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

Fulong Li
lif12@aston.ac.uk

Aston University
Engineering & Applied Science

International Conference on DC Microgrids

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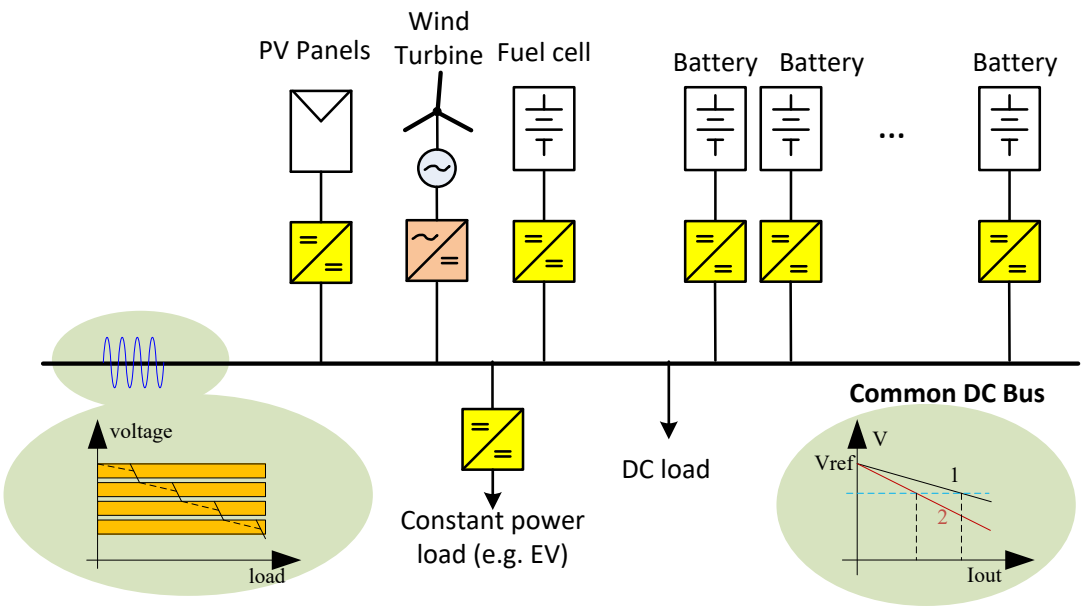
Introductions

Control strategies

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

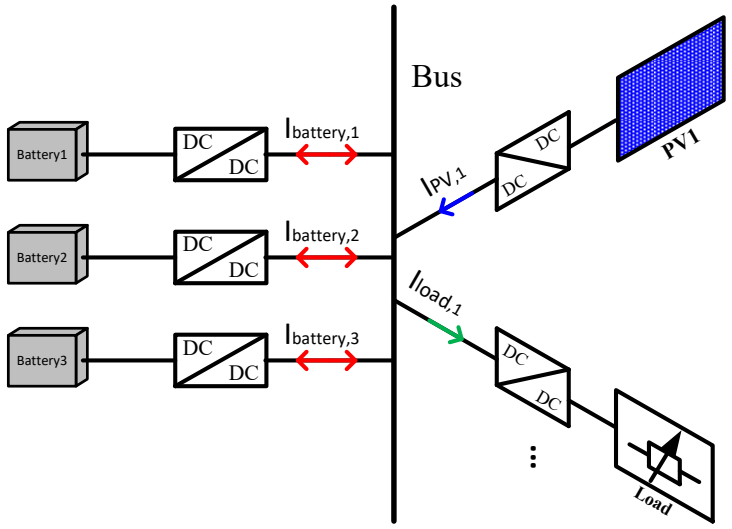


Control methods in DC microgrids

Explanations of Proposed Method

- Proposed method
  - Master-Slave based
- Battery1 → master
- Battery2 → slave1
- Battery3 → slave2

The DC bus voltage is actively controlled by the master controller for information collection

