

Voltage Support using Grid Forming Inverter

Dr. Andreas Nikolaou

14/10/2025



Part 1 Outline

- High IBR Integration- Voltage Issues
- Grid Connected Inverters
- Literature Review
- LVRT- Low Voltage Right Through



Part 2



High IBR Integration- Voltage Issues

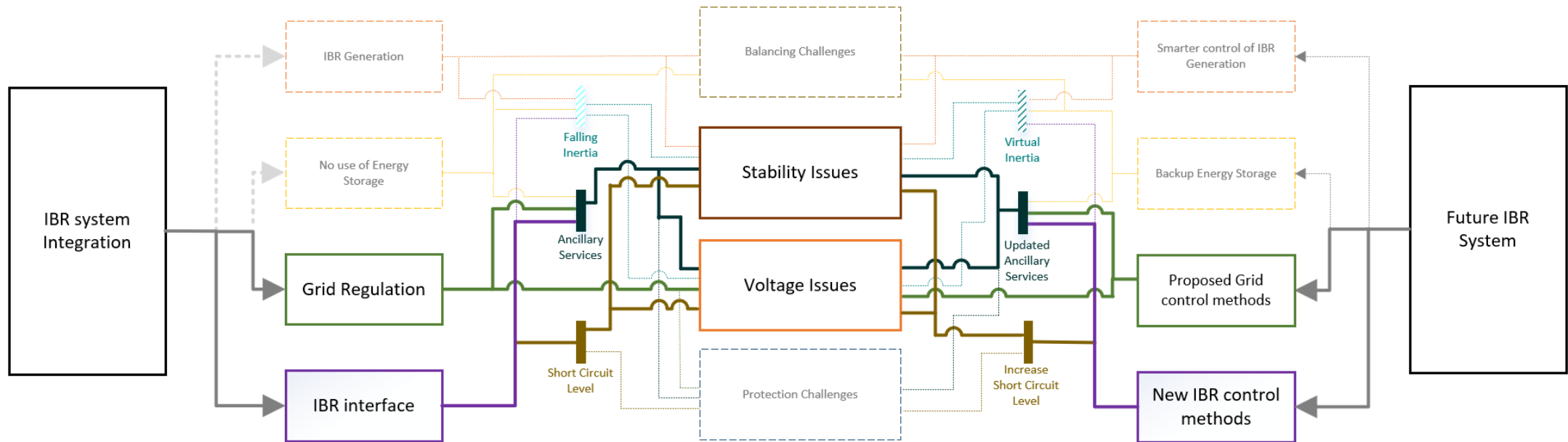


Figure 1. Voltage and Stability Implications.



System Model

- Grid Forming Inverter operates as a voltage source
- Reaching maximum capacity became uncontrollable voltage source not aligned with dq-frame
- Optimal Voltage Support has been used for improved voltage profile during a fault

