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A stepless-power-reconfigurable converter for a constant current underwater observatory

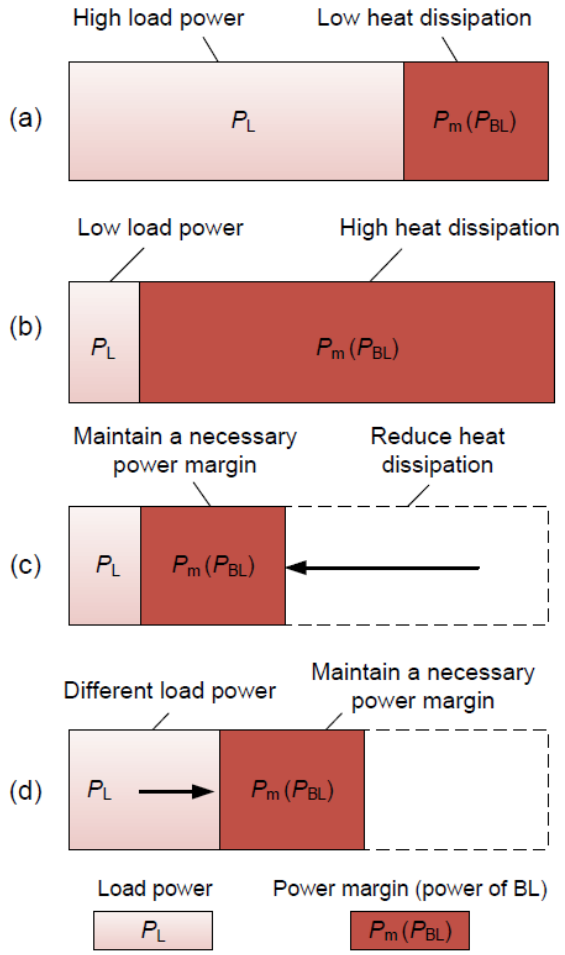
Key words: Constant current to constant voltage (CC/CV) conversion; Shunt regulator; Stepless power configuration; Underwater observatory

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Motivation & main idea

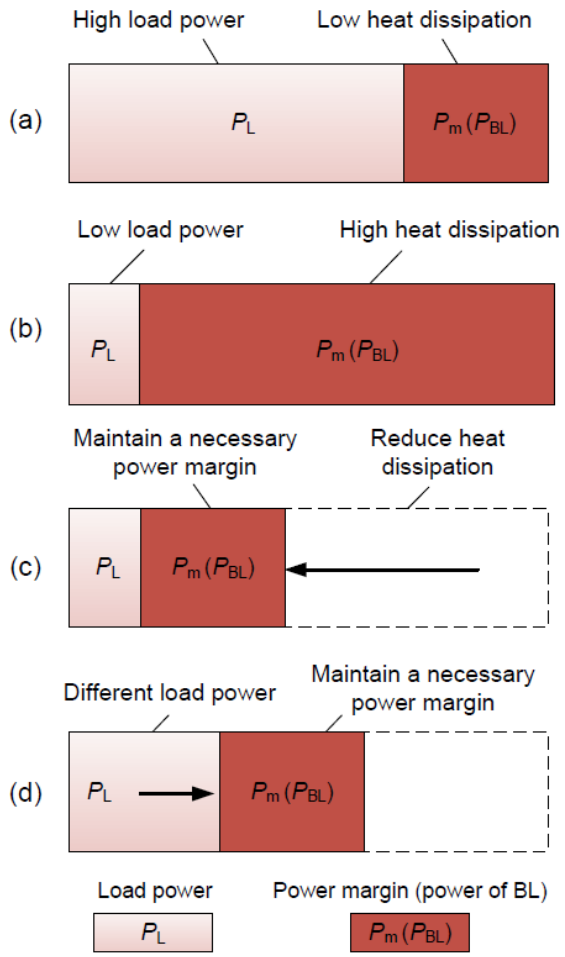
In a constant current (CC) underwater observatory with a shunt regulator:

- if the load power is kept at a high level, this results in a low level of heat dissipation on the balance-load (BL), as shown in figure (a);
- if the load power is kept at a low level, an unnecessary power margin is possibly left on the BL, leading to a waste of power, as shown in figure (b);