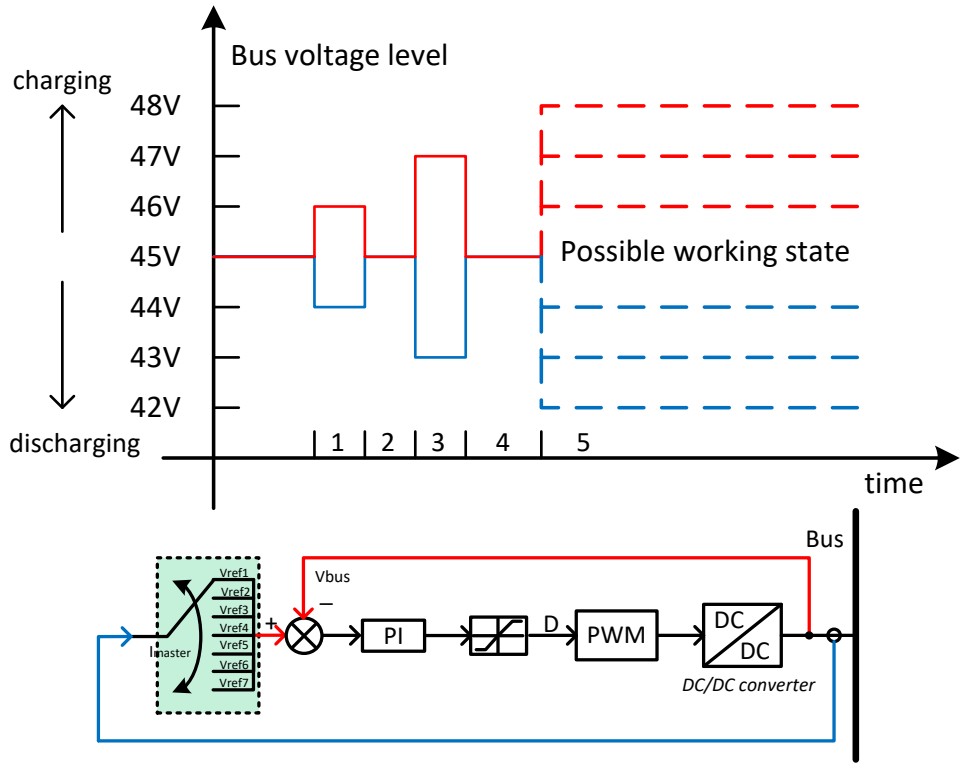


Configuration of proposed method

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

Explanations of Proposed Method

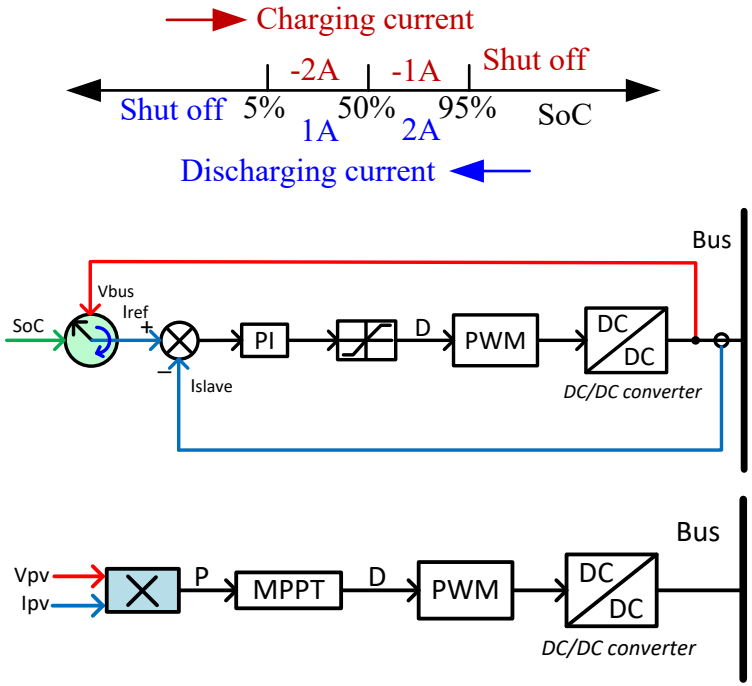
- Master module
  - Voltage mode
  - Active period: 1-4
  - Decision-making: 5
- 46V, 44V for slave 1 charging /discharging
- 47V, 43V for slave 2 charging/discharging
- 48V, 42V for both



