Multi-functional Inverter of Microgrids

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Intruductions

The main activities of TJPU’s Microgrid Laboratory focus on control and stability analysis of Microgrids. Multifunctional inverters of Microgrids is defined to provide UPS, reactive power compensation, harmonic suppression, frequency auxiliary regulation, power quality improvement and so on that can help to improve the supply reliability, power quality, economy of the users, and a friendly interaction with the grid. A hierarchical control strategy is usually employed to achieve the multi-functions if the system has different operation modes. When the Microgrid is grid-connected, multifunctional inverters can supply the reactive power compensation, harmonic suppression, frequency auxiliary regulation and power quality improvement. When the grid fails, it can provides short time UPS function for users; When the Microgrid is islanded, it can realize the no difference regulation of the Microgrid frequency and voltage.

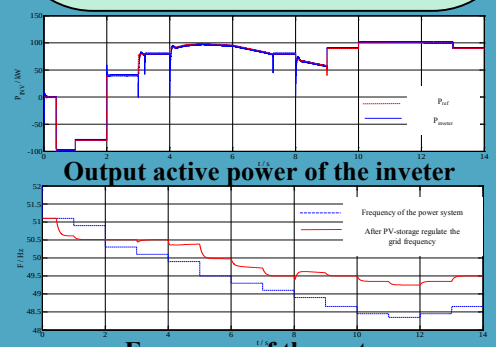
Grid-connected Microgrids

1.Grid auxiliary frequency regulation：PV System with energy storage system as a frequency regulation plant to participate the grid frequency regulation.

Mode1:$f > F_N+\Delta F$ ⟹ $P_{ref} < 0$

Mode2:$f < F_N-\Delta F$ ⟹ $P_{ref}= P_{mpp}+P_{bat}$

Mode:$F_N-\Delta F \geq f \cong F_N+\Delta F$ ⟹ $P_{ref} =P_{mpp}$



2.Power factor improvement of PCC.

Mode1:$\cos\varphi > \cos\varphi_o$ $P_{ref}=P_{mpp}$

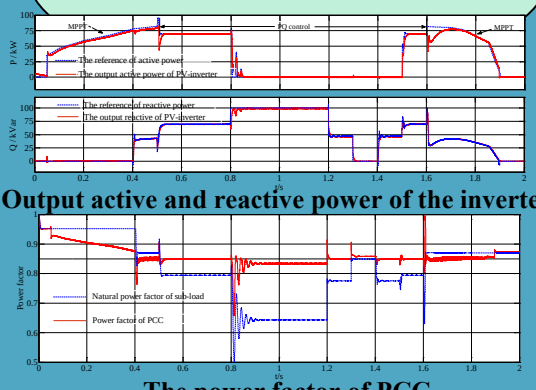
Mode2:$\cos\varphi < \cos\varphi_o$

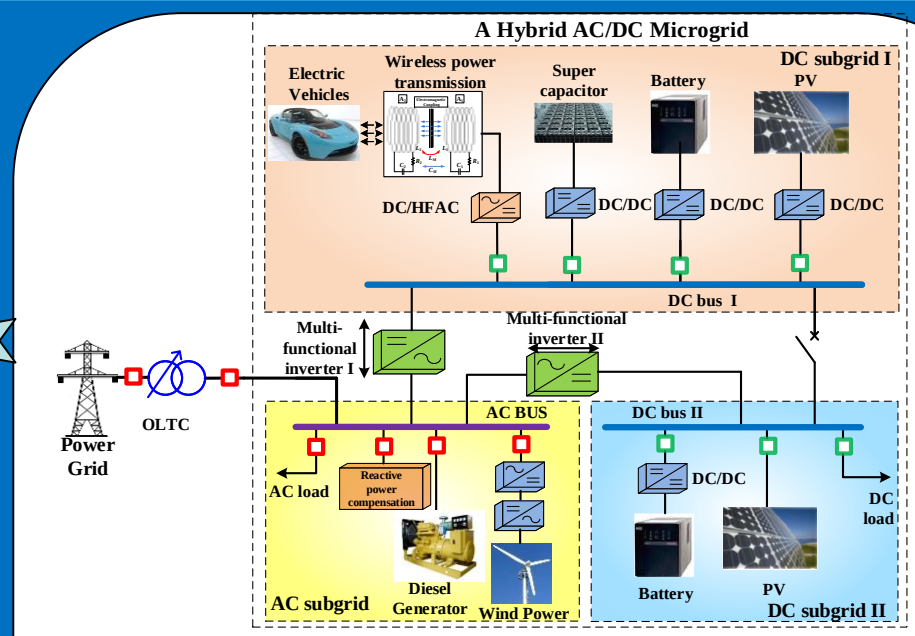
case1: $\sqrt{S_N^2 - P_{mpp}^2} \geq Q_{need}$ $P_{ref}=P_{mpp}$ & $Q_{ref} = Q_{need}$

