



PROMOTION TSO WORKSHOP, 17TH FEBRUARY 2017

ABB Hybrid HVDC Breaker

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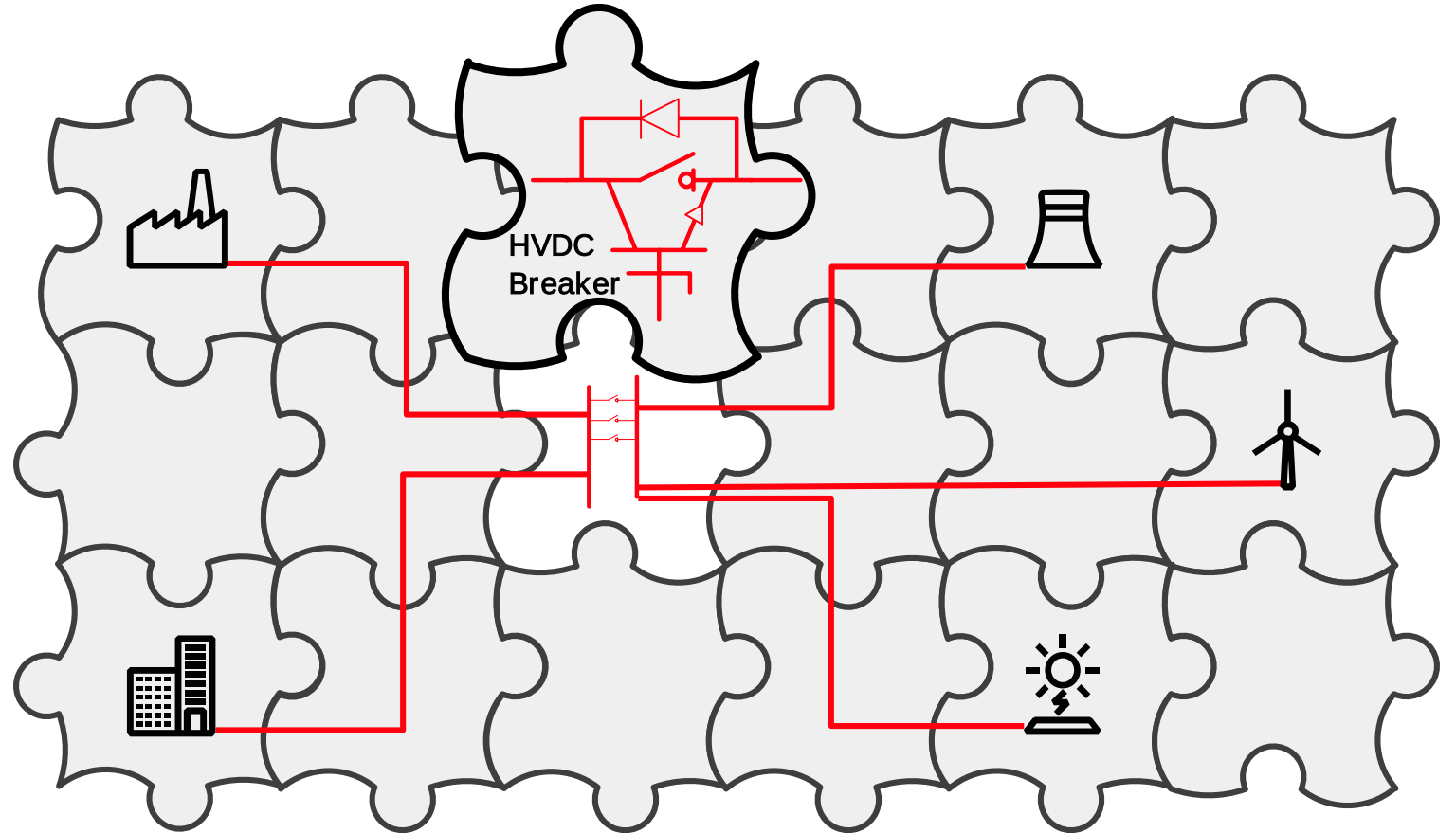
HVDC Breaker