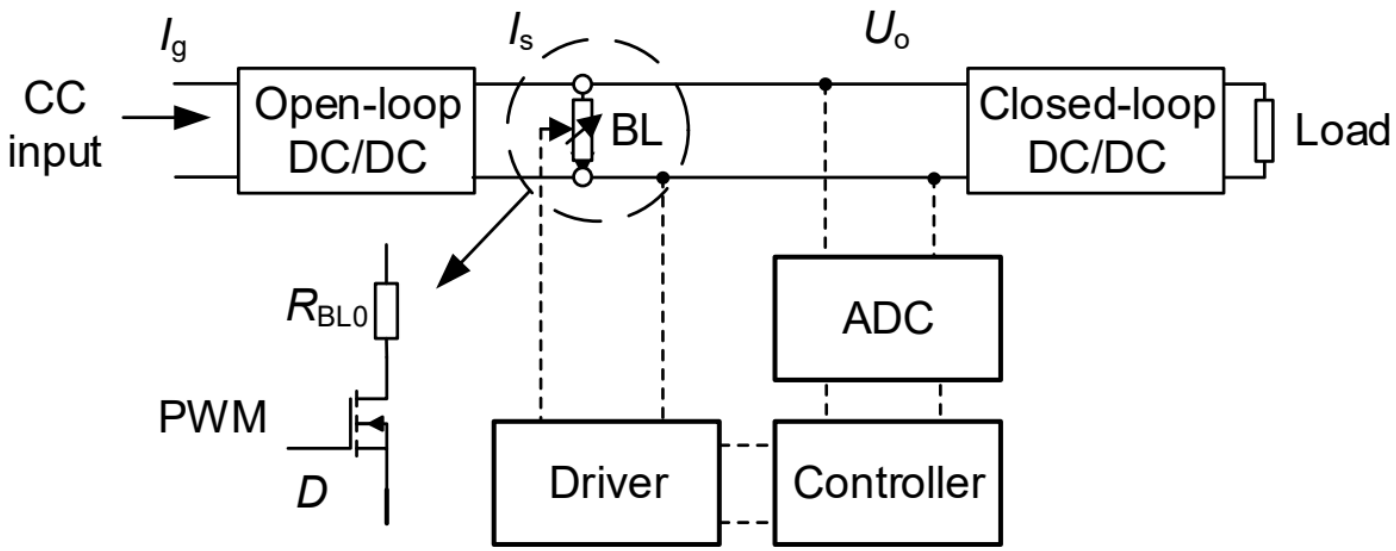
Motivation & main idea (Cont'd)

- when adjusting the power of BL steplessly, only a reasonable power margin can be reserved for the system to prevent the power failure caused by sudden load rise, as shown in figure (c);
- if the load changes slowly, the strategy in this study adjusts the power of BL automatically to ensure that the power margin of the system is kept in a necessary range, as shown in figure (d).