Analysis and control block of master module

Explanations of Proposed Method

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

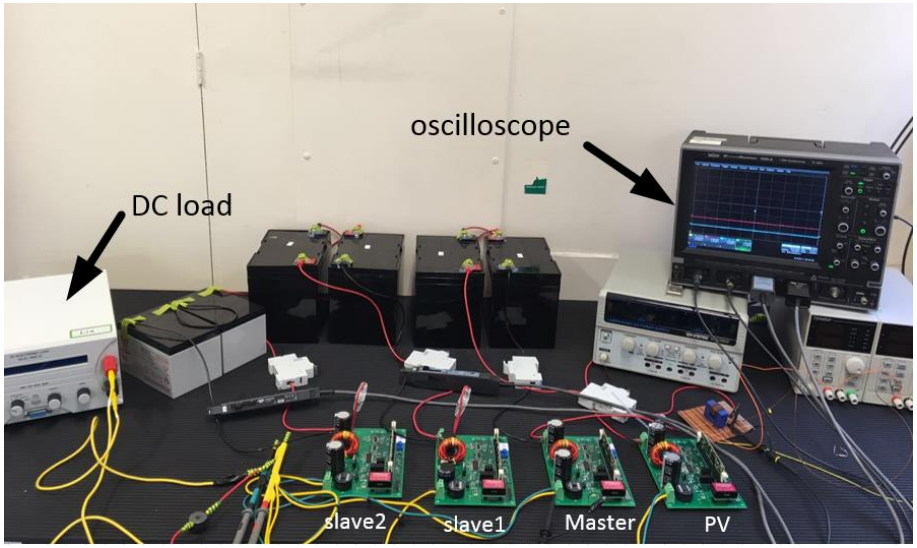


Analysis and control block of slave module

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

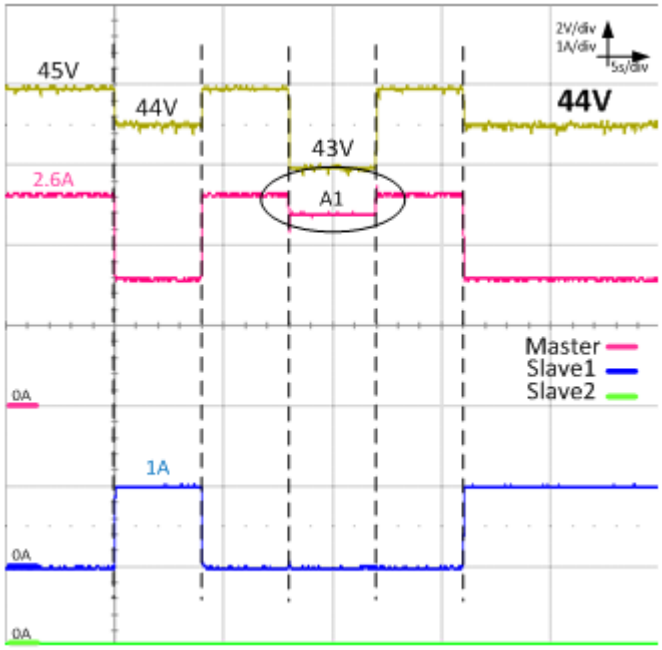
Experimental Results

	Discharging				Charging		
Bus voltage	44V	43V	42V	45V	46V	47V	48V
SoC	S1>S2	S1<S2			S1<S2	S1>S2	
State	S1 ON S2 OFF	S2 ON S1 OFF	Both	S1 OFF S2 OFF	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 0A S2 0A	S1 1A	S2 2A	S1 1A S2 0A

