Active DC Bus Signaling Control Method for Coordinating Multiple Energy Storage Devices in DC Microgrids

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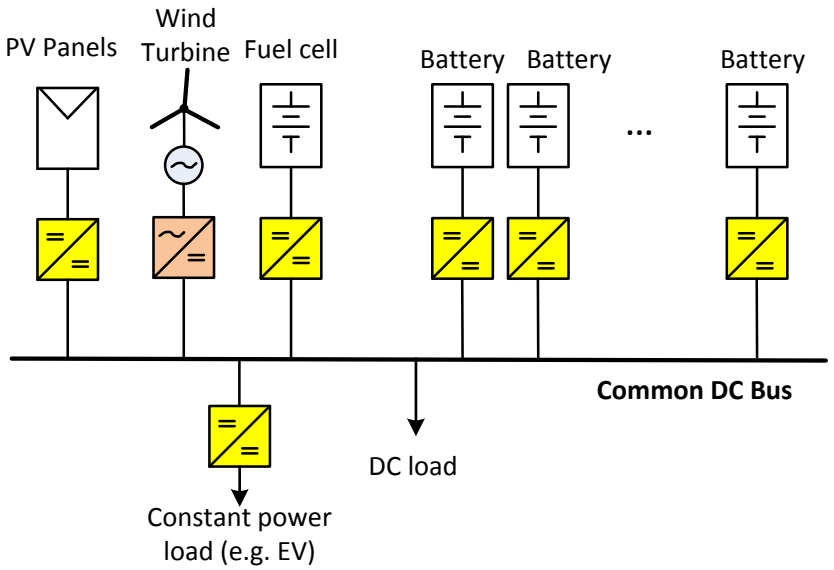
Introductions

- A DC Microgrid?
- Advantages?
- How to operate?

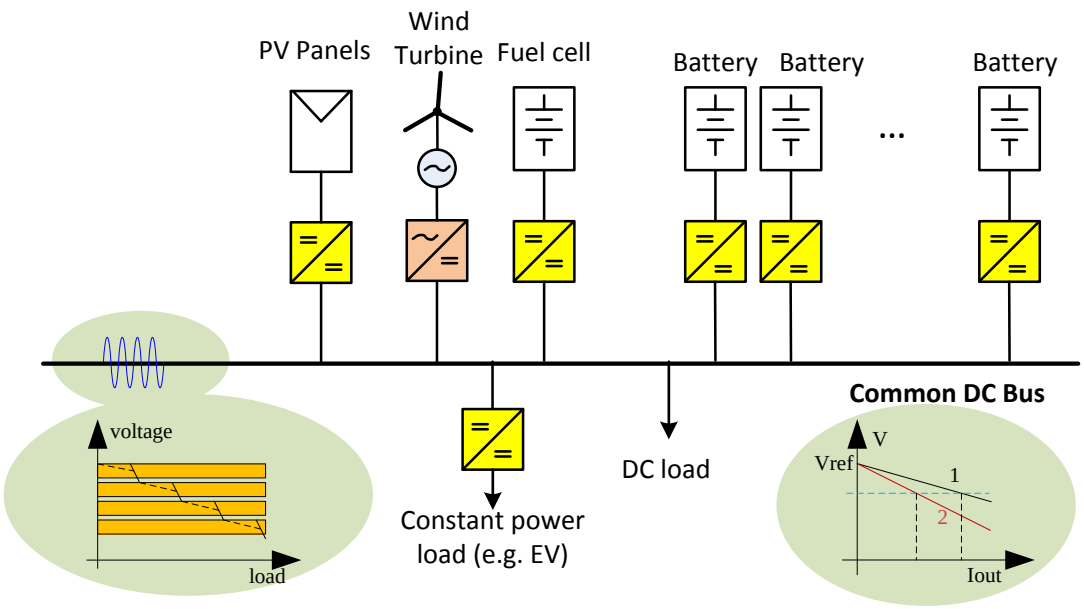


A typical configuration of DC Microgrid with single DC bus

Introductions

Control strategies

- Centralized
- Decentralized
  - Droop control
  - DC bus signaling
  - Power line communication
- Distributed