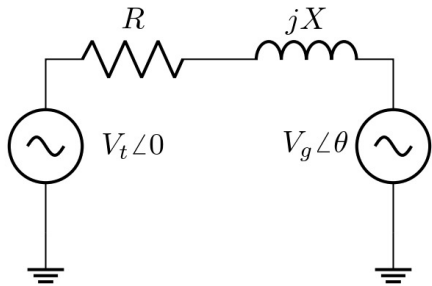


Figure 2. Independent voltage source

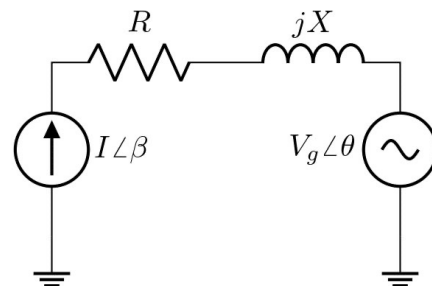


Figure 3. Current source with saturated current

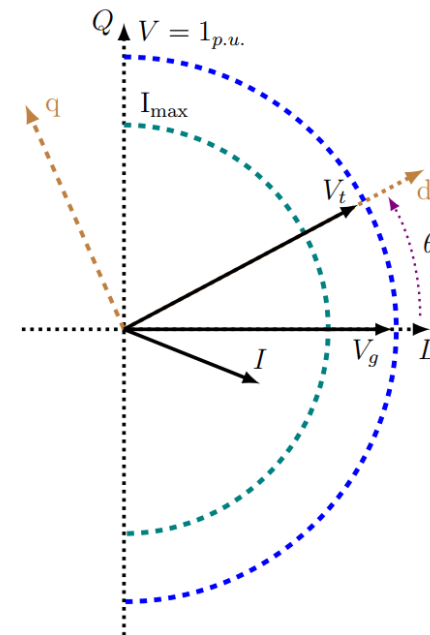


Figure 4. Phasors on saturated mode

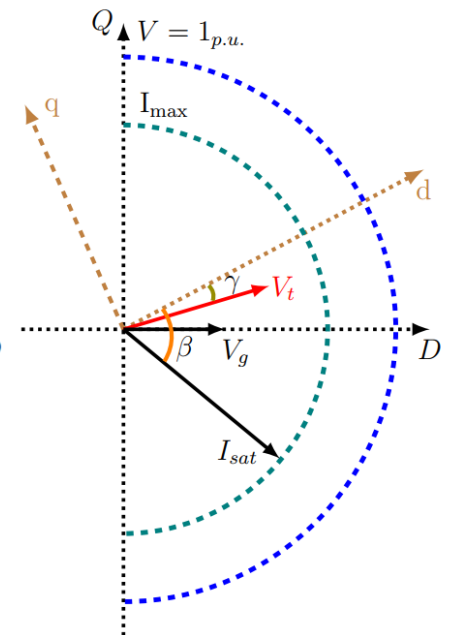


Figure 5. Phasors using OVS



Inverter Schematic and Grid Connection Parameters

Table 1. System Parameters

Parameters	Value
X/R	2 (UG)
V_n	33kV/132kV
I_{max}	1 p.u

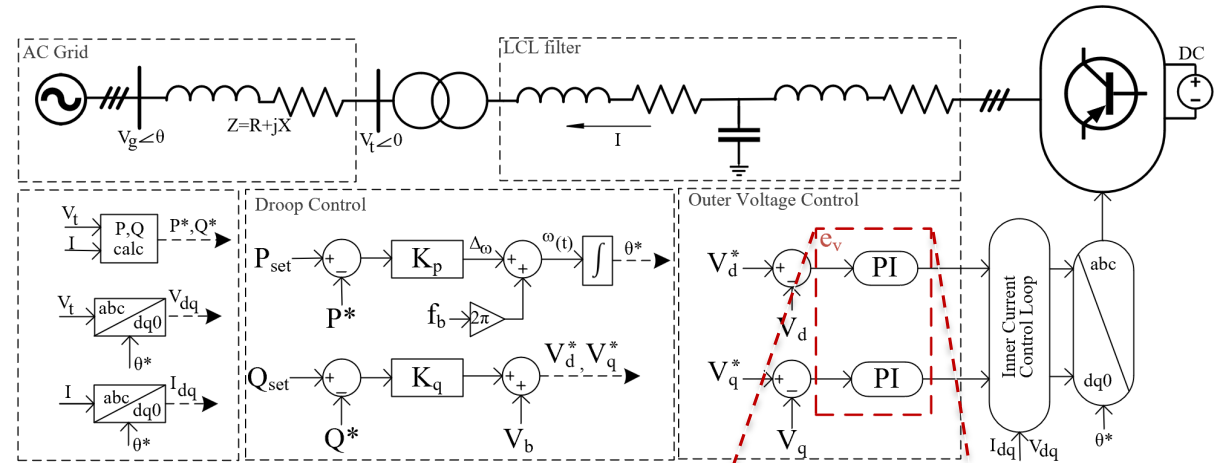


Figure 6. Schematic diagram of a GFM inverter

$$I_d^* = \begin{cases} I_{d,u} = I_{max} \cdot \cos(\rho - \phi) \\ I_{d,\ell}, \text{ otherwise} \end{cases} \quad \forall \sqrt{I_d^2 + I_q^2} = I_{max}$$

$$I_q^* = \begin{cases} I_{q,\ell} = -I_{max} \cdot \sin(\rho - \phi) \\ I_{q,u}, \text{ otherwise} \end{cases} \quad \forall \sqrt{I_d^2 + I_q^2} = I_{max}$$

