

AFB ARC-FREE CIRCUIT BREAKER

**DC CIRCUIT BREAKER
WITH INNOVATIVE ARC-FREE
SWITCHING CONCEPT**

PRESENTATION 2019

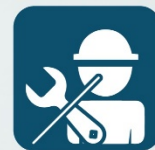
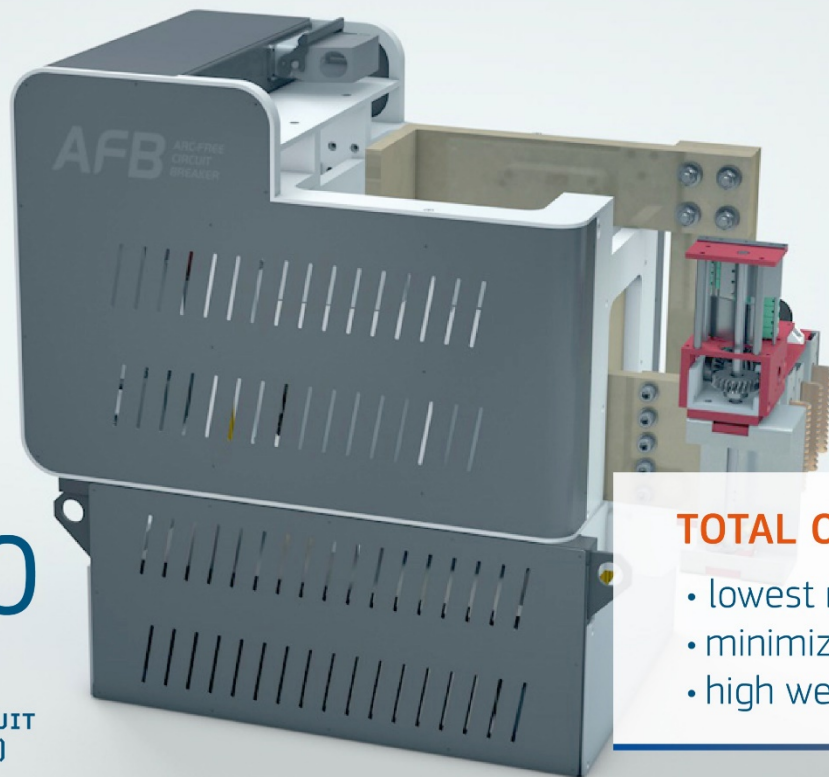


AFB

ARC-FREE
CIRCUIT
BREAKER



AFB, arc-free ultra high-speed DC circuit breaker, combines innovative solutions, modern technologies and high quality

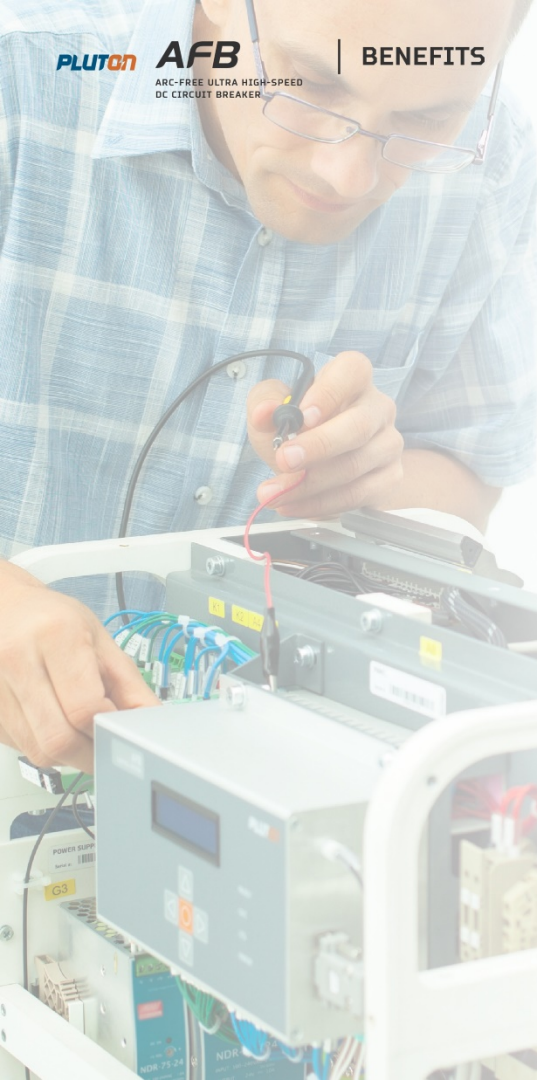


50 000

SWITCHINGS
TO MAINTENANCE
(INCLUDING SHORT CIRCUIT
CURRENT INTERRUPTION)

TOTAL OPERATION COSTS SAVING:

- lowest maintenance
- minimized costs on components
- high wear resistance and long lifetime



- / adjustment of fine current interruption setting;
- / no need for circuit breaker tripping setting calibration;
- / constant opening time that does not depend on short circuit current value;
- / number of emergency current interruptions is much higher in comparison with circuit breaker with conventional switching and arc interruption;
- / no arc breaking contacts, and as a result, no need for their periodic replacement;
- / no main contacts wear;
- / no need for main contacts replacement up to the expiry of vacuum interrupter mechanical life;
- / no need for contacts inspection after emergency currents interruption with unlimited number of trippings;
- / no arc plasma emission;
- / no combustion products;
- / no combustion products deposits on circuit breaker components and switchgear units;
- / no arc plasma overpressure in switchgear during tripping;
- / no arc plasma flashover during tripping;
- / fire risk reduction;
- / possibility of remote resetting;
- / secure interruption of low current and prevention of circuit breaker contact damage.