Applications

Isolation of faults on point-to-point transmission line

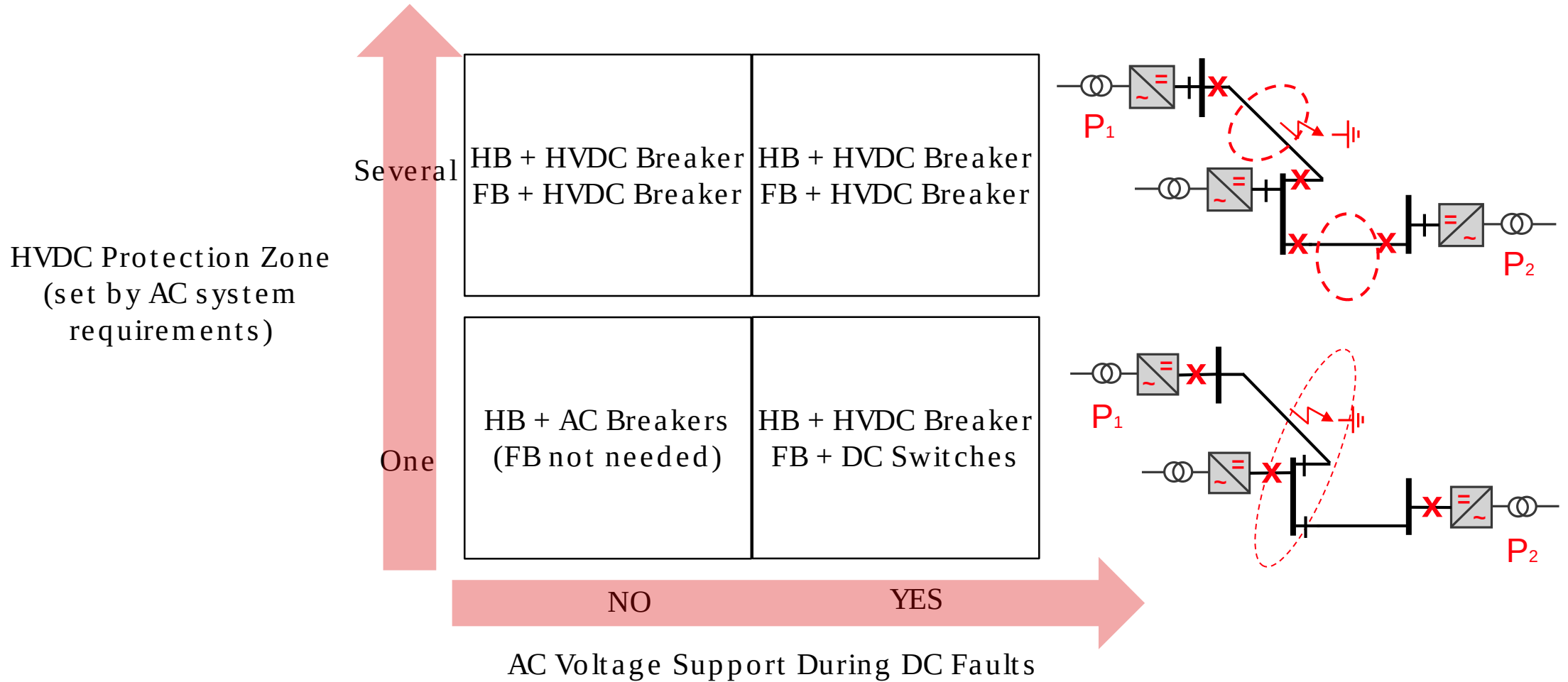
- Continuous operation in SVC mode
- Fast restoration of active power transmission

Several protection zones and continuous transmission capacity in the non-isolated parts, i.e. DC grid applications



Comparison of topology options

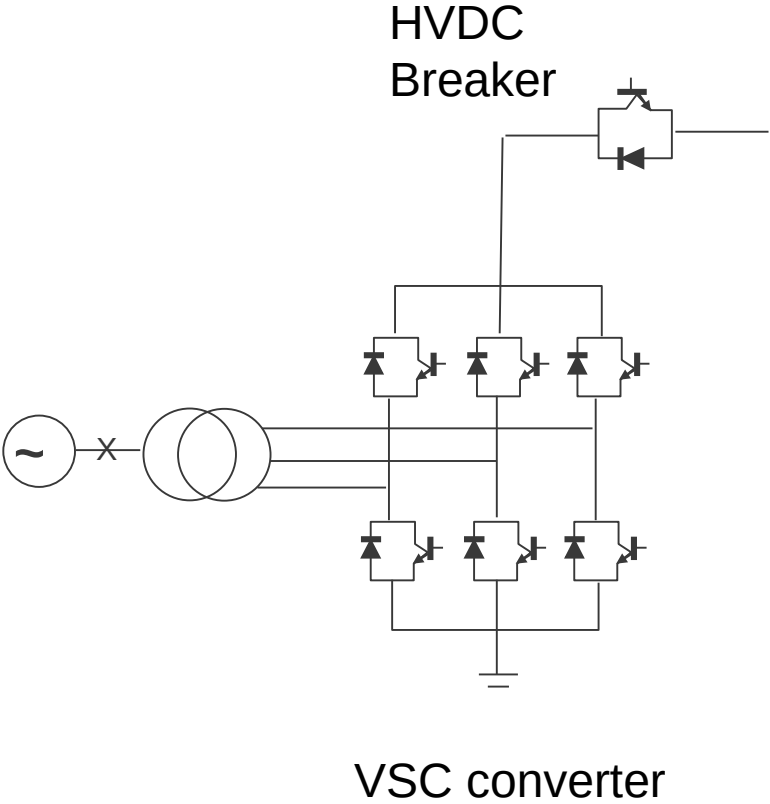
Multi-terminal HVDC systems depending on AC system performance



