

Yan-hu CHEN, Yu-jia ZANG, Jia-jie YAO, Gul MUHAMMAD, 2019. Optimal communication frequency for switching cabled ocean networks with commands carried over the power line. *Frontiers of Information Technology & Electronic Engineering*, 20(10):1331-1343. <https://doi.org/10.1631/FITEE.1900125>

Optimal communication frequency for switching cabled ocean networks with commands carried over the power line

Key words: Cable switching; Cabled ocean network; Branching unit; Transmission line theory; Communication frequency

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Motivation

- Due to the time-consuming need for field maintenance, cable switching technology that can actively switch the power on/off on certain branches of the network becomes essential for enhancing the reliability and availability of the network.
- Once ground faults and short faults occur on the backbone cables, there is difficulty in maintaining the voltage signal. However, with the current being used as the digital signal to broadcast commands, even if ground faults and short faults occur on the backbone cable, the commands can still be normally broadcasted.

Main idea

- We propose a new cable switching method that works by inverting the power transmission polarity and varying the current on the power line with low frequency to broadcast information including addresses and commands to the network.
- Every branch unit in the network can decode the information, and the branch unit with the right address can execute the switching commands.

Method

1. Control logic of the BU in the maintenance mode

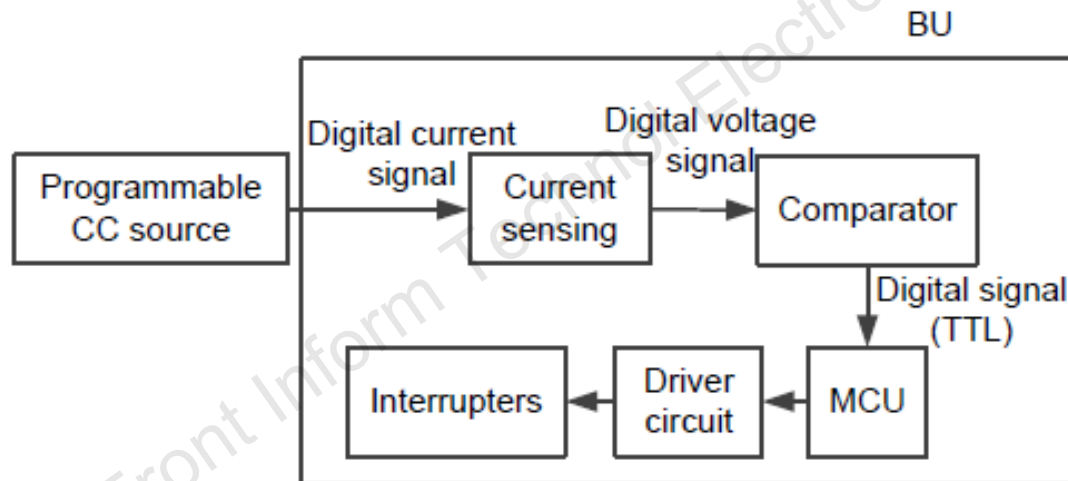


Fig. 2 Control logic of the BU in the maintenance mode

2. Switching circuit of the BU under the maintenance scenario and normal scenario

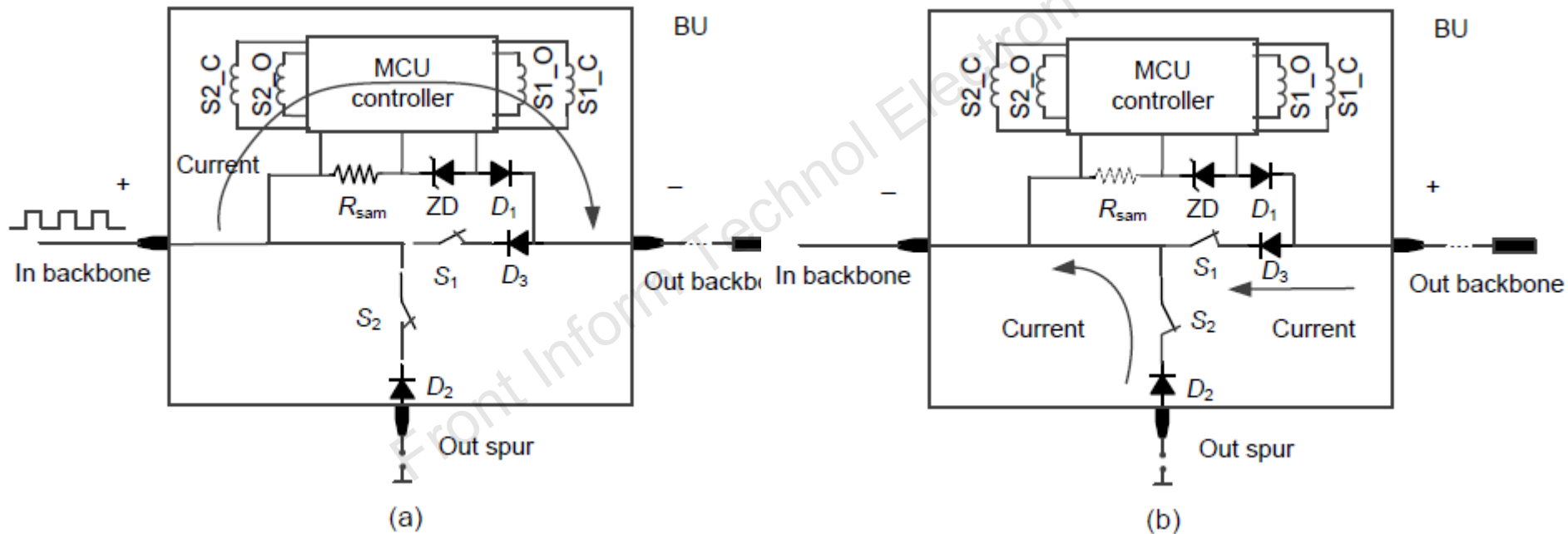


Fig. 3 Switching circuit of the BU under the maintenance scenario (a) and normal scenario (b)

Major results

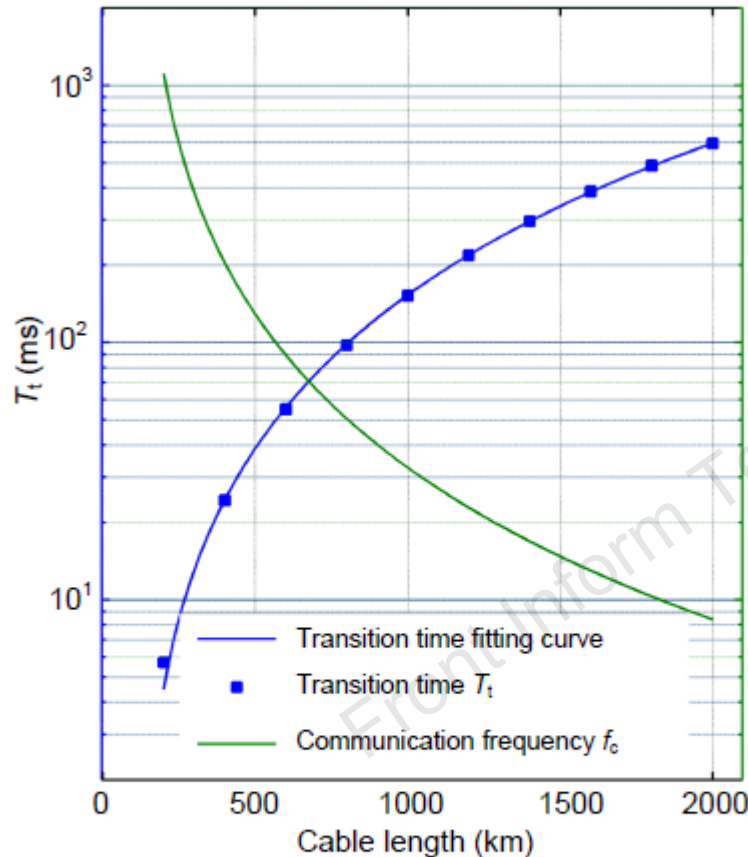


Fig. 10 Simulated transition time T_t with its fitting curve
 The optimal communication frequency of the digital current signals f_c is obtained by Eq. (14)

