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GEIRI EUROPE
全球能源互联网欧洲研究院

Power System with VSC- HVDC Interconnection

Frequency Stability Control Strategy

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- **GEIRI: Global Energy Interconnection Research Institute**
- **Main Working Areas**
 - Offshore windfarm grid connection
 - Offshore HVDC platform design
 - Interconnection researches
 - Participating research projects, i.e. Horizon 2020, Schaufenster Projects, BMWI Projects etc.



1GW 320kV VSC





Contents

- Introduction: VSC-HVDC connections
- VSC-HVDC structure and controller
- VSC-HVDC connected OWF frequency control
 - Control strategy
 - Simulation results
- VSC-HVDC interconnector frequency control
 - Control strategy
 - Simulation results
- Conclusion and future works



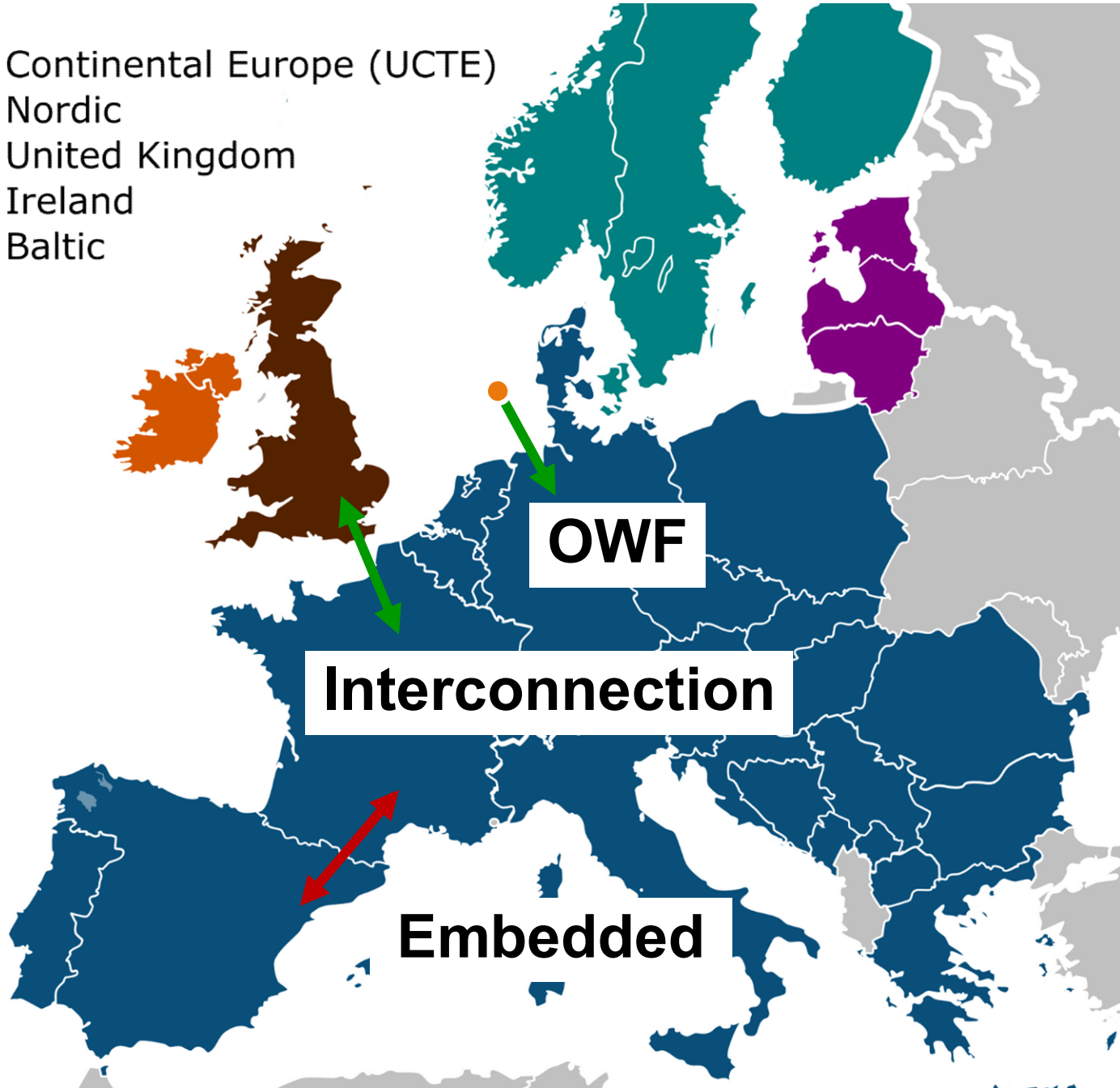
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VSC HVDC

- RG Continental Europe (UCTE)
- RG Nordic
- RG United Kingdom
- RG Ireland
- RG Baltic