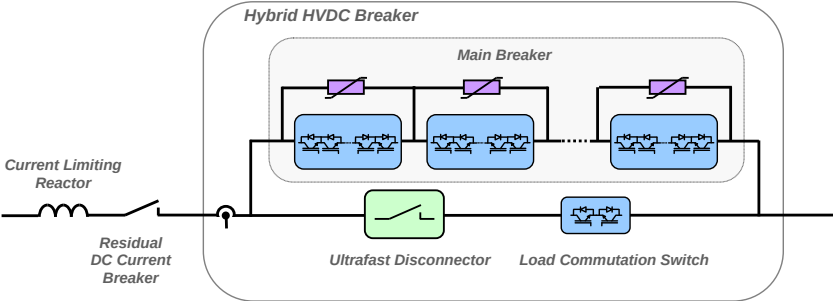


HVDC Breaker in ABB HVDC Light

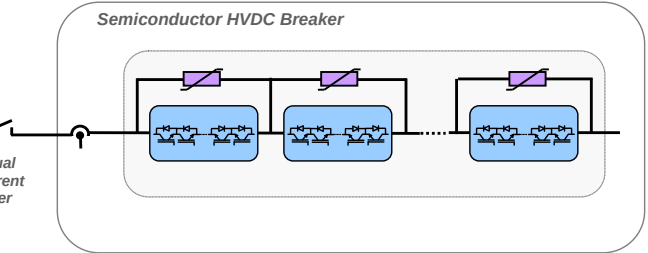
Design alternatives to meet technical requirements