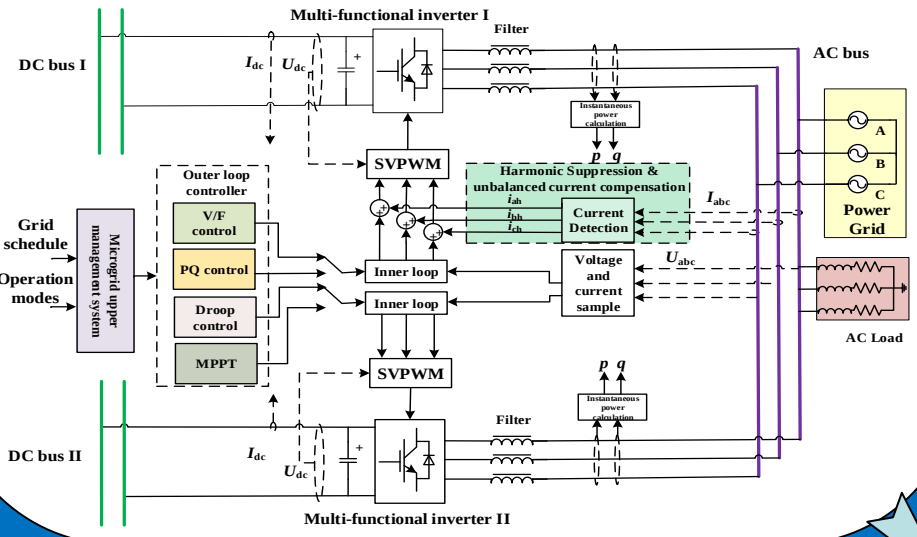
case2: $\sqrt{S_N^2 - P_{mpp}^2} < Q_{need}$ $P_{ref} < P_{mpp}$ & $Q_{ref}=Q_{need}$

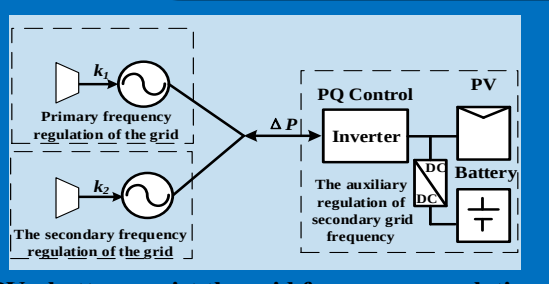
case3: $S_N < Q_{need}$ $P_{ref}= 0$ & $Q_{ref}= S_N$

Mode3:$\cos\varphi < \cos\varphi_o$ & $P_{pv}<10$ kW $P_{ref}= 0$ & $Q_{ref}=Q_{need}$ $Q_{need} < S_N$