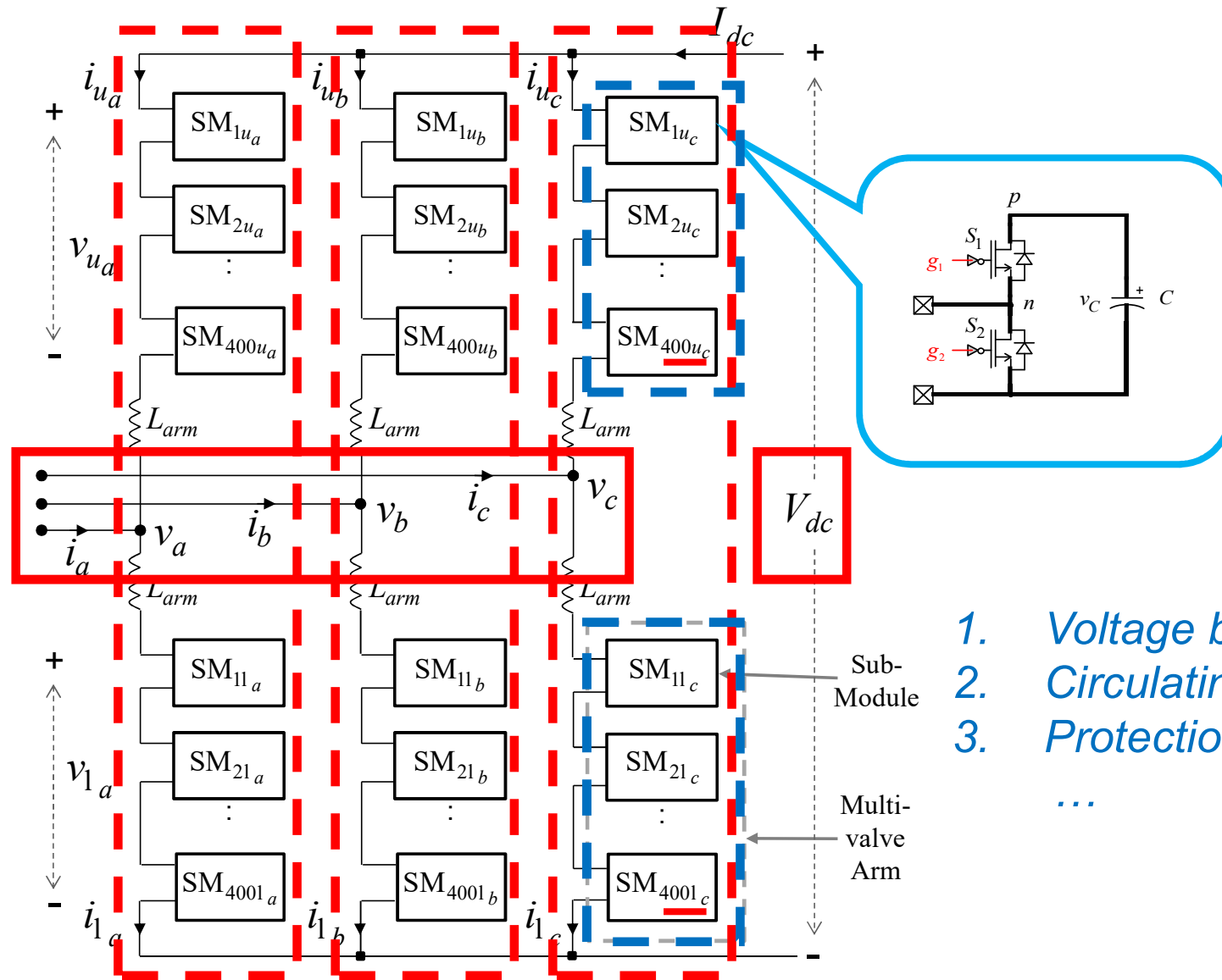




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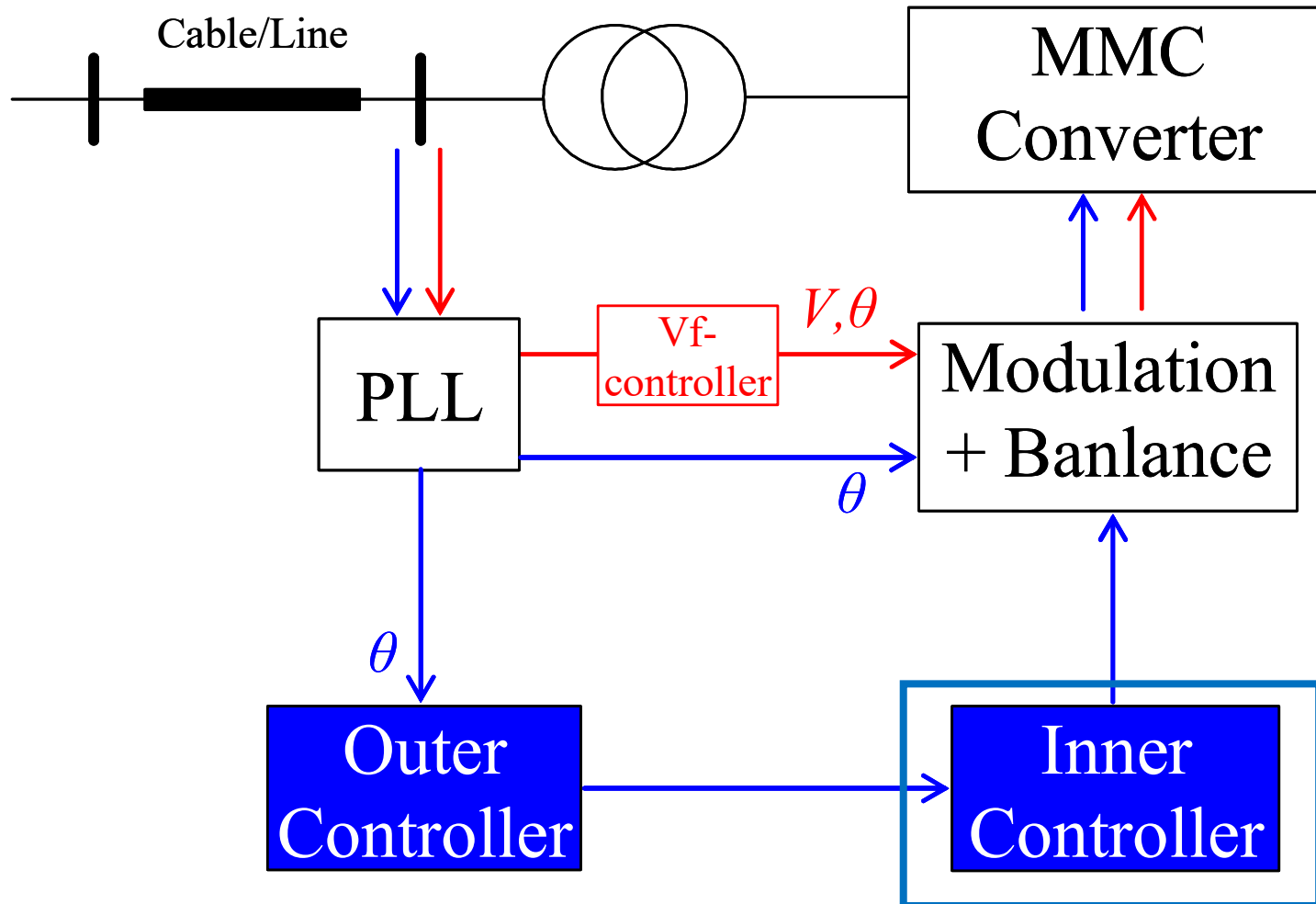
VSC HVDC Structure



1. Voltage balancing control
2. Circulating current control
3. Protections

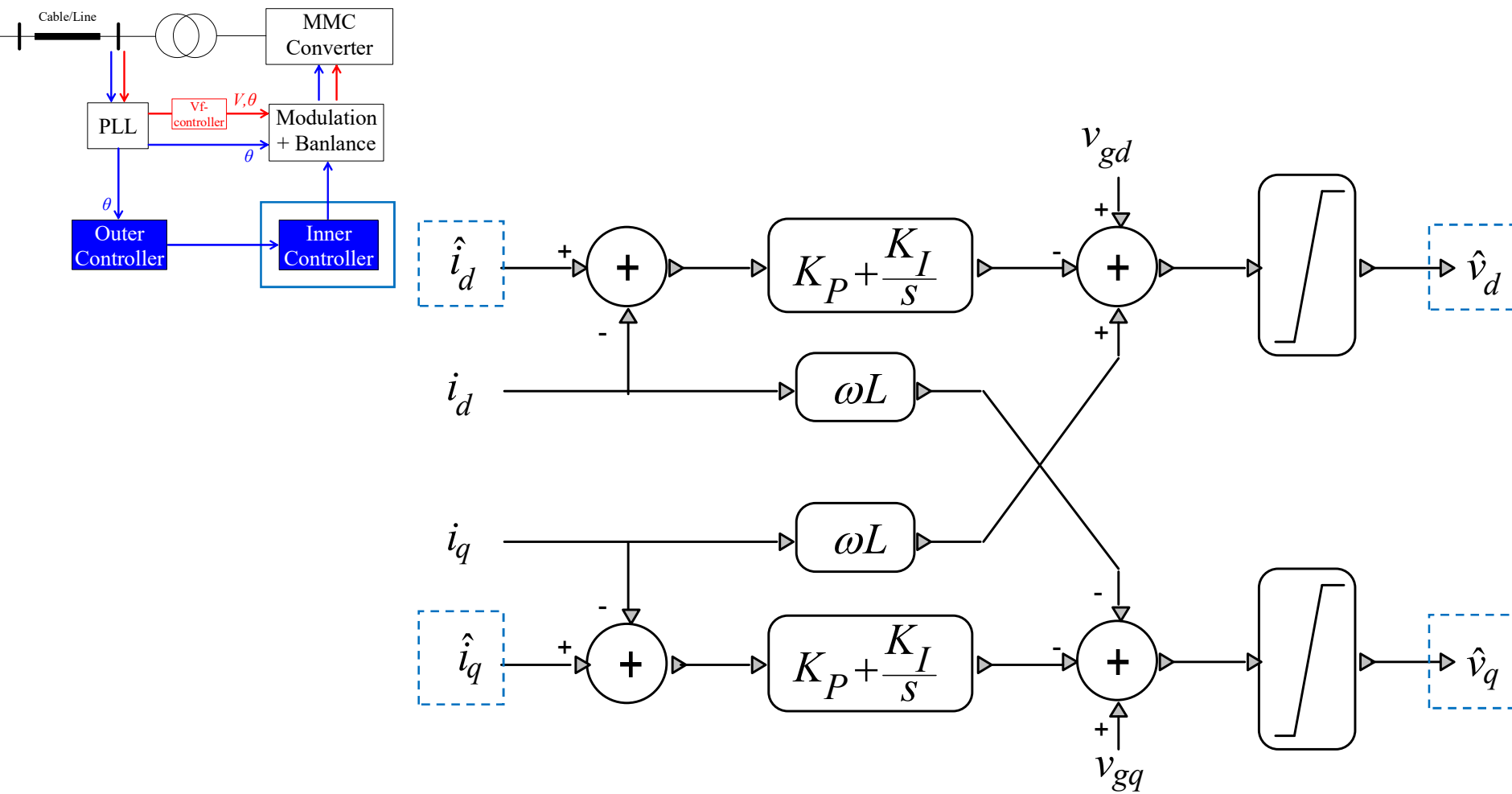
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VSC HVDC Controller

