

160 KV MECHANICAL HVDC CIRCUIT BREAKER DEVELOPMENT AND APPLICATION IN CSG

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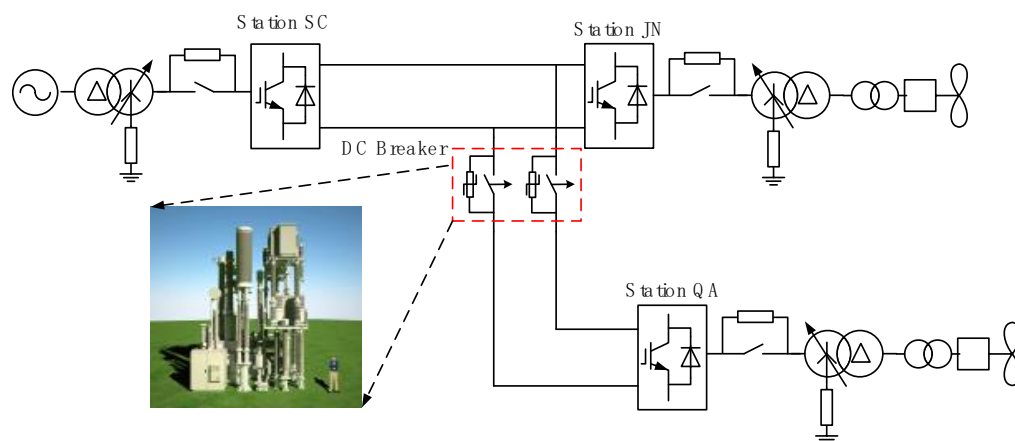
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1. Background

NanAo VSC-HVDC Transmission System is the first multi-terminal VSC-HVDC transmission project of the world. In order to improve the reliability and flexibility of the system, it is necessary to develop HVDC circuit breakers.



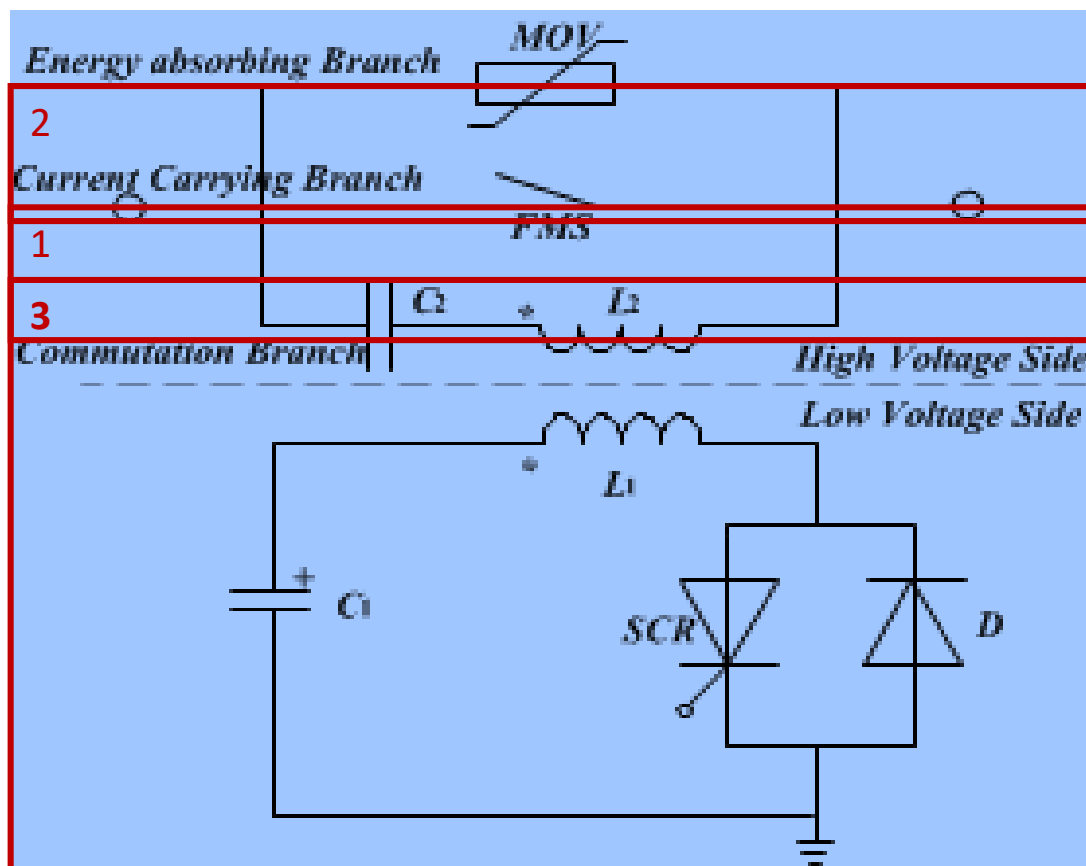
DC circuit breaker installation plan

Parameter requirements :

