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Power system design for constant current subsea observatories

Key words: Observatory; Electric energy conversion; Heat dissipation

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Motivation

- Constant current (CC) transmission is superior to constant voltage (CV) transmission in resistance to shunt faults. When a shunt fault occurs, the system before the fault can continue to operate with the sea ground location changing instantaneously, whereas a CV system will collapse because it is not resistant to shunt faults.
- CC observatories have been established worldwide. Based on those observatories, some improvements have been made in power conversion topology and heat dissipation systems in this study.

Main idea

- Considering the −1-A input power, the output power of each 48-V DC-DC conversion circuit is constant (100 W), and the output voltage to the load will not be constant when load changes. To obtain a constant output voltage, the load is set parallel to the power compensation circuit, which can consume unnecessary power.
- The electric energy system works in a closed underwater environment, and therefore it is necessary to monitor the power system in real time. The power management system is designed for the basic functions, such as overvoltage protection, power and environmental measurement, and relay control.
- Heat dissipation of the power resistor is crucial for the normal operation. The radiating plate is added between the cavity and the power resistor, and thermal grease is smeared on all of the contact gaps.

Method

1. Design of a power system

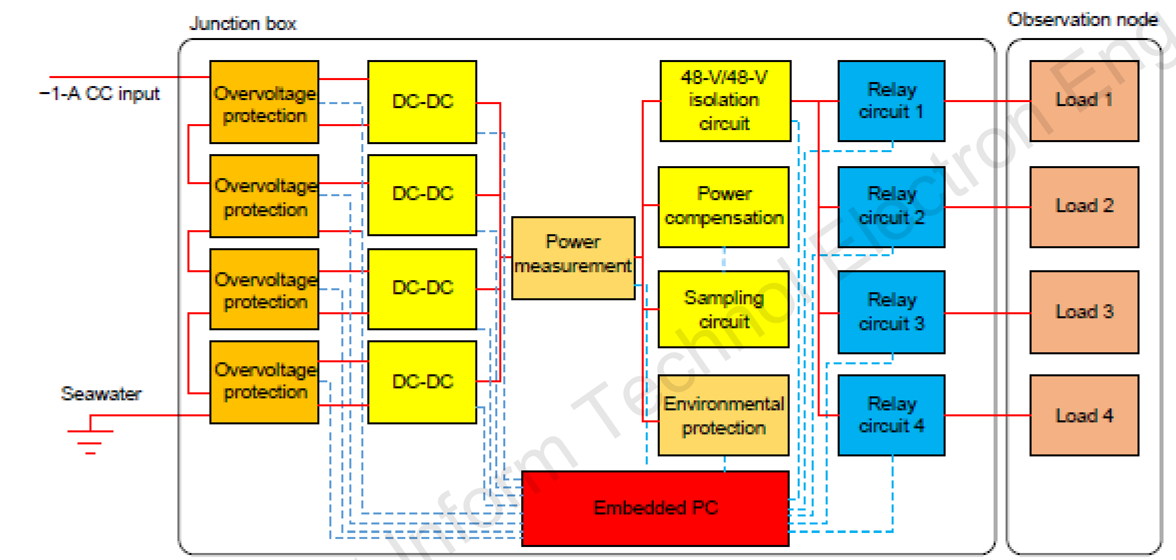

Fig. 2 Design of a power system

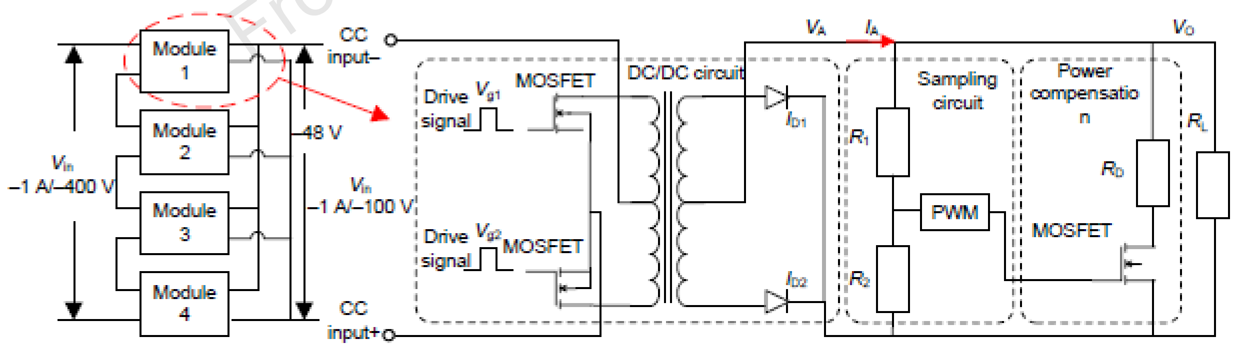

Fig. 3 Designed power conversion circuit

Method

2. Experimental setup

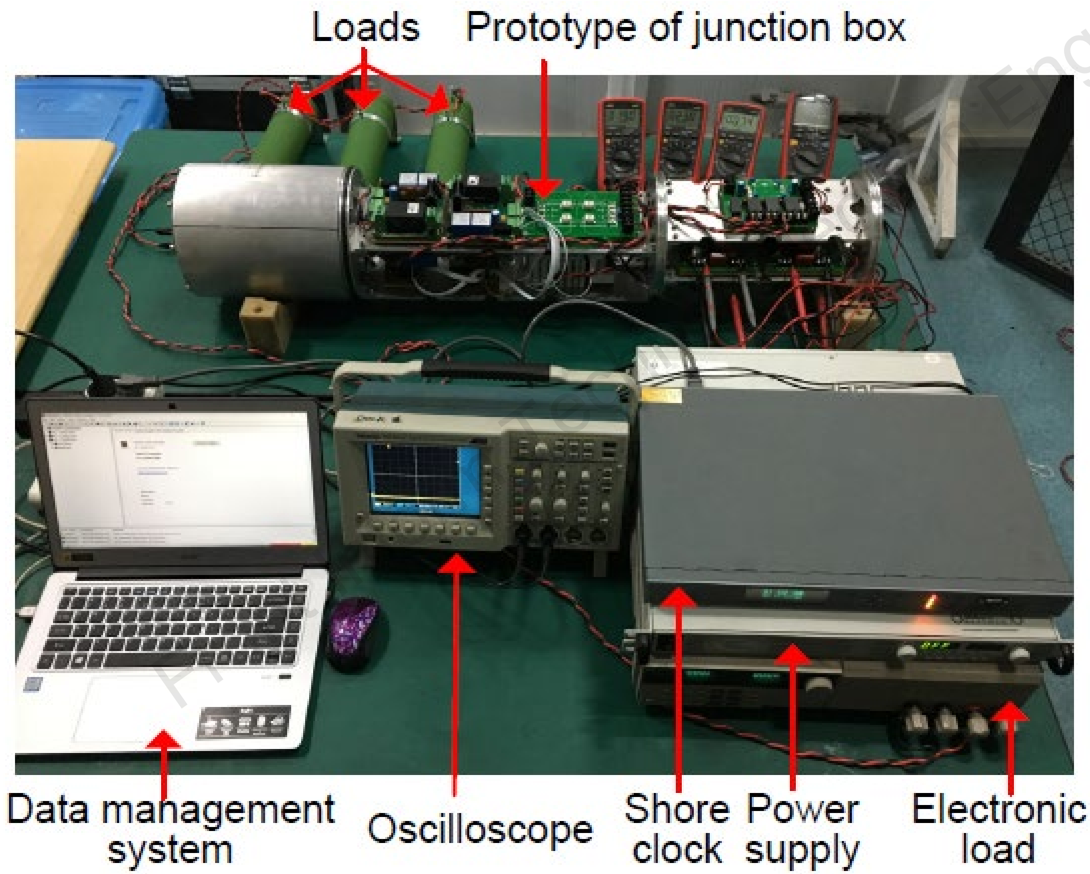

Fig. 16 Laboratory tests on the prototype

Major results

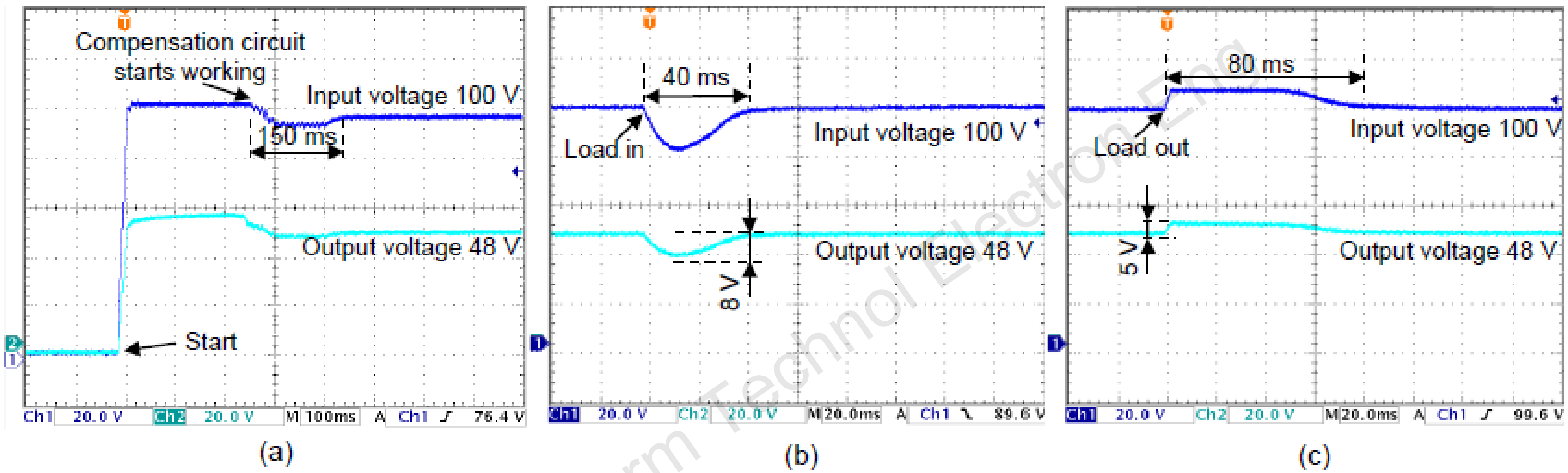

Fig. 13 Waveforms of the power conversion methods: (a) startup characteristics; (b) load in; (c) load out

Output voltage remained stable at 48 V about 150 ms later.

Output remained at 48 V about 40 ms later.