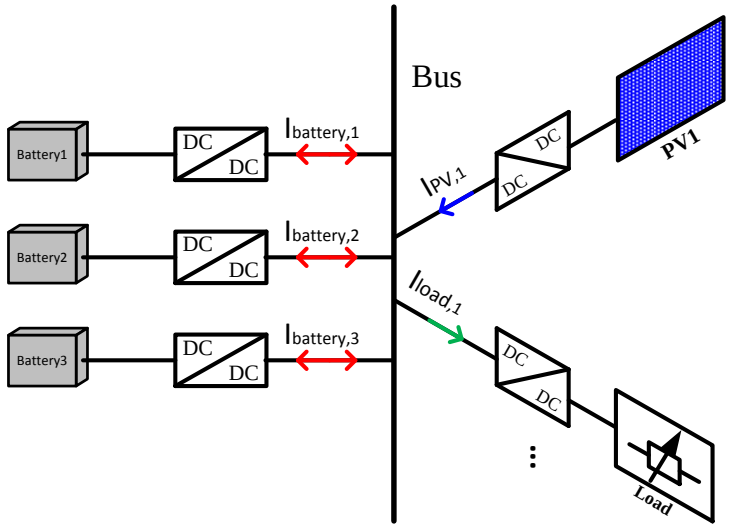


Control methods in DC microgrids

Explanations of Proposed Method

- Proposed method
  - Active DC bus signaling
  - Master-Slave based

- Battery1 → master
- Battery2 → slave1
- Battery3 → slave2

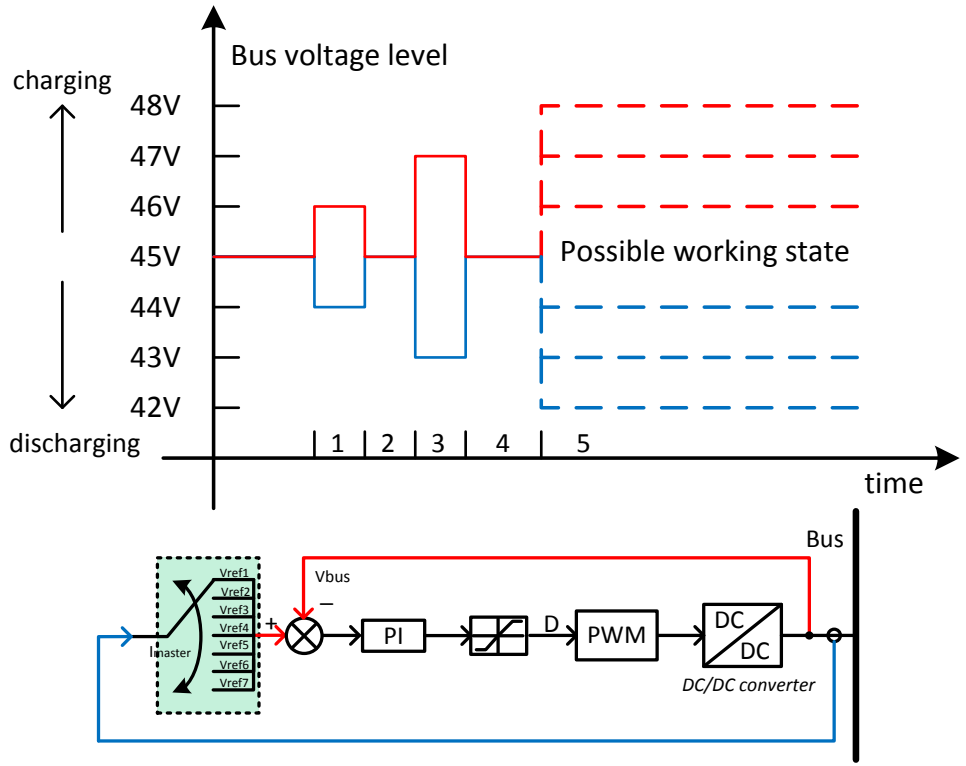


Configuration of proposed method

$$\mp I_{b1} = I_{PV} - I_{l} \pm I_{b2} \pm I_{b3}$$

Explanations of Proposed Method

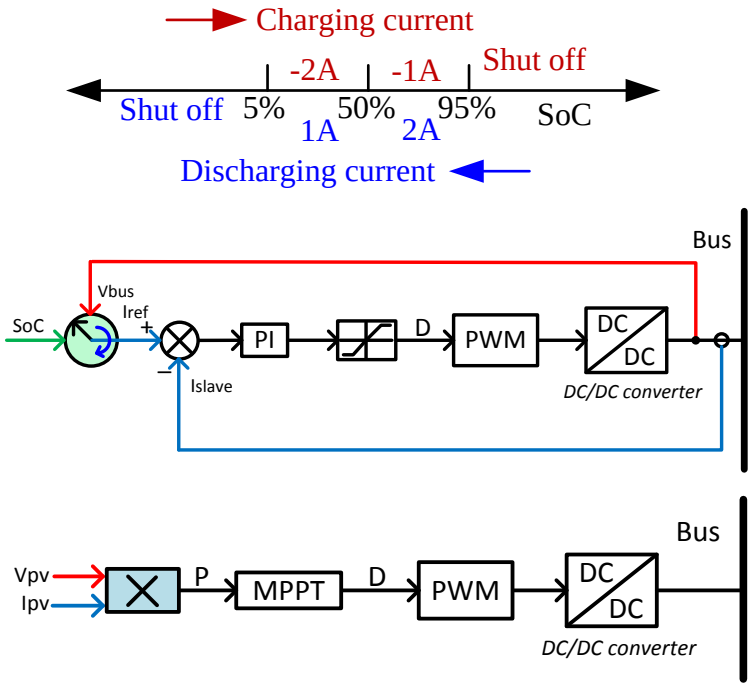
- Master module
  - Voltage mode
  - Active period: 1-4
  - Decision-making:5
- 46V, 44V for slave 1
- 47V, 43V for slave 2
- 48V, 42V for both



Analysis and control block of master module

Explanations of Proposed Method

- Slave module
  - Current mode
- SoC↗, I_{charge}↘, $I_{discharge}$↗