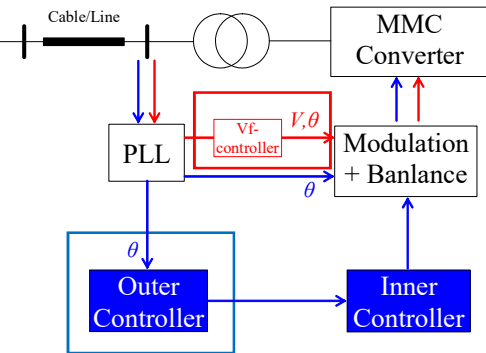




Inner Controller



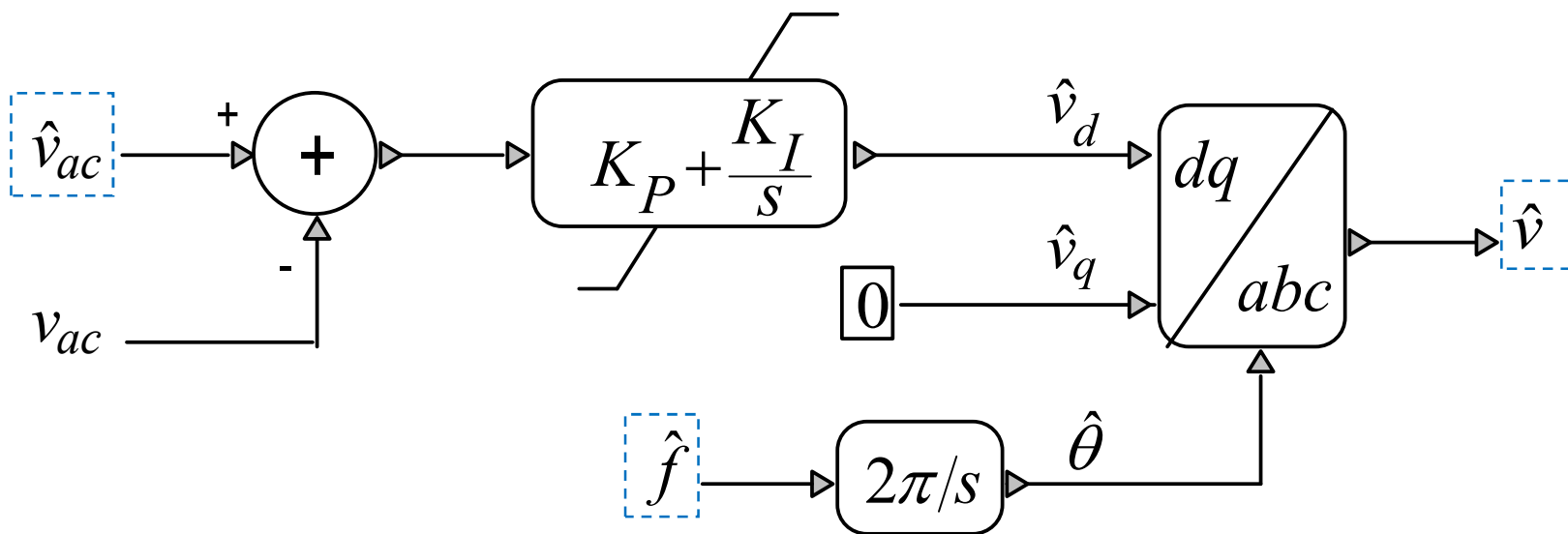
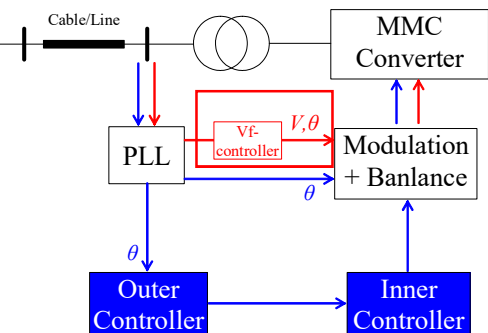
Outer Controller



- Voltage frequency control (**Vf-control**)
- DC-Voltage and AC voltage/reactive power control (**Vdc-Vac-control**)
- Active power control (**P-control**)
- Droop control (**Droop**, for multi-terminal operation)

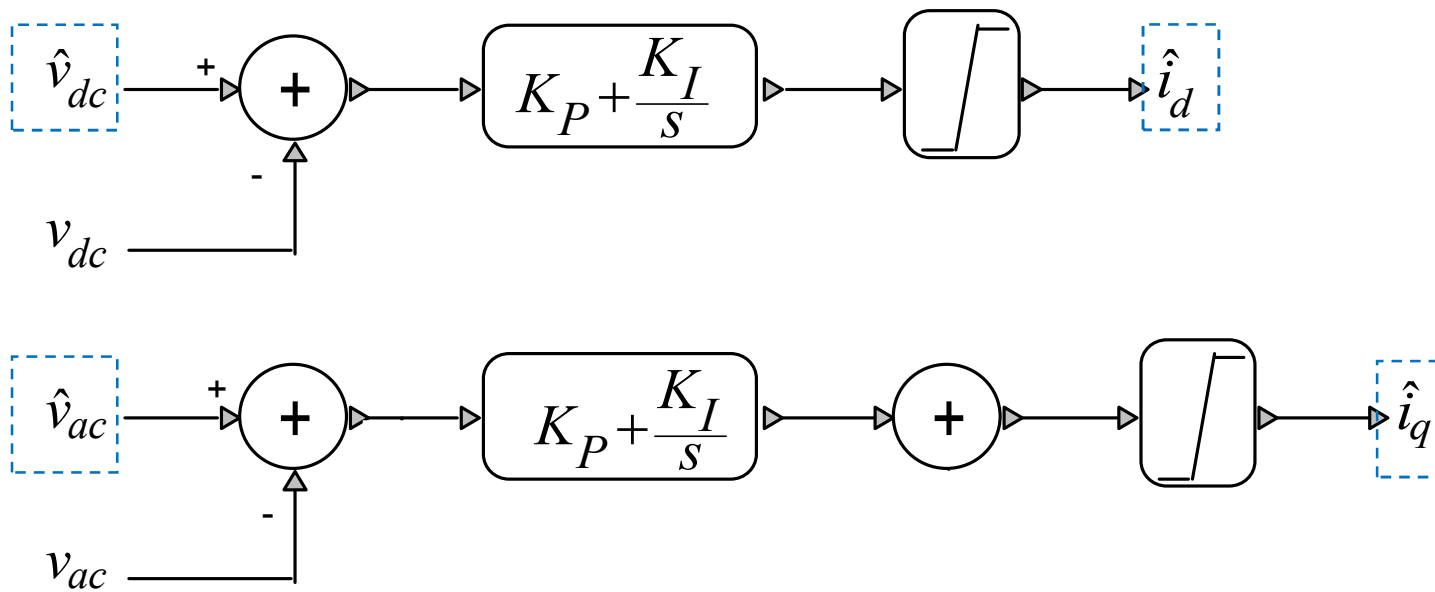
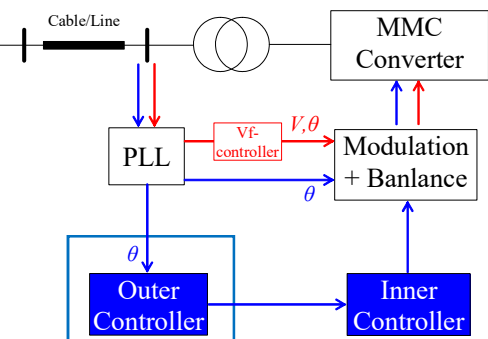