AFB circuit breakers are designed to be used in power distribution systems in traction substations of:

- metro,
- light-rail transport,
- tram,
- trolleybus.



RELIABILITY AND HIGH SPEED
PERFORMANCE IN ONE
COMPACT DEVICE

SHORT
TRIPPING
TIME

<1 ms

OPENING TIME

high-speed power contact opening and circuit
breaker di/dt tripping before short-circuit current
setting reaching



SAFETY GUARANTEE AND SUPERIOR BREAKING FEATURES

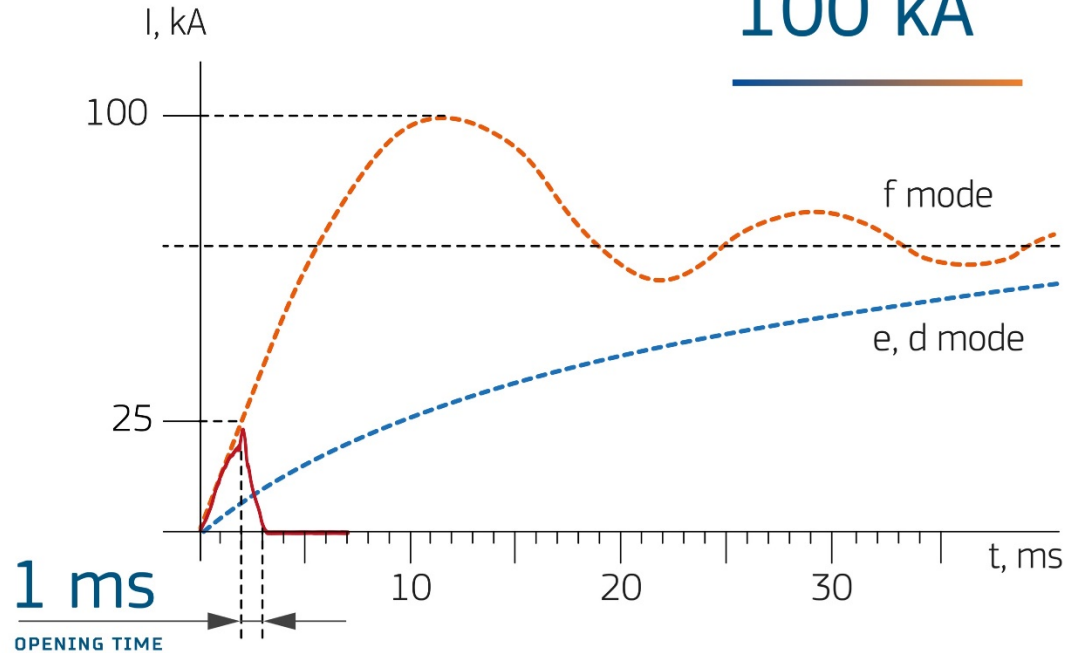
High speed tripping **under nearby short circuit** (f mode according to EN 50123-2/ IEC 61992-2) leads to current rate of rise (di/dt), amplitude and actual short circuit values limitation. This **reduces electrodynamic load on conductive parts**.

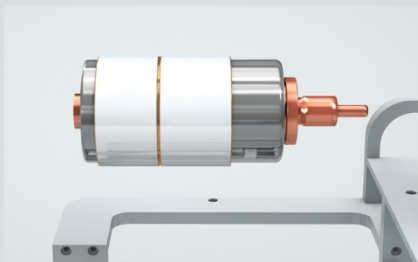
Power stored in circuit dissipates in load circuit **upon high inductivity** load tripping (e, d mode according to EN 50123-2/ IEC 61992-2). This **eliminates overvoltage and circuit breaker components wear** (under forward current direction). Power stores in capacitor, or **dissipates** on resistor upon reverse current interruption.

