Exceeding Customer Expectations — ABB Live Tank Circuit Breakers

ABB has over a century of experience in developing, testing and manufacturing high voltage circuit breakers. Through the years, our circuit breakers have acquired a reputation for high reliability and long life in all climates and in all parts of the world.

Our apparatus are manufactured in a workshop where we continuously are working with improvements regarding quality, work environment, environment and safety.

Product range	Type	Maximum rated voltage (kV)	Maximum rated current (A)	Maximum rated breaking current (kA)
Circuit Breaker LTB	LTB D1/B	170	3150	40
SF_6 Auto-Puffer™ interrupter design	LTB E1	245	4000	50
Spring or Motor Drive operating	LTB E2	550	4000	50
mechanism(s)	LTB E4	800	4000	50
Circuit Breaker HPL	HPL B1	300	5000	80
SF_6 puffer interrupter design	HPL B2	550	5000	80
Spring operating mechanism(s)	HPL B4	800 *)	4000	80
Controlled Switching	Switchsync™			
Condition Monitoring	OLM2			

*) Up to 1200 kV on request

Other data and/or special applications not covered in this Buyer's Guide will be quoted on request.

How to interpret the type designations

The circuit breaker type designations are for simplicity reasons not always given in full in this document.
The product portfolio basically consists of three product groups:

- LTB xxxD1/B (a single-unit circuit breaker)
- LTB xxxEy (a single-, two- or four-unit circuit-breaker)
- HPL xxxBy (a single-, two- or four-unit circuit breaker)

Circuit breakers of type LTB are SF_6 gas circuit-breaker of self-blast design while circuits-breakers of type HPL are SF_6 puffer circuit breakers.
In the full type designation xxx indicates the rated voltage and y indicates number of series connected breaking units per pole. In this document where the circuit breakers are described in general the voltage designations as well as the number of series connected breaking units are omitted.

Other informations

For information about Compact air insulated HV switchgear solutions with Disconnecting Circuit Breaker, please see separate Application Guide.
Catalogue publication 1HSM 9543 23-03 en.

Further information about controlled switching applications and Switchsync™ controllers is found in Controlled Switching, Buyer's Guide/Application Guide.
Catalogue publication 1HSM 9543 22-01en.

Information about the new CO_2 insulated high voltage circuit breaker LTA is found in brochure 1HSM 9543 21-06en

Вярно с оригинала ЕЛЕКТРИКСИТИ ООД София

Explanations

Technical specifications - General

Standard/Customer specification

There are international and national standards, as well as customer specifications. ABB High Voltage Products can meet most requirements, as long as we are aware of them. When in doubt, please enclose a copy of your specifications with the inquiry.

Tests

Type tests (design tests) and routine tests (production tests) are required by standards.

- Type tests

Type tests are performed only once on one representative test object in accordance with applicable standards and are not repeated without extra charge. The purpose of the type tests is to verify the ratings of the design.

- Routine tests

Before delivery routine tests are performed in accordance with applicable standards on each circuit breaker. The purpose of the routine tests is to verify the assembly and the function on every individual circuit breaker. Routine test certificates are sent to the user with each delivery.

Extended routine tests exceeding requirements by standards will be charged extra.
Please see special chapter Quality Control and Testing.

Rated voltage

The rated voltage is the maximum voltage (phase-phase), expressed in kV rms, of the system for which the equipment is intended. It is also known as maximum system voltage.

Rated insulation level

The combination of voltage values which characterizes the insulation of a circuit breaker with regard to its capability to withstand dielectric stresses.

The rated value given is valid for altitudes ≤1000 m above sea level. A correction factor is introduced for higher altitudes.

The definition "Across isolating distance" is only applicable for disconnectors and disconnecting circuit breakers.

Rated LIWL

The lightning impulse test is performed with a standardized wave shape 1.2/50 μs for simulation of lightning over-voltage.

The rated Lightning Impulse Withstand Level (LIWL) indicates the required withstand level phase-to-earth (phase-to-ground), between phases and across open contacts.
The value is expressed in kV as a peak value.

For voltages ≥300 kV two values are stated by IEC, a LIWL voltage on one of the main terminals and power frequency voltage on the other.

Example 420 kV: 1425 (+240) kV.

Alternatively a LIWL pulse with the sum of the two voltages (1665 kV) can be applied on one terminal, while the other is grounded.

BIL (Basic Insulating Level) is an old expression but means the same as LIWL.

Rated Full Wave is often used in older ANSI/IEEE standards but means the same as LIWL.

Rated Power Frequency Withstand Voltage

This test is to show that the apparatus can withstand the power frequency over-voltages that can occur.

The Rated Power Frequency Withstand voltage indicates the required withstand voltage phase-to-earth (phase-to-ground), between phases and across open contacts. The value is expressed in kV rms.

Rated SIWL

For voltages ≥300 kV the power-frequency voltage test is partly replaced by the switching impulse test. The wave shape 250/2500 μs simulates switching over-voltage.

The rated Switching Impulse Withstand Level (SIWL) indicates the required withstand level phase-to-earth (phase-to-ground), between phases and across open contacts. The value is expressed in kV as a peak value. The switching impulse is required only for voltages ≥300 kV. Two values are stated by IEC, a SIWL voltage on one of the main terminals and power frequency voltage on the other.

Example 420 kV: 900 (+345) kV.

Alternatively a SIWL pulse with the sum of the two voltages (1245 kV) can be applied on one terminal, while the other is grounded.

Rated Chopped Wave Impulse Withstand voltage Phase-to-earth and Across open gap
The rated chopped wave impulse withstand level at 2 μs and 3 μs respectively, indicates the required withstand level phase-to-earth (phase-to-ground) and across open contacts.

The chopped wave impulse is only referred to in IEEE standards and hence, not applicable for IEC.

Rated frequency
The rated (power) frequency is the nominal frequency of the system expressed in Hz, which the circuit breaker is designed to operate in.

Standard frequencies are 50 Hz and 60 Hz.

Other frequencies, such as 16 2/3 Hz and 25 Hz might be applicable for some railway applications.

Rated normal current
The rated normal current (sometimes referred to as rated current, nominal current or rated continuous current) is the maximum continuous current the equipment is allowed to carry. The current is expressed in A rms.

The rated normal current is based on a maximum ambient temperature of +40 °C. At higher temperatures derating of the normal current might be necessary.

Rated short-time withstand current
The rated short-time withstand current is the maximum current (expressed in kA rms) which the equipment shall be able to carry in closed position for a specified time duration. The rated short-time withstand current is equal to the rated short-circuit breaking current.

Standard values for duration are 1 or 3 s.

Rated peak withstand current
The peak withstand current is the peak value of the first major loop (expressed in kA) during a short-time withstand current that the equipment shall be able to carry.
The peak value is related to the rms value, frequency and time constant (τ). Specified values are:

- 2.5 x rated short-time withstand current at 50 Hz at τ = 45 ms
- 2.6 x rated short-time withstand current at 60 Hz at τ = 45 ms
- 2.7 x rated short-time withstand current at 50/60 Hz at τ > 45 ms

Rated short-circuit breaking current
The rated short-circuit (breaking) current is the maximum symmetrical short-circuit current in kA rms, which a circuit breaker shall be capable of breaking.

Two values are related to the rated short-circuit current:

- The rms value of the AC component
- The percentage DC component (depending on the minimum opening time of the circuit breaker and the time constant τ)

Rated short-circuit making current
The rated short-circuit making current is the maximum peak current the circuit breaker shall be able to close and latch against. This is also referred to in IEEE as closing and latching capability.

Rated short-circuit making current is equal to Rated peak withstand current.

The peak value is related to the rms value of the rated short-circuit breaking current, frequency and time constant (τ). Specified values are:

- 2.5 x rated short-time withstand current at 50 Hz at τ = 45 ms
- 2.6 x rated short-time withstand current at 60 Hz at τ = 45 ms
- 2.7 x rated short-time withstand current at 50/60 Hz at τ > 45 ms

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКИТИ СОФИЯ ООД

Explanations

System and Switching Conditions

Earthing of the network
The earthing of the network may vary with region and rated voltage.

For higher rated voltages, networks tend to have effectively earthed neutral. For lower rated voltages, networks usually have non-effectively earthed neutral (isolated or resonant earthed).

The type of earthing is an important parameter for defining the transient recovery voltage

First-pole-to-clear-factor
The first-pole-to-clear-factor (k_{pp}) is depending on the earthing of the network. The first-pole-to-clear-factor is used for calculating the transient recovery voltage for three-phase faults.

In general the following cases apply:

- k_{pp} = 1.3 corresponds to three-phase faults in systems with an effectively earthed neutral.
- k_{pp} = 1.5 corresponds to three-phase faults in isolated systems or resonant earthed systems.
- k_{pp} = 1.0 corresponds to special cases, e.g. two-phase railway systems, short-line fault.

A special case is when there is a three-phase fault without involving earth. This case corresponds to k_{pp} = 1.5. This case is covered by the IEEE standards.

Rated Transient Recovery Voltage
The rated transient recovery voltage (TRV) is the peak transient voltage (expressed in kV) that corresponds to the first-pole-to-clear when interrupting a three-phase fault at rated short-circuit current.

The rated transient recovery voltage (u_c) is calculated as follows (based on IEC):

$$u_c = \frac{U_r \times k_{pp} \times \sqrt{2} \times k_{af}}{\sqrt{3}}$$

Where:
U_r Rated voltage (kV)
k_{pp} first-pole-to-clear-factor
k_{af} Amplitude factor (According to IEC: 1.4 at 100% short-circuit current)

Example:
At 145 kV with k_{pp} = 1.5 the rated transient recovery voltage will be 249 kV

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Rated out-of-phase making and breaking current
The rated out-of-phase breaking current is the maximum out-of-phase breaking
current the circuit breaker shall be capable of breaking.

The standard value of the rated out-of-phase breaking current is 25% of the rated short-circuit breaking current.

Out-of-phase
The power frequency recovery voltage (rms) for out-of-phase conditions can be calculated as:

$$u = \frac{U_r \times k_{pp}}{\sqrt{3}}$$

The corresponding transient recovery voltage (u_c) can be calculated as:

$$u_c = \frac{U_r \times k_{pp} \times \sqrt{2} \times k_{af}}{\sqrt{3}}$$

Where:
U_r Rated voltage (kV)
k_{pp} first-pole-to-clear-factor (out-of-phase) or out-of-phase voltage factor
k_{af} Amplitude factor (According to IEC: 1.25)

Standardized values for the out-of-phase voltage factors are:

- 2.0 for systems with effectively earthed neutral
- 2.5 for systems with non-effectively earthed neutral

Example:
At 245 kV with k_{pp} = 2.0, the out-of-phase transient recovery voltage will be 500 kV

The applied voltage before making is not affected by the earthing of the system. The maximum applied voltage during out-of-phase conditions is always 2.0 times the single-phase voltage.

Rated surge impedance and other short-line fault characteristics
When a short-circuit occurs on an overhead line not far from a circuit breaker, traveling waves will generate a very steep first part of the transient recovery voltage. The Rate of Rise of Recovery Voltage, RRRV is depending on the short-circuit current and the surge impedance.

The surge impedance may vary depending on e.g. type of conductors.

In standards IEC and IEEE, the surge impedance has been standardized to a value of 450 Ω.