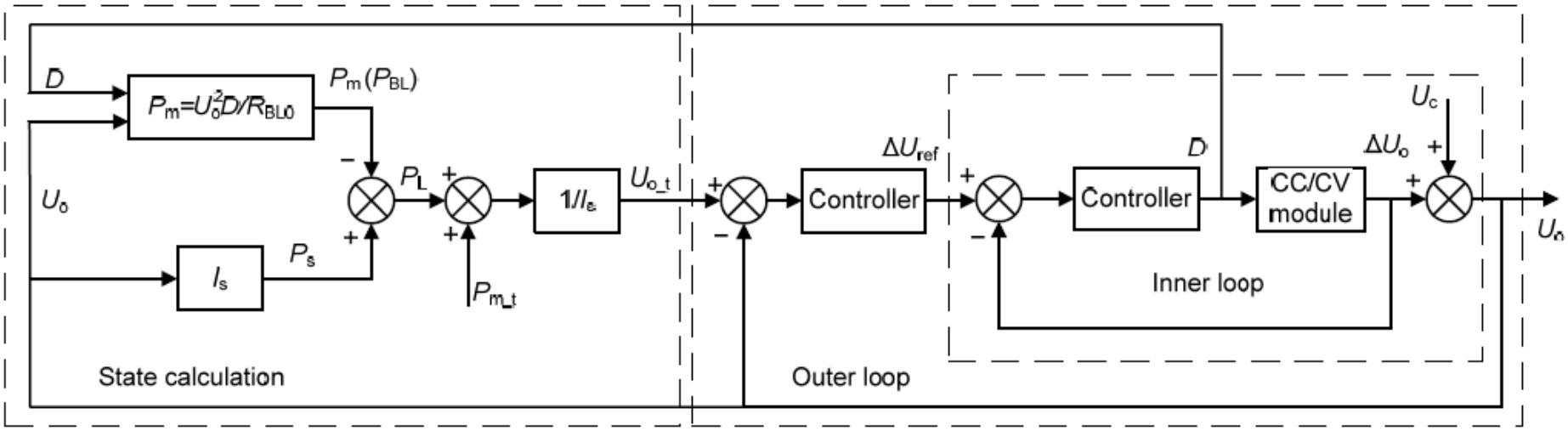
Method

1. Block diagram of the stepless-power-reconfigurable CC/CV module



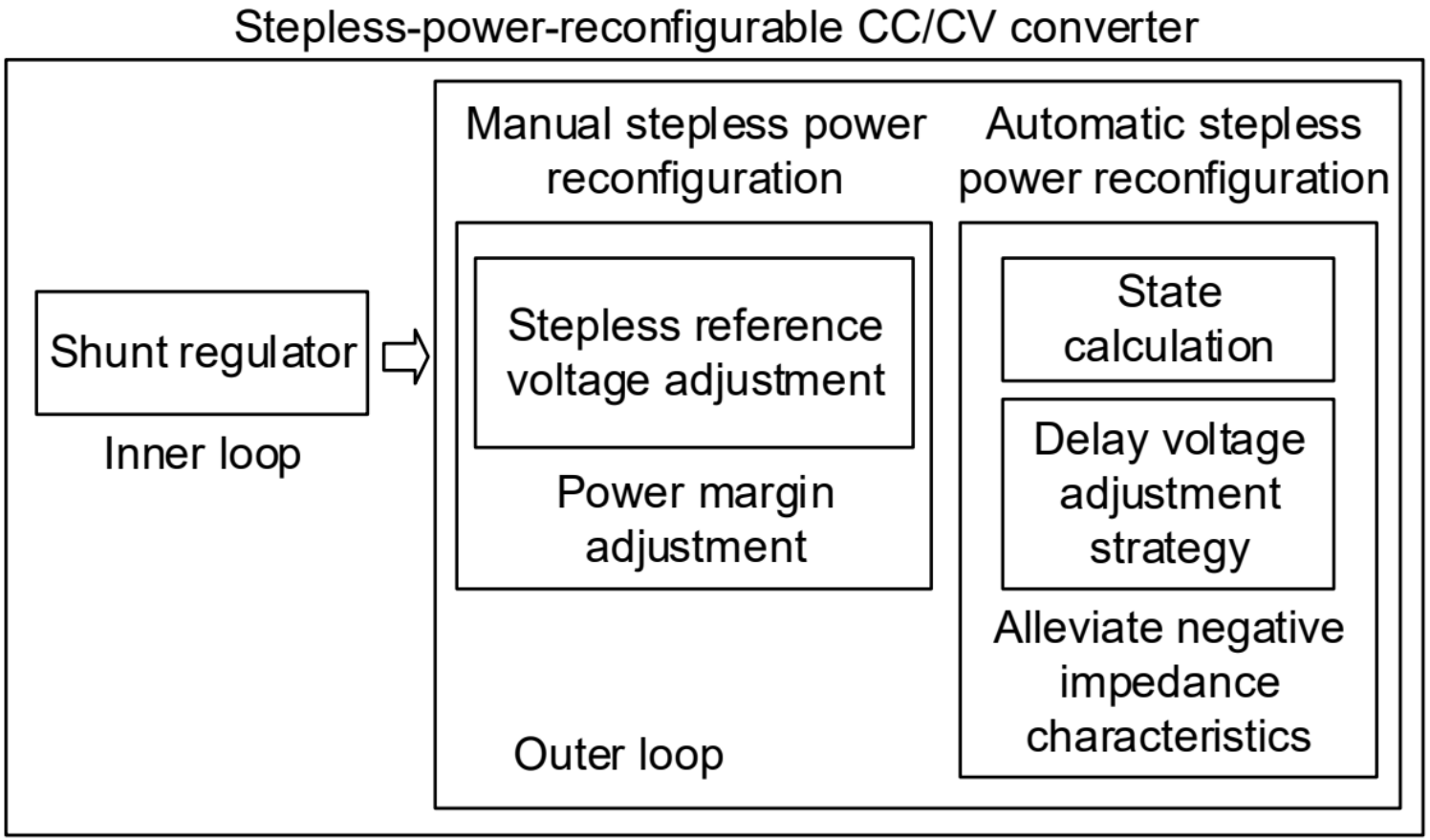
Method (Cont'd)