V/f Controller





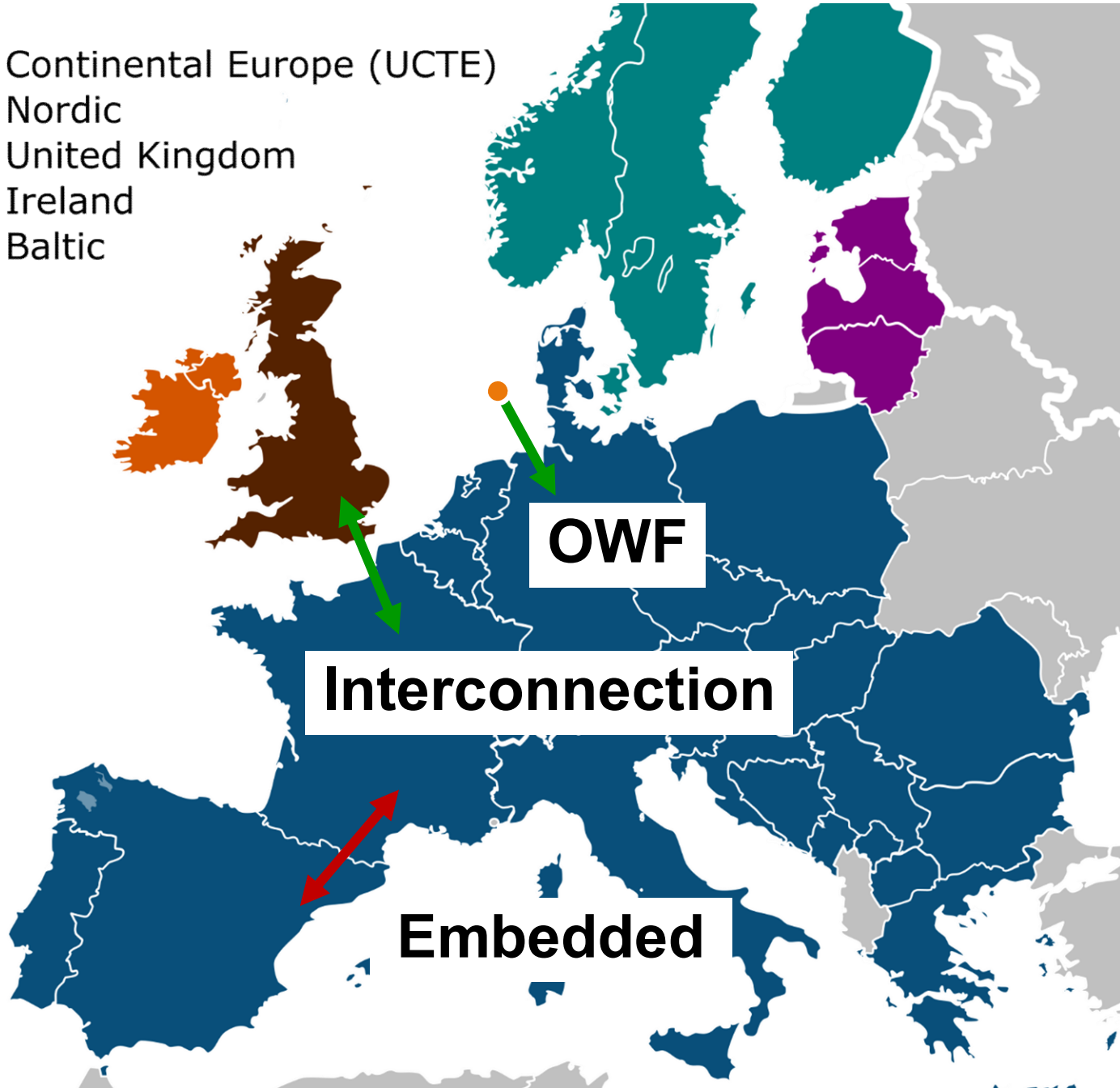
Vdc/Vac Controller





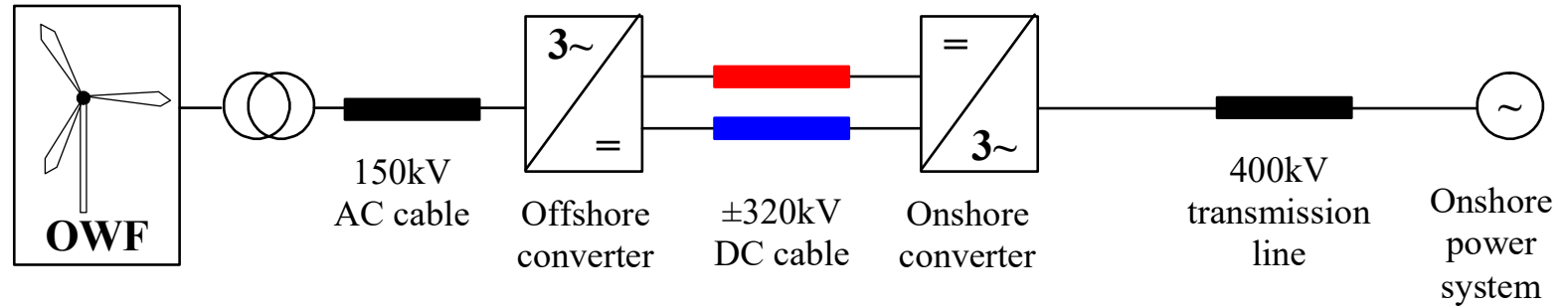
VSC HVDC

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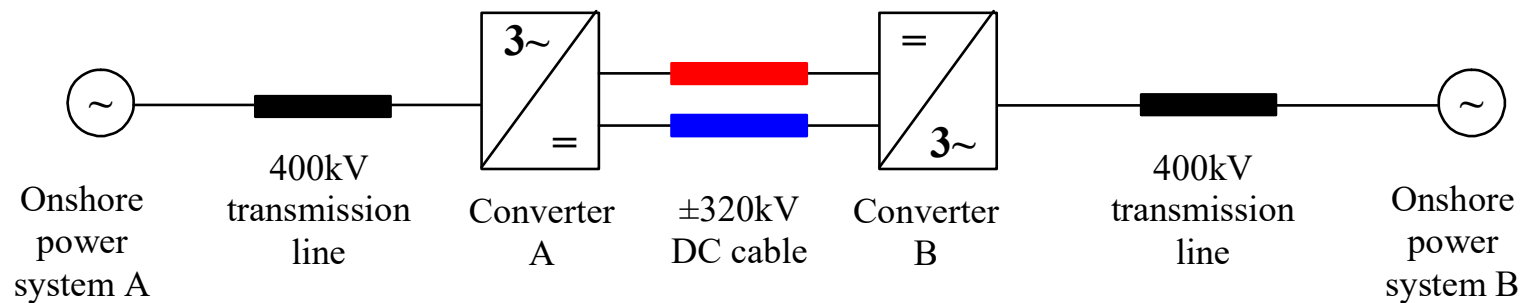


OWF VSC-HVDC

OWF



Inter-connection

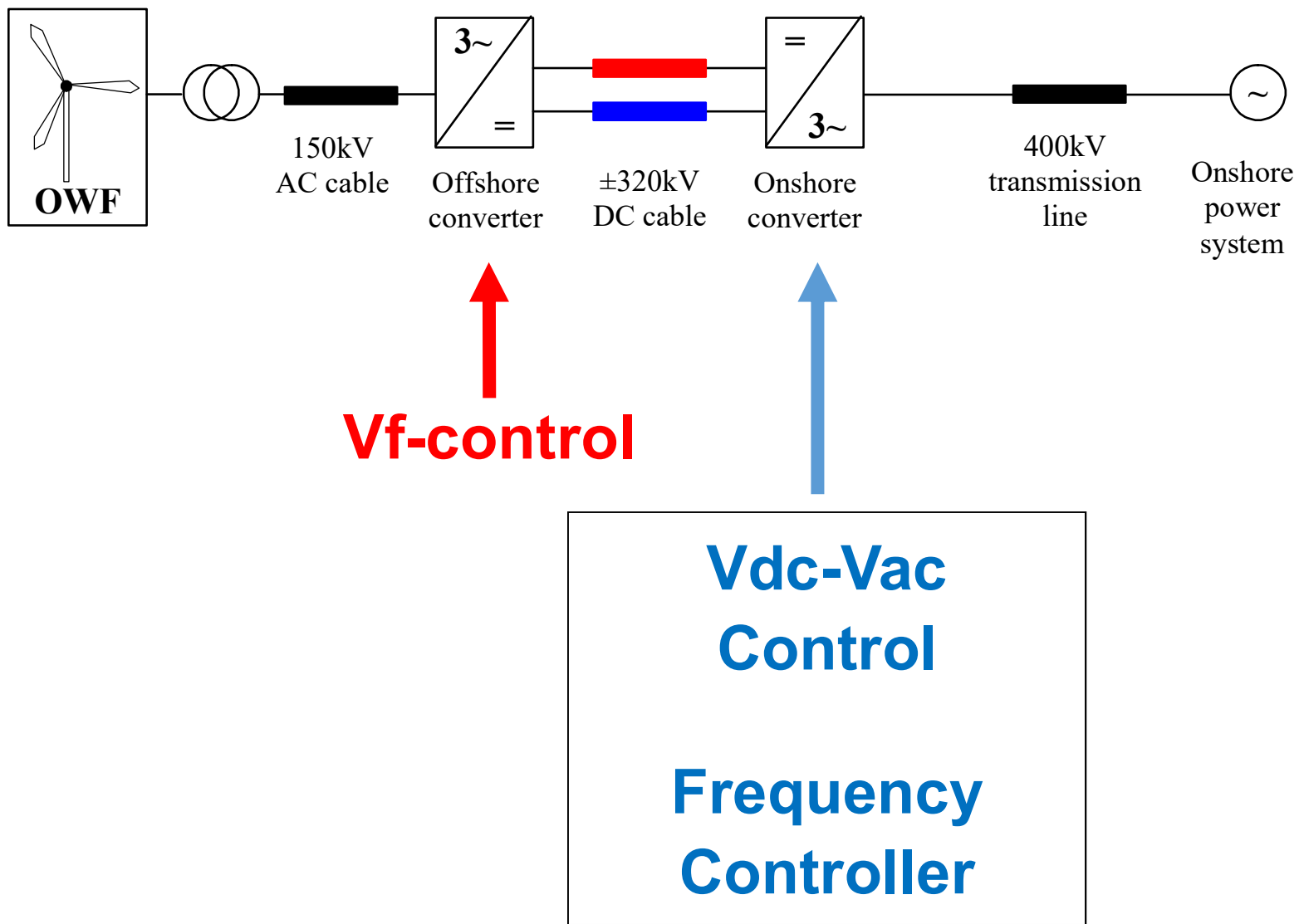




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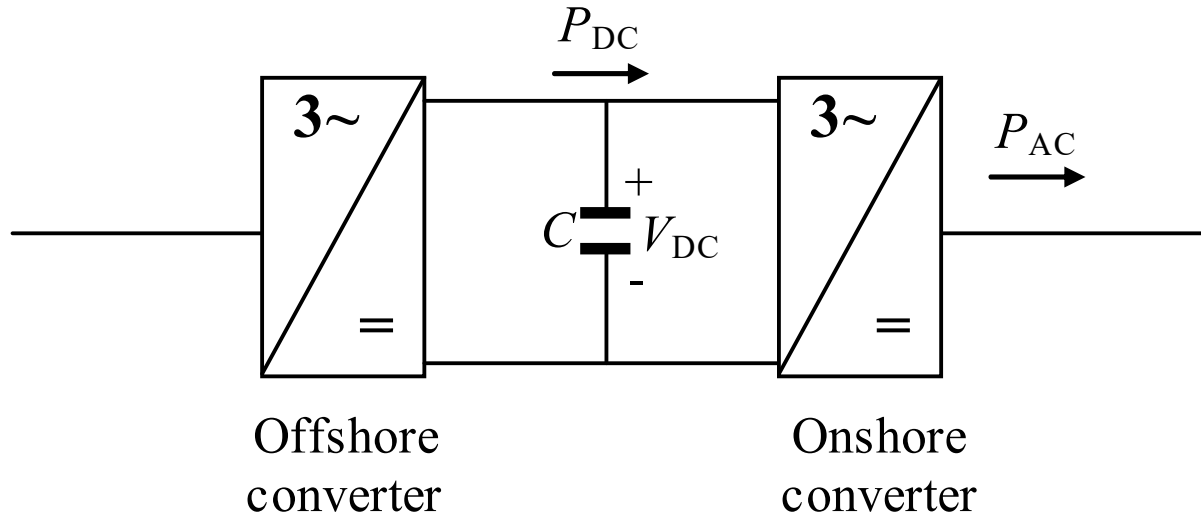
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OWF