Other characteristics for the short-line fault are the peak factor and the RRRV factor. These have been standardized to the following values:

Peak factor: 1.6
RRRV factor: 0.2 (kV/μs)/kA for 50 Hz
0.24 (kV/μs)/kA for 60 Hz

Capacitive voltage factor
The capacitive voltage factor is used for defining the single-phase recovery voltage for different capacitive switching applications. The factor is depending on the following:

Application
- No-load line switching
- No-load cable switching
- Capacitor bank switching

Earthing of the network
- Earthed neutral
- Non-effectively earthed neutral (isolated or resonant earthed)

Standard values for capacitive voltage factors for normal service conditions are as follows:

No-load line switching:
- 1.2 (effectively earthed neutral)
- 1.4 (non-effectively earthed neutral)

No-load cable switching:
- 1.0 (screened cables in systems with solidly earthed neutral)
- 1.2 (belted cables in systems with effectively earthed neutral)
- 1.4 (in systems with non-effectively earthed neutral)

Capacitor bank switching:
- 1.0 (capacitor bank with earthed neutral in systems with solidly earthed neutral)
- 1.4 (capacitor bank with non-effectively earthed neutral)

When different capacitive voltage factors apply from different applications, the highest value should be referred to.

The voltage factor can be used to calculate the single-phase recovery voltage peak:

$$u_c = \frac{U_r \times k_c \times 2 \times \sqrt{2}}{\sqrt{3}}$$

Where:
U_r Rated voltage
k_c Capacitive voltage factor

Example:
What is the peak recovery voltage for a 245 kV breaker when switching a no-load line with earthed neutral?

The voltage factor is 1.2 due to earthed neutral system.

The peak recovery voltage is:

$$u_c = \frac{245 \times 1.2 \times 2 \times \sqrt{2}}{\sqrt{3}} = 480\,kV$$

Capacitive switching class
There are two different capacitive switching classes:

- Class C1: Circuit breaker with low probability of restrike during capacitive switching.
- Class C2: Circuit breaker with very low probability of restrike during capacitive switching.

A circuit breaker intended for Class C2 can of course also be used for Class C1.

Rated capacitive inrush current and inrush frequency
The rated capacitive inrush current (peak value) is only applicable for circuit breakers intended for switching of (mainly back-to-back) capacitor banks.

The inrush current is characterized by a very high inrush current and inrush frequency.

Values may vary due to different configurations of capacitor banks, current limiting inductance etc.

Standardized value of inrush current is 20 kA (peak value) and with an inrush current frequency of 4.25 kHz.

Time constant
The time constant of the system is equal to the ratio between inductance and resistance in the network (L/R) and is expressed in ms. Standard value is 45 ms. The time constant will affect the required DC component.

There is a relationship between the time constant and the X/R-ratio.
If a required X/R-ratio has been given, the time constant in ms can easily be calculated by dividing the X/R-ratio with (2 x π x f), where f is the rated frequency.

Example:
X/R = 14 corresponds to a time constant of 45 ms at 50 Hz
X/R = 17 corresponds to a time constant of 45 ms at 60 Hz

Explanations

Ambient Conditions

Minimum ambient temperature

The minimum ambient (air) temperature specifies the lowest temperature at which the circuit breaker shall be able to operate, at specified ratings.

Important standard values are -30 °C and -40 °C

The minimum ambient temperature affects the choice of gas pressure and/or gas mixture.

Maximum ambient temperature

The maximum ambient (air) temperature specifies the highest temperature at which the circuit breaker shall be able to operate, at specified ratings.

The maximum ambient temperature can affect the continuous current carrying capability.

Standard value is +40 °C.

Altitude

The external dielectric strength becomes reduced at higher altitudes due to the lower density of air. Standard dielectric type tests are valid for installations up to 1000 masl. For verification of the suitability of installation at higher altitudes the test voltages has to be corrected.
Correction factor according to standard has to be used for external insulation. (IEC 62271-1)

Creepage distance

The creepage distance is defined as the shortest distance along the surface of an insulator between two conductive parts.

The required creepage distance is specified by the user in:

- mm (total creepage distance)
- mm/kV (creepage distance in relation to the phase to ground voltage).

NOTE!
Creepage distance voltage used to be phase to phase voltage. To avoid confusion check which voltage reference that is used.

Pollution level

Environmental conditions, with respect to pollution, are sometimes categorized in pollution levels. The pollution levels are described in IEC 60815. During 2008 the former levels I, II, III and IV were replaced with the five levels a, b, c, d, and e.

There is a relation between each pollution level and a corresponding minimum nominal specific creepage distance. Since 2008 IEC 60815 states that the phase - ground voltage shall be used for description of creepage distances instead of phase - phase voltage as in the old versions of the standard.

As a reference the old values are also given below.

Pollution level	Creepage distance Phase - Ground voltage mm/kV	Creepage distance (Old) Phase - Phase voltage mm/kV
a - Very light	22.0	-
b - Light	27.8	(16)
c - Medium	34.7	(20)
d - Heavy	43.3	(25)
e - Very Heavy	53.7	(31)

Ice class

If applicable, outdoor switchgear may be assigned to withstand a specified ice coating. Three classes exist in IEC:

- 1 mm of ice coating
- 10 mm of ice coating
- 20 mm of ice coating

Wind load

The specified wind loads for circuit breakers intended for outdoor normal conditions are based on a wind speed of 34 m/s, (IEC).

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Design

Single- or three-pole operation

For single-pole operation (1-pole operation), each individual pole of the circuit breaker is operated by its own operating mechanism. This makes single-phase as well as three-phase auto-reclosing possible.

For three-pole operation, (ganged operation) all three poles are operated by a common operating mechanism. The three poles are mechanically linked together for three-phase auto-reclosing.

(Two-pole operation applies only for special applications, i.e. railway systems.)

Trip-free circuit breaker

A circuit breaker which can perform a complete opening operation, even if the trip command is activated during a closing operation and with the closing command maintained.

NOTE! To ensure proper breaking of the current that may be established, it may be necessary that the contacts momentarily reach the closed position.

Fixed trip

A circuit breaker that cannot be released except when it is in the closed position.

Pre-Insertion Resistors (PIR)

Pre-insertion resistors (closing resistors) are used to limit over-voltages in the network during switching operations. The pre-insertion resistors are only used during closing and consist of resistor blocks that are connected in parallel with the breaking chamber.

The resistor blocks will close the circuit approximately 8-12 ms before the arcing contacts.

Pre-insertion resistors are mainly used at higher system voltages (≥362 kV).

For several applications, controlled switching using Switchsync™ is preferred.

Pre-insertion resistors should not be mixed up with opening resistors, which are used for reducing (damping) the TRV during opening. Opening resistors are mainly used on older types of circuit breakers, e.g. air-blast circuit breakers.

Rated operating sequence

The rated operating sequence (also known as standard operating duty or standard duty cycle) is the specified operating sequence, which the circuit breaker shall be able to perform at specified ratings.

There are two main alternatives:

a) O - t - CO - t' - CO

Where:

t 0.3 s for circuit breakers intended for rapid auto-reclosing

t 3 min for circuit breakers not intended for rapid auto-reclosing

t' 3 min

b) CO - t'' - CO

Where:

t'' 15 s for circuit breakers not intended for rapid auto-reclosing

Mechanical endurance class

There are two different mechanical endurance classes:

Class M1: Circuit breaker with normal mechanical endurance (2 000 operations).

Class M2: Frequently operated circuit-breaker for special service requirements (10 000 operations).

A circuit breaker intended for Class M2 can of course also be used for Class M1.

Terminal load

The conductors connected to the circuit breaker terminals, as well as ice and wind loads, cause the resultant static terminal loads.

Standard values for static terminal loads are given by the standards.

The rated static terminal loads of the equipment are normally verified by load calculations.

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Explanations

Design

Pressure

Gas pressures can be expressed in several units, such as MPa, bar, P.s.i etc.

1 MPa = 10^6 Pa = 10 bar = 145 P.s.i

Rated filling pressure

The rated filling pressure is given at the reference temperature of +20 °C and may be expressed in relative or absolute terms. The rated filling pressure is the pressure to which the circuit breaker is filled before being put into service.

Alarm pressure

The alarm pressure is given at the reference temperature of +20 °C and may be expressed in relative or absolute terms. The alarm pressure is the pressure at which a monitoring (alarm) signal indicates that replenishment is necessary in a relatively short time.

Minimum pressure
(Lock out, interlocking or blocking pressure)

The minimum pressure is given at the reference temperature of +20 °C and may be expressed in relative or absolute terms. The minimum pressure is the pressure at which the circuit breaker becomes interlocked for further operation and when replenishment is necessary.

All type tests, except mechanical endurance test, are performed at this pressure.

Maximum pressure

The maximum pressure is given at the reference temperature of +20 °C and may be expressed in relative or absolute terms. The maximum pressure is the pressure at which the circuit breaker is carrying its normal current at maximum ambient temperature.

Grading capacitors

Grading capacitors are sometimes used on circuit breakers of multi-break design (two or more identical making/breaking units connected in series) to obtain uniform distribution of the voltage stresses across the open gaps.

The grading capacitor is connected in parallel with each and every making/breaking unit and has a standard value of 1600 pF/capacitor.

The total capacitance across one open pole is calculated as follows: $C_{tot} = C_{gr}/n$

Where:

C_{gr} is the capacitance of each grading capacitor.

n is the number of making/breaking units connected in series

Parallel capacitor

Parallel capacitors are used to modify the line-side transient recovery voltage during short-line fault conditions. Use of a parallel capacitor may result in a higher short-circuit breaking capacity.

Time Quantities

Opening time
The opening time is the interval of time from energizing of the opening release (e.g. opening coil) for a circuit breaker being in closed position and the instant when the (arcing) contacts have separated in all poles.

Closing time
The closing time is the interval of time from energizing of the closing release (e.g. closing coil) for a circuit breaker being in open position and the instant when the (arcing) contacts touch in all poles.

Rated break time
The rated (maximum) break time (interrupting time) is the time interval between energizing the trip circuit and when the arc is extinguished in all poles.
The break time is expressed in ms or cycles
(20 ms = 1 cycle at 50 Hz).
In IEC, the break-time is based on the results of the terminal fault test duties with symmetrical current.
Compensation is made for single-phase testing and for reduced control voltages.

Dead time
The dead time (during auto-reclosing) is the interval of time between final arc extinction in all poles in the opening operation and the first re-establishment of current in any pole in the subsequent closing operation.
IEC and ANSI/IEEE specify a dead-time of 300 ms.

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Arcing time
Interval of time between the instant of the first initiation of an arc and the instant of final arc extinction in all poles.

Pre-arcing time
Interval of time between the initiation of current flow in the first pole during a closing operation and the instant when the contacts touch in all poles for three-phase conditions and the instant when the contacts touch in the arcing pole for single-phase conditions.

Reclosing time
The reclosing time is the interval of time between the energizing of the opening release (e.g. opening coil) and the instant when the contacts touch in all poles during a reclosing cycle.
If the differences in operating times (closing and opening time respectively) between poles are small and can be neglected, the following approximative formula can be applied:
Reclosing time = Opening time + Arcing time + Dead time + Pre-arcing time

Close-Open time
The close-open time is the interval of time between the instant of contact touch in the first pole during a closing operation and the instant when the (arcing) contacts have separated in all poles during the following opening operation.
The opening release (e.g. opening coil) shall have been energized at the instant when the contacts touch during closing (CO-operation without any intentional time delay; pre-tripped CO-operation).
NOTE: The close-open time is not equal to Closing time + Opening time.