Hybrid HVDC breaker



	Time	Loss	Scalable
Hybrid	OK	Very Low	OK
Semiconductor	Very fast	Medium	OK



Semiconductor HVDC breaker

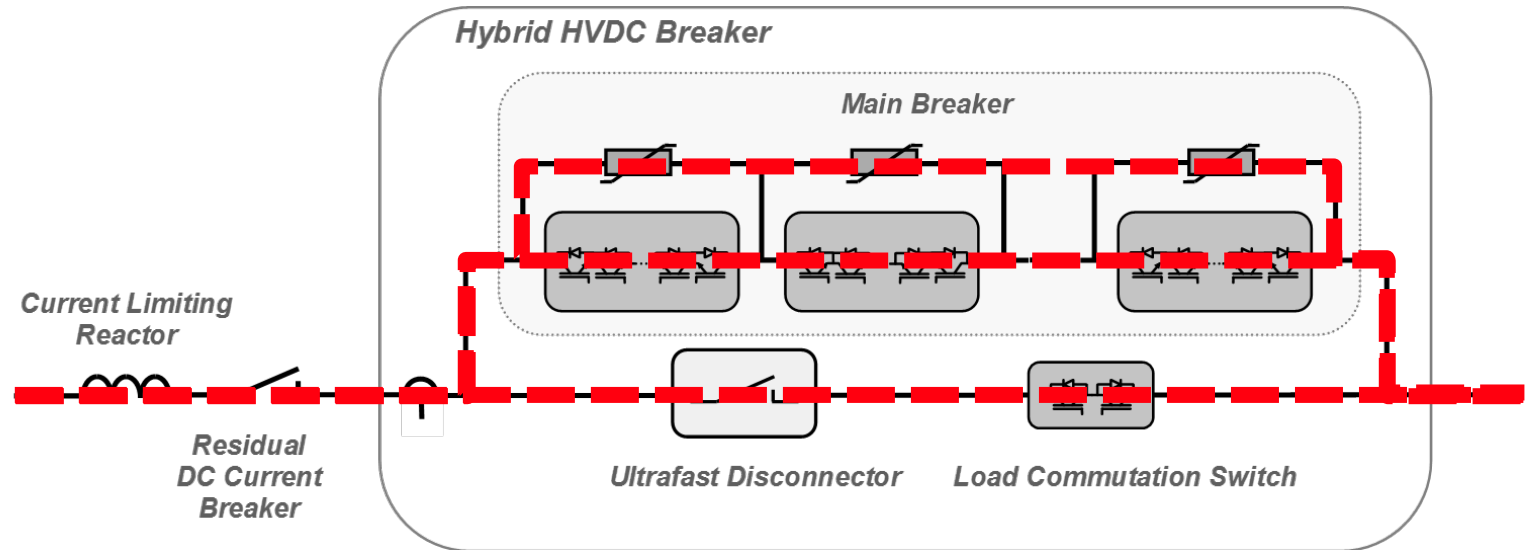
Hybrid HVDC Breaker

Basic functionality

Normal operation: Current flows in low-loss main branch