2. Block diagram of the inner-outer loop control strategy

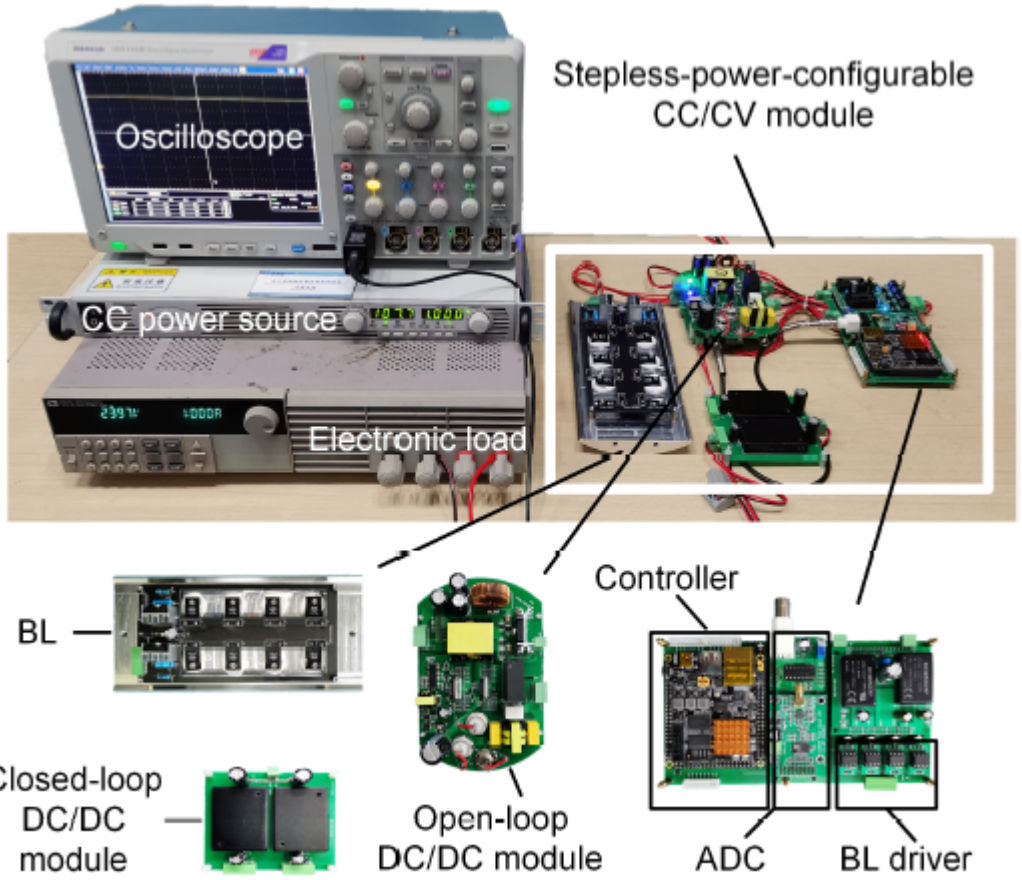


Method (Cont'd)