Open-Close time
The open-close time (during auto-reclosing) is the interval of time between the instant of contact separation in all poles and the instant when the contacts touch in the first pole in the subsequent closing operation.
If the differences in operating times (closing and opening time respectively) between poles are small and can be neglected, the following approximative formula can be applied:
Open-Close time = Arcing time + Dead time + Pre-arcing time

Make time
Interval of time between energizing the closing circuit, the circuit breaker being in the open position, and the instant when the current begins to flow in the first pole.

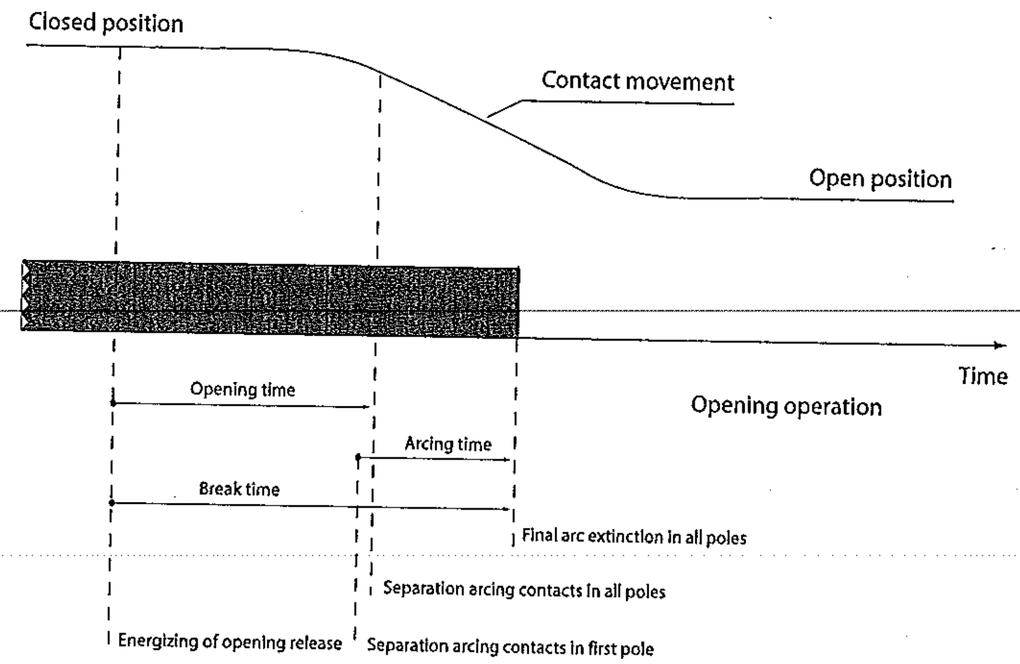
Make-Break time
The make-break time is the interval of time between the initiation of current flow in the first pole during a closing operation an the end of the arcing time during the subsequent opening operation.
The make-break time is based on an operation where the opening release (e.g. opening coil) shall have been energized at the instant when the contacts touch during closing (CO-operation without any intentional time delay also known as a pre-tripped CO-operation).
If the differences in operating times (closing and opening time respectively) between poles are small and can be neglected, the following approximative formula can be applied:
Make-break time = Pre-arcing time + Close-open time + Arcing time

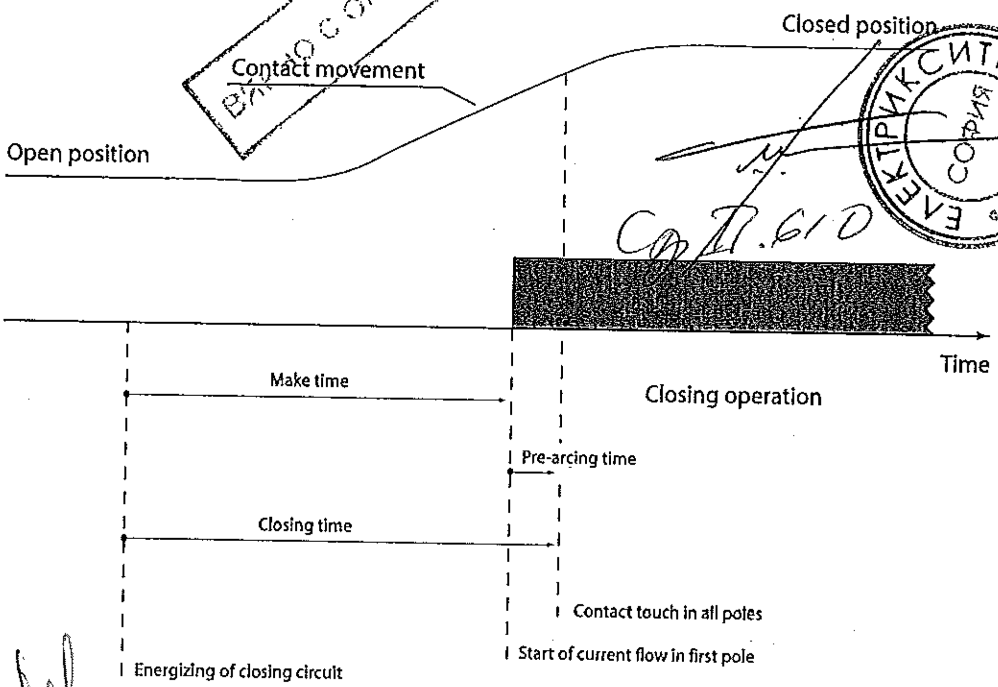
ЕЛЕКТРИКСИТИ ООД СОФИЯ

Стр. II 609

Explanations

Time definitions according to IEC





Operation and Control
Operating Mechanism - Contròl Cubicle

Control voltage
Control voltage is a DC supply used for the control circuits such as: Close circuit and trip circuits etc.

Common rated control voltages:
110, 125, 220 or 240 V DC
(Less common rated control voltages: 250, 60 or 48 V DC)

The operating mechanism, including the control circuit, is designed for a rated control voltage but must additionally have operational capability throughout a specific voltage range to accommodate variations in supply voltage. The following required voltage ranges are required according to IEC:

Minimum voltage (auxiliary equipment): 85% of rated voltage
Maximum voltage (auxiliary equipment): 110% of rated voltage

Minimum voltage (close circuit): 85% of rated voltage
Maximum voltage (close circuit): 110% of rated voltage

Minimum voltage (trip circuit): 70% of rated voltage
Maximum voltage (trip circuit): 110% of rated voltage

Heating voltage / AC Auxiliary voltage
AC Auxiliary voltage is an AC single-phase (phase – neutral) supply used for Heaters, Socket outlet and Lighting etc. when used.
Normal values:
110 - 127 V AC
220 - 254 V AC

Motor voltage
Motor voltage is a DC supply or an AC single-phase (phase – neutral) supply for the spring charging motor.

Common rated motor voltages:
110, 125, 220 and 240 V DC
115, 120, 127, 230 and 240 V AC

The motor and the motor circuit are designed for a rated voltage but must additionally have operational capability throughout a specific voltage range to accommodate variations in supply voltage. The following required voltage range is required according to IEC:

Minimum voltage for motor circuit: 85% of rated voltage
Maximum voltage for motor circuit: 110% of rated voltage

Closing spring charge motor
The closing spring charging motor charges the closing spring after every closing operation.

Motor contactor
Motor contactor is controlled by the limit switch and starts / stops the closing spring charging motor.
(N.A. for FSA operating mechanism)

Limit switch
The limit switch is monitoring the closing spring charging status.

For operating mechanism BLK and FSA1 it can be of inductive or mechanical type.

For operating mechanism BLG and MSD only mechanical type.

Auxiliary contacts
Auxiliary contacts are contacts that show the circuit breaker position.

At least one contact is used in each control circuit (trip / close) to control the coil supply. Contacts not used in control circuits, are normally connected to terminals for customer use.

Normal spare contact quantities for customer use:
FSA: 7 NO + 7 NC
BLK: 8 NO + 8 NC
BLG: 9 NO + 9 NC
MSD: 9 NO + 9 NC

NO = Normally open, NC = Normally closed

Impulse contact / Wiping contact
A contact that gives an short impulse during contact movement.

Local / Remote / Disconnected selector switch
The local / remote / disconnected selector switch is used to switch between remote operating and local operating (via the open / close switch). It also has a disconnected position where operation is not possible. However a protection trip bypass can be supplied that makes it possible to trip the circuit breaker remotely even in disconnected position.

As an alternative a Local / Remote switch without disconnecting possibility can be provided.

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ЕЛЕКТРИКСИТИ ООД СОФИЯ

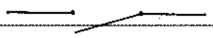
Explanations

Operation and Control
Operating Mechanism - Control Cubicle

NC-contact

NC-contact (normally closed contact) is a closed contact when device is not energized or in the drawn situation, according to circuit diagram.
Could also be called: Break contact or b-contact.

NO-contact



NO-contact (normally open contact) is an open contact in the same situation.
Could also be called: Make contact or a-contact.

NOC-contact

NOC-contact (normally open-closed contact) is a closed contact that opens and an open contact that closes with a common backside when changing position.
Could also be called: Change-over contact.

Trip / Close switch
The trip / close switch is used for control operations, when the local / remote (/ disconnected) switch is in local position.

Counter
The counter is a non-resettable electromechanical counter that counts every close operation. (FSA has a mechanical counter)

Anti-pumping relay
The anti-pumping relay is a device that makes sure that there can be only one closing operation for each closing order.

MCB – Miniature Circuit Breaker
The MCB (Miniature Circuit Breaker) is a small automatic breaker that can be manually controlled or automatically tripped due to over-current.

The over-current is either thermal (type K) or peak value (type B). 1NO + 1NC auxiliary contacts, that shows MCB position, can be included.

The MCB is normally used for AC auxiliary circuit (and motor circuit for operating mechanism type BLK)

Direct On Line Motor Starter
Direct On Line Motor Starter is a motor protection and manual control unit. This could also be an MCB (thermal controlled type). This unit trips the motor supply when motor overload occurs or when the Direct On Line Motor Starter is manually operated.

Operating coils
Close and trip coils in operating mechanisms BLK, BLG and MSD have relatively low power consumption, normally 200 W, due to a very good latch design.
One close and two trip coils are supplied as standard.

Additional close coils can be supplied as option. Also the second trip coil can be of the double type and additional trip circuit can be used.

Hand / Motor switch
The hand / motor switch disconnects the motor circuit during hand cranking.
The hand / motor switch, either manual or automatic, has the following functions:

- Motor position; connects the motor to the power supply.
- Hand position; short-circuits the motor and is used as a generator brake.

(N.A. for FSA and MSD operating mechanism)

Heaters, Thermostat, Humidity controller
Every operating mechanism has a continuous connected anti-condensation heater of 70 W.

In addition to that, one or more controlled heaters are fitted, depending on ambient temperature or humidity. These are controlled by a thermostat, or as an option, a humidity controller (a moisture detector controller).

Density switch
The density switch is a device that measures the ambient temperature compensated gas pressure, inside the circuit breaker. Therefore, alarm signal and blocking function are activated only if the pressure drops due to leakage.

The density switch includes normally: a scale display, one contact indicating the alarm pressure and two contacts controlling the gas-supervision interlocking relays at the blocking level.

ВЯРНО С ОРИГИНАЛА

Operation and control - ABB options

Gas supervision
- Fail-safe
Normally a switch with contacts closing at low gas-pressure is used.

A fail-safe option can be supplied where contacts are opening at low gas-pressure, so the gas supervision interlocking relays are energized until the blocking occurs.