Note: Slave1=S1; Slave2=S2

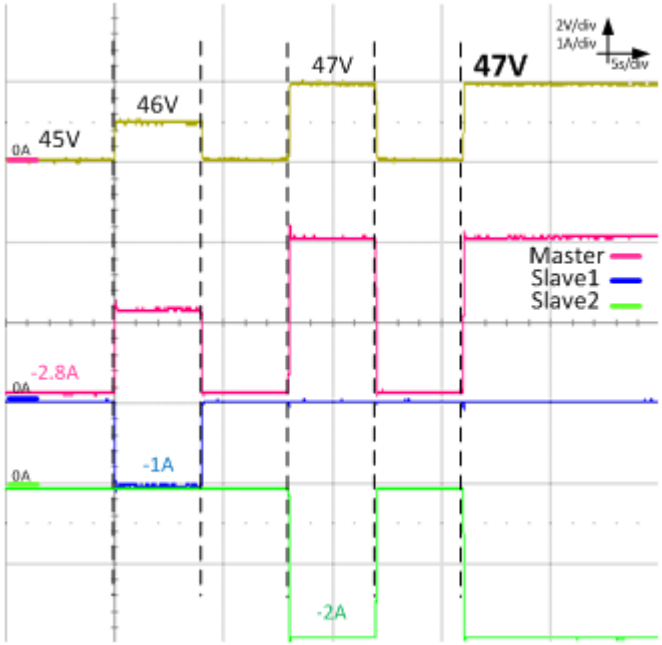
Experimental Results

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



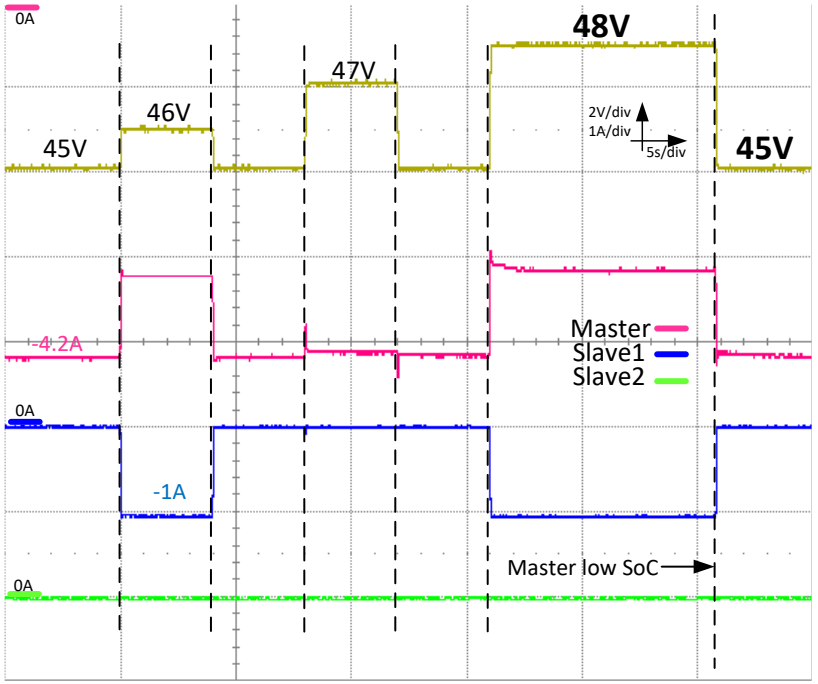
Experimental Results

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



Experimental Results

- Master
  - Low SoC
  - 45V



Conclusions

- Conclusions
  - An active DC bus signalling method was proposed for DC microgrid
  - The proposed method has been experimentally validated
  - Accurate current sharing and power distribution

Thanks!

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