- Rated voltage: **168 kV**;
- Rated current: **1 kA**;
- The max. breaking current: **9 kA**;
- Breaking time: **<5 ms**.

2. Principle and componts of MDCCB

- 1-Current carrying branch : Fast mechanical switch ;
- 2-Energy absorption branch : MOV;

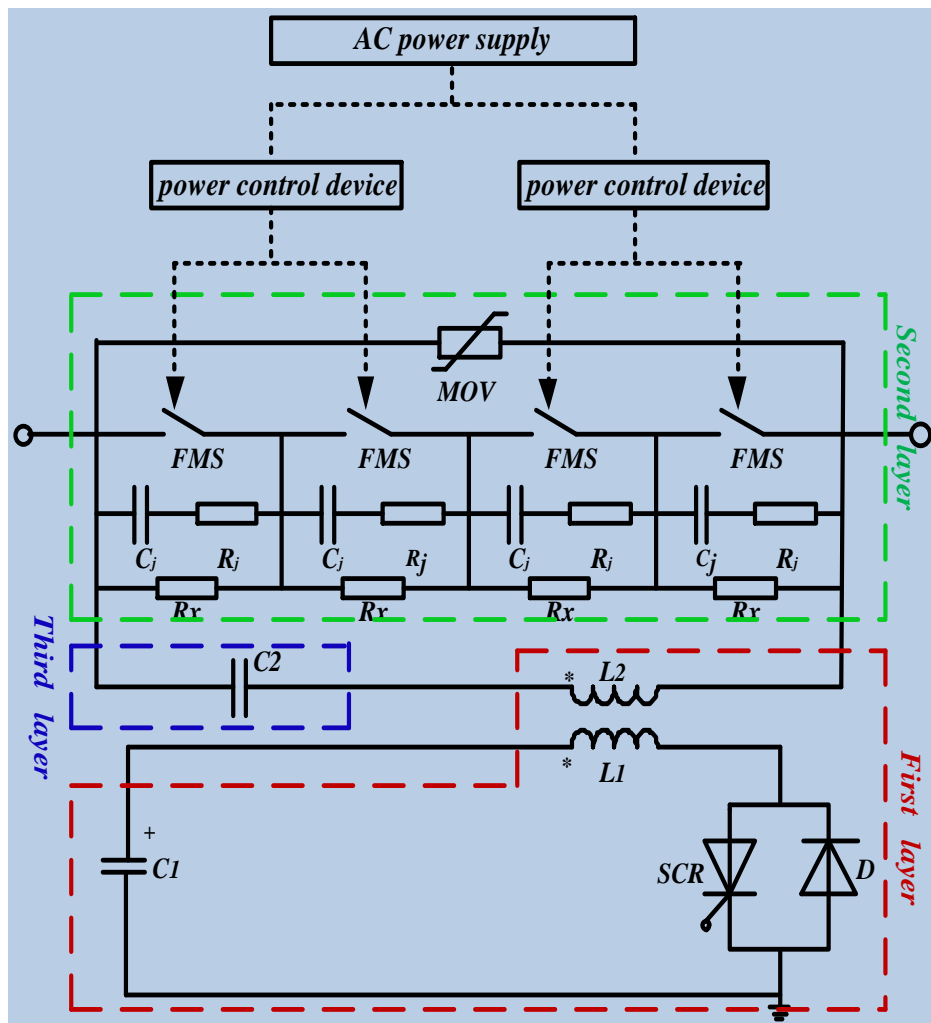


- 3-Commutation branch :
Consists of the
commutation capacitor,
pulse transformer,
energy storage
capacitor and trigger
switch (SCR).

Coupling mechanical DC circuit breaker(MDCCB)

3. Developement and test of 160kV MDCCB

Topology and Parameters





Parameters	Design
Frequency	2500 Hz
C_2	10 μF
C_1	135 μF
MOV	Operating voltage: 200 kV
	Residual voltage: 280 kV
	Energy absorption: 10 MJ
FMS	4*45 kV

Based on the above parameter selection, the prototype of 160kV MDCCB was developed.