- Trip at low SF_6
Another option is trip at low SF_6-pressure. This option gives a trip order via the gas- supervision interlocking relays at the same time blocking occurs.
Most type tests are carried out at this blocking pressure.

Panel light
Panel light can as an option be fitted on the control panel.

The panel lamp is automatically switched on when the panel door is opened.

Socket outlet
Socket outlet can be fitted inside the cubicle.

Normal designs are:

- Schucko – Commonly used in Northern Europe
- (CEE 7/7) Round 2-pole socket with earth-bars on side.
- CEE 7/4 – French/Belgium std. with round 2-pole plug with inverted earth-pole,
- Hubbel – American standard.
- Crabtree – British standard.
- GPO – Australia

TCS – Trip Circuit Supervision
TCS – Trip Circuit Supervision is mainly used to check the connection between the protection trip relay (control room) and the operating mechanism and secondly the trip coil(s) inside the operating mechanism(s).

The TCS is a device that can be fitted in parallel with the protection trip relay(s) and sends a low (< 50 mA) testing current through the trip circuit(s).

To be able to monitor the trip circuits when the circuit breaker is in open position (when the auxiliary contact in the trip circuit is open), there is a parallel wiring to this contact. There are two normal ways to do this:

1. A resistor in parallel with this contact, with resistance value given by the supplier of the TCS device.

2. A NC-contact of the auxiliary contact in parallel with the original NO-contact. This requires either 2 outputs from the TCS-device or two parallel TCS-devices.

An example of TCS device is SPER from ABB ATCF.

Resistor values for SPER, according to 1. above:
220 V dc. 33 kΩ
110 V dc. 22 kΩ
60 V dc. 5.6 kΩ
48 V dc. 1.2 kΩ

Protective trip
The protective trip in the trip circuits is a direct line, by-passing the Local / Remote selector switch.

Note! Used only when protective tripping should override the selector switch.

Position indicating lamps
As an option we can supply green/red-indicating **LED**-lamps connected to the auxiliary switch for circuit breaker position indication inside the cubicle.

Explanations

Operation and control - ABB options

Key-interlock
Provision for key-interlock is mechanical (and electrical) interlocking device, which interlocks the closing function, with a bracket suitable for installing the following brands:
Castell, Kirk and Fortress.

Emergency trip, manual trip push-button
Manual mechanical trip push-button can on request be fitted on the inside or the outside of the operating mechanism. (Only inside for FSA)
Note! Mechanical trip overrides SF_6-blocking

69-device
An interlocking device, according to device No. 69 in the ANSI standard, that requires a resetting after each manual tripping before closing of the circuit breaker can be done.
(N.A. for FSA operating mechanism)

Spring charge supervision
As an option a relay can be fitted to give an alarm when one or more of the errors / events below occurs:

1. Loss of motor voltage.
2. The direct on line motor starter is tripped manually.
3. The direct on line motor starter is tripped due to over-current.
4. An electrical error prevents spring charging.
5. A mechanical error prevents spring charging.

The relay can be an auxiliary relay or with a time delay relay depending on alarm delaying possibility in the bay control unit. The alarm delay must be at least as long as the spring charging time, normally 15 s.

Voltage supervision
The circuits can be equipped with voltage supervision relay(s).

This could be a zero-voltage relay (a standard auxiliary relay -not adjustable) or voltage supervision relays (with adjustable setting for voltage and hysteresis).

Heater supervision
The heating circuit can be equipped with a current supervision relay (with adjustable setting for current and hysteresis) or an indicating lamp in series with the continuously connected heater.

Capacitor tripping
Trip circuits can be equipped with capacitor tripping devices. Used to automatically trip the circuit breaker at loss of, or at low operating voltage.

The capacitor tripping device is always used together with a voltage supervision relay (adjustable setting for voltage and hysteresis) that controls the tripping voltage level (one capacitor device / trip coil is required).

0-voltage trip coil
The operating mechanisms can be equipped with 0-voltage Trip coil.
It is used to automatically trip the circuit breaker at loss of, or low operating voltage.

The 0-voltage Trip coil is always used together with a voltage supervision relay (adjustable setting for voltage and hysteresis) that controls the tripping voltage level.

Fuses
Fuses can be fitted in every circuit on request.

Normal types:

- MCB – Miniature Circuit Breaker
- Red spot – Fuses (Links)
- UK 10,3-HESI – Fuses (Links)

Note! The trip and close circuits should preferably not include fuses.

Phase discrepancy
Phase discrepancy (Pole discordance) is a device that could be used on single pole operated circuit breakers, that uses auxiliary contacts to indicate that all phases are in the same position. When the poles are in different positions a time relay starts, and after a pre-set time, a trip order and alarm signal is normally initiated.

Seismic conditions

Seismic stress

There are many zones in the world where earthquakes may occur, and where circuit breakers should be designed to withstand the corresponding stresses. When an earthquake occurs, the acceleration and amplitude of the motion of the ground will vary in a statistical manner. The stress conditions are normally most severe in the horizontal direction. The type of soil (sand, clay, rock, etc) has a strong influence on the actual local severity of an earthquake and the damage it may inflict.

For technical purposes earthquake stresses are normally defined by the maximum value of the horizontal acceleration. IEC has standardized three values of maximum horizontal acceleration 2, 3, and 5 m/s², corresponding to 0.2, 0.3, and 0.5 g.

IEEE, which is more relevant (more severe) has corresponding standardized values, 0.25 g and 0.5 g respectively for moderate and heavy seismic action.

Resulting stress on circuit breakers

When a HV circuit breaker is subjected to an earthquake, the motion of the ground will induce oscillations in the circuit breaker with corresponding mechanical stress. The mechanical stress will normally be most severe at the lower end of the support column.

ВЯРНО С ОРИГИНАЛА

The circuit breaker will have one or more natural oscillation frequencies, eigenfrequencies, where the predominant one is typically a few Hz. Since the frequency of typical earthquake oscillations is also of the order of a few Hz, the actual stress on the breaker may be is amplified due to mechanical resonance. The degree of amplification depends on the eigenfrequency (natural oscillation frequency) and damping of the circuit breaker, and may be deduced from response spectra, published e.g. by IEC.

Earthquake dampers

An earthquake damper will increase the damping of the natural oscillation of the circuit breaker. In this way the amplification of earthquake stresses due to resonance is significantly decreased, and the maximum mechanical stress on the circuit breaker significantly reduced.

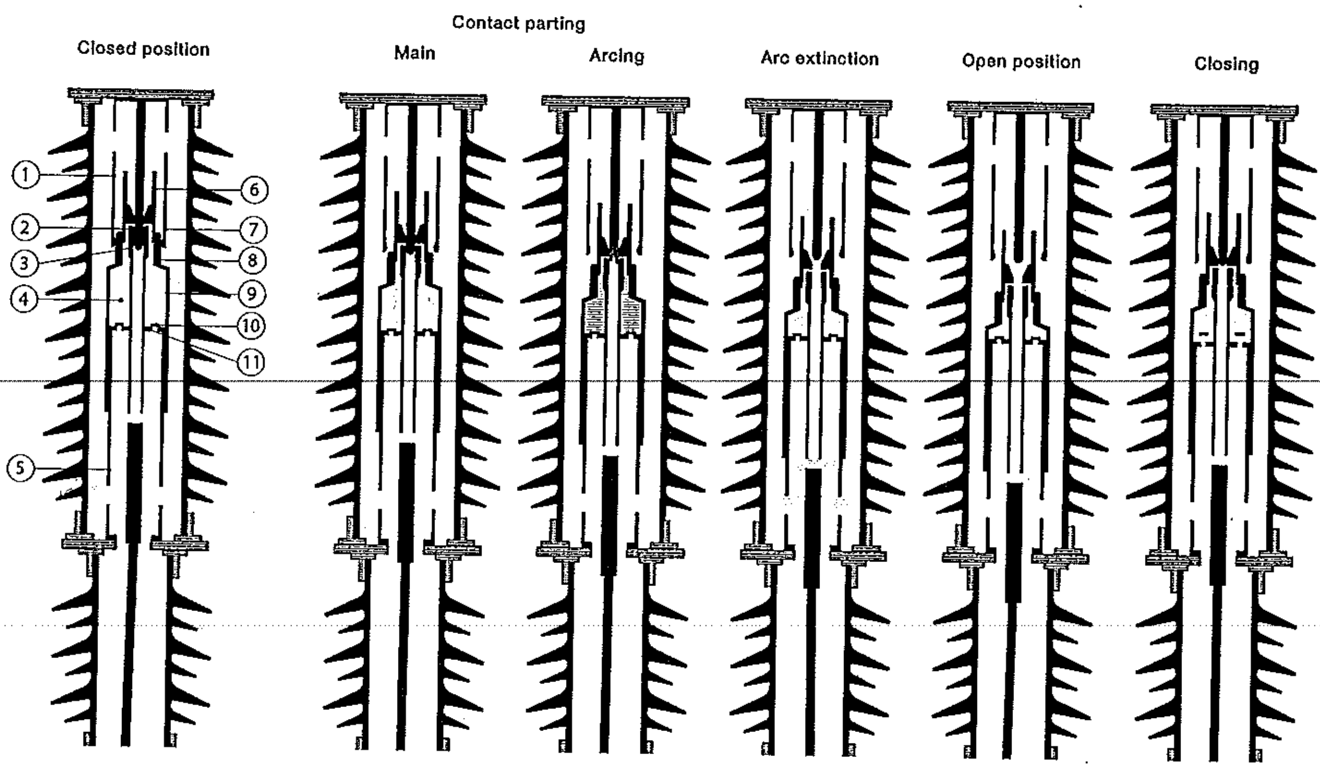
Verification of seismic capability

The seismic capability of a circuit breaker may be verified by a direct test, where a complete circuit breaker, or pole, is subjected to simulated earthquake stress on a shaker table.

Alternatively, the mechanical stresses can be determined by calculations. The most reliable calculations are based on a snap-back test. In this test a force is applied on the top of the circuit breaker pole. When the force is suddenly released the pole will oscillate and the eigenfrequencies and the damping can be measured.

ЕЛЕКТРИКСИТИ ООД СОФИЯ

Design features Puffer interrupters



1 Upper current carrier
2 Stationary arcing contact
3 Moving arcing contact
4 Puffer volume
5 Lower current carrier
6 Nozzle
7 Stationary main contact
8 Moving main contact
9 Puffer cylinder
10 Refill valve
11 Stationary piston

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

In its normal position, the circuit breaker contacts are closed and current is conducted from the upper current collector to the lower current collector via the main contacts, the puffer cylinder and the sliding contact system in between the puffer cylinder and the lower current collector.

At opening, the moving parts of the main and arcing contacts, as well as the puffer cylinder and nozzle, are pulled towards the open position. Note that the moving contacts, nozzle and puffer cylinder form one moving assembly.

As the moving assembly is drawn towards the open position, the refill valve is forced to close. The movement of the puffer cylinder versus the stationary piston now starts creating a compression of the SF_6 gas inside the puffer cylinder. Due to the contact overlap this gas compression starts before any contacts separate. After some further movement of the moving assembly the main contacts separate which results in a commutation of the current into the arcing contact path, which is still engaged. The much longer contact penetration of the arcing contact system versus the main contact system will ensure that any arc established will be trapped in between the arcing contacts and within the surrounding nozzle.

When the arcing contacts separate after some further contact travel an arc is drawn between the moving and stationary arcing contacts. As the arc flows it will also to some degree block the flow of SF_6 gas through the nozzle. Thus the gas pressure in the puffer volume continues to increase.