<25 kA

SHORT CIRCUIT CURRENT
LIMITATION WITH PEAK
CALCULATED VALUE

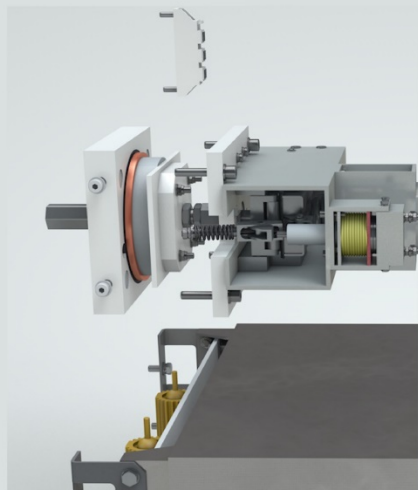
100 kA





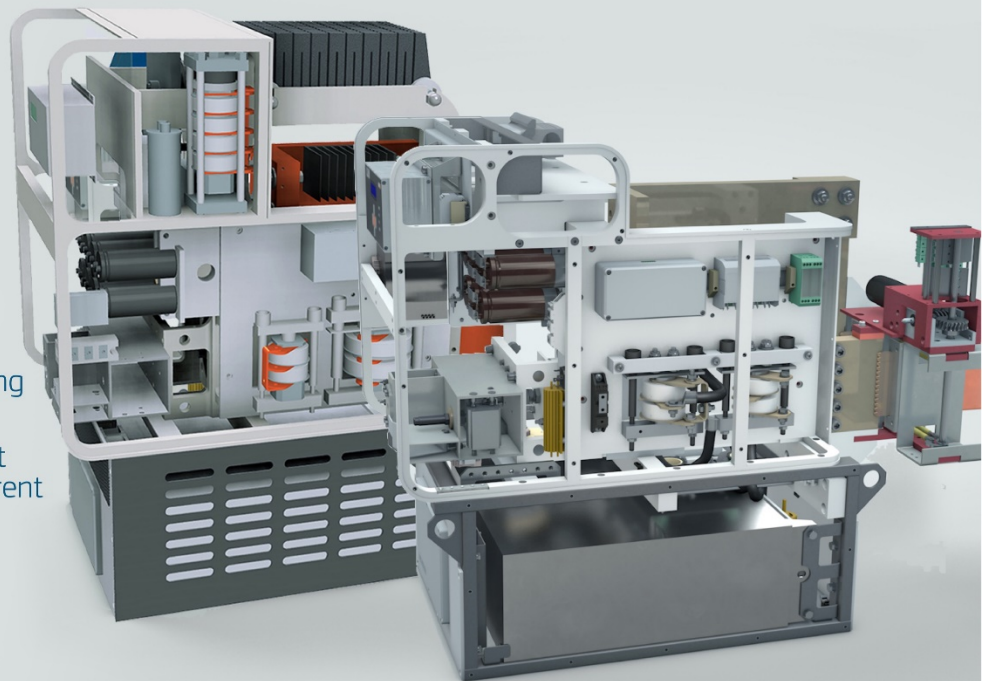
Vacuum interrupter

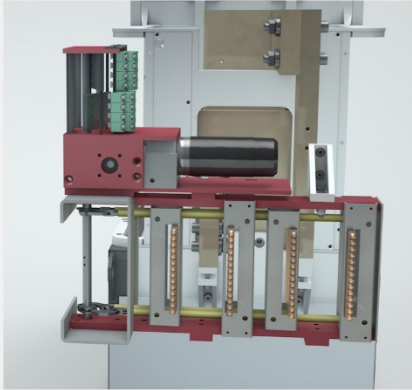
- high switching wear resistance
- no open arc
- reduction of circuit breaker work space



Electrodynamic tripping drive

- high-speed contacts opening system
- interruption speed does not depend on short circuit current value





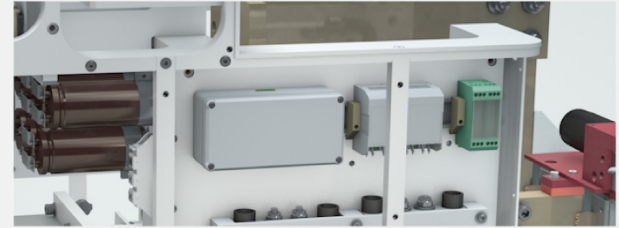
Disconnecter

- high dynamic stability
- long mechanical life
- maintenance-free



Control and internal monitoring system

- main circuit breaker units status monitoring
- line test
- fine and flexible parameters setting



Thyristors controls

- countercurrent generation for secure arc interruption

Overvoltage protection components

- effective overvoltage limitation **up to max 2 kV** level during even heaviest short circuit interruption



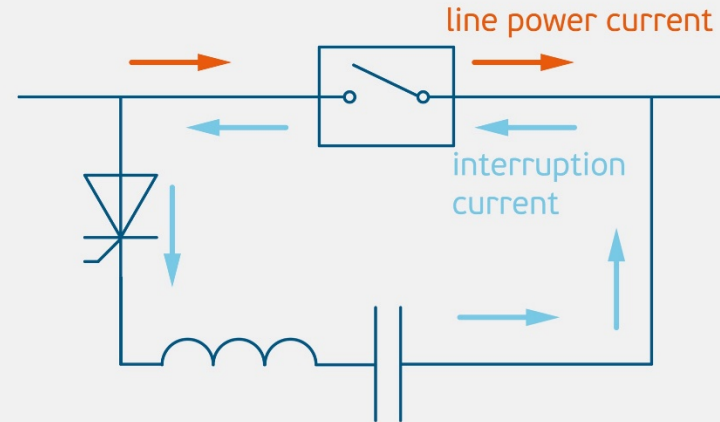
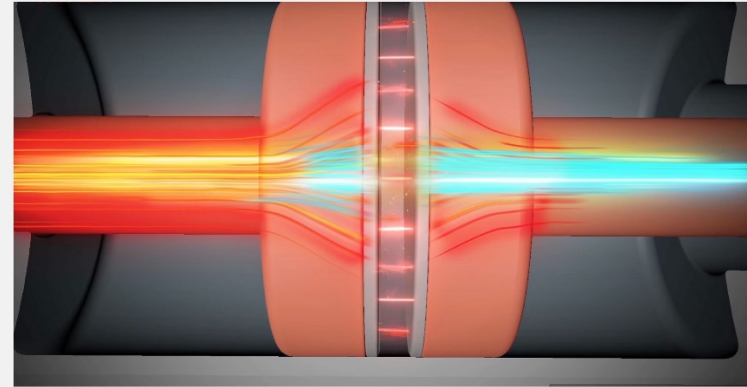
CONTROL AND INTERNAL MONITORING SYSTEM