Output remained at 48 V about 80 ms later.

Major results (Cont'd)

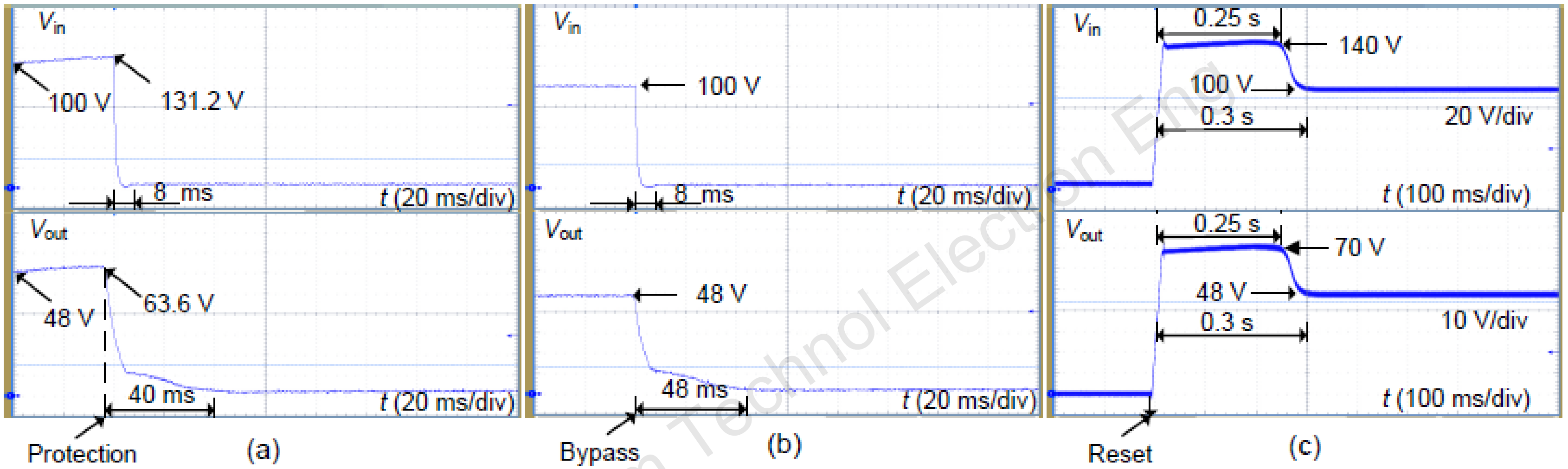

Fig. 14 Waveforms of the overvoltage protection function: (a) automatic overvoltage protection; (b) bypass operation; (c) reset operation

The overvoltage process was completed in 8 ms, and the output-voltage protection process ended in 40 ms.

Bypass operation was completed in 8 ms, and the output-voltage protection process ended in 48 ms.

The corresponding voltages depict a voltage overshoot of 70 V for the output side during the initial 0.25 s. Then the output voltage remained 48 V at 0.3 s after sending the reset signal to the circuit.

Conclusions

- The proposed structure can obtain a constant output voltage by paralleling the loads and the PWM-controlled power compensation circuit.
- The power management system can realize the functions as overvoltage protection, power and environmental measurement, and relay control.
- Experiment results showed that the heat dissipation structure is effective, capable of extending the lifetime of the junction box.