When the current waveform approaches a current zero, the arc becomes relatively weak and the pressurized SF_6 gas inside the puffer cylinder flows through the nozzle and cools the contact gap which reduces the electrical conductivity such that the arc is extinguished. The low electrical conductivity then prevents the current to continue.

When the current is blocked the recovery voltage starts rising across the contacts. At this time the circuit breaker contacts must have reached a contact distance long enough to create a voltage withstand that all the time exceeds the recovery voltage.

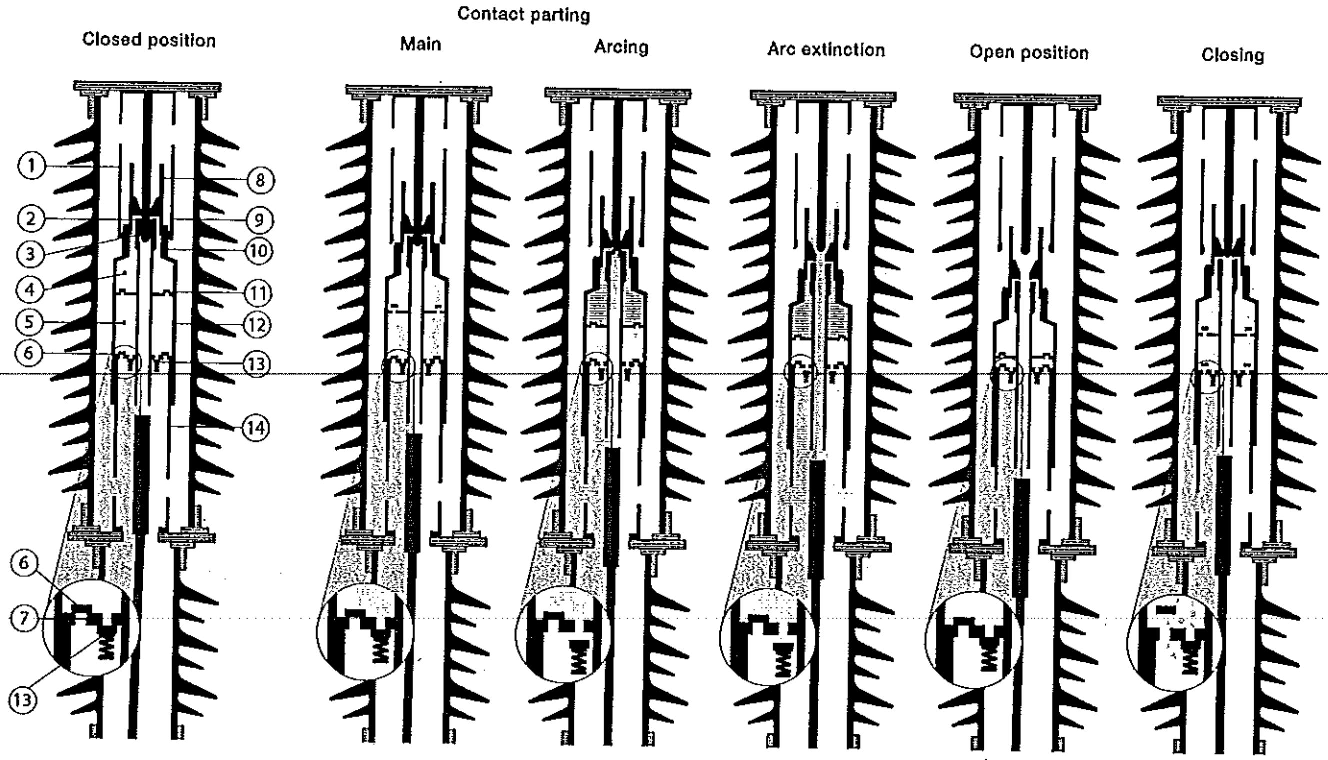
In the fully open contact position there is sufficient distance between the stationary and moving contacts to withstand rated dielectric levels.

On closing, the refill valve opens so that SF_6 gas can be drawn into the puffer volume making the circuit breaker ready for the next opening operation.

Note that the SF_6-gas pressure required for interruption is built up by mechanical means. Therefore circuit breakers using puffer interrupters require trip mechanisms with sufficient energy to overcome the pressure build up in the puffer volume required to interrupt rated short-circuit current while at the same time maintaining the contact speed required to withstand recovery voltage.

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ СОФИЯ ООД

Design features Auto-Puffer™ interrupters



1 Upper current carrier
2 Stationary arcing contact
3 Moving arcing contact
4 Auto-Puffer™ volume
5 Puffer volume
6 Refill valve
7 Stationary piston
8 Nozzle
9 Stationary main contact
10 Moving main contact
11 Auto-Puffer™ valve
12 Puffer cylinder
13 Over-pressure relief valve
14 Lower current carrier

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

High current interruption

When interrupting high currents (e.g. rated short-circuit current), Auto-Puffer™ interrupters show the advantage they were designed to provide.

At opening, the operation of an Auto-Puffer™ interrupting a high current begins the same way as for a puffer interrupter. It is not until after the arcing period begins that a difference in the operation principle is seen between the high and low current interrupting modes.

When the arcing contacts separate, an arc is drawn between the moving and stationary arcing contacts. As the arc flows, it to some degree blocks the flow of SF_6 gas through the nozzle. Due to the high temperature of the arc it radiates a lot of heat and begins to heat the SF_6 gas in the arc quenching zone. Thus, the pressure inside the Auto-Puffer™ and puffer volumes increases due to the rise in temperature as well as due to the compression of gas between the puffer cylinder and the stationary piston.

Gas pressure inside the Auto-Puffer™ volume continues to increase and a certain pressure it is high enough to force the Auto-Puffer™ valve to the closed position.

All SF_6 gas required for interruption is now trapped in the fixed Auto-Puffer™ volume and any further increase in gas pressure in that volume is due solely to heating from the arc.

At about the same time, the gas pressure in the puffer volume reaches a level high enough to open the overpressure relief valve in the puffer piston. Since the gas in the puffer volume then escapes through the overpressure valve, there is no need for a high operating energy to overcome the compression of SF_6 gas while at the same time maintaining the contact speed necessary to create contact distance for withstanding the recovery voltage.

When the current waveform approaches zero, the arc becomes relatively weak. At this point, the pressurized SF_6 gas returns from the Auto-Puffer™ volume and flows through the nozzle and extinguishes the arc.

At closing, the refill valve opens such that gas can be drawn into the puffer and Auto-Puffer™ volumes.

Low current interruption

When interrupting low currents, Auto-Puffer™ interrupters act very much in the same way as puffer interrupters. There is not sufficient gas pressure generated by the heat of the arc to force the Auto-Puffer™ valve to close. Therefore the fixed Auto-Puffer™ volume and puffer volume form one large common puffer volume. In such a case, the SF_6 gas pressure required for interruption is built up by mechanical means only as in a puffer interrupter.

Unlike a puffer interrupter, however, Auto-Puffers™ need only mechanically generated pressure build-up sufficient to interrupt a portion of the rated short-circuit current (i.e. 20% to 30% of the rated short-circuit current).

In the open position, there is sufficient distance between the stationary and moving contacts to withstand rated dielectric levels.

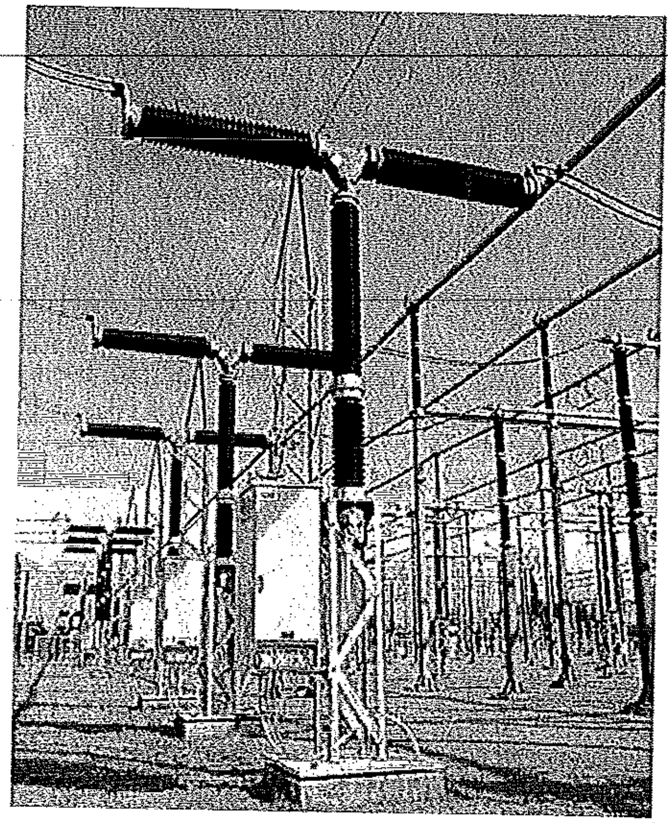
Because interruption of low currents requires only moderate build-up of SF_6 gas pressure which is generated by mechanical means and since high current interruption uses heating from the arc to generate necessary gas pressure in a fixed volume, Auto-Puffer™ interrupters require far less operating energy than puffer interrupters (i.e. about 50% less).

ЕЛЕКТРИКСИТИ ООД СОФИЯ

LTB
Design features and advantages

Introduction
ABB's LTB circuit breaker family, with rated voltage 72–800 kV and breaking current up to 50 kA, satisfies the highest demands. It is based on latest developments in dielectric dimensioning and arc physics research.

ABB produced the world's first SF_6 circuit breakers with arc-assisted interrupters in the mid-1980's - Auto-Puffer™. The Auto-Puffer™ principle is described on page 24.



The energy required for interrupting short-circuit currents is partly taken from the arc itself, significantly reducing the energy required from the operating mechanism.

Lower operating energy inherently reduces mechanical stresses, on the circuit breaker itself as well as on the foundation, and increases circuit breaker reliability.

For many years, ABB has used operating mechanisms with energy mechanically stored in springs. This solution offers considerable advantages in that the energy in the tensioned springs is always available. Our spring operating mechanisms BLK, BLG, MSD and FSA1 are described in separate chapters in this Buyer's Guide.

In the year 2001 ABB introduced Motor Drive, a digital servomotor system capable of directly driving the circuit breaker contacts with high precision and reliability. The number of moving parts in the drive is reduced to only one – the rotating motor shaft.

The Motor Drive is described in separate chapters.

The design of the LTB is a well-proven technology (over 30 000 units are in service).

Design features
LTB is available for single- or three-pole operation.

For circuit breakers with one breaking element per pole, both modes of operation are possible. For two- or four-chamber circuit breakers only single-pole operation applies.

For three-pole operation, the circuit breaker poles and the operating mechanism are linked together. The opening spring is integrated in the operating mechanism for MSD and FSA.

Each circuit breaker pole constitutes a sealed SF_6 filled unit, which includes the breaking unit, the hollow post insulator and the mechanism housing.

The three poles of the circuit breaker can be mounted on individual pole supports or in the case of LTB D1/B on a common support frame (pole beam).

