Combined Disconnecting SF$_6$ circuit-breakers

HPL and LTB SF$_6$ circuit-breakers with integrated disconnector function. Optional earthing switch, DOIT (Digital Optical Instrument Transducer) or conventional current transformer.

Rated voltages 72.5 - 420 kV.

ABB Power Transmission
Introduction

LTB and HPL are both SF₆ breakers of well proven design. LTB is an Auto-Puffer™ breaker, operated by a motor charged spring operating mechanism type BLK. HPL is a puffer breaker, operated by a motor charged spring operating mechanism type BLG.

Combined is a disconnecting circuit-breaker based on the LTB or the HPL circuit-breaker. A disconnecting circuit-breaker is a combination of a disconnector and a circuit-breaker, which fulfill all requirements for a circuit-breaker as well as for a disconnector. Combined therefore replace conventional combinations of separate circuit-breakers and disconnectors.

A simple and compact substation layout with highest availability and lowest maintenance demand is then obtained.

Visual indication of the open position and earthed contact ensures personal safety.

Design and ratings

Combined is a single or three-pole operated disconnecting circuit-breaker with a motor charged spring operating mechanism. The mechanism is enclosed in a corrosion resistant housing rated IP55.

The LTB Combined is designed for 72.5 - 145 kV with one common SF₆ chamber per phase. The HPL Combined is designed for 170 - 245 kV with one common SF₆ chamber per phase and for 362 - 420 kV with two common SF₆ chambers per phase.

Combined can optionally be equipped with an integrated earthing switch. Safe operation sequence and interlocking is gained by a mechanical and electrical interlocking scheme.

All ratings related to current carrying and switching capability are the same as for standard LTB and HPL designs, and comply with IEC Publ. 60056 and ANSI C 37. Dielectric ratings fulfill the more stringent requirements for disconnectors of the same rated voltage, and comply with IEC Publ. 60129 and ANSI C 37.

Composite insulators

Composite insulators (silicone rubber) is standard for Combined. Compared to porcelain, these insulators have superior properties with regard to pollution and associated creepage current along the insulator surface. Creepage currents across open devices are thus kept at a minimum.

Safety and interlocking

A disconnecting circuit-breaker must be equipped with a safe and reliable system which prevents mal-operation and indicates the disconnected position. The system shall prevent the circuit-breaker to be unintentionally closed and the grounding switch, if applicable, to be closed to a live circuit.

For Combined, this is carried out as a logic chain with key exchanges. Indicators such as signs, lamps and position of the earthing switch, if applicable, show when the circuit-breaker is locked in the open position. Furthermore, each breaker-pole is equipped with a direct-connected “Open/Closed” sign.

Another safety feature is the use of composite insulators, which, beside their excellent electrical properties, also are tolerant towards mechanical stress and damage.

Earthing switch

Combined can be equipped with an integrated earthing switch. The earthing switch can either be manually operated with a hand-operating gear type BCH-F or motor operated with a motor-operating gear type BCM-F. The operation of the earthing switch is integrated in the unique and advanced interlocking system for Combined. The earthing switch has a well proven design with superior mechanical endurance and low maintenance requirement.
Simplified substation layouts

The disconnecting circuit-breakers replace conventional combinations of breakers and disconnectors in many different substation layouts. A substation that is simplified in this way have comparable, or even better, availability than one with conventional breakers and disconnectors. The main reasons are reduced maintenance requirements and lower risk of equipment failure, due to reduced number of disconnectors.

Figure 1a and 1b show how a conventional double busbar scheme can be replaced by a sectionalled busbar equipped with disconnecting circuit-breakers in a combination with a COMPACT switching module. Here, three conventional disconnectors are eliminated in each line and transformer bay.

Legend:

- Disconnecting circuit-breaker
- Withdrawable Switching module
- Circuit-breaker

Power transformer

Disconnected

Combined: Features & Benefits

Features:

- Pre-manufactured multi-function module
- Integrated SF₆ breaker and disconnector function
- Pollution & explosion resistant composite (polymer) insulation
- Simplified station layout with no disconnectors
- Optional Digital Optical communication (DOIT) with condition monitoring

Benefits:

- Fast and simple installation at minimum area
- Reduced operating and maintenance cost
- Maximum personal and equipment safety
- Maintained or improved availability with lower cost
- Reliable, accurate & secure measurement, protection & control system.
Combined applications

In figure 2a and 2b, it is shown how the disconnecting circuit-breaker, Combined, together with Compact Switching modules is used to significantly reduce the number of disconnectors in a 1 ½-breaker scheme.

The disconnecting circuit-breaker can also replace the conventional combination of circuit-breaker and disconnector in a double-breaker configuration, as shown in figures 3a and 3b.
## Technical data for LTB 72.5 - 145 and HPL 245 - 420 Combined

### Rated voltage (IEC, ANSI)

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>LTB 72.5</th>
<th>145</th>
<th>242/245</th>
<th>362/420</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase-to-earth / across-open-contacts</td>
<td>650/750</td>
<td>900/900</td>
<td>1160/1160</td>
<td>1680/1680</td>
</tr>
<tr>
<td>Minimum creepage distance to earth</td>
<td>1750</td>
<td>1750</td>
<td>3500</td>
<td>--</td>
</tr>
<tr>
<td>Minimum creepage distance across break</td>
<td>25</td>
<td>25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Lightning impulse withstand voltage
- LIWL (IEC) kV: 325/375, 350/350, 452/452, 402/402
- Full wave 1.2/50 µs (ANSI) kV: 2 µs, 3 µs

### Switching impulse withstand voltage
- IEC kV: -- / --
- ANSI kV: -- / --

### Power frequency withstand voltage
- 1 min dry (IEC) kV: 140/160
- 1 min wet (IEC) kV: 275/315, 460/530, 520/610
- 1 min dry (ANSI) kV: 175/175
- 10 sec wet (ANSI) kV: 275/275

### Phase distance
- mm: 1750, 1750, 3500, --
- mm/kV: 25
- A: 3150/4000
- kA: 31.5/40/50
- First pole to clear factor: 1.3/1.5

### Making current/peak (IEC)
- kA: 79/100/125

### Making current/peak (ANSI)
- kA: 85/108/135

### Duration of short circuit
- s: 3

### Closing time (LTB/HPL)
- ms: 40/65
- ms: 20

### Opening time
- ms: 40

### Total break time
- ms: 300

### Dead time
- ms: 20 cycles

### Rated reclosing time, 50 Hz (ANSI)
- IEC: O - 0.3 sec - CO - 3 min - CO
- ANSI: CO - 15 sec - CO

### Maintenance

Since the contacts are enclosed in the controlled SF₆ gas, ageing and maintenance problems related to open-air disconnector contacts do not occur. The maintenance requirement of an disconnecting circuit-breaker is low, and is the same as for a standard circuit-breaker. There is no additional maintenance required for the disconnector function.

### Optional equipment

In addition, an integrated earthing switch will enhance safety during de-energized conditions. Finally, Digital Optical Instrument Transducers (DOIT) or conventional current transformers are available (option).
At ABB Switchgear in Ludvika over a hundred years of tradition is mixed with the latest steps within high voltage technology. Our engineers and technicians are pioneers within a number of areas, forming a platform for modern high voltage technology.

Ludvika - a centre of high voltage technology