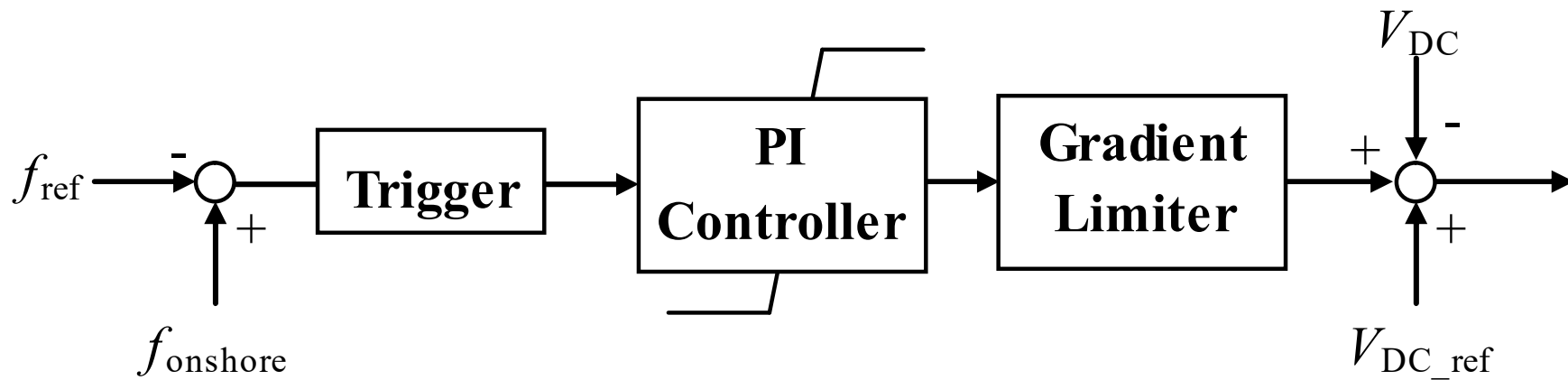
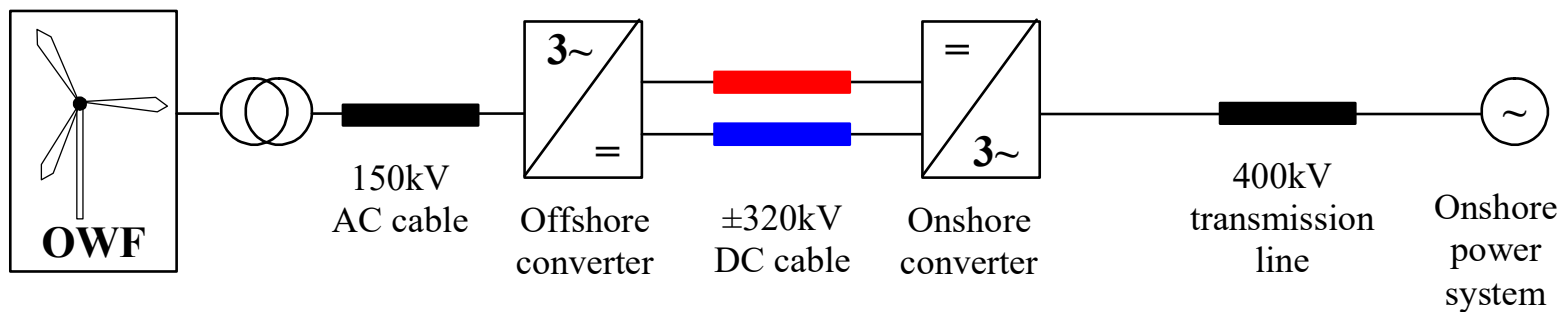


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$$P_{DC} - P_{AC} = C \cdot V_{DC} \cdot \frac{dV_{DC}}{dt}$$

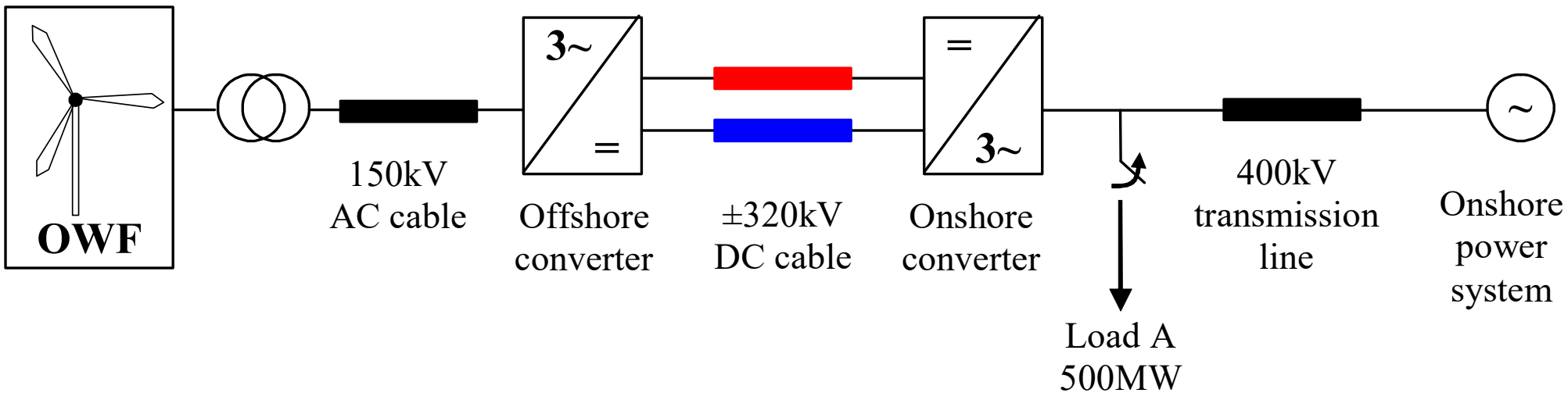
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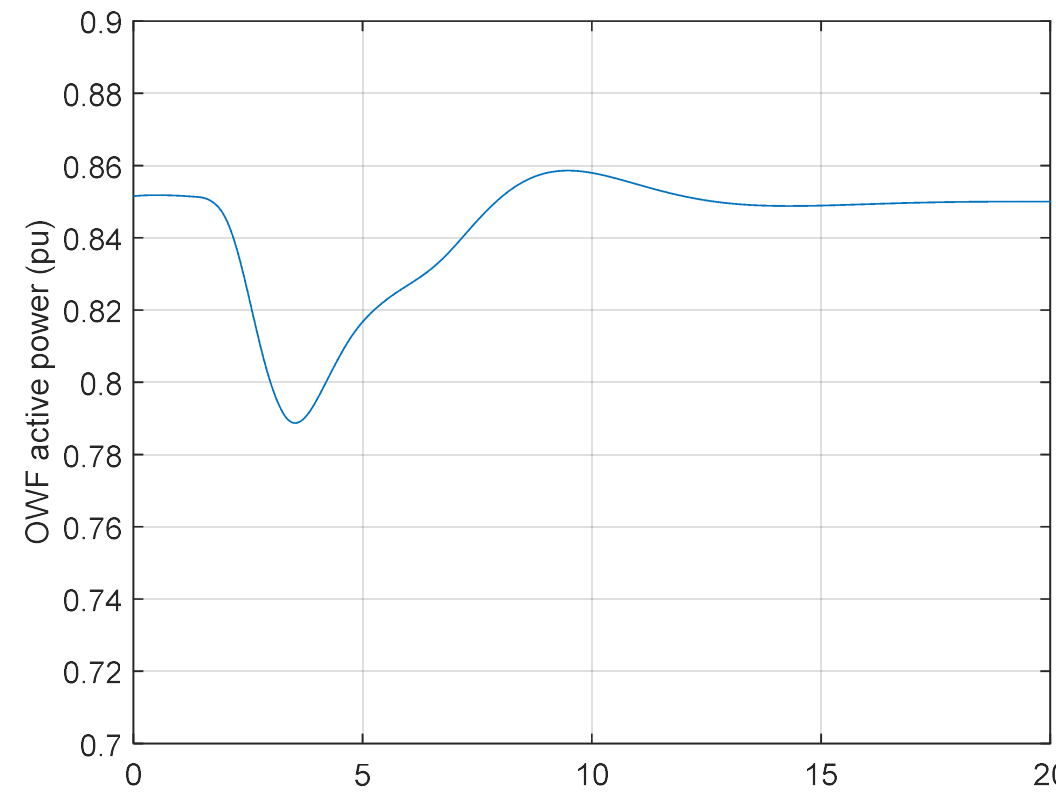
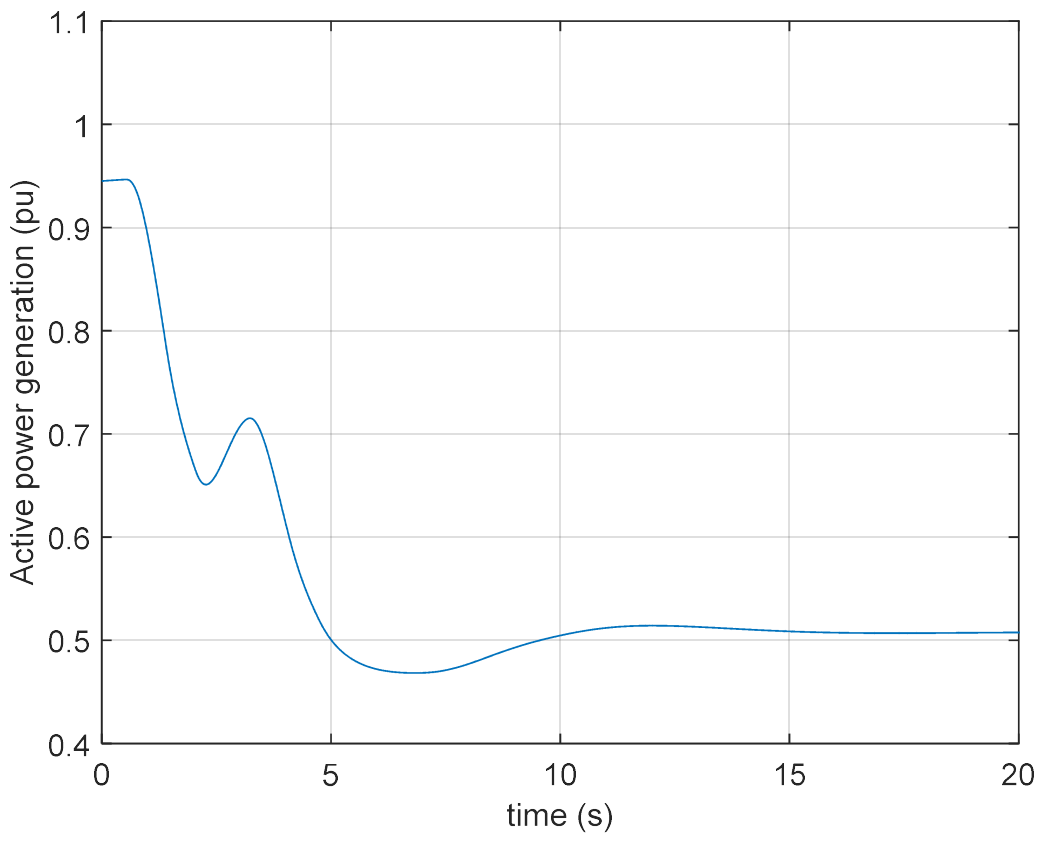
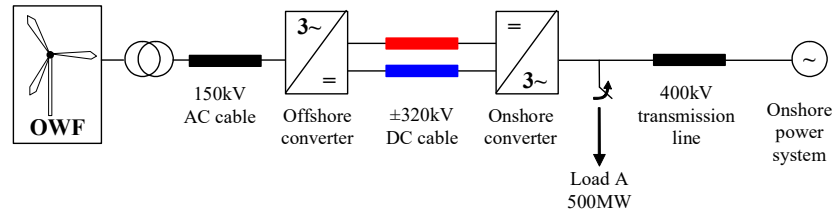




