**Test System Description**  
The test system used for the case study consists of four IEEE 5-bus systems connected asynchronously. The topology and resource connection points of each IEEE 5-bus system are identical, as shown in Fig. 1. The grid connection relationships are based on [A-1], and the connections between the four grids are illustrated in Fig. 2. The node numbers where HVDC is connected to each grid are listed in Table Ⅰ.



Fig. 1. IEEE 5-bus system topology.



Fig. 2. Network connection.

TABLE I

The connection relationships between the grids

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| HVDC | From | To | From bus | To bus |
| HVDC #1 | Grid #1 | Grid #2 | Bus-3 | Bus-2 |
| HVDC #2 | Grid #1 | Grid #3 | Bus-3 | Bus-2 |
| HVDC #3 | Grid #2 | Grid #3 | Bus-1 | Bus-4 |
| HVDC #4 | Grid #3 | Grid #4 | Bus-2 | Bus-2 |

**Reference**

[A-1] Y. He, H. Zhong, G. Ruan, B. Zhou, S. Lu, and Y. Zhuo, “Multi-Area Asynchronous Grid Operation with Frequency Reserve Sharing,” IEEE Trans. Power Syst., pp. 1–13, 2024, doi: 10.1109/TPWRS.2024.3382288.