Control and internal monitoring system provides complete all-sufficient control of circuit breaker, and fulfills all necessary functions, including protection, as well as remote control and measurement, etc.:

- 1/ all circuit breaker components and parts operation **control**
- 2/ continuous **diagnostics** of circuit breaker units
- 3/ **receipt of control signals** from upper level (via discrete signals and isolated RS-485 interface, Modbus RTU protocol)
- 4/ built-in power current and voltage **measurement system**
- 5/ **output of the system status data** and measurements for the upper level
- 6/ built-in **HMI** (LCD display with keyboard for adjusting main system parameters)
- 7/ switching overvoltages **protection system control**

Arc starts between contacts upon their opening, and is interrupted by power, stored in pre-charged high-voltage capacitor. Capacitor discharge current is switched in antiphase to the main current of power circuit. The arc is interrupted at the moment, when currents algebraic sum is zero. Afterwards the contacts open and interrupt power circuit.

Arc is interrupted regardless current direction.



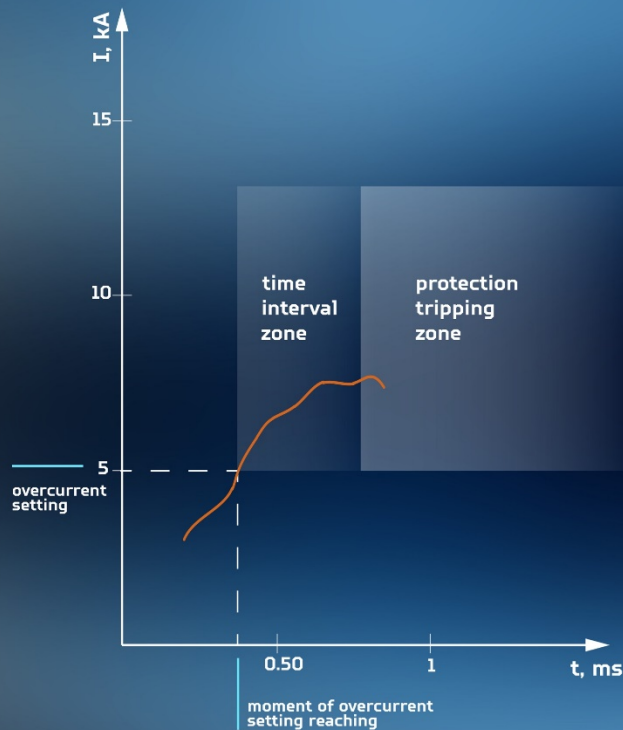
Control system has built-in adjustable

protection functions:

- I_{max} protection
- di/dt protection

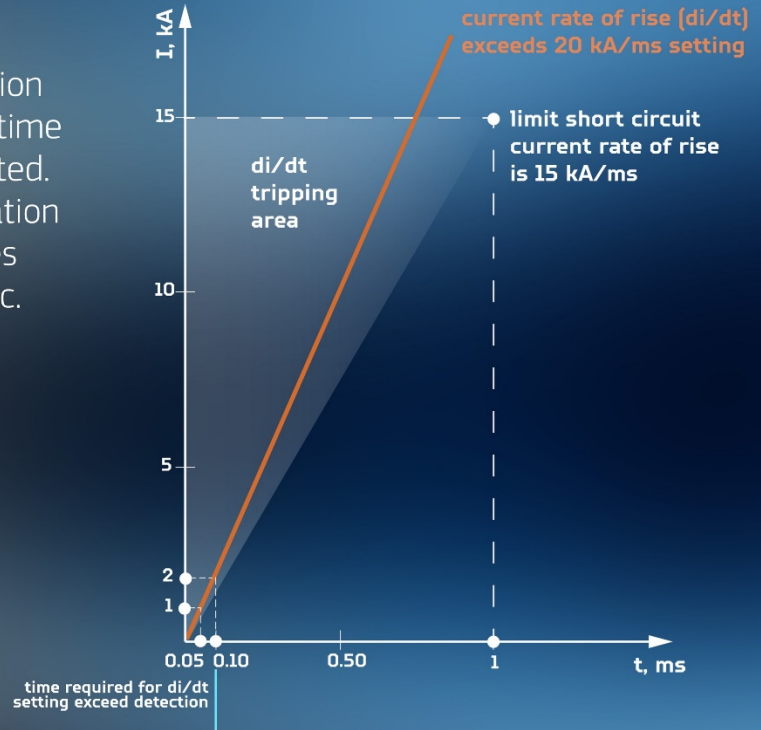
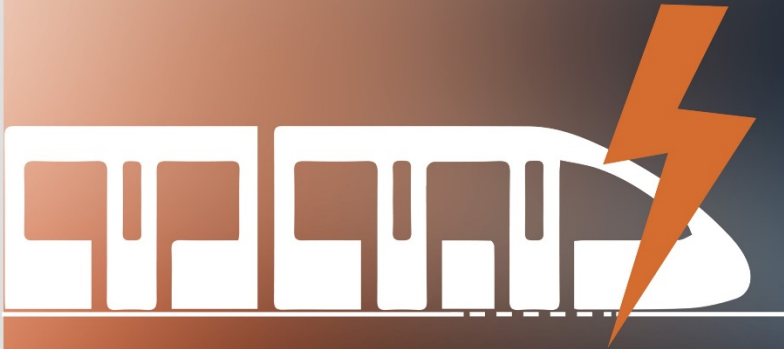
I_{max} PROTECTION