- SoC↘, I_{charge}↗, $I_{discharge}$↘
- Charging and discharging ability
- PV → MPPT mode

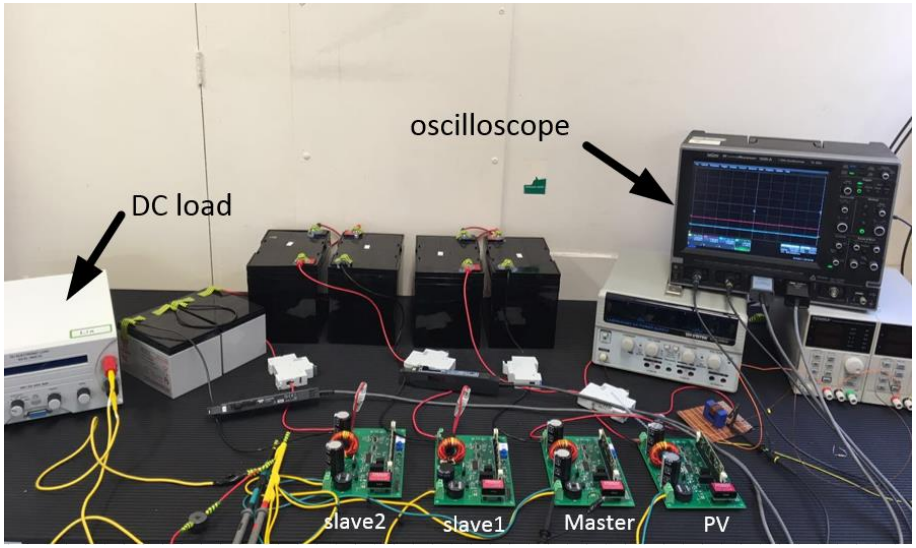


Analysis and control block of slave module

Experimental Evaluation

- Experimental setup

	Specifications	
	Type	Quantity
PV emulator	62050H-600S	1
Battery	YPC33-12	4
Battery	NP12-12	2
DC load	EA-EL 3400-25	1
Boost converter	200W*1	4



Experimental setup

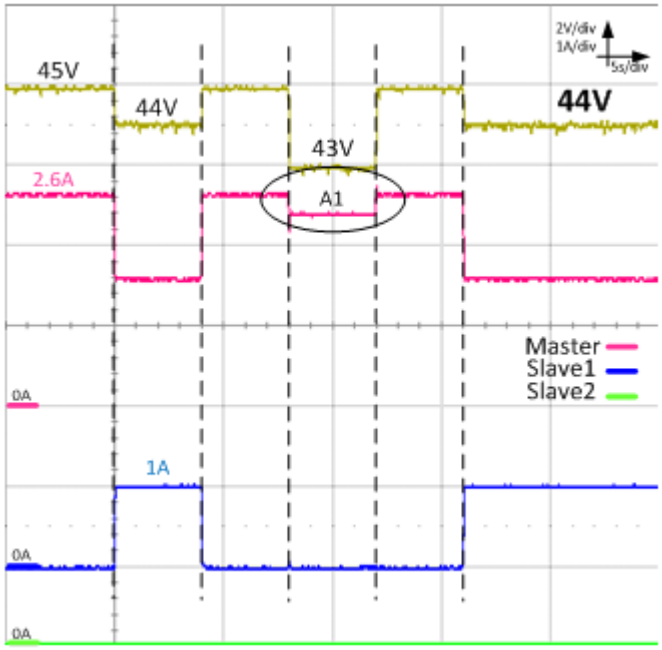
Experimental Results

	Discharging			Charging		
Bus voltage	44V	43V	42V	46V	47V	48V
SoC	S1>S2	S1<S2		S1<S2	S1>S2	
State	S1 ON S2 OFF	S2 ON S1 OFF	Both	S1 ON S2 OFF	S2 ON S1 OFF	Both
Active current	S1 1A S2 0A	S1 1A S2 2A	S1 1A S2 1A	S1 1A S2 0A	S1 1A S2 2A	S1 1A S2 0A
Working current	S1 1A	S2 2A	S1 1A S2 1A	S1 1A	S2 2A	S1 1A S2 0A