$$f_c = \frac{1000}{T_c} = \frac{1000}{10 \times (2T_t)} \quad (14)$$

$$= \frac{50}{0.00015L^2 + 0.014L - 4},$$

Major results

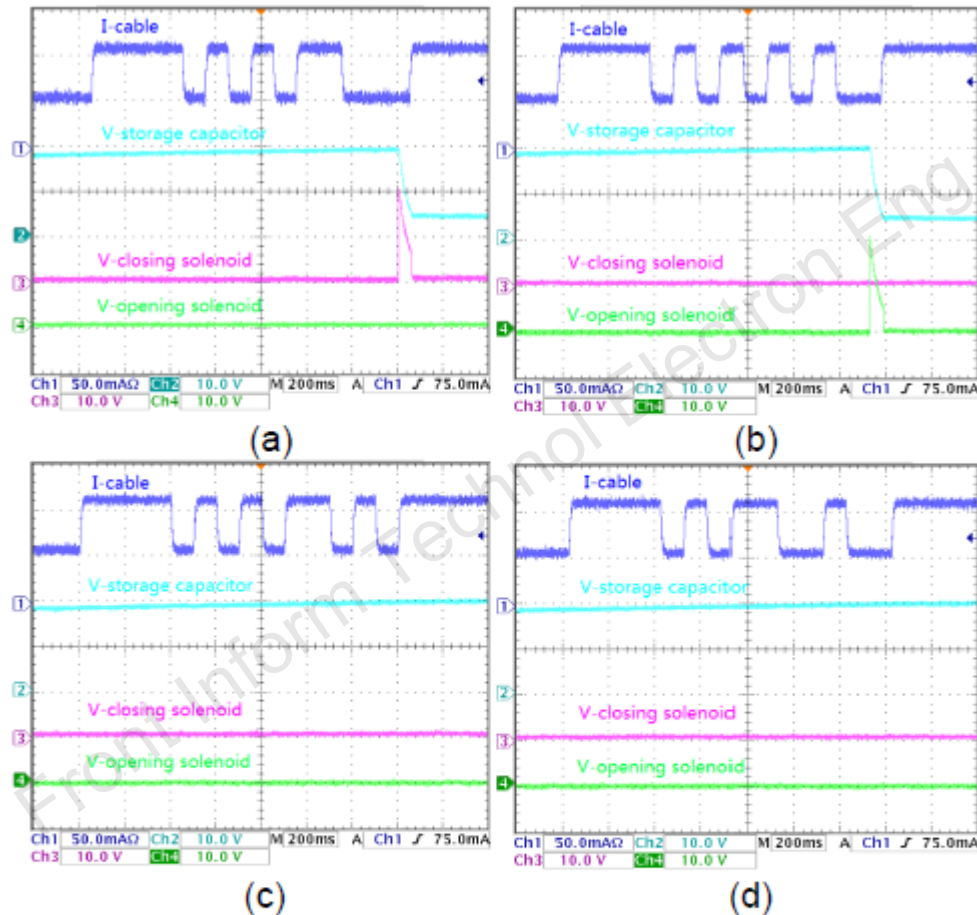


Fig. 12 Operations with command signals: (a) command to close an interrupter; (b) command to open an interrupter; (c) command with wrong check bit; (d) command with non-corresponding address

References to color refer to the online version of this figure

Conclusions

- An active node isolating method based on digital current signals has been introduced for an ocean network.
- The mathematical model, software simulation, and laboratory model have been established for the fault isolation system.
- Signal integrity analysis has ensured the accuracy and efficiency of the digital control command.