

Questions

Q1: Are you controlling the node voltage at $v_1/v_2/v_3$, respectively? When you connect VSCs in parallel, are they going fight each other? Or if there is some impedance between where your VSCs are controlling to the interconnection point?

- The primary GFM controls are modulating the voltage behind the output filter impedance. Accordingly, there is some impedance between the GFM inverters which acts to limit current flows when connecting units that are initialized with differing voltages. The presence of droop function (active power versus frequency and reactive power versus voltage) prevents the units from fighting against one another and ensures they settle to a condition where circulating reactive currents are small, power is shared, and the system frequency is stable.

Q2: Could you please explain why for VSM GFM control method requires PLL?

- This PLL is used to estimate the grid frequency such that the damping term, which is proportional to the grid-frequency deviation, can be included within the VSM swing equation. This term is optional and is often excluded from VSM implementations.

Q3: I'm wondering is the necessity of PLL the fundamental difference between GFL and GFM? If not, what's the fundamental difference between GFL and GFM?

- I think the most meaningful way to define GFM is to define it in terms of the ability of the inverter to carry out all of the following functions: i) operate while islanded, ii) operate grid-connected, and iii) carry out power sharing when connected in parallel with other GFM units. It is possible to design an inverter which has a PLL and is capable of executing these functions. In other words, I consider GFM as a functional attribute that is independent of whether the controller has a PLL.

Q4: Could you please share your knowledge on GFM inverter connected to the zero inertia load?

- Most of our experiments are with passive RL loads which do not have mechanical inertia. Having said that, I have conducted experiments with mechanical loads as well as nonlinear loads. In general, the GFM inverters can accommodate any of these load types.