Note: Slave1=S1; Slave2=S2

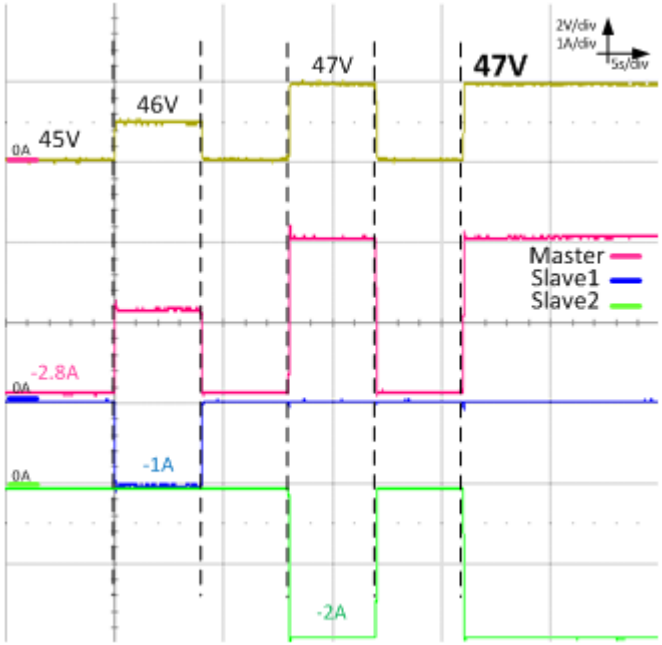
Experimental Results

- SoC1>SoC2
  - SoC1: 5%~50%
  - SoC2: low → off
- Discharging
  - Slave1 ON
  - 44V



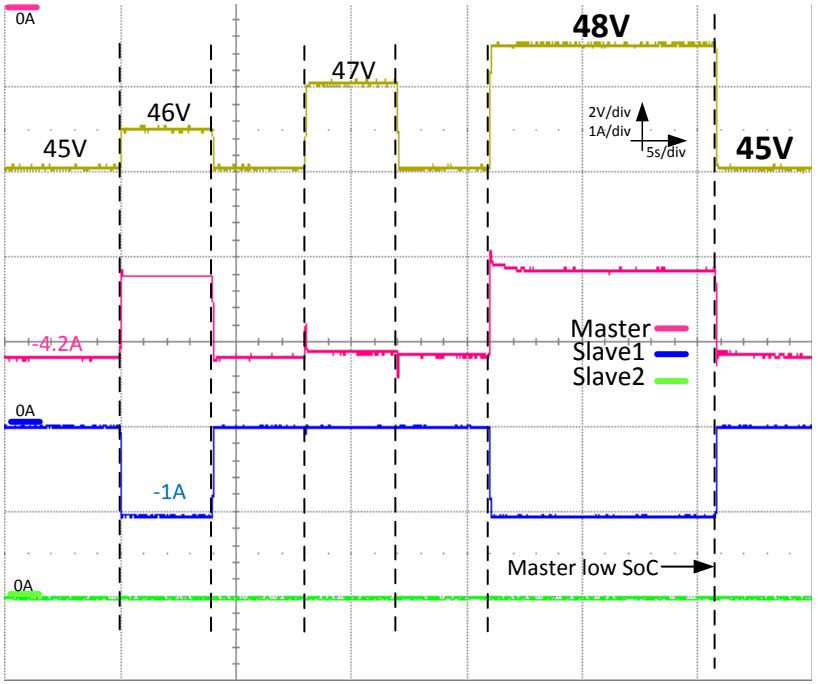
Experimental Results

- SoC2 < SoC1
  - SoC1:50%~95%
  - SoC2:<50%
- Charging
  - Slave2 ON
  - 47V



Experimental Results

- Master
  - Low SoC
  - 45V



Conclusions and Future Work

- Conclusions
  - The proposed method was explained and experimentally validated
  - Accurate current sharing and power distribution

Thanks!

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