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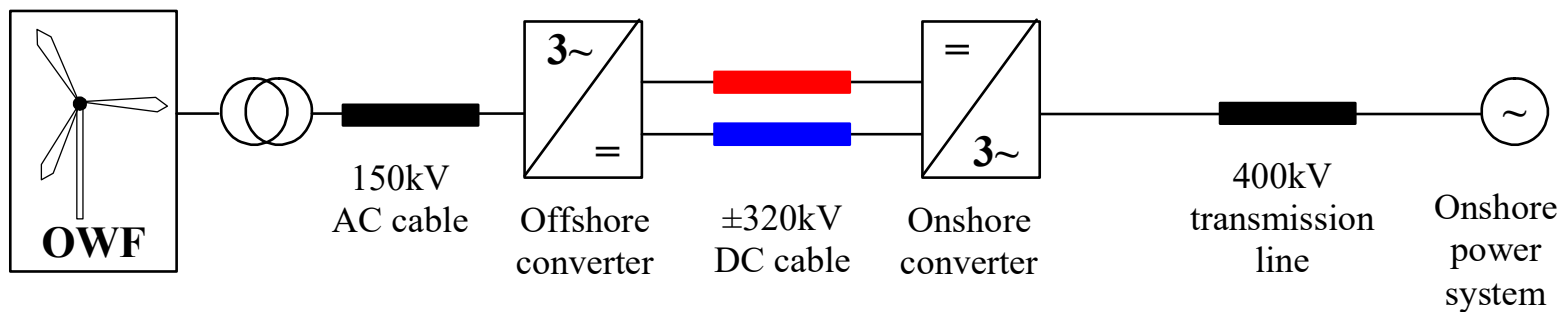




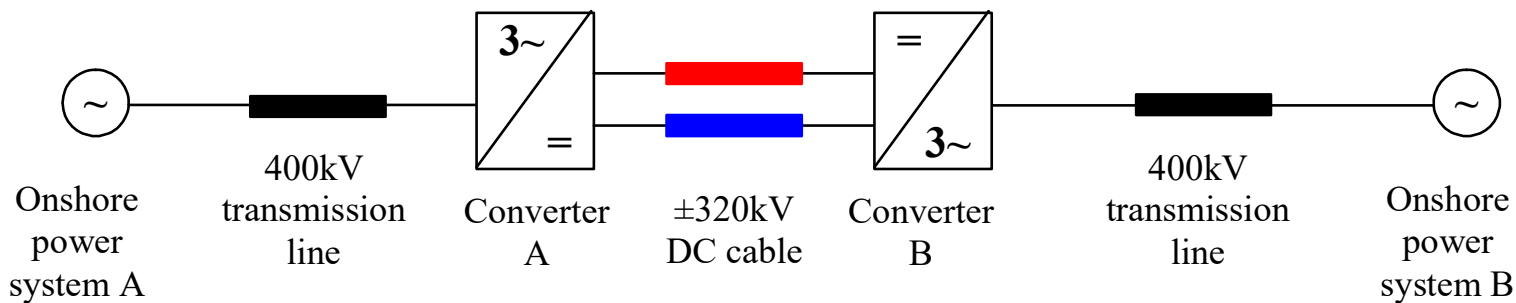
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OWF

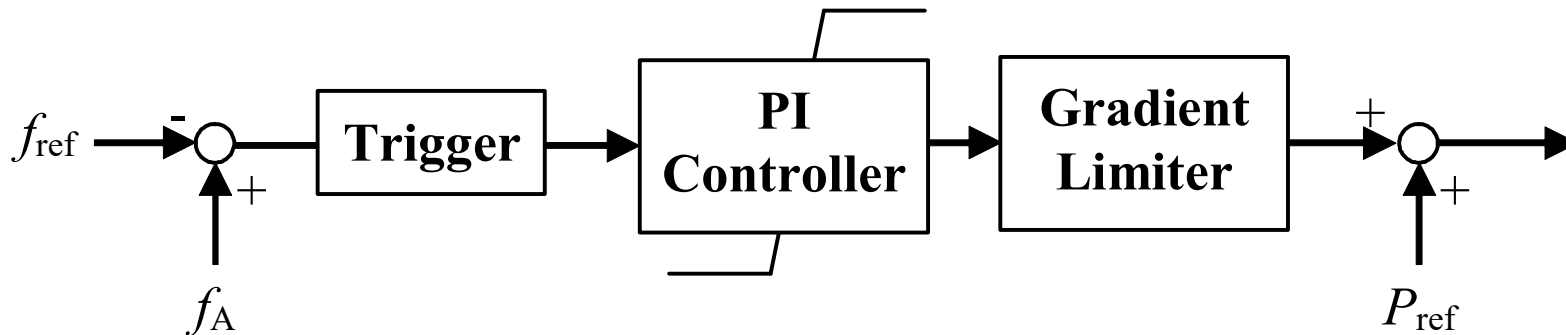
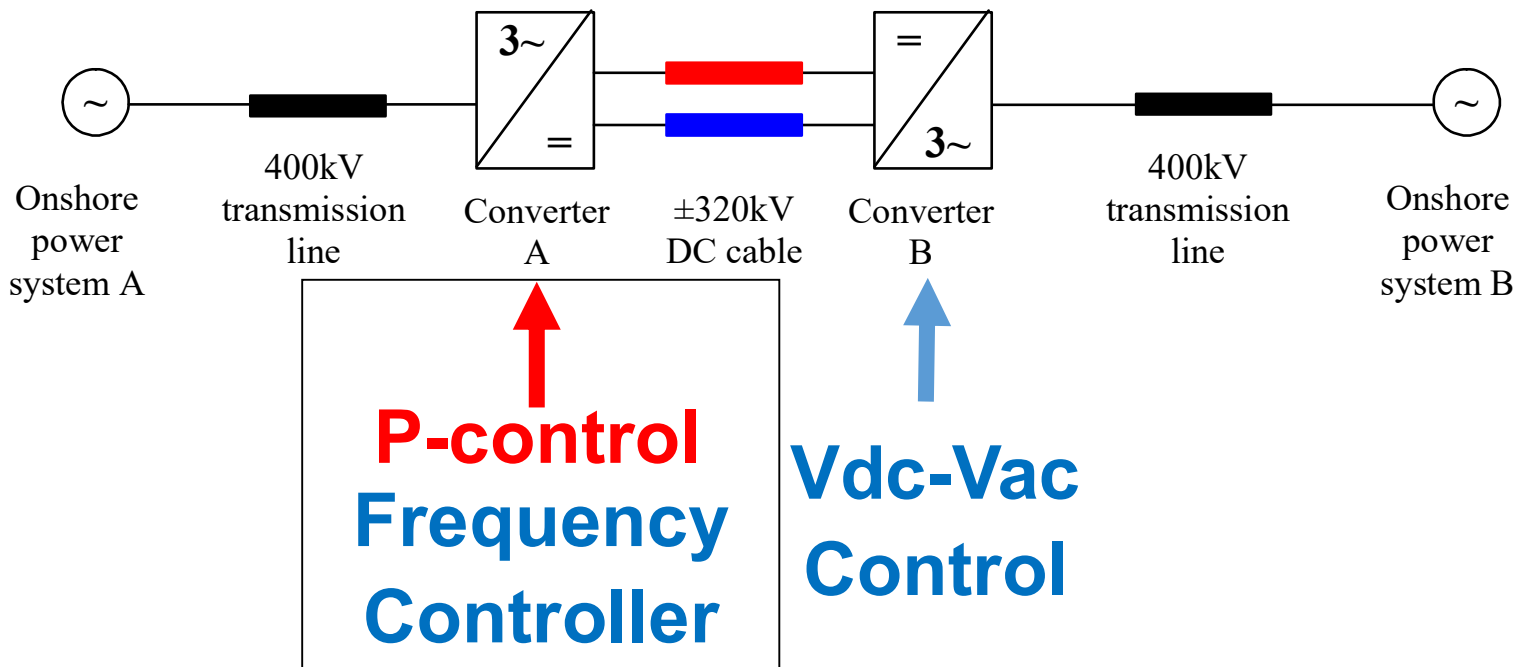


