Supercapacitor Energy Storage System for PV Applications

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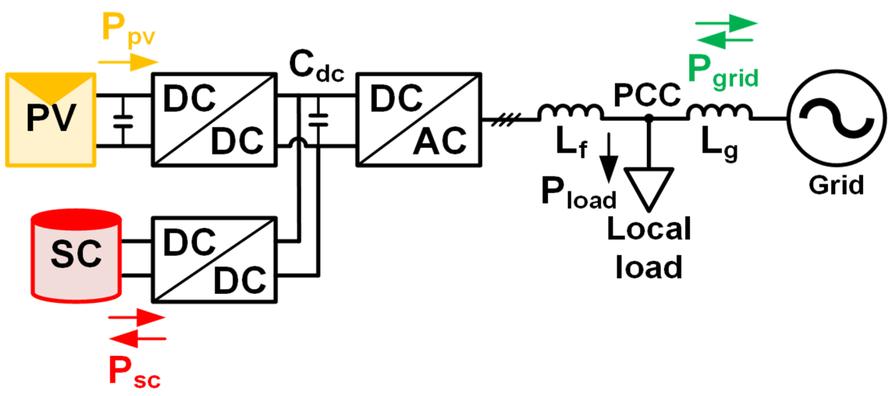
BACKGROUND

- Supercapacitor (SC) is used as a short-term energy storage for PV system.
- SC helps PV system to provide grid ancillary services during severe grid disturbances.
- PV with SC system can stay connected to the grid without curtailing the PV power output.

OBJECTIVE

- To demonstrate the SC capabilities to support the PV system in hardware testbed (HTB).

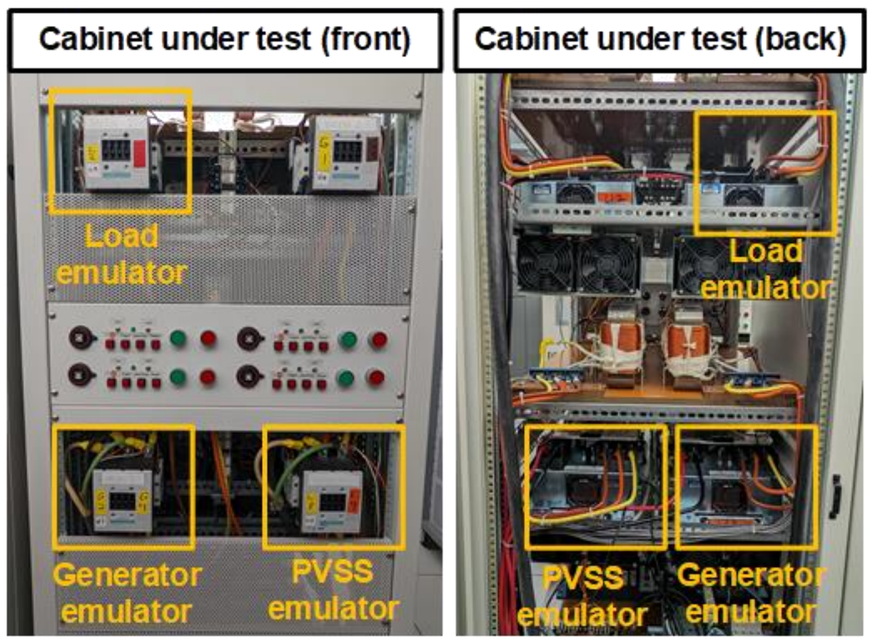
GRID-CONNECTED PV WITH SUPERCAPACITOR SYSTEM



Schematic of a grid-connected photovoltaic with supercapacitor system (PVSS).

Table I. Supercapacitor's Parameters.

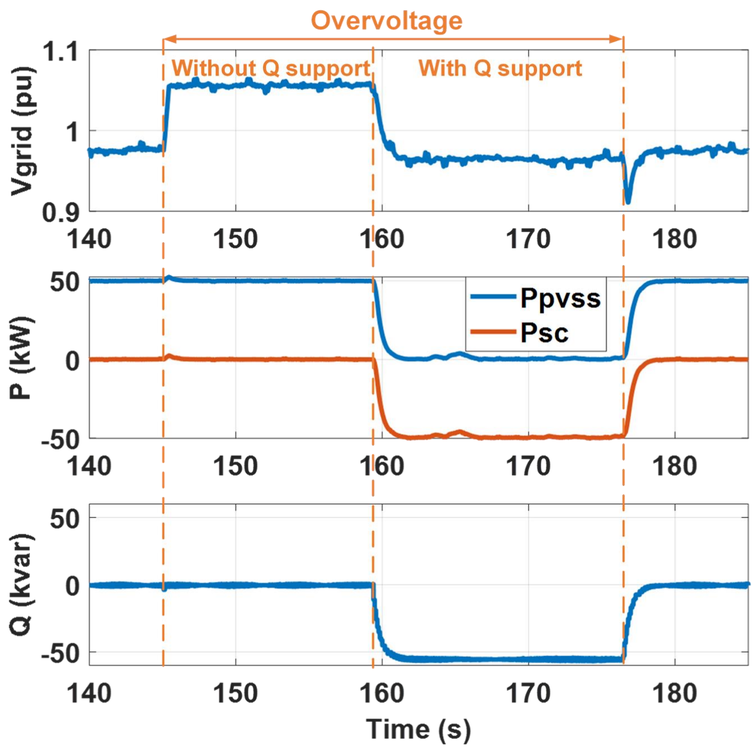
Parameters	Values
Usable energy capacity	0.35 kWh
Usable power capacity	63.18 kW
Number of series (Ns)	180
Number of parallel (Np)	1
Voltage rating (V)	480 V



Experimental test setup on the HTB.