3. Developement and test of 160kV MDCCB

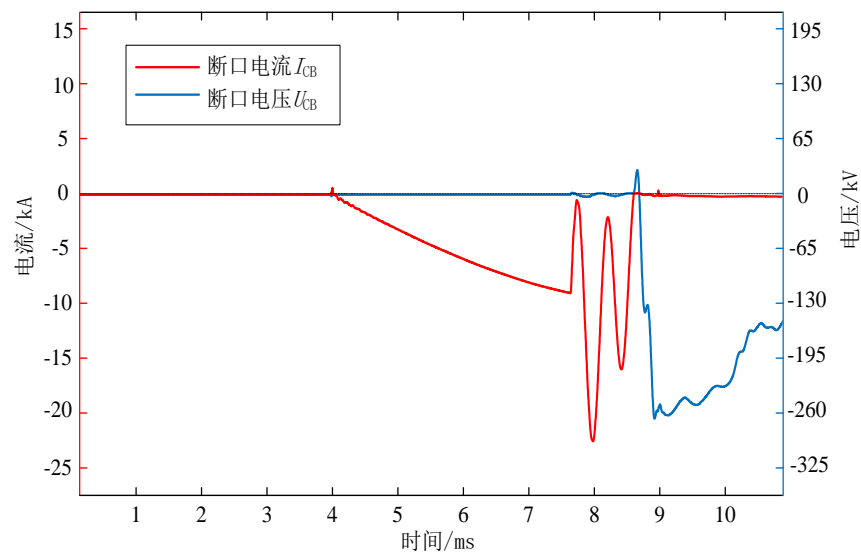
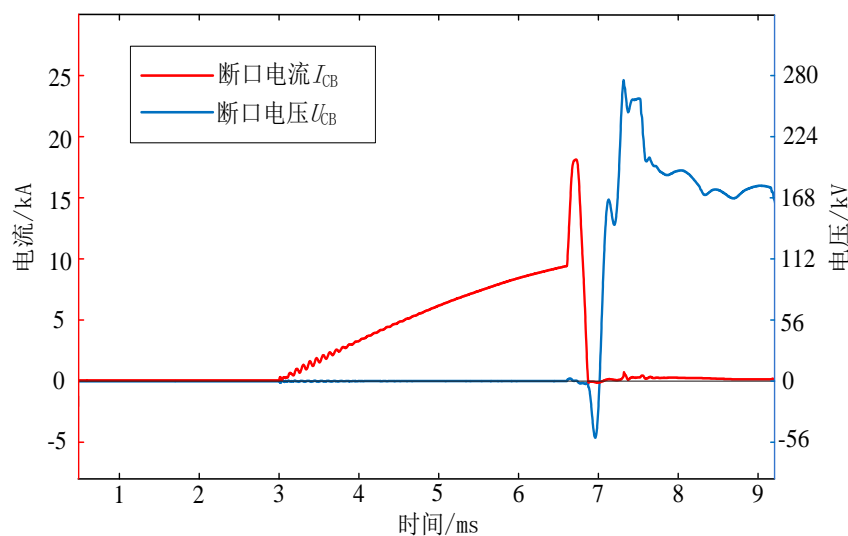
Tests of 160 kV DC Circuit Breaker

Insulation test	terminal to terminal	DC voltage
	terminal to ground	Lightning impulse Operating impulse
Operational test	Breaking test	
	Closing test	
	Main circuit resistance measurement test	
	Temperature test	
Mechanical operation test	 	
Terminal static load test		
Auxiliary loop and control test		
Radio interference test		
EMC test		