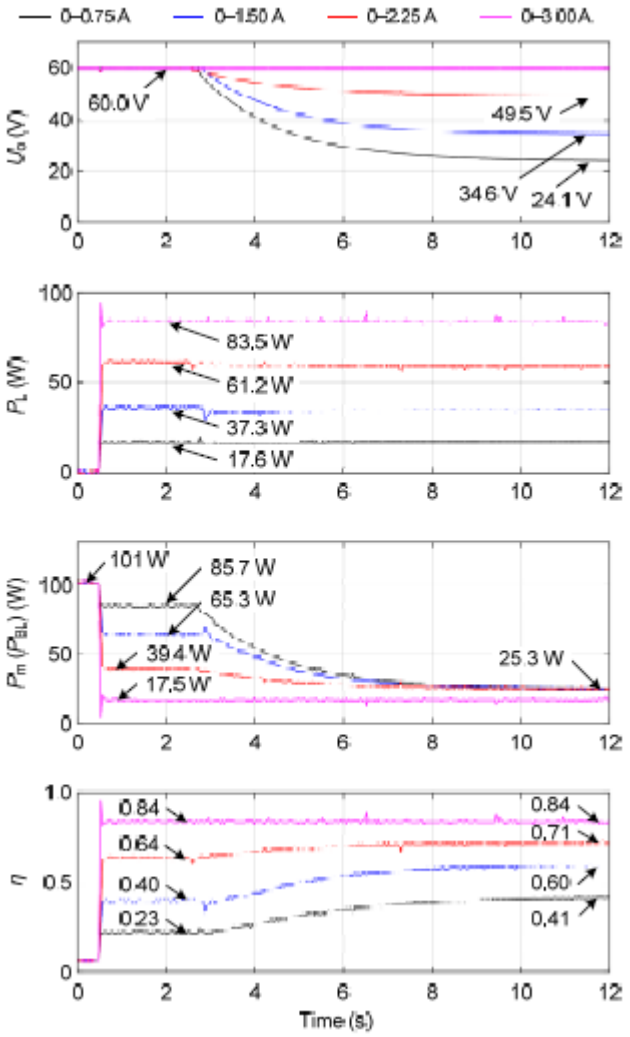
3. Key technologies of the stepless-power reconfigurable converter