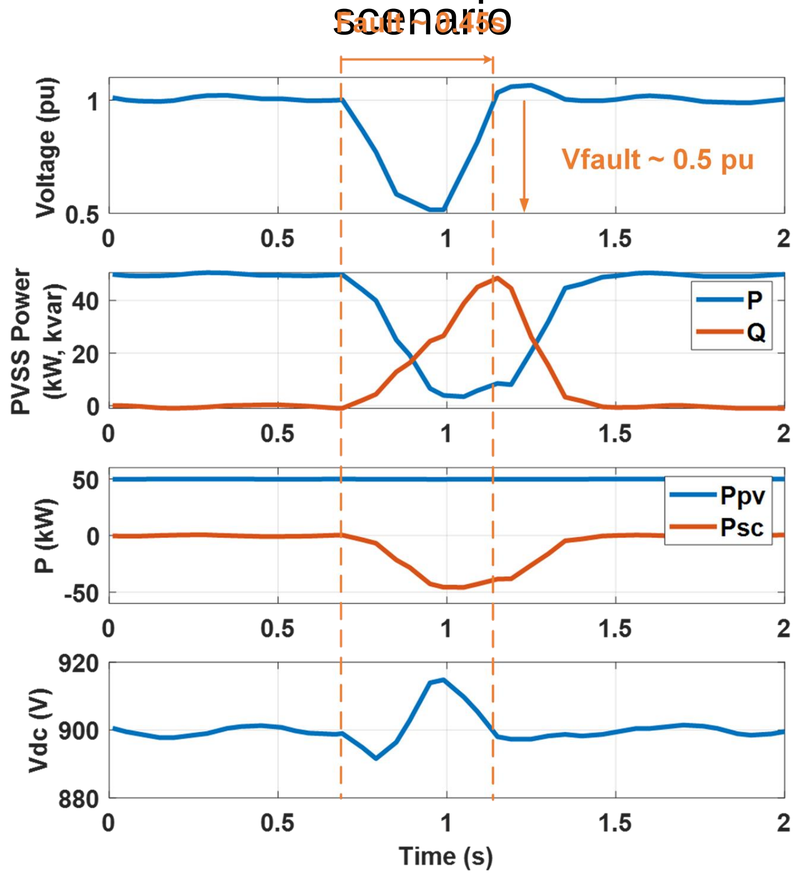
SUPERCAPACITOR CAPABILITIES UNDER SHORT-TERM GRID DISTURBANCES

Overvoltage scenario



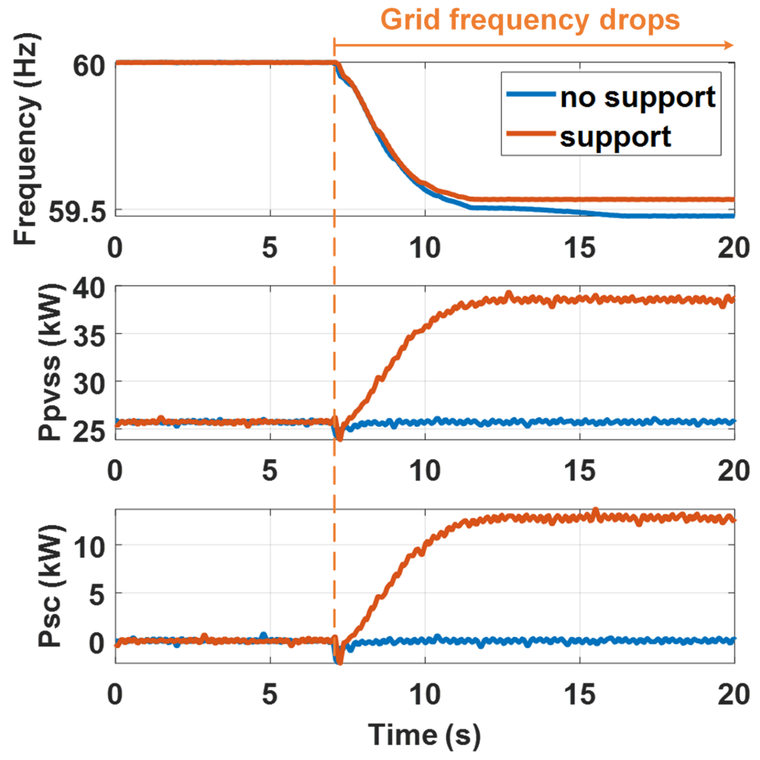
- SC absorbs PV power to make room for the reactive power support.
- The absorbed power in the SC can be injected back to the grid when the grid returns to normal condition.

Low voltage ride through (LVRT) scenario



- SC absorbs PV power during LVRT event when the grid voltage is low.
- A fast SC response can improve PV system stability.
- PV system can stay connected to the grid while providing reactive power support without PV power curtailment.

Frequency support scenario



- SC injects active power to reduce the frequency nadir of the underfrequency event.
- SC can absorb active power to reduce power generation on the grid during overfrequency event.

CONCLUSION

- Grid-connected PV with SC system can safely operate under severe disturbances while providing support to the system.
- PV system can operate in MPP mode during the disturbances.
- SC can maintain the dc-link voltage stability of the PV system due to its quick response time.