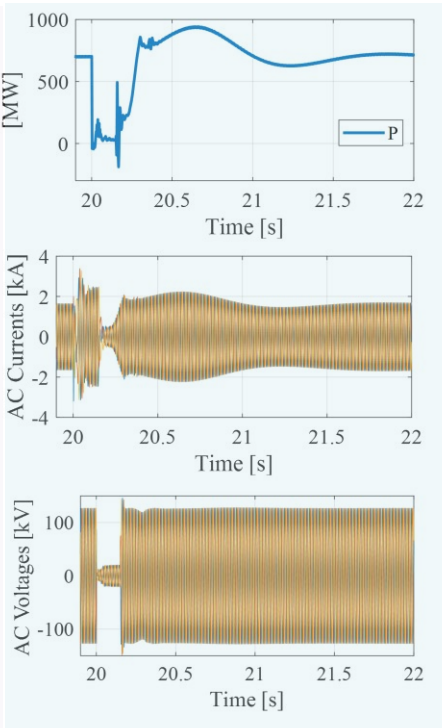


Without feed-forward controller

Active power dynamics during post-fault phase (config. 1)



Without feed-forward controller



With feed-forward controller