Major results

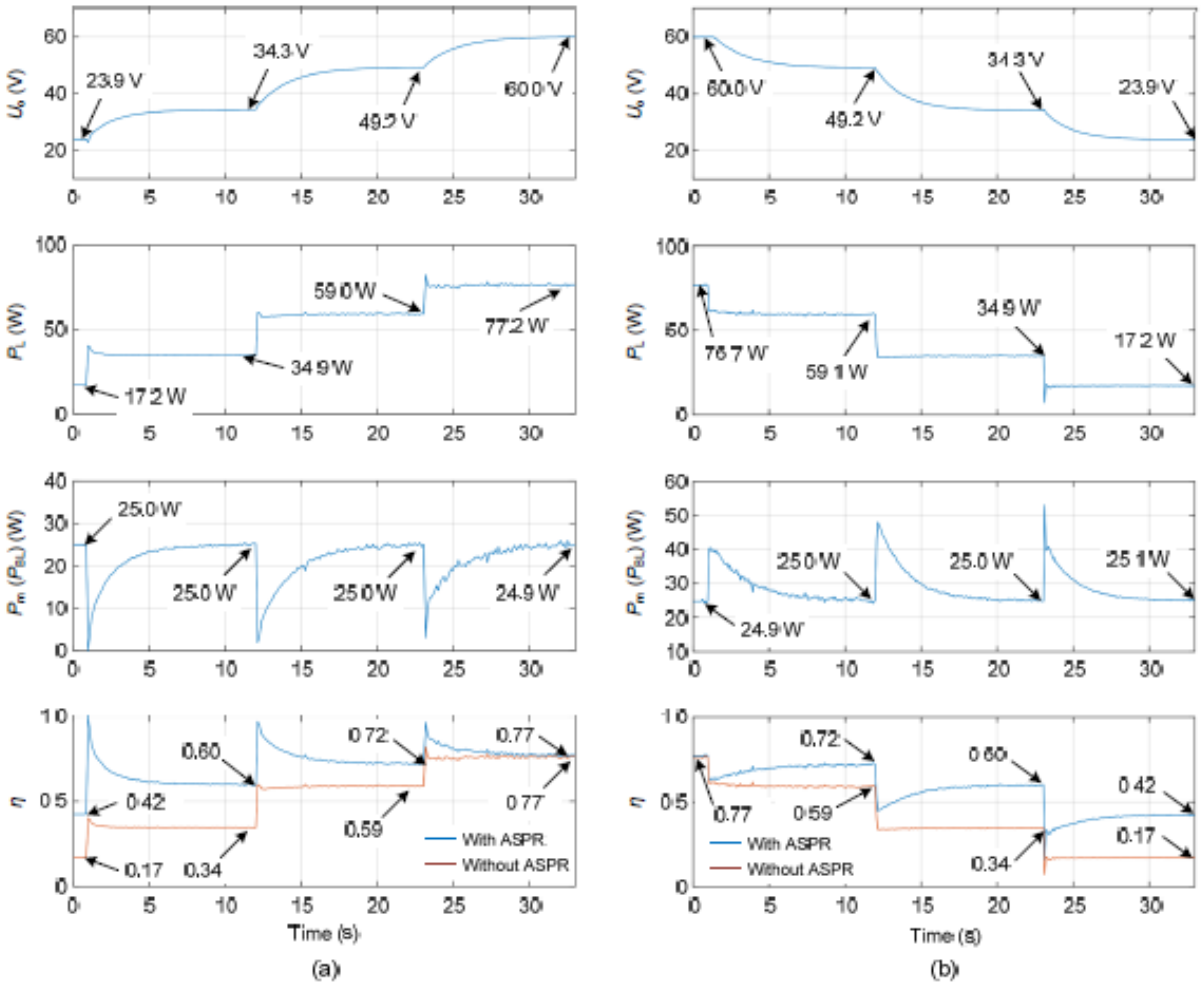


Setup of the experiment



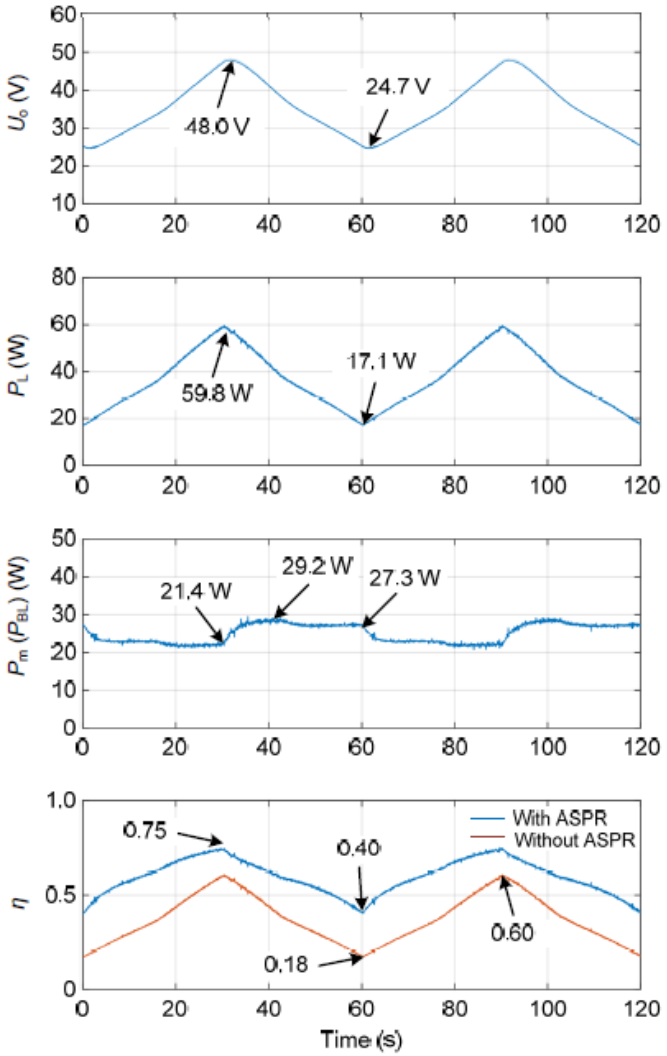
Experimental results under the strategy with load starting up