3. Developement and test of 160kV MDCCB

Breaking Test of 160 kV DC Circuit Breaker

Tests	Current/kA	Peak TRV/kV
1	9.2	272
2	-9.2	-262

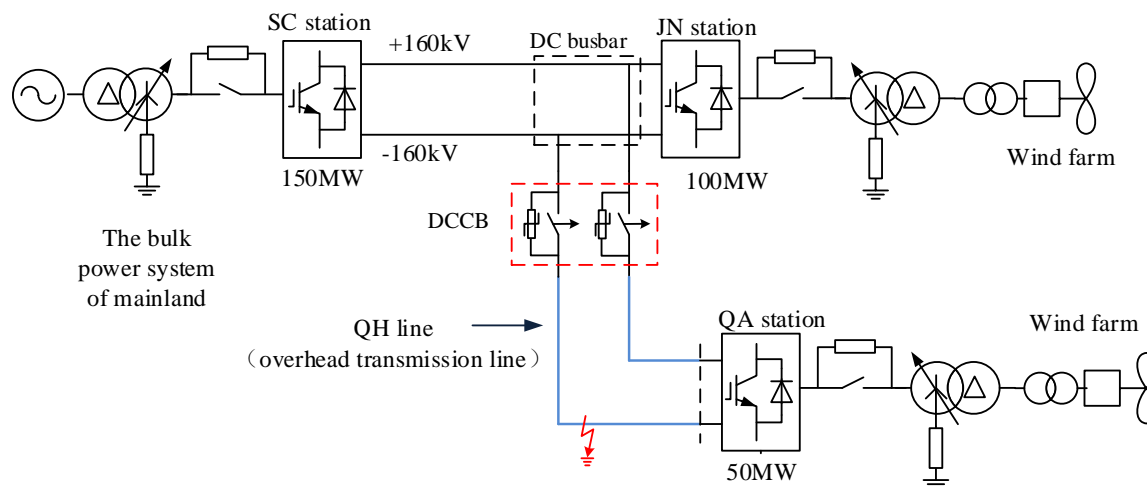


Test results: Sucessfully break bidirectional current more than 9 kA.

Withstand transient recovery voltage (TRV) up to 272 kV.

4. Demonstration in Nan'ao VSC-HVDC system

At the end of 2017, the world first MDCCBs installed on the Nan'ao HVDC system.



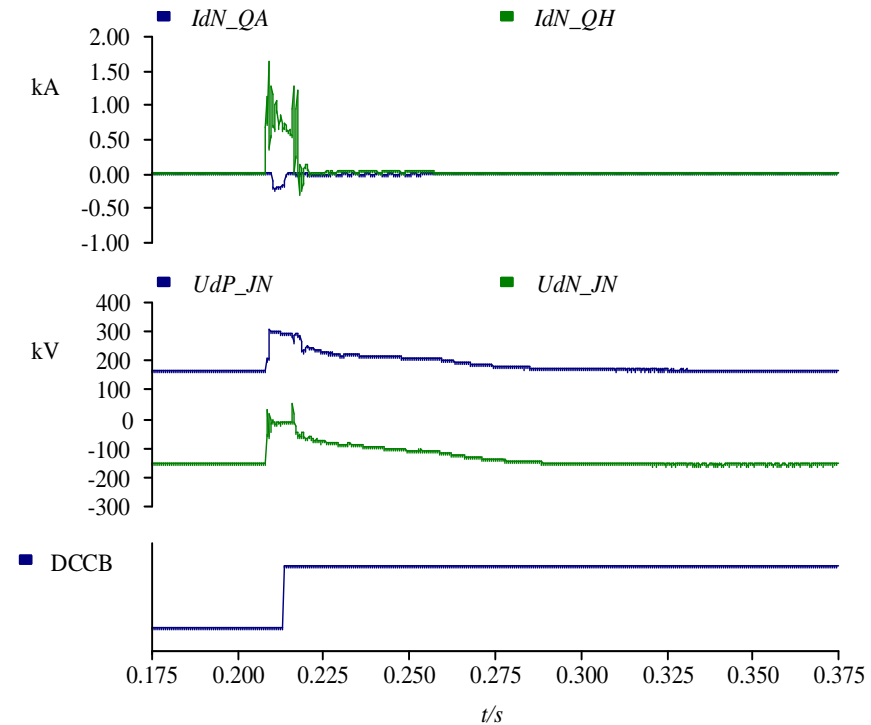
MDCCBs in site

With the DCCBs, following functions can be achieved :

- QA station can be put into online
- QA station can be exit online
- The fault occurs in QA station and QH line (overhead transmission line) can be isolated

4. Demonstration in Nan'ao VSC-HVDC system

◆ Monopolar grounding fault on the negative QH line



Grounding fault test

- The current differential protection was triggered after the fault.
- Then, QA station was blocked, the MDCCBs were tripped and interrupt the fault.
- The fault was isolated successfully, the other two stations continued to operate normally.
- The breaking DC current of DCCB is **1.4kA**, the operating time is **about 3.5ms**.

THANK YOU!