Overcurrent protection is activated upon exceeding of measured current value setting within the specified time interval.



di/dt PROTECTION

In case of current preset rate of rise exceed, protection trips before setting is reached. Thus, total tripping time is reduced and maximum short circuit current is limited. It helps to significantly reduce the number of substation equipment failures, eliminate contact network cables burn off, overheating and fire caused by overload, etc.





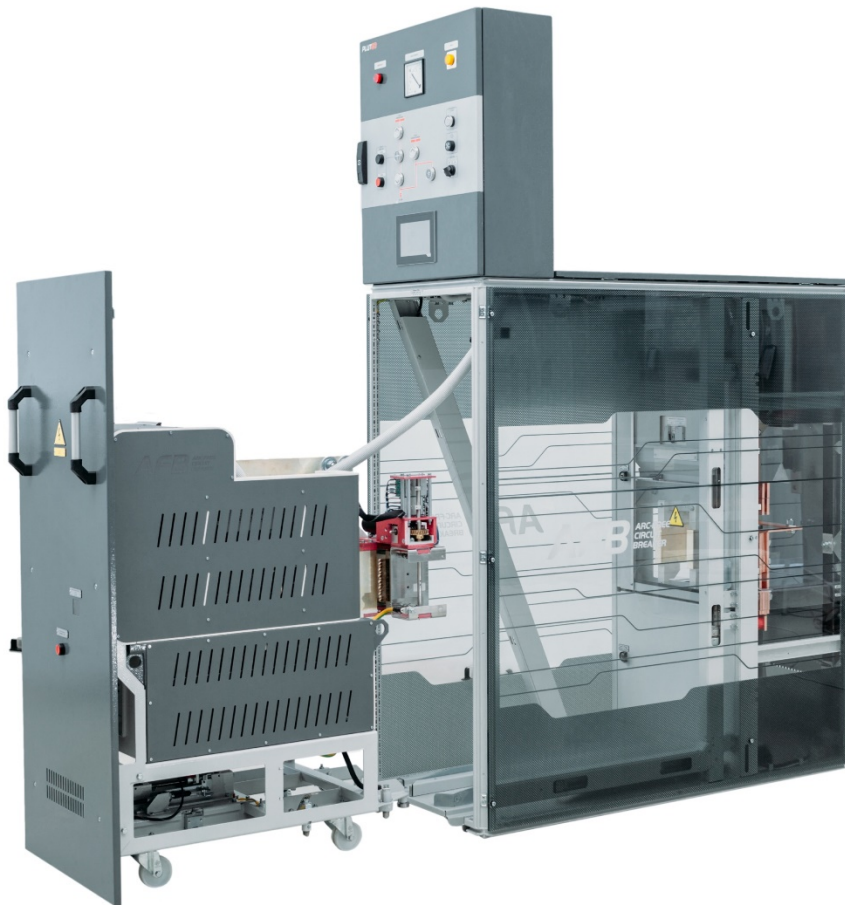
AFB ARC-FREE CIRCUIT BREAKER MAIN TECHNICAL CHARACTERISTICS

Circuit breaker type	AFB25	AFB40	
Voltage			
Rated voltage U_{Ne}	1000		V DC
Rated insulation voltage U_{Nm}	1200		V DC
Rated limit pulse voltage U_{Ni}	8000		V DC
Maximum switching overvoltage Zone B acc. to EN50124.2 (<20 ms)	2500	6000	V DC
Current			
Rated thermal current I_{th} , I_{the}	2500	4000	A DC
Rated operational current I_{Ne}	2500	4000	A DC
Duty class I_{Ncw} acc. to IEC 60146-1-1		VI	
Short-circuit current			
Rated short-circuit current I_{Nss}	80		kA
Rated short-circuit current limit value I_{ss}	100		kA
Interrupting current amplitude I_d	<25		kA
di/dt limit value	20		kA/ms