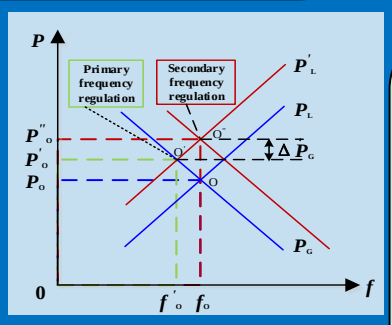


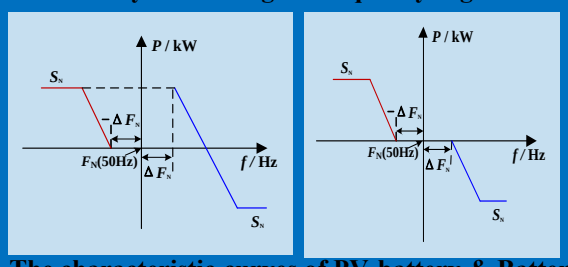






PV - battery assist the grid frequency regulation





Islanded Microgrids

6. Microgrid no difference frequency regulation.

Mode1:$f > F_N+\Delta F$ $P_{ref} < 0$

Mode2:$f < F_N-\Delta F$ ⟹ $P_{ref}= P_{mpp}+P_{bat}$ ⟹

Mode:$F_N-\Delta F \geq f \cong F_N+\Delta F$ $P_{ref}=P_{mpp}$ ⟹

5.Voltage and reactive power regulation：

1 Providing reactive compensation for mico-grid;

2 Based on the micro-grid droop control, achieve the regulation of voltage without difference.

4.Harmonic suppression：

1 Detecting harmonic current of the load;

2 The grid or micro-sources power supply at unity power factor.

3. UPS：when the grid fails, it can provides short time UPS function for the users.

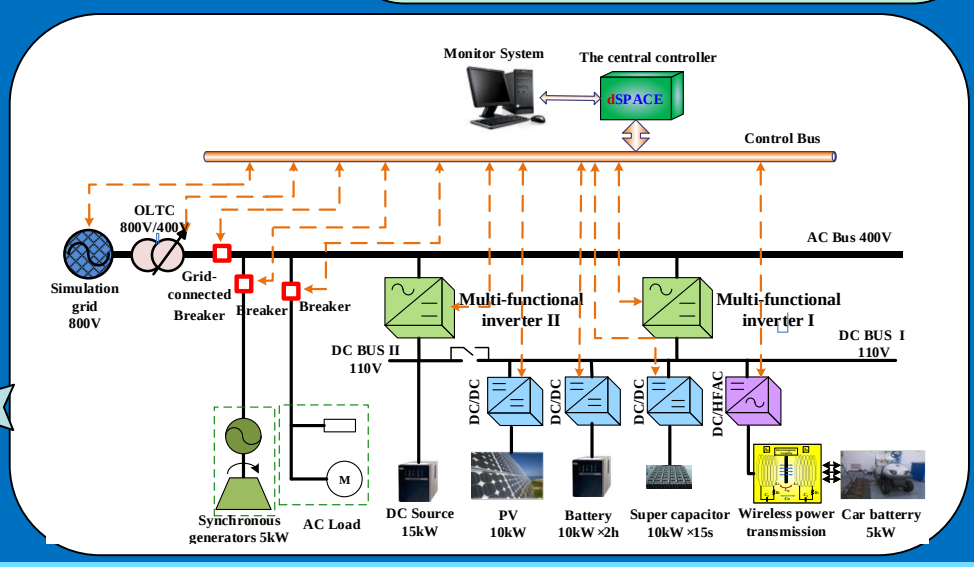
Mode1: $P_{pv}+P_{bat} > P_L$

case1: $P_{pv} > P_L$ ⟹ $P_{pv}=P_L+P_{bat}$

case2: $P_{pv} \leq P_L$ ⟹ $P_{pv}=P_L+P_{bat}$

Mode2: $P_{pv} \leq 10$ kW ⟹ $P_L = P_{bat}$

Mode3:$V_{bat} < V_{max}$ ⟹ System stop



A Hybrid AC/DC Microgrid System:

1. Hybrid AC/DC Microgrid with EV wireless charging system.
2. Central monitoring system of the test system based on the dSPACE;
3. Multi-functional inverter and its hierarchical control strategy;
4. Diffrent control strategies for multiple inverter parallel;
5. Diffrent control strategies of multiple DC/DC parallel and DC bus voltage control;

References:

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