Operating mechanism

BLK is used for:
LTB D1/B 72.5 - 170 kV
LTB E 72.5 - 245 kV singe-pole operation

FSA1 is used for:
LTB D1/B 72.5 - 170 kV

BLG is used for:
LTB E 72.5 - 245 kV three-pole operation
LTB E 362 - 800 kV single-pole operation

MSD is used for:
LTB D1/B 72.5 - 170 kV
LTB E 72.5 - 245 kV single pole operation

Motor Drive™ is used for:
LTB D1/B 72.5 - 170 kV

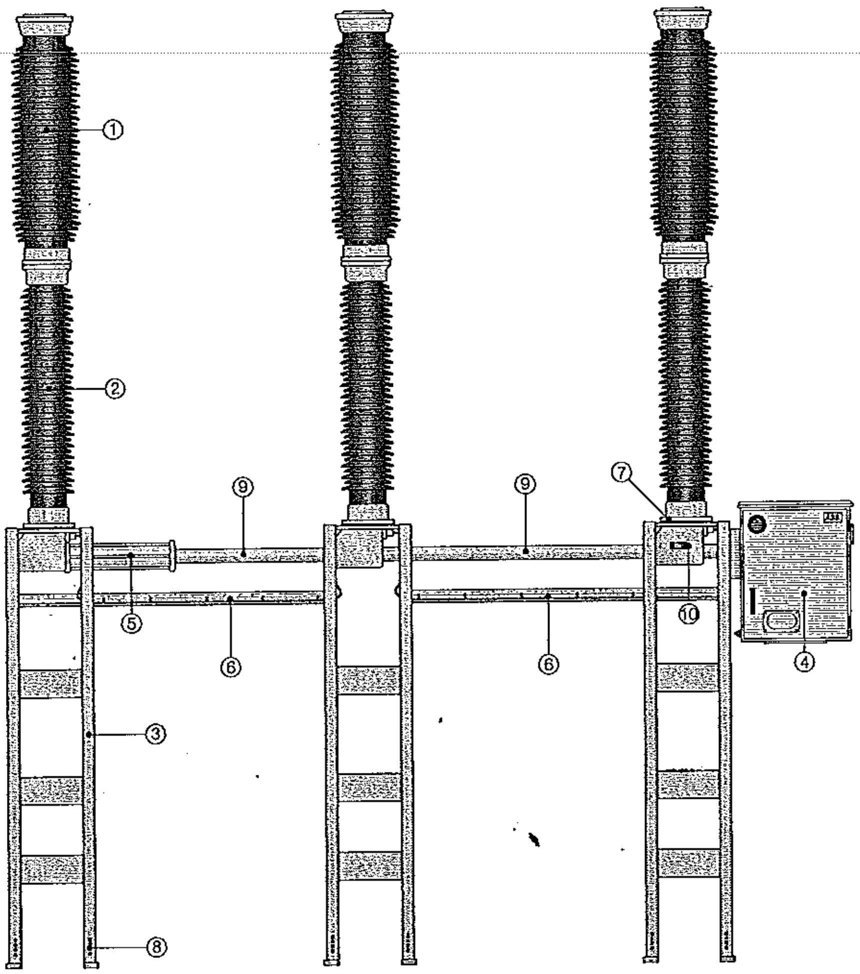
The operational reliability and the service life of an SF_6 circuit breaker is very much dependent on the ability to ensure sealing of the SF_6 gas volume and to neutralize the effects of moisture and decomposition products in the gas.

- The risk for gas leakage is negligible; double nitrile rubber O-rings and X-rings are used with excellent result.

- Each breaking unit is provided with a desiccant, which absorbs the moisture and the decomposition products from the interruption process.

- Since the interrupting capability is dependent on the density of the SF_6 gas, the LTB circuit breaker is provided with a density monitor.
  The density monitor consists of a temperature compensated pressure switch. Therefore, alarm signal and blocking function are activated only if the pressure drops due to leakage.

The design corresponds with the demands in the standards IEC and IEEE. Special design solutions to meet other standards and/or specifications are also available.



ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

Circuit breaker type LTB D1/B

1. Breaking chamber
2. Support insulator
3. Support structure
4. Operating mechanism type BLK
5. Trip spring with housing
6. Gas tube with protective beam
7. Gas supervision (On opposite side)
8. Drilled holes for connection to ground
9. Pullrod with protective tube
10. Position indicator

LTB
Design features and advantages

Current switching capability
Most ABB LTB circuit breakers are capable of interrupting short-circuit currents with a maximum break time of 40 ms. For the LTB D with FSA1 the maximum break time is 60 ms. We can also guarantee interruption of capacitive currents with very low probability of restrike due to optimized contact design and movement.

For inductive current switching the overvoltages are low as a result of optimum quenching at current zero.

Dielectric strength
LTB has high dielectric strength even at atmospheric SF_6 pressure, due to optimized contact gap.

Controlled switching
As option LTB circuit breakers can be used for controlled switching by applying our controlling device type Switchsync™.
For further information please see page 138 "Controlled Switching with Switchsync™".

Stable operating times
For controlled switching it is of the utmost importance that the functional times for closing and tripping operations are constant. We can guarantee ±1 ms between consecutive operations for all LTB circuit breakers.

Climatic withstand
The LTB circuit breakers are designed for, and are installed in, widely shifting conditions from polar to desert climate throughout the world.

For circuit breakers installed in areas with extreme low temperatures there is a risk of condensation of the SF_6 gas.

In order to avoid condensation consequences, one of the following gas-mixtures is used:

- SF_6 and N_2
- SF_6 and CF_4

Resistance to corrosion
The selected components of aluminum (mechanism housings, HV-terminals, cubicles) give a high degree of resistance to corrosion, without the need of extra protection. For use in extreme trying environments LTB can be delivered with a protective painting.

The support structure and protective tubes for the pull rods are made of hot-dipped galvanized steel.

Seismic strength
All LTB circuit breakers have a mechanically robust construction due to optimized pole and support structure, designed to withstand seismic accelerations up to 3 m/s², (0.3 g according to IEC) without extra precautions.

With reinforced support structure, insulators or earthquake dampers or combinations thereof, the circuit breakers can withstand seismic accelerations considerably higher than 5 m/s², (0.5 g).

Read more about "Seismic Withstand Capability" on page 146.

Simple erection
Each LTB is pre-tested in our factory and transported to site as a few pre-assembled units.

The circuit breakers can easily be installed and put into service in 1–4 days depending on type and size.

Low maintenance requirements
The operational reliability and the service life of a SF_6 circuit breaker is very much dependent on the ability to ensure sealing of the SF_6 gas volume and to neutralize the effects of moisture and decomposition products in the gas.

However, LTB is designed for a service life of more than 30 years or 10 000 mechanical (no load) operations. For current switching the number of operations before service is dependent on the accumulated interrupted current.

Condition monitoring
As an option we can offer supervisory control by means of our condition monitoring system. This is described in chapter "On-Line Monitoring System" on page 144.

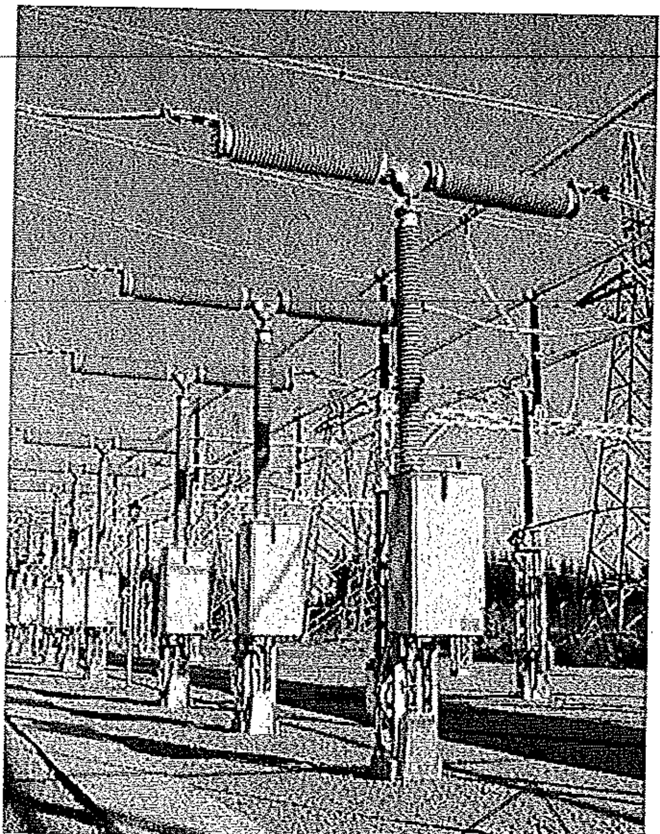
ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

HPL
Design features and advantages

Introduction
ABB:s HPL circuit breaker family with rated voltage 72 – 800 kV (1200 kV on request) and breaking current up to 80 kA, satisfies the highest demands. It is based on latest developments in dielectric dimensioning and arc physics research.

We have produced SF_6 circuit breakers with Puffer interrupters since 1981. The Puffer principle is described on page 22.



The HPL circuit breaker is operated by the motor charged spring operating mechanism type BLG which is described in separate chapters in this Buyer's Guide.

The design of the HPL is a well-proven technology (over 16 500 units are in service).

Design features
HPL can be single- or three-pole operated.

For circuit breakers with one breaking element per pole, both modes of operation are possible. For multi chamber circuit breakers only one-pole operation applies.

The three poles of the circuit breaker are mounted on individual pole supports. For three-pole operation, the breaker poles and the operating mechanism are linked together with pull rods. Each circuit breaker pole has its own individual opening spring.

HPL 420 – 550 can handle 63 kA without the need of grading capacitors.

Each circuit breaker pole constitutes a sealed SF_6 filled unit, which includes the breaking unit, the hollow post insulator and the mechanism housing.

The operational reliability and the service life of a SF_6 circuit breaker is very much dependent on the ability to ensure sealing of the SF_6 gas volume and to neutralize the effects of moisture and decomposition products in the gas.

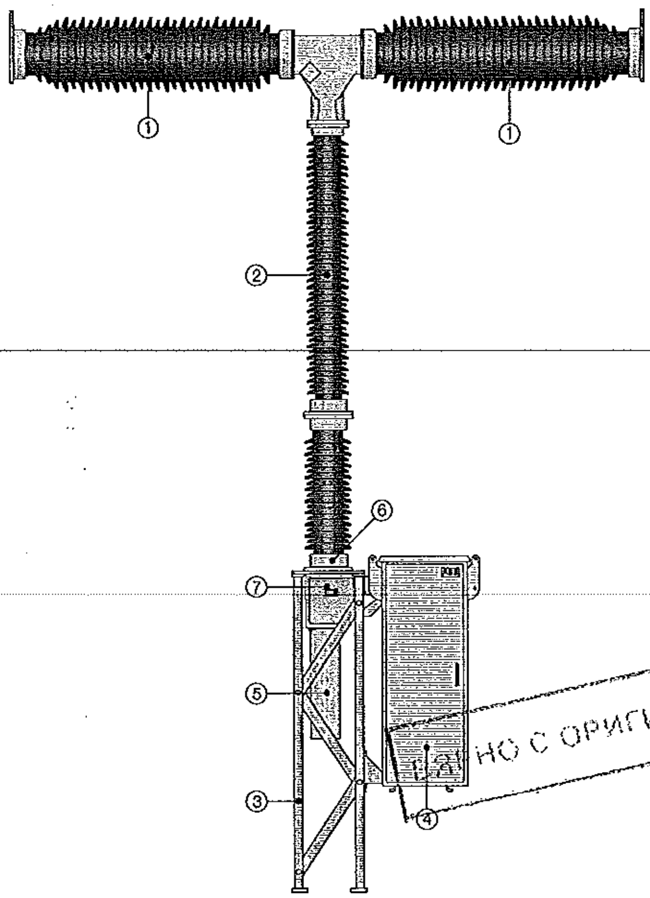
- The risk for gas leakage is negligible; double nitrile rubber O-rings and X-rings are used with excellent result.
- Each breaking unit is provided with a desiccant, which absorbs the moisture and some of the decomposition products from the interruption process.
- Since the interrupting capability is dependent on the density of the SF_6 gas, the HPL circuit breaker pole is provided with a density monitor.
  The density monitor consists of a temperature compensated pressure switch. Therefore, alarm signal and blocking function are activated only if the pressure drops due to leakage.

