Fast backup protection similar to pure semiconductor breakers is possible for hybrid HVDC breakers applied to HVDC switchyards.

Due to the proactive mode, over-currents in the line or superior switchyard protection will activate the current transfer from the bypass into the main HVDC breaker or possible backup breakers prior to the trip signal of the backup protection.

In the case of a breaker failure, the backup breakers are activated almost instantaneously, typically within less than 0.2 ms. This will avoid major disturbances in the HVDC grid, and keep the required current-breaking capability of the backup breaker at reasonable values. If not utilized for backup protection, the hybrid HVDC breakers automatically return to normal operation mode after the fault is cleared.

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Prototype Design Of The Hybrid HVDC Breaker

The hybrid HVDC breaker is designed to achieve a current breaking capability of 9.0 kA in an HVDC grid with rated voltage of 320 kV and rated HVDC transmission current of 2 kA. The maximum current breaking capability is independent of the current rating and depends on the design of the main HVDC breaker only.

The fast disconnector and main HVDC breaker are designed for ***switching voltages exceeding 1.5 p.u.*** in consideration of fast voltage transients during current breaking.

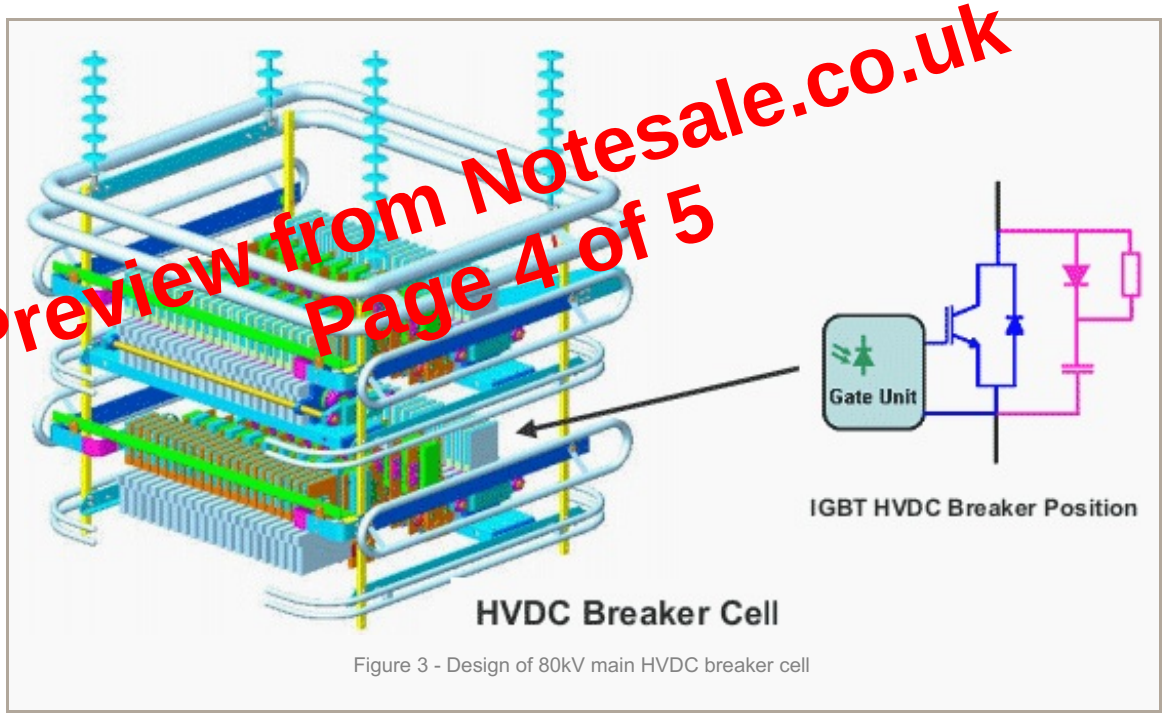

Figure 3 - Design of 80kV main HVDC breaker cell

The main HVDC breaker consists of several HVDC breaker cells with individual arrester banks limiting the maximum voltage across each cell to a specific level during current breaking. Each HVDC breaker cell contains four HVDC breaker stacks as shown in ***Figure 3***.

Two stacks are required to break the current in either current direction.

Each stack is composed of up to 20 series connected ***IGBT (insulated gate bipolar transistor) HVDC breaker*** positions.

Due to the large di/dt stress during current breaking, a mechanical design with low stray inductance is required.

Application of press pack IGBTs with 4.5 kV voltage rating [6] enables a compact stack design and ensures a stable short circuit failure mode in case of individual component failure. Individual RCD snubbers across each IGBT position ensure ***equal voltage distribution during current breaking***.