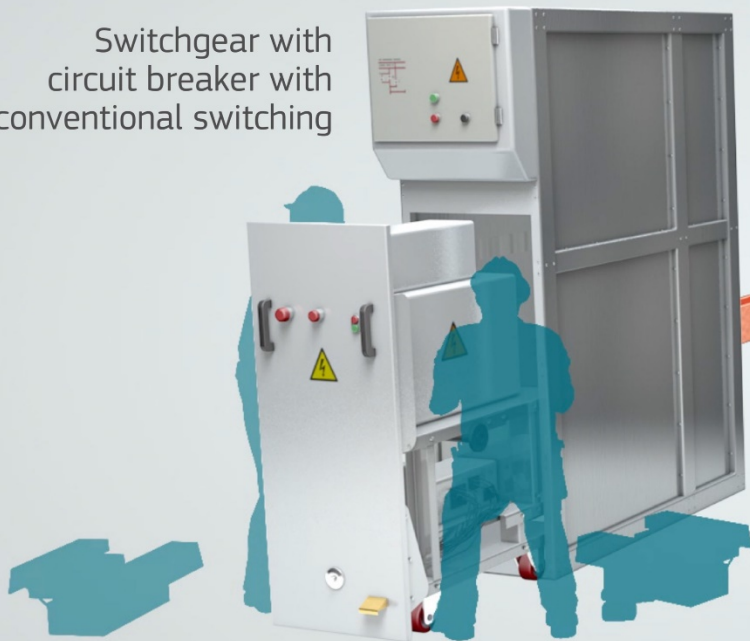
Circuit breaker type	AFB25	AFB40	
Time			
Opening time	< 1		ms
Total interrupting time	< 4		ms
Interrupting current settings range			
Forward current settings range	500 - 7500	800 - 12000	A
Backward current settings range	500 - 3750	800 - 7500	A
Weight and size parameters			
Circuit breaker weight	215	280	kg
Circuit breaker dimensions			
Width	470	470	
Height	810	940	
Depth (Length)	955	955	mm
Additional data			
Vacuum interrupter mechanical/ electrical wear resistance	50 000		switchings
Protection level	IP 00		
Auxiliaries supply voltage	220, 110, 60		V AC/DC
Control circuits supply voltage	24		V DC

NEW CONCEPT OF DC SWITCHGEAR

- / compact design
- / lowest maintenance
- / high reliability
- / serviceability and operational safety
- / compliance with
EN 50123-1/IEC 61992-1,
EN 50123-6/IEC 61992-6
international standards.