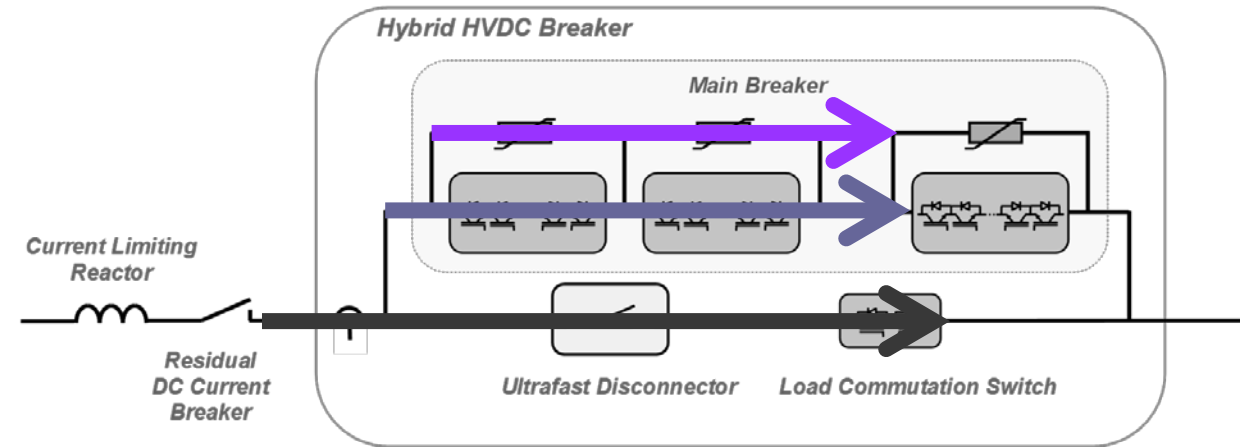
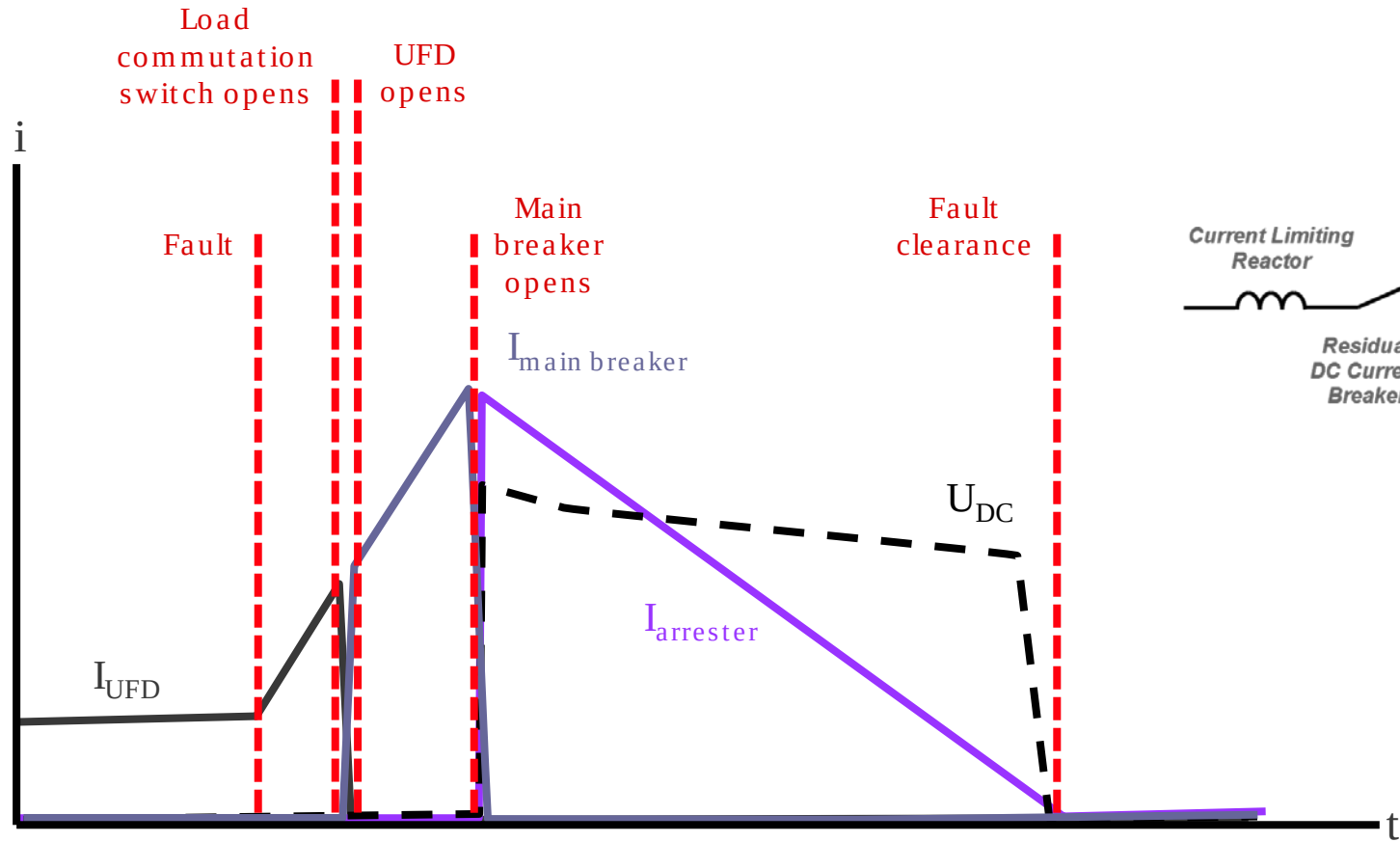
Proactive control: Load commutation switch commutates current into Main Breaker, the Ultrafast Disconnecter opens with very low voltage stress

