A Review of DC Bus Signalling Control Methods in DC Microgrids

Fulong Li, Zhengyu Lin, Haoge Xu, Ruichi Wang

Loughborough University

fulong.li@ieee.org

Loughborough University

IEEE PEAC 2022

The 3rd IEEE International Power Electronics and Application Conference

1. Background

DC microgrids has been proposed to adopt more renewable energy sources in future smart electric power distribution networks. DC bus signalling is one of the secondary layer control methods that has been widely used in DC microgrids when the communication infrastructure is absent or under failure. It has advantages in regulating specific DC microgrids with countable working states, such as household applications. This method has achieved fast development over the past decades and there is still no existing literature review that classifies and compares those methods. Driven by this idea, this paper provides **a review based on reported DC bus signalling methods** in the IEEE Xplore library.

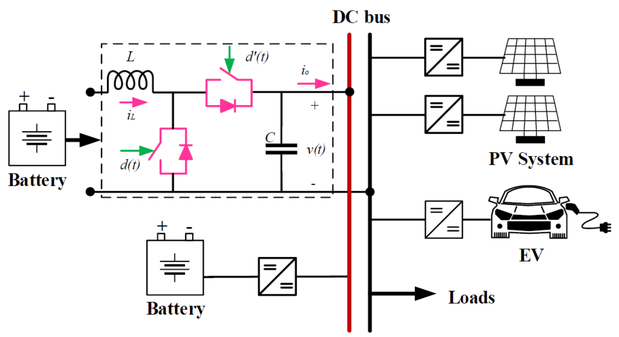

Figure1: A DC microgrid

2. Hierarchical Control

It mainly contains three control layers, which are primary control, secondary control and tertiary control, respectively.

- Power electronics interface converters are the fundamental elements of microgrids. The control of those interface converters forms the primary control, which mainly includes inductor/output current control and output voltage control.
- Secondary control normally includes the DC bus voltage regulation, which is **where DBS methods are implemented and will be the focus of this paper.**
- Communication links are usually needed for the EMS control on the tertiary layer to deliver system control information to the primary and secondary layers.

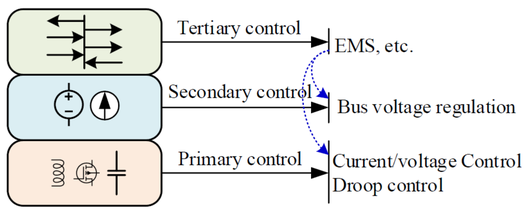

Figure 2: A hierarchical control scheme.

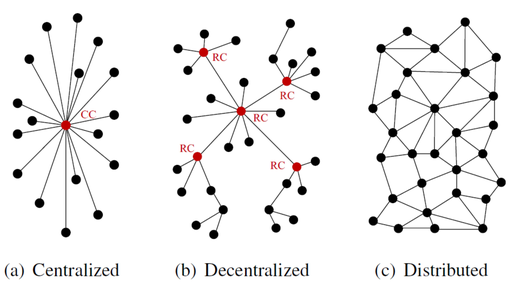

Figure 3. Different control mode with communication links

This work has received funding from the U.K. EPSRC UKRI Innovation Fellowship scheme under grant No. EP/S001662/2

3. DBS Control

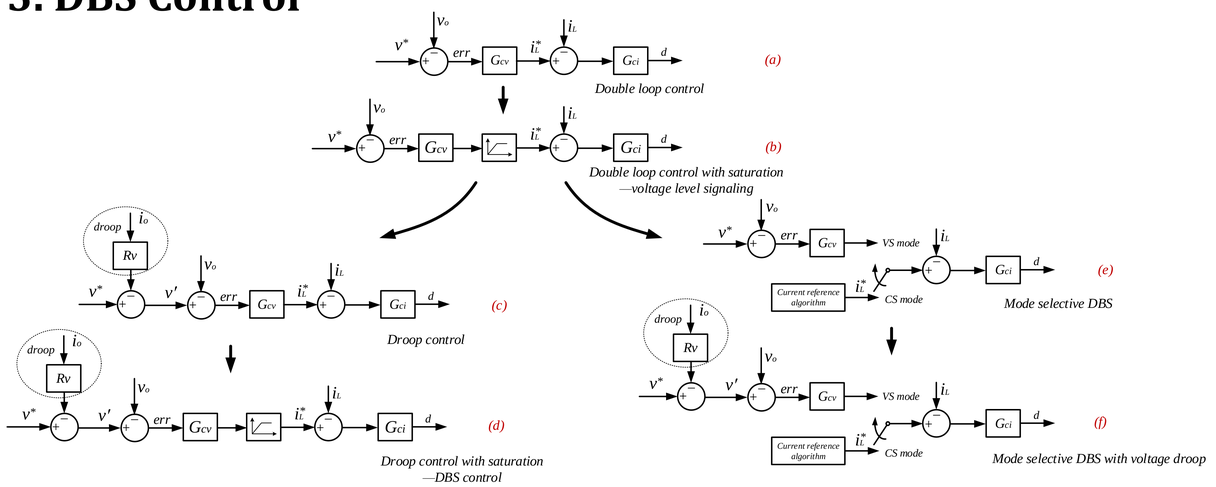

Figure 4 . Formulation of control blocks of DBS methods: (a). conventional double loop control; (b) double loop control with saturation to form conventional voltage level signalling; (c). typical droop control; (d). droop control with saturation to form conventional DBS control; (e). Mode selective DBS control; (f). mode selective DBS control inclusive of voltage droop.

4. DBS Applications

- Battery storage EMS→ SoC
- PV→MPPT, Power scheduling
- Small DC system EMS
- DC system without/with communications infrastructure.
- Potentially DC system security from cyber attack.

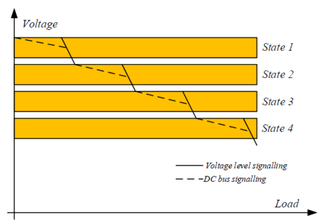

Figure 5. Conventional DBS with defined voltage windows.

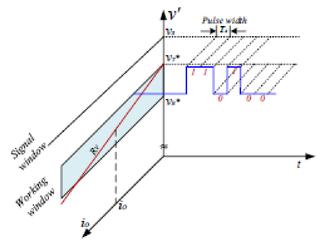

Figure 6. Communicative DBS with protocols.

5. Conclusions

This paper reviewed the DC bus signalling methods applied in the DC microgrids. The **origins, development and applications** of these methods are introduced. The control design and working mechanism are explained in this paper. Finally, their typical applications are introduced and future potentials are pointed out.

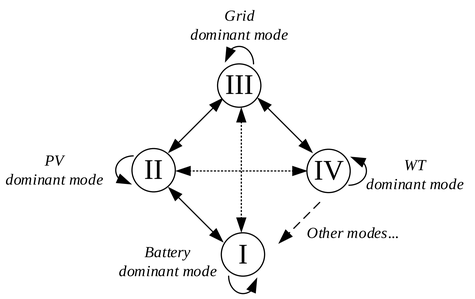

Figure 7. State machine based DBS.