Inter-connection



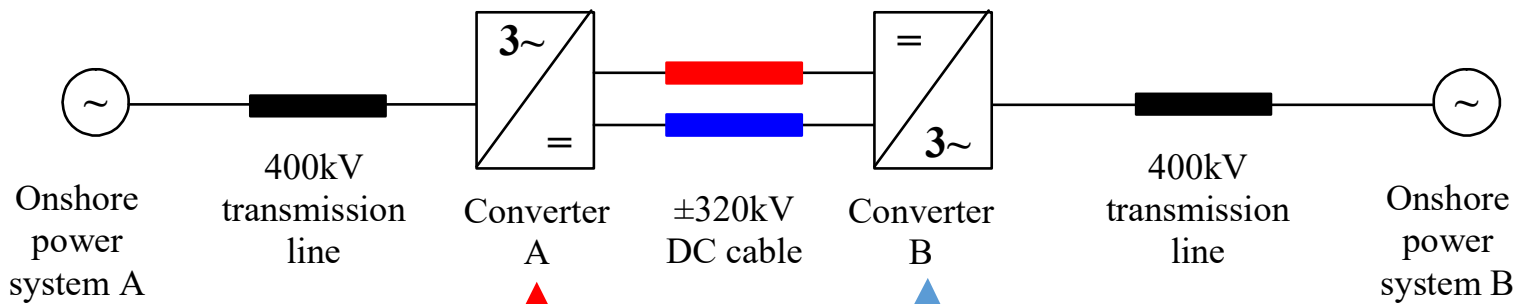


■ Inter-connection



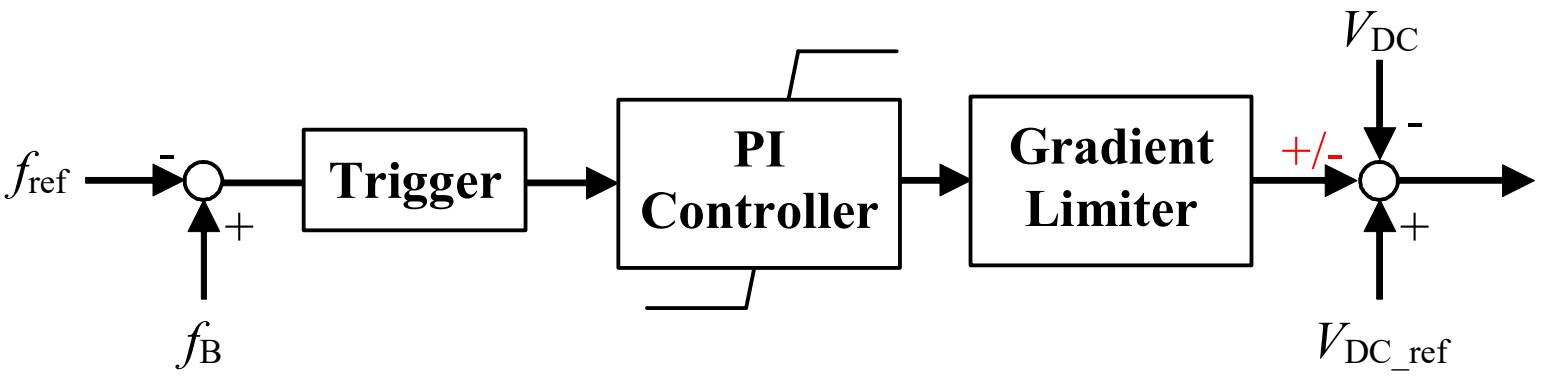


■ Inter-connection



P-control

**Vdc-Vac
Control
Frequency
Controller**





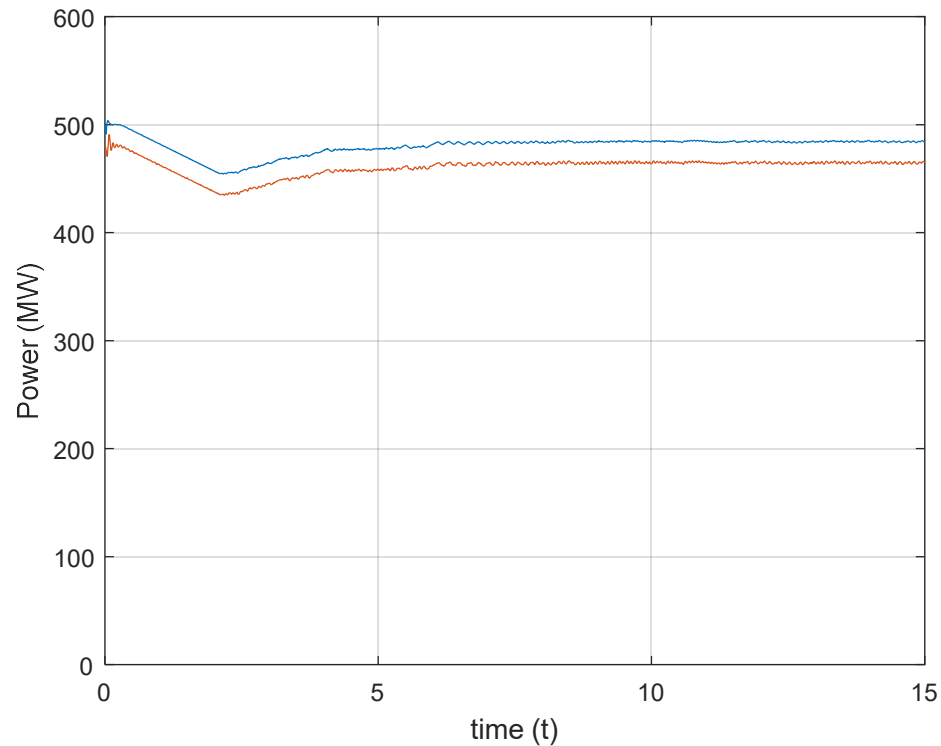
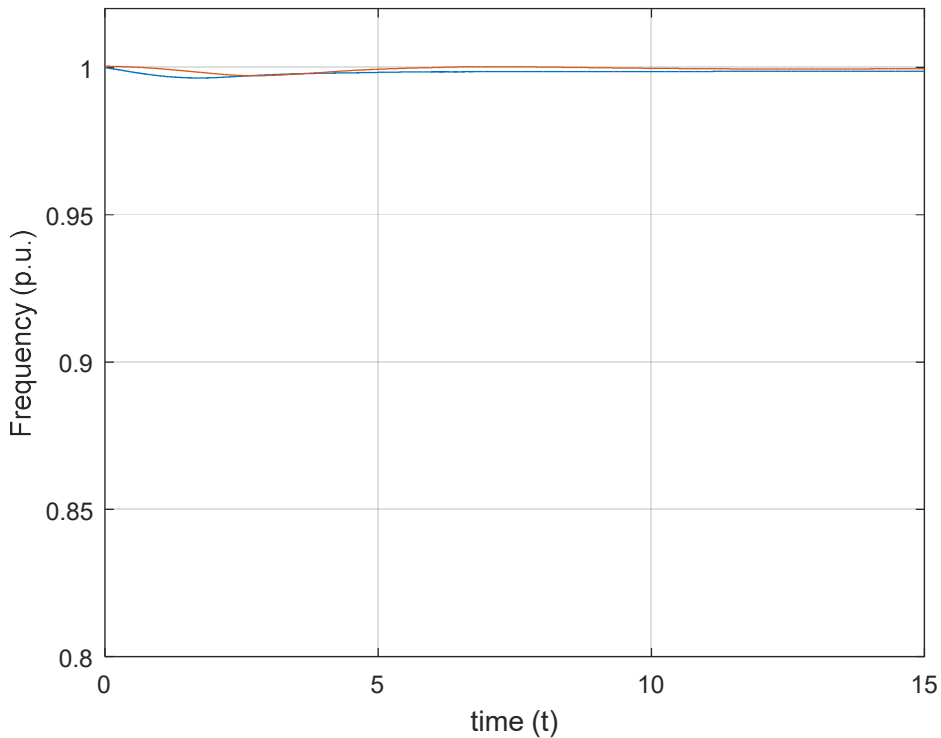
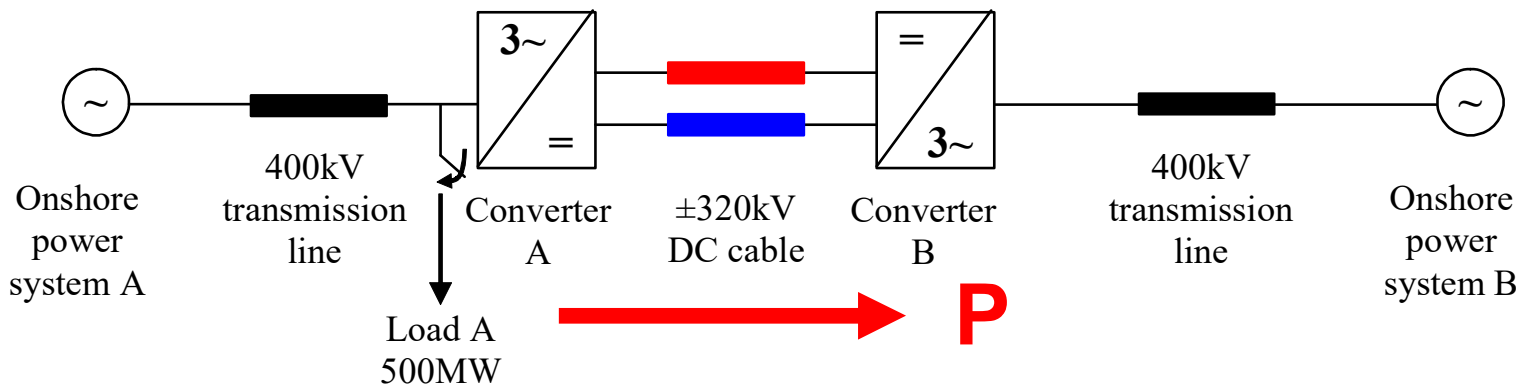
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P Control

