Paris Session 2022

Considerations for Low Inertia and Short Circuit Level Improvement

Study Committee B4

PS1-2 – Question 1.4

Reduced inertia and short circuit capacity due to large integration of inverter-based power generation

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Considerations for Low Inertia and Short Circuit Level

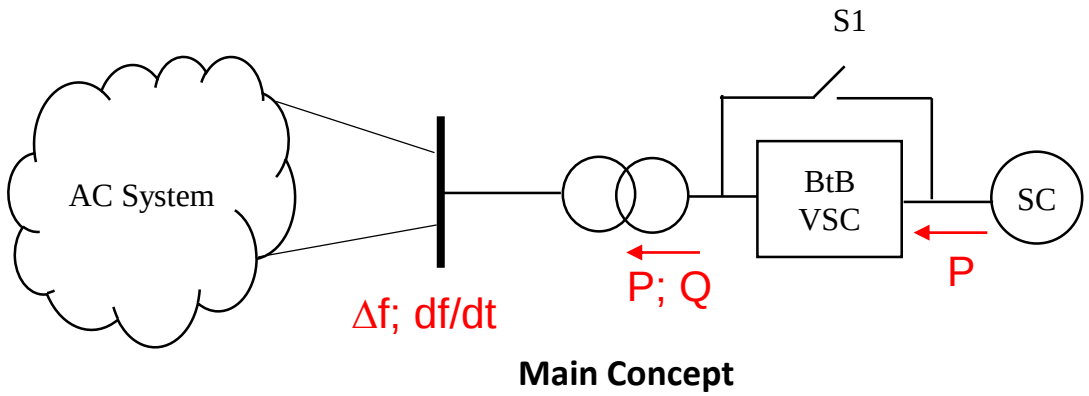
- Syncon provides:
  - Large short circuit current (~3pu) for a short time
  - Inertia

- Syncon limitations
  - In a typical event df/dt is small (<1Hz/s)
    - only a small portion of the machine's stored energy is exchanged with the power system
  - Machine's stored kinetic energy cannot be utilized to support the system frequency
  - Machine inertia opposes the recovery from a frequency event
  - Experiences electromechanical oscillations after a frequency or voltage event
  - Has a slower response compared to power electronic devices such as STATCOM and SVC

Proposed Solution

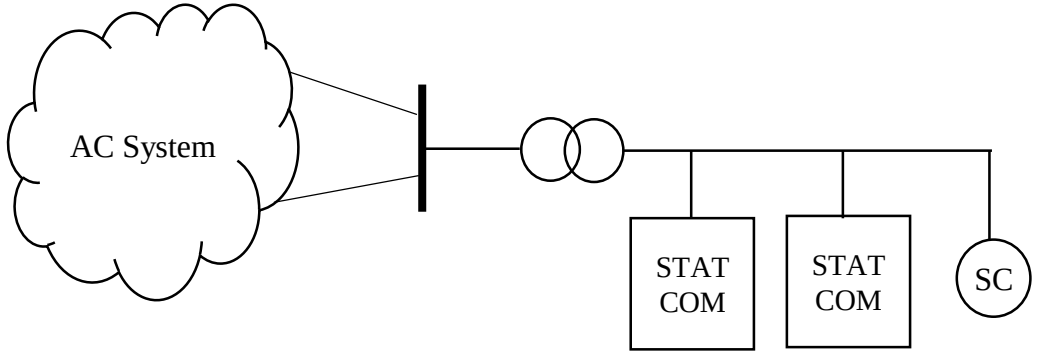
In a voltage event (and steady state)

- S1 is closed and the SC is synchronized to the power system
- Active power order for the BtB is zero
- Equivalent to syncon parallel with two STATCOMs
- Provides reactive power support and large SC current