The design corresponds with the demands in the standards IEC and ANSI. Special design solutions to meet other standards and/or specifications are also available.

Current switching capability
All HPL circuit breakers are capable of interrupting short-circuit currents in a maximum of 40 ms. We can also guarantee interruption of capacitive currents with very low probability of restrike due to optimized contact design and movement.

For inductive current switching the overvoltages are low as a result of optimum quenching at current zero.

Dielectric strength
HPL has high dielectric strength even at atmospheric SF_6 pressure, due to optimized contact gap.



Circuit breaker type HPL B2

1 Breaking chamber
2 Support insulator
3 Support structure
4 Operating mechanism type BLG
5 Trip spring with protective housing
6 Gas supervision (On opposite side)
7 Position indicator

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

Controlled switching
As option HPL circuit breakers can be used for controlled switching by applying our controlling device type Switchsync™. For further information please see chapter "Controlled Switching".

Stable operating times
For controlled switching it is of the utmost importance that the functional times for closing and tripping operations are constant. We can guarantee ±1 ms between consecutive operations for all HPL circuit breakers.

Climatic withstand
The HPL circuit breakers are designed for, and are installed in, widely shifting conditions from polar to desert climate throughout the world.

For circuit breakers installed in areas with extreme low temperatures there is a risk of condensation of the SF_6 gas.

In order to avoid condensation consequences, one of the following gas-mixtures is used:

- SF_6 and N_2
- SF_6 and CF_4

Resistance to corrosion
The selected components of aluminum (mechanism housings, HV-terminals, cubicles) give a high degree of resistance to corrosion, without the need of extra protection. For use in extreme trying environments HPL can be delivered with a protective painting.

The support structure and protective tubes for the pull rods are made of hot-dipped galvanized steel.

HPL
Design features and advantages

Seismic strength
All HPL circuit breakers have a mechanically robust construction due to optimized pole and structure, designed to withstand seismic accelerations up to 3 m/s², (0.3 g according to IEC) without extra precautions.

With reinforced support structure, insulators or earthquake dampers or combinations thereof, the circuit breakers can withstand seismic accelerations considerably higher than 5 m/s², (0.5 g).

Read more about "Seismic Withstand Capability" on page 146.

Simple erection
Each HPL is pre-tested in our factory and transported to site as a few pre-assembled units.

The circuit breakers can easily be installed and put into service in 1–4 days depending on type and size.

Low maintenance requirements
The operational reliability and the service life of an SF_6 circuit breaker is very much dependent on the ability to ensure sealing of the SF_6 gas volume and to neutralize the effects of moisture and decomposition products in the gas.

However, HPL is designed for a service life of more than 30 years or 10 000 mechanical (no load) operations. For current switching the number of operations before service is dependent on the accumulated interrupted current.

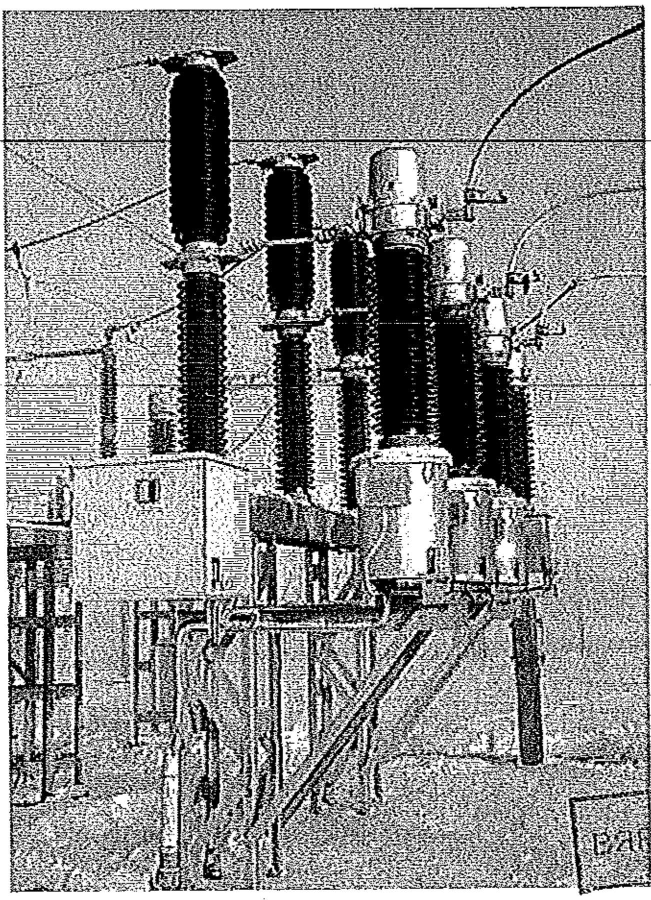
Condition monitoring
As option we can offer supervisory control by means of our condition monitoring system.
This is described in chapter "On-Line Monitoring System" on page 142.

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД София

BLK
Design features and advantages

Introduction
Demands on the reliability of power transmission networks are increasing continuously. As such, today many customers strongly focus on the reliability and maintenance requirements of system equipment.



Circuit breakers are the last link in a chain of apparatus that form the protection equipment for a power supply system. Within a few milliseconds an operating mechanism must supply the energy needed to transform the circuit breaker from a perfect conductor to a perfect insulator. A failure in the operating mechanism often means a failure in the total breaking operation. Thus, operating mechanisms play a major role of the reliability of the circuit breaker and, thereby, of the total power supply system.

In addition, capacitor bank and reactor switching applications, which impose added requirements on operational endurance, are becoming more common.

In an international investigation it was shown that eighty percent (80%) of all failures in high voltage circuit breakers originated in the operating mechanism. Therefore, to achieve highest operational reliability, circuit breakers should be equipped with highly reliable operating mechanisms.

In the light of the above, the BLK motor charged spring operating mechanism was developed. The BLK spring operating mechanism is designed with a minimum of components. Such a design ensures a high degree of total reliability and minimal need for maintenance for the operating mechanism and, thus, the circuit breaker as a whole.

With over 40 000 BLK operating mechanisms delivered, ABB is confident that the design is one of the most reliable on the market.

Applications
BLK spring operating mechanisms are used for the following types of ABB live tank circuit breakers:

- LTB D1/B
- LTB E1 (single-pole operated)

Design features
Perhaps the most important feature of the BLK operating mechanism is its operating principle.

In the ABB design, the opening spring is part of the circuit breaker's link system and placed near the mechanism housing.

The closing spring in the operating mechanism generates the required driving force to close the circuit breaker and charge the opening spring. As such, the mechanical energy needed for the vital opening operation is always stored in the opening spring when the circuit breaker is in the closed position. In other words, a closed breaker is always prepared for immediate opening.

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

BLK
Design features and advantages

Immediately after each closing operation, a motor drives the spring charging gear to automatically charge the closing spring. After recharging the closing spring, the circuit breaker is capable of a rapid reclosing with a dead time interval of 0.3 s.

Both open and close springs are kept in the charged state by very reliable triple-action latches.

The power unit is characterized by the following robust main components:

- A spiral closing spring, which drives the operating lever of the circuit breaker.
- Robust, universal charging motor
  - Operates only after closing operation
  - Charges closing springs in ≤15 seconds
- Trip and close latches that are identical, fast acting and vibration proof.
- A damping device to retard the motion of the contact system at the end of an opening operation.
- A closed, oil-filled worm drive for a minimum of maintenance.

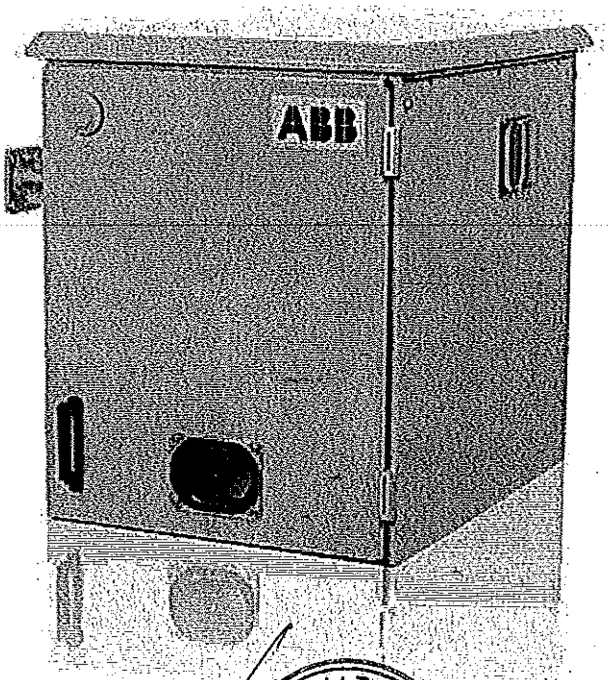
The auxiliary equipment is characterized by the following:
- Robust auxiliary contacts and limit switches.
- Mechanical indication of charged, partly charged or discharged closing spring.
- All electrical wiring used for external connections is brought to terminal blocks.
- Good accessibility through large housing and a hinged control panel.
- Consistent operating times for all environmental conditions, making the circuit breaker very suitable for controlled switching.

ВЯРНО С ОРИГИНАЛА

Interlocking against unintentional operation
Interlocking is achieved partly electrically and partly mechanically. Electrical interlocking is achieved by having the circuits of the operation coils connected through the auxiliary contacts of the operating mechanism. In addition, the closing coil is connected through a limit switch that is controlled by the position of the spring drum. In this way the closing circuit is only closed when the breaker is in the open position and the closing springs are fully charged.

Based on the above interlocking design, the following operations are not possible when in service:

- Closing operation when the breaker is already closed (i.e. a "blind" stroke)
- Closing operation during an opening operation



BLK housing
- Corrosion resistant housing of painted aluminum of 2 mm thickness.
- Mechanical spring charge indicator
  - Located on the side of the housing
  - Visible with housing doors closed
- Front and back doors equipped with doorstops and provisions for padlock on door handles.
- Insulated doors and walls for low energy consumption and low noise level.

Panels

Behind the front door there is a panel that may be equipped differently, depending on customer specific requirements. As a standard, the following equipment is included on the control panel:

- Casing with instruction manual and final drawings
- Local open / close switch
- Local / remote / disconnect selector switch
- Electro-mechanical operations counter – non-resettable
- MCB (Miniature Circuit Breaker) for motor- and AC auxiliary circuits

There is easy access to relays and contactors, which are placed on the rear side of the hinged control panel.

Behind the rear door of the operating mechanism housing there is an interface panel containing all necessary terminal blocks for customer connections. Standard terminal blocks are compression type in which a bare wire is compressed between two metallic plates in the terminal.