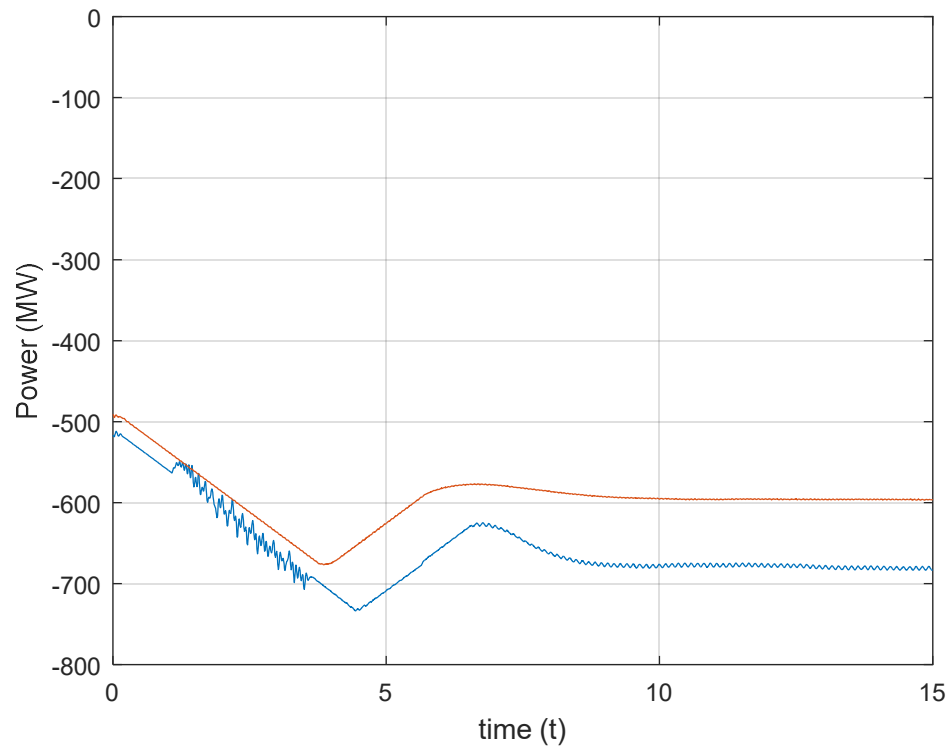
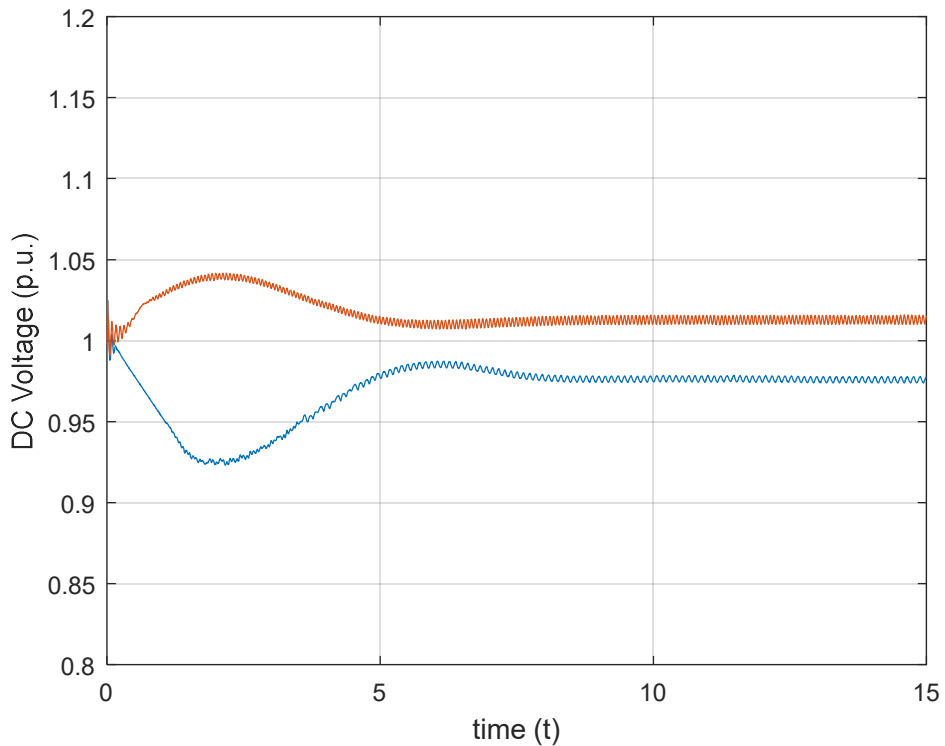
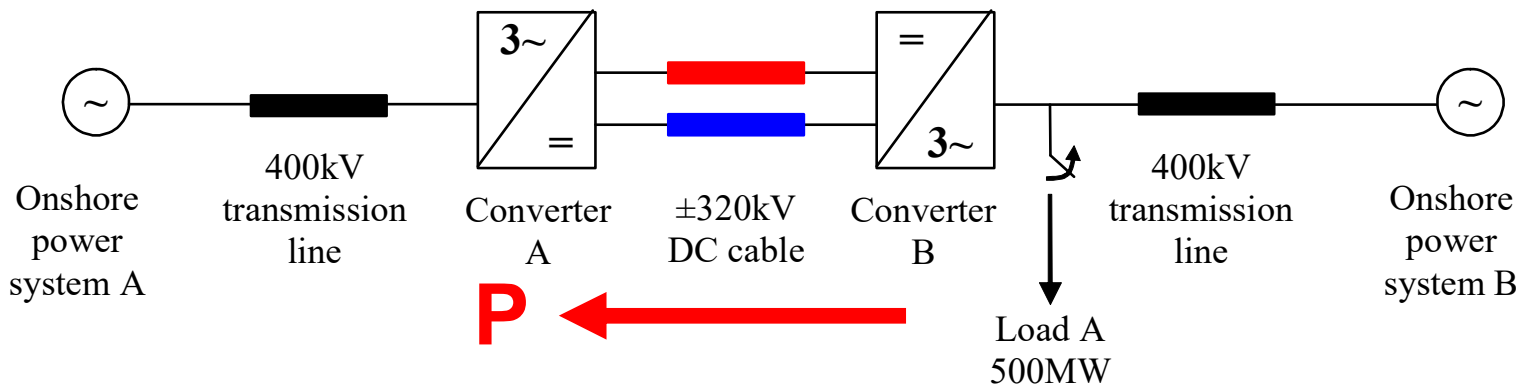
■ Inter-connection





VDC Control

■ Inter-connection





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Conclusion

■ Conclusion

- VSC-HVDC connected OWF frequency control
- VSC-HVDC interconnector frequency control

■ Future works

- Coordinated control: OWF, VSC-HVDC and onshore controllers
- VSC-HVDC voltage stability control
- VSC-HVDC oscillation stability control
- ...

Thank you very much for your attention!