Main Concept

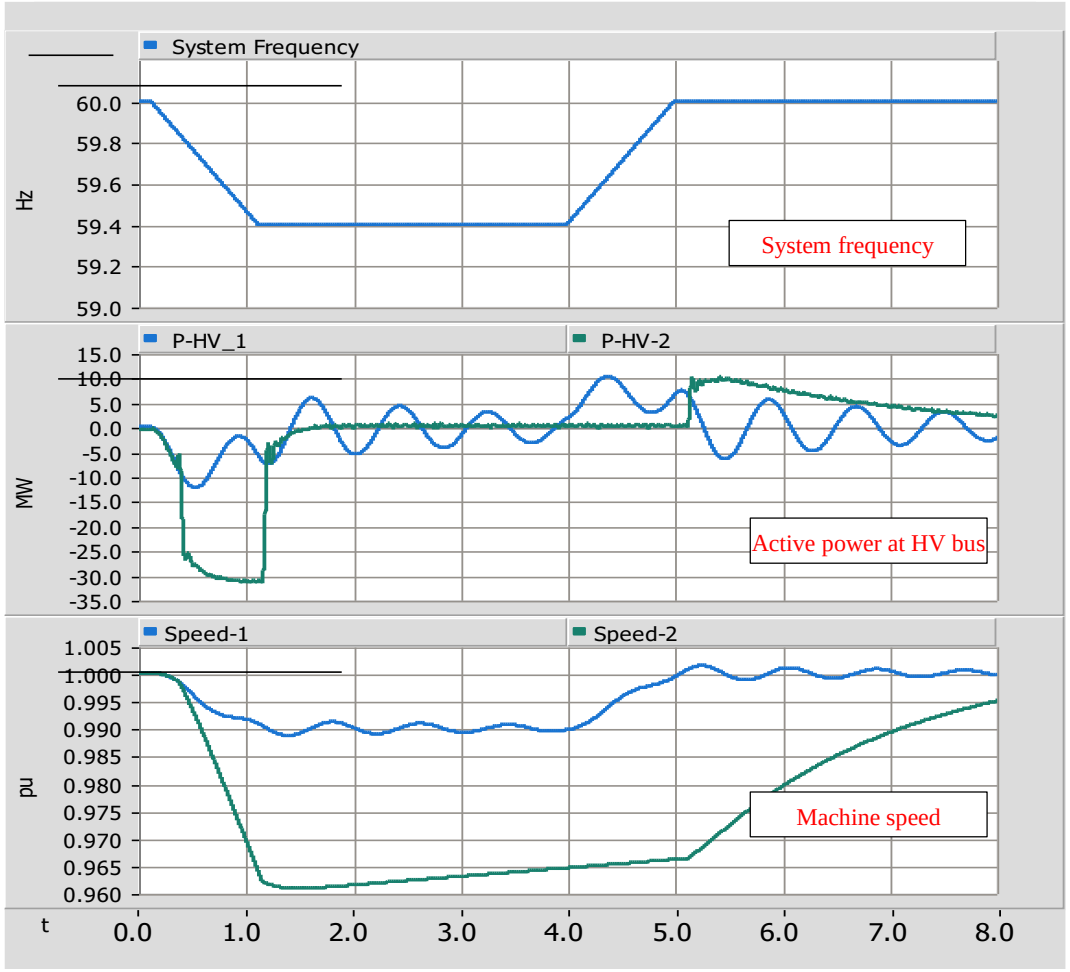
- In a frequency event
  - S1 is opened
  - Machine side converter synchronized to the machine bu
  - Grid side converter continues to synchronize to the grid
  - Pref = K1 . Δf + K2 df/dt
  - **Provides inertia AND fast frequency support**
  - Use of BtB allows larger amount of the kinetic energy to be extracted from the SC



Steady state equivalent

Comparison to Standalone Syncon

Response to 1% drop in system frequency at a rate of 1% per second



Blue: Standalone SC; Green: Proposed solution

- **Standalone SC:**
  - provides/absorbs 6.5MW active power during the frequency ramps
  - Oscillatory power
- **Proposed Solution:**
  - Pref = K1 . Δf + K2 df/dt
  - In this case K1=0 → SC provides pure inertia
  - **Apparent inertia 5 times the machine inertia**
  - No oscillatory response
  - K2 set to zero during recovery to allow faster recover of frequency

Conclusions

Comparison of the proposed solution to standalone SC

- In steady state provides considerably higher reactive power support
- During voltage events provides higher short circuit current
- Provides fast dynamic response upon fault recovery
- In a frequency event can provide much higher inertia
- Can provide short term frequency support in a fast and controlled manner
- Does not oppose frequency restoration
- P and Q outputs are not oscillatory
- Capability of Power Oscillation Damping through both P and Q