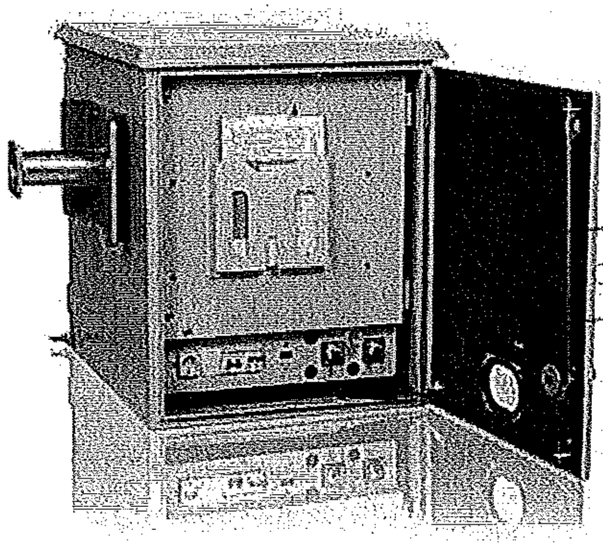
Tools

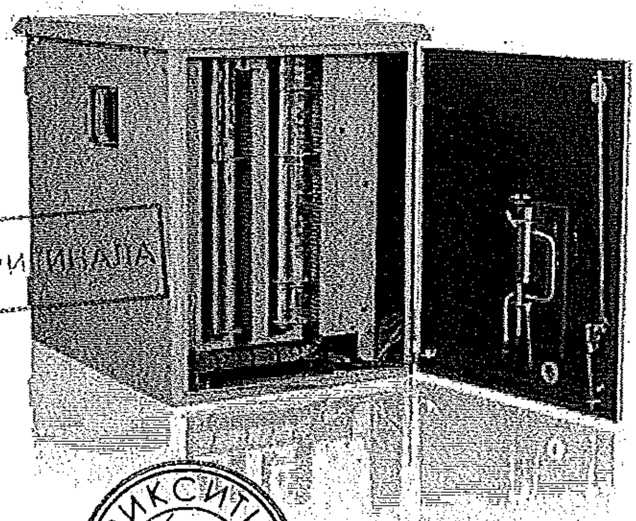
A compartment for tools is located on the backside of the rear door.

Central Control Cubicle (CCC) or Integrated Control Cubicle (ICC)

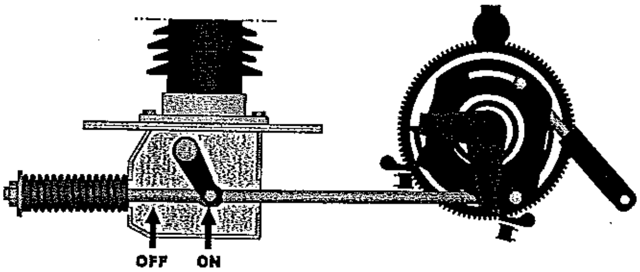
For local three-pole operation of a single-pole operated circuit breaker a Central Control Cubicle (CCC) can be used. The CCC can be delivered by ABB or arranged by the customer. As an alternative to the CCC we can also provide an Integrated Control Cubicle solution (ICC), which eliminates the need for the CCC. Integrated control means that the function and the components in the CCC have instead been incorporated in one of the three operating mechanisms which is larger. This saves time for installation and cabling work.

We are open for discussions how to arrange the two alternatives.

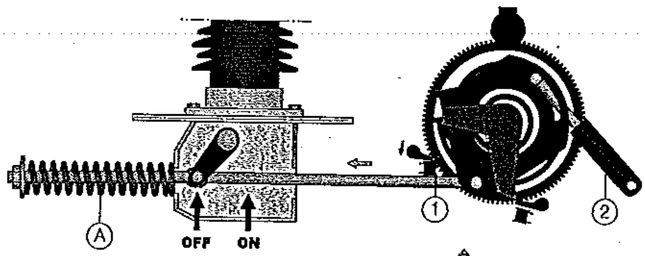




BLK
Operating principles

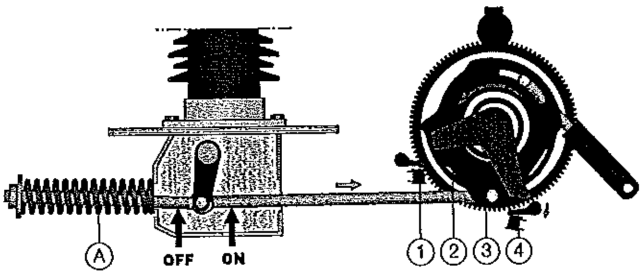


Closed position
In the normal service position of the circuit breaker the contacts are closed and the opening and closing springs are charged.
In this position the circuit breaker is always ready to perform an opening operation or a complete auto-reclosing O - 0.3 s - CO.



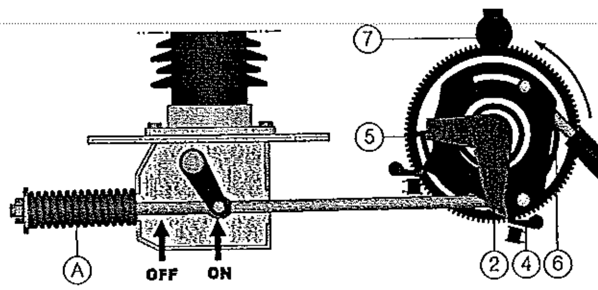
Opening operation
To open the circuit breaker, the opening latch (1) is released by the tripping coil, and the opening spring (A) of the circuit breaker carries out the operation. The motion of the contact system is retarded by a damping device (2).
With a spring operated circuit breaker the opening operation is extremely reliable as the operation is only dependent on the functioning of the opening latch and the opening spring.

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ СОФИЯ ООД



Closing operation

Releasing of the closing latch (4) means an immediate response to close the circuit breaker. The driver lever (2) brings the eccentric guided closing lever (3) to the closed position. At the same time the opening spring (A) is charged. At the end of the stroke the closing lever (3) connected to the circuit breaker is hooked up by the opening latch (1) in the closed position. Due to the eccentric guided lever (3) the driver lever (2) is declutched and continues to the resting position.



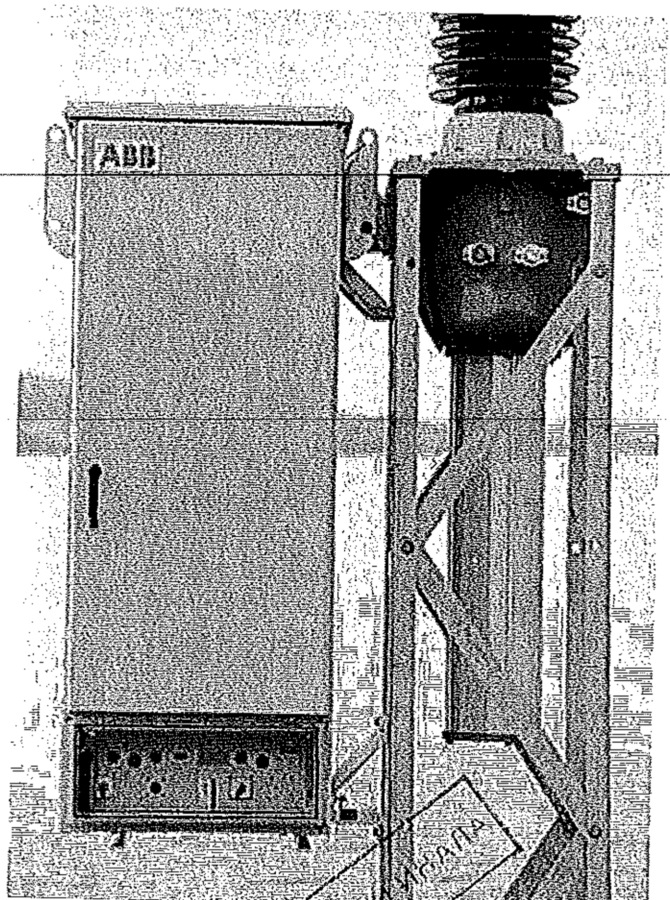
Charging of the closing spring

The circuit breaker has been closed. The motor circuit is closed by a limit switch. The motor (7) starts and charges the closing spring (6) as the main shaft (5) and the driver (2) are hooked up by the closing latch (4). When the closing spring is fully charged the limit switch will open the motor circuit. In case of emergency, the spring can be charged by means of the hand crank enclosed in the cubicle.

ЕЛЕКТРИКСИТИ ООД СОФИЯ

BLG
Design features and advantages

Introduction
Demands on the reliability of power transmission networks are increasing continuously. As such, today many customers strongly focus on the reliability and maintenance requirements of system equipment.



Circuit breakers are the last link in a chain of apparatus that form the protection equipment for a power supply system. Within a few milliseconds an operating mechanism must supply the energy needed to transform the circuit breaker from a perfect conductor to a perfect insulator. A failure in the operating mechanism often means a failure in the total breaking operation. Thus, operating mechanisms play a major role of the reliability of the circuit breaker and, thereby, of the total power supply system.

In addition, capacitor bank and reactor switching applications, which impose added requirements on operational endurance, are becoming more common.

In an international investigation it was shown that eighty percent (80%) of all failures in high voltage circuit breakers originated in the operating mechanism. Therefore, to achieve highest operational reliability, circuit breakers should be equipped with highly reliable operating mechanisms.

With over 55 000 BLG operating mechanisms delivered, ABB is confident that the design is one of the most reliable on the market.

The design ensures a high degree of total reliability and minimal need for maintenance for the operating mechanism and, thus, the circuit breaker as a whole.

Applications
The BLG spring operating mechanisms are used for the following types of circuit breaker:

- HPL B
- LTB E1 (three-pole operated)
- LTB E2
- LTB E4

Design features
The closing springs in the mechanism generate the required driving force to close the breaker and charge the opening spring.

The opening springs are part of the circuit breaker's link system and placed underneath the mechanism housing. This means that the mechanical energy needed for the vital opening operation is always stored in the opening spring when the circuit breaker is in closed position. In other words, a closed breaker is always prepared for immediate opening.

A universal motor(s) drive(s) the spring charging gear, which automatically charges the closing springs immediately after each closing operation. The springs are kept in the charged state by a latch that is released when the breaker is being closed. This enables rapid reclosing of the breaker after a dead time interval of 0.3 s.

The principle of the operating mechanism can be briefly described as follows: an endless chain links a cam disc and a set of springs. The chain, which is in two loops and runs over a motor-driven sprocket, transmits energy when the springs are being charged and drives the cam disc around when the circuit breaker is to be closed.
During its rotation the cam disc actuates a link that converts the rotating motion into a linear motion.

The trip and closing latches are identical, fast acting and vibration proof.

A damping device is included to retard the motion of the contact system in the end positions.

The auxiliary equipment is characterized by the following:

- Robust auxiliary contacts and limit switches
- Mechanical indication of charged, partly charged or discharged closing spring.
- All electrical wiring used for external connections is brought to terminal blocks.
- Local open / close switch
- Local / remote / disconnect selector switch
- Electromechanical operations counter – non-resettable
- Mechanical spring charge indicator – visible through the transparent shutter

Behind the rear door of the operating mechanism housing there is an interface panel containing all necessary terminal blocks for customer connections. As a standard, the following equipment is included:

Consistent operating times for all environmental conditions which make the circuit breaker suitable for controlled switching.

Interlocking against unintentional operation
Interlocking is achieved partly electrically and partly mechanically. Electrical interlocking is achieved by having the circuits of the operation coils connected through the auxiliary contacts of the operating mechanism. In addition, the closing coil is connected through a limit switch that is controlled by the position