Switchgear with
circuit breaker with
conventional switching



3-280
trippings
to maintenance

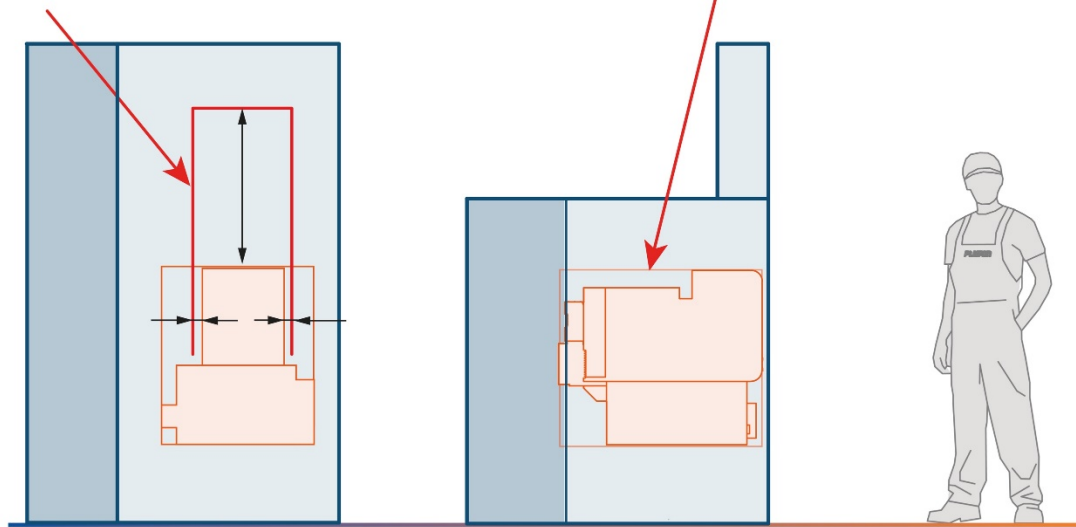
Switchgear with AFB



50 000
trippings
to maintenance

NO SPECIAL REQUIREMENTS TO APPROXIMATION GAPS

Approximation gaps

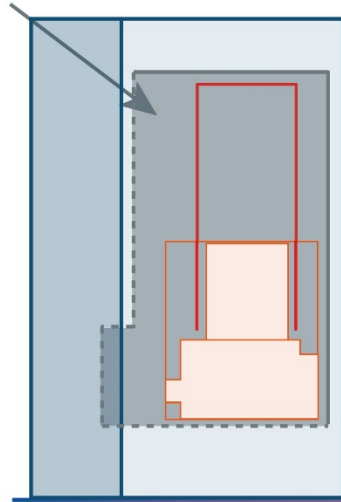


Circuit breaker
with conventional
switching

AFB

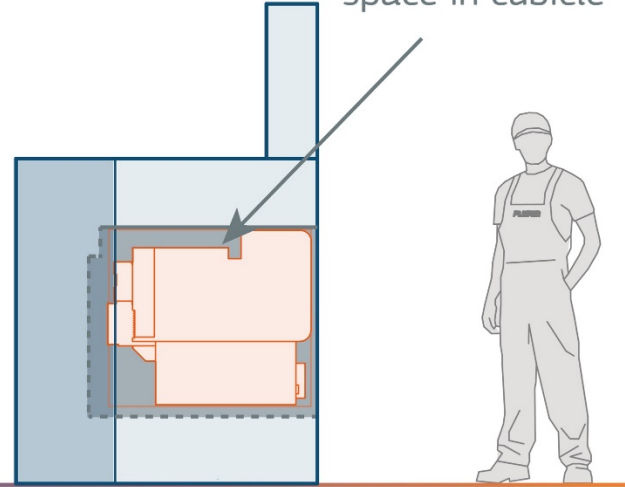
HALF THE SIZE OF WORK SPACE

Circuit breaker work
space in cubicle



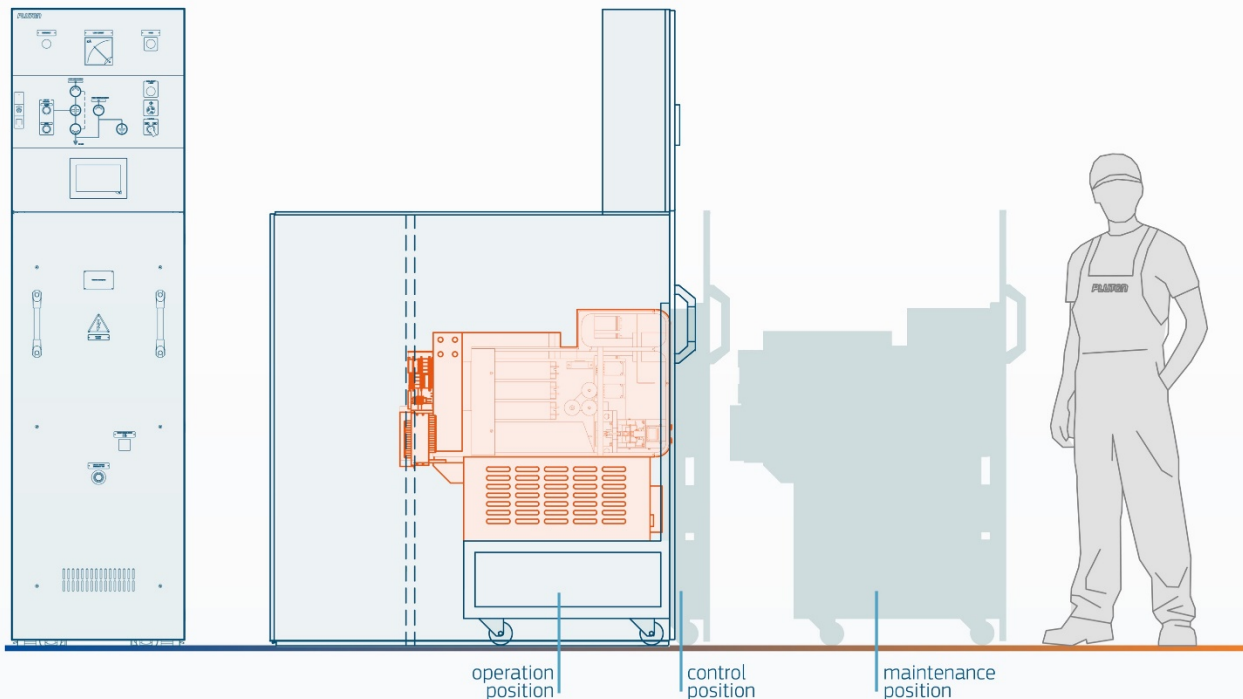
Circuit breaker
with conventional
switching

Circuit breaker work
space in cubicle



AFB

SERVICEABLE DESIGN



Circuit breaker is located on **withdrawable trolley** with 3 positions:

- **operation;**
- **control;**
- **maintenance.**

Control position provides reliable main current circuit opening and air gap visual monitoring.

Maintenance position provides circuit breaker maintainability.