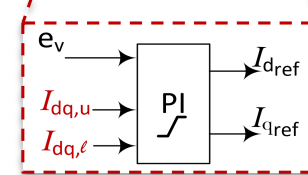


Figure 7. PI limitation technique



Suboptimal-Optimal Voltage Support

Impact on:

- Frequency restoration
- Angle stability
- Power quality issues
- Post fault spikes
- **Grid code cannot be satisfied**

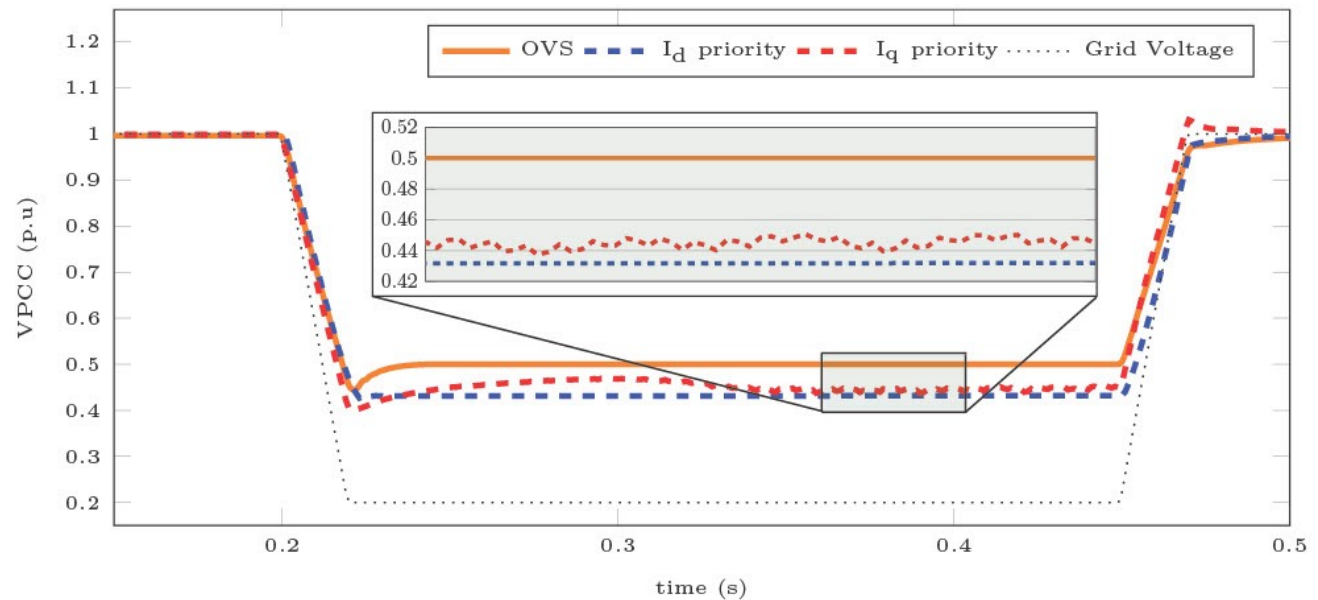
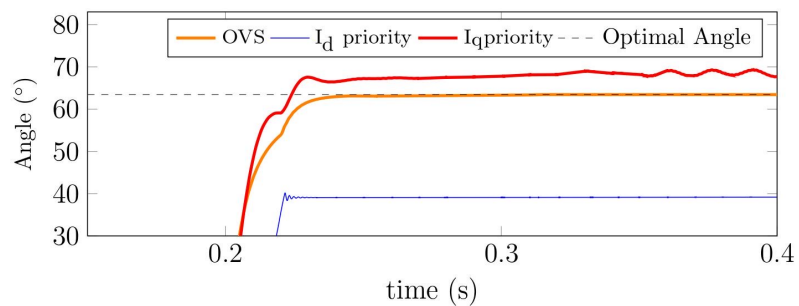


Figure 10. Voltage with Iq and Id priority and OVS.