Fault clearance: Main Breaker switch commutates fault current into arrester bank



Hybrid HVDC Breaker

Breaking timeline



Test program

Material tests

- Characteristics on samples
- E.g. insulation materials

Component tests

- Limit tests, endurance tests
- E.g. Semiconductors IGBT and BiGT, Gate drive units, Snubber components

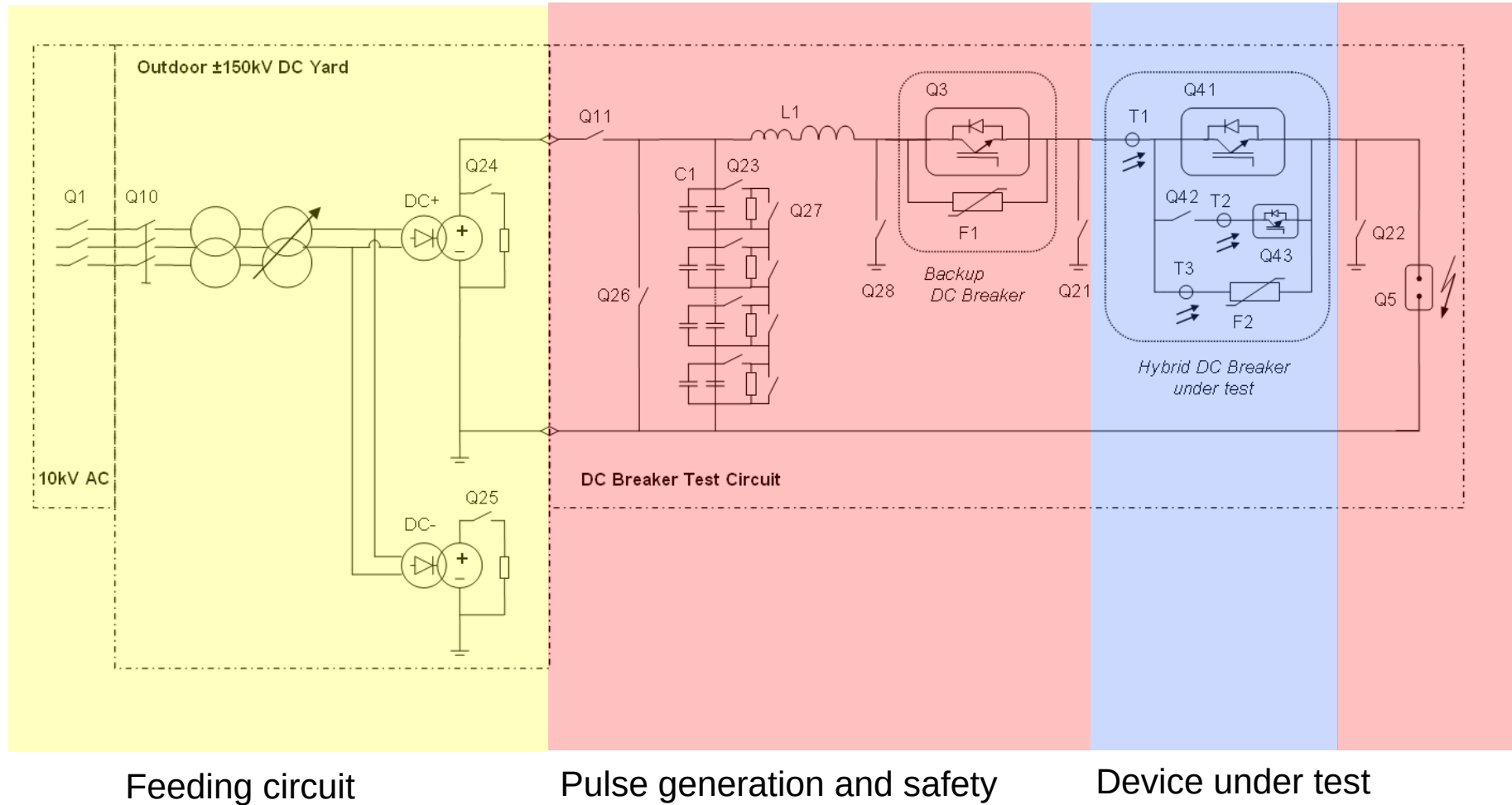
Subsystem tests

- Tests of functional principles, endurance tests
- E.g. Ultra-fast disconnectors: manoeuvre tests, dielectric tests

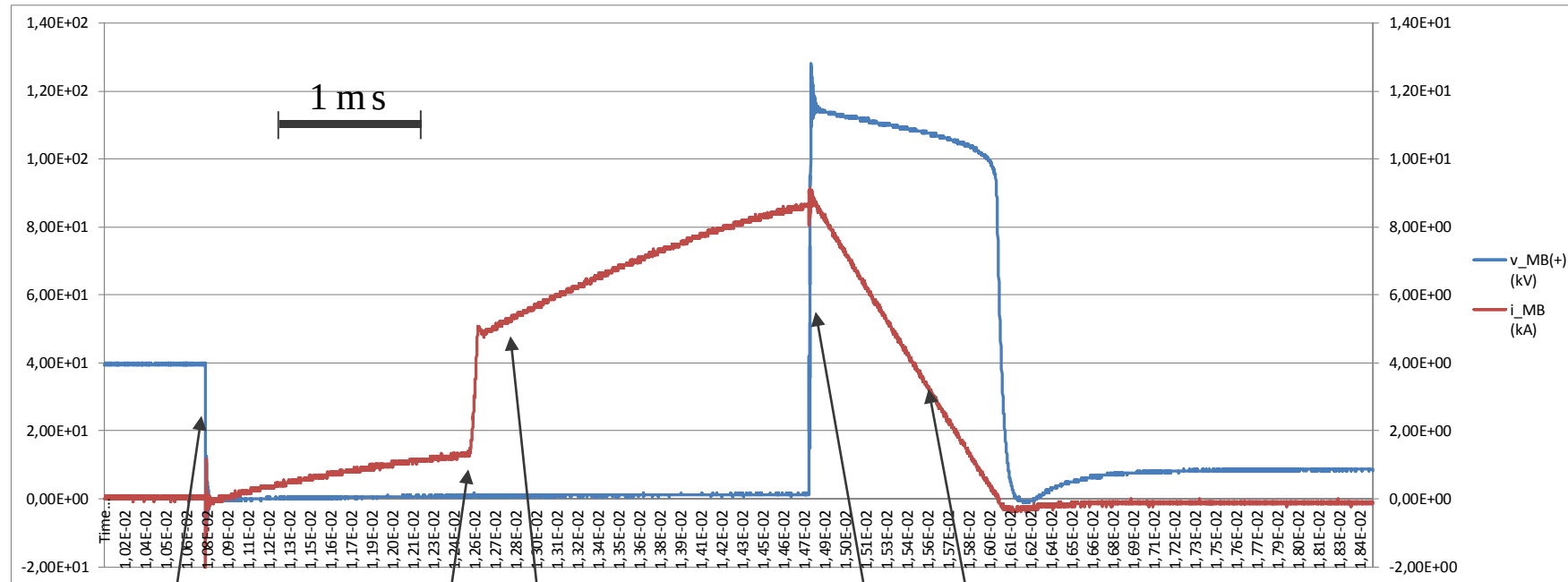
Hybrid HVDC Breaker system tests

- Normal breaking operations
- Gradually increasing the stress levels
- Factory system test (FST) on overall control system (MACH system)

Hybrid HVDC Breaker testing



Test Result



Ignite spark gap

Open UFD

Open Load Commutation switch

Open Main breaker

Fault current energy dissipated in arresters

Test purpose

Testing at Hybrid HVDC Breaker test circuit demonstrates

- Hybrid HVDC Breaker system main functionality
- Coordination of measurements and control
- Distribution of stresses, in particular voltage division
- Stack design, gate drivers, snubber circuits
- Reliable measurement and control systems