Switchgear with
circuit breaker with
conventional switching



Switchgear with AFB

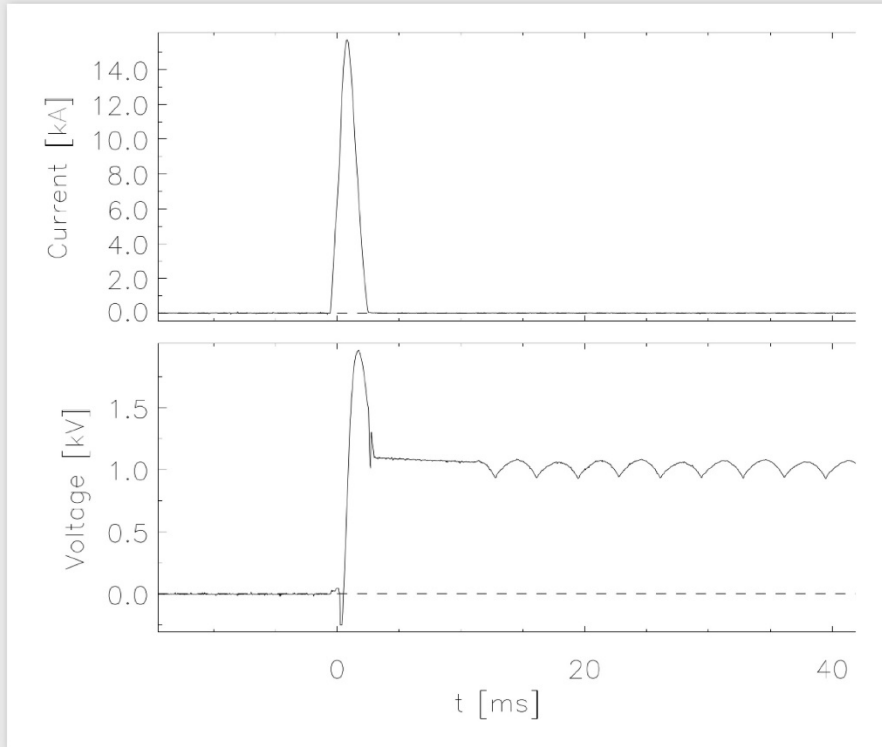
- ✓ **reliability**
- ✓ **maintenance safety**
- ✓ **environmental safety**

SUCCESSFUL OPERATION

Arc-free circuit breakers similar to AFB type are successfully applied in **Germany** at transport enterprises of Berlin, Jena, Karlsruhe, Cologne and other cities.

Switchgear with arc-free circuit breaker has successfully passed trial operation at Kyivpastrans (**Ukraine**), has positive references from operational personnel, and is passing trial operation at Minskgoelectrotrans (**the Republic of Belarus**).

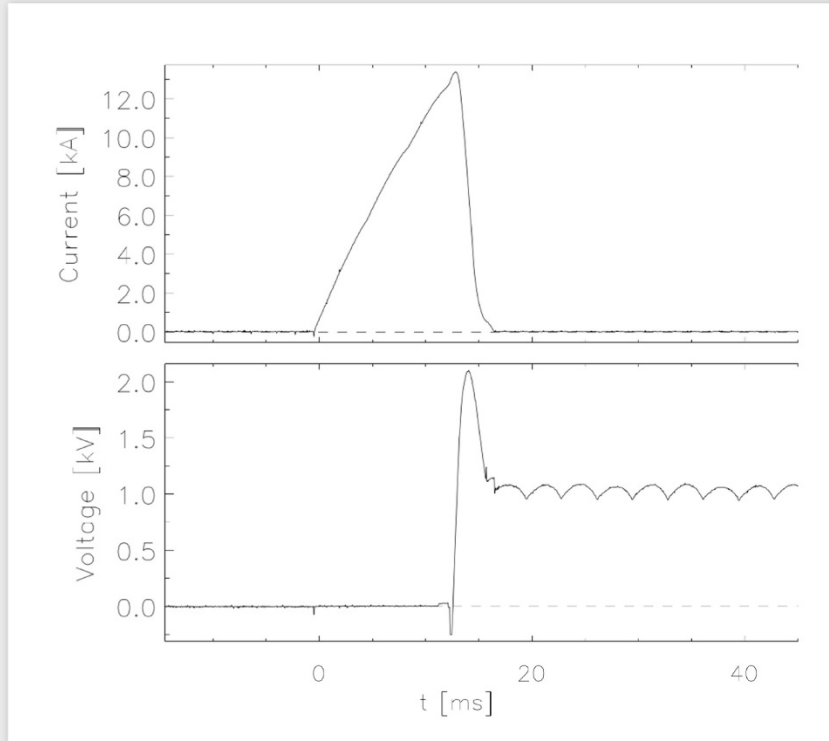




Test conditions:

Rated short circuit current, limit value	100 kA
Rated short circuit current	88 kA
Current rise speed	12.3 kA/ms
Tripping current	15.7 kA
Tripping setting	6 kA
Switching overvoltage	1.97 kV

Circuit breaker tripping current and voltage waveform for short circuit during tests at IPH Institut (Berlin, Germany)



Test conditions:

Rated short circuit current, limit value	41.8 kA
Rated short circuit current	34.7 kA
Current rise speed	1.22 kA/ms
Tripping current	13.4 kA
Tripping setting	12 kA
Switching overvoltage	2.10 kV

Circuit breaker tripping current and voltage waveform for short circuit during tests at IPH Institut (Berlin, Germany)

PLUTON ARC-FREE SOLUTIONS:

reliability and high-speed
performance

operational and environmental
safety

the lowest maintenance



A blurred high-speed train in a station with a large steel roof structure. The train is moving from left to right, creating a sense of motion. The station's roof is made of a complex network of steel beams and supports. The lighting is bright, with a strong orange glow on the left side, suggesting a bright light source or a sunset/sunrise. The overall color palette is dominated by blues and oranges.

Thank you for attention!

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