Major results (Cont'd)

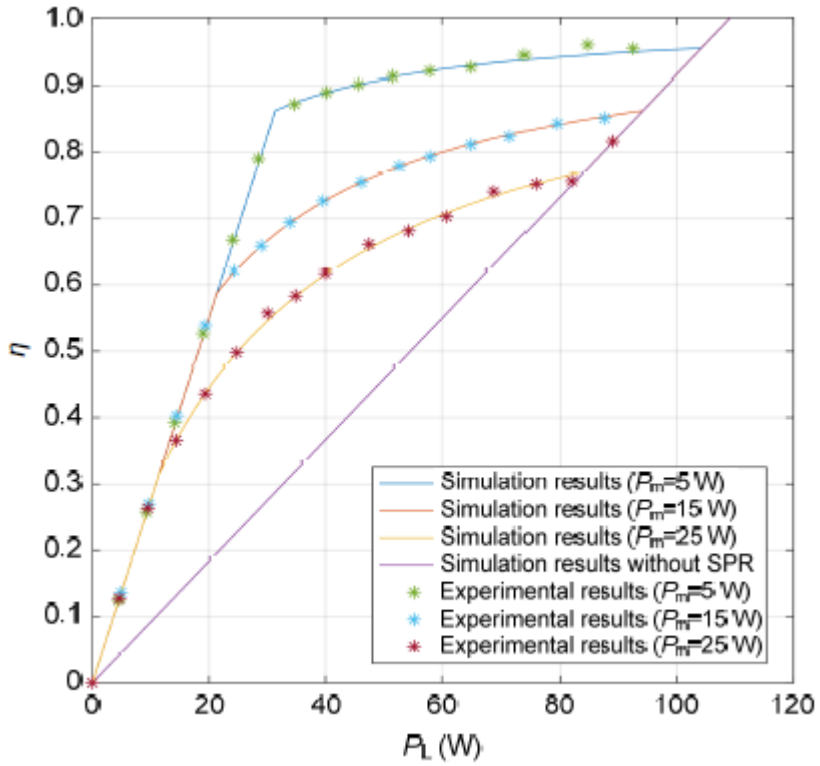


Experimental results with load in stepped variation: (a) load steps up; (b) load steps down

Major results (Cont'd)



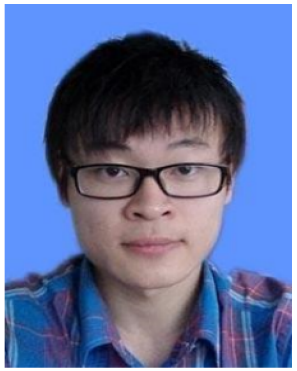
Experimental results with load in continuous variation



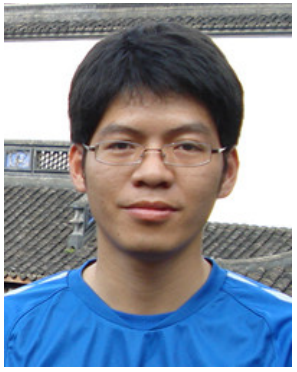
Results of efficiency

Conclusions

- The concept of stepless power reconfiguration (SPR), which is a novel active shunt regulation method that can be used in the CC/CV converter, has been introduced.
- Two effective and practical methods named manual SPR (MSPR) and automatic SPR (ASPR) have been discussed. They can steplessly reconfigure the system power manually and automatically, respectively, to reduce the unnecessary dissipation of the system and greatly improve the efficiency compared with the traditional shunt regulation methods, while ensuring the stability of the system.
- The experimental results showed that the steady-state efficiency of the stepless power reconfiguration can be increased up to 1.47 times that of a typical shunt regulator.



Yujia ZANG received the BS degree in mechatronic engineering from Yanshan University, Qinhuangdao, China, in 2016 and PhD degree in mechanical engineering from Zhejiang University, China, in 2021. His research interests include intelligent control, cabled ocean observation, and constant current power conversion & transmission.



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