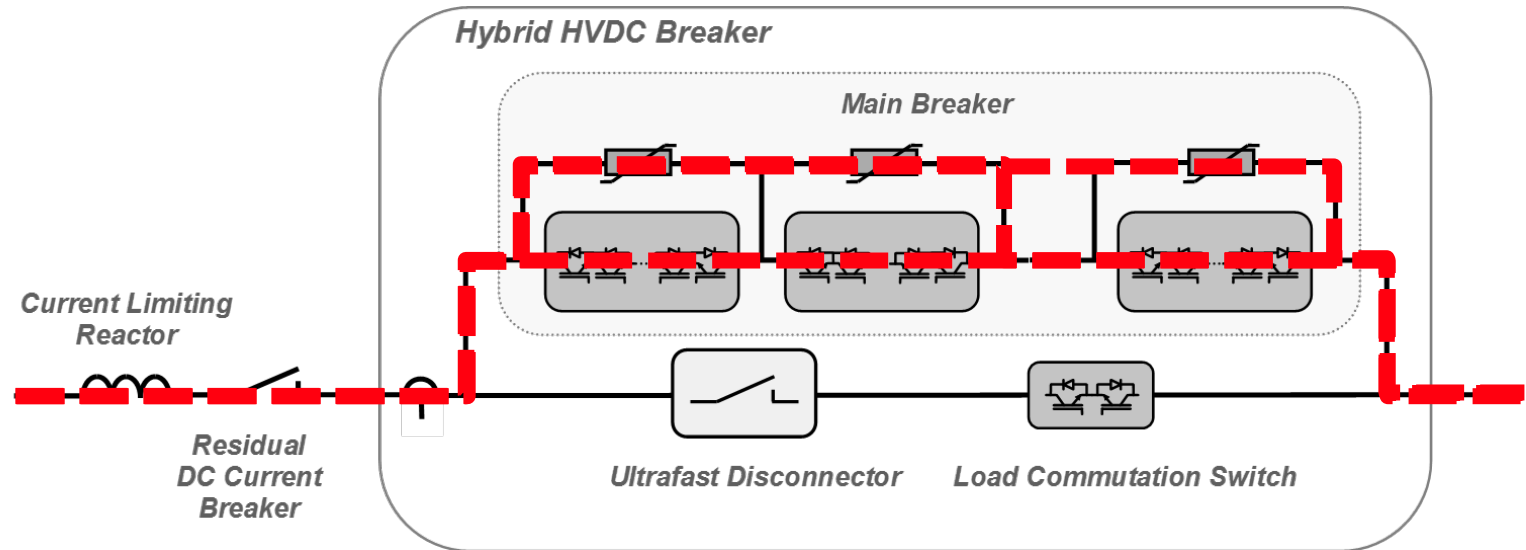
Hybrid HVDC Breaker

Advanced Functionality (1)

Proactive control: Load commutation switch commutates current into Main Breaker, the ultra-fast disconnecter opens with very low voltage stress.

Current limiting mode: Main breaker commutates parts of sections to arrestors. The remaining sections is switched on and off limiting the fault current.

Fault clearance: Main Breaker switch commutates fault current into arrester bank.



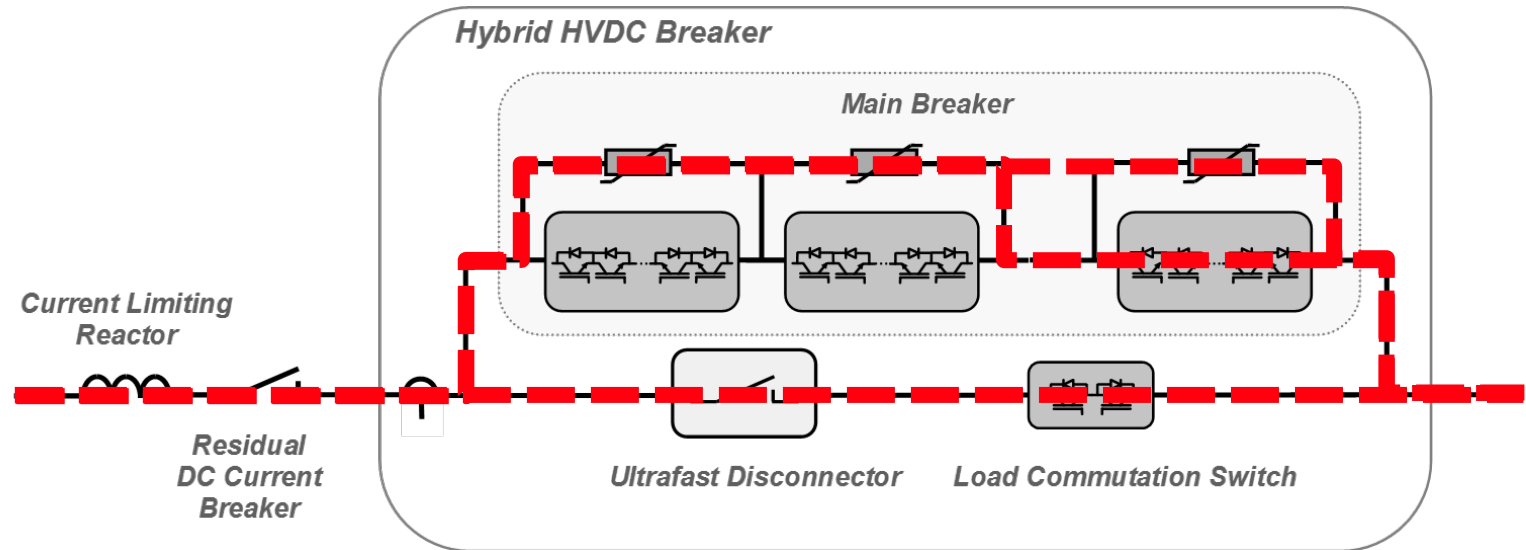
Hybrid HVDC Breaker

Advanced Functionality (2)

Ready for Energization: Load commutation and Main Breaker opened

Reduced voltage Energization: One segment of the Main Breaker closed, reduced voltage on cable/ OH-line

Normal operation: Current path through UFD and load commutation switch



Hybrid HVDC Breaker for DC connections

The planning for the connections of the future will begin

Fast: Switching times of less than 3 ms

Powerful: Very high current limitation to 16 kA

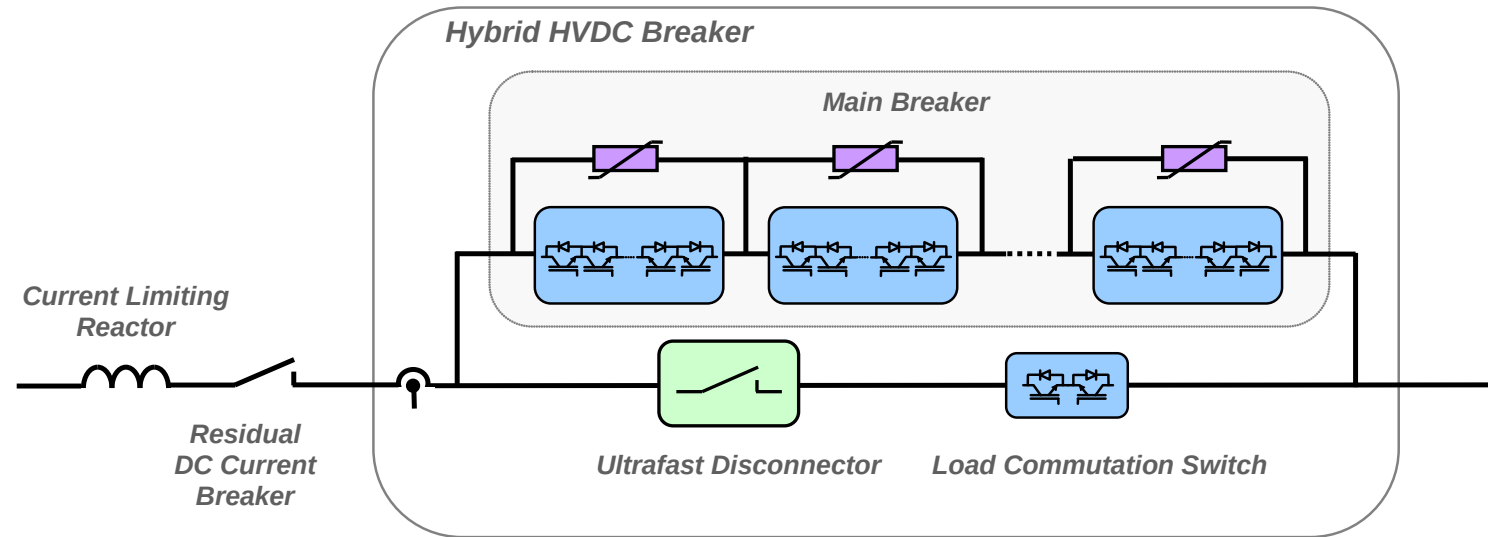
Efficient: Transmission losses of less than 0.01%

Modular: Easily adaptable to voltage and current

Reliable: Protection, current limiting, functional testing during operation

Proven: Power electronics for similar HVDC Light technology

HVDC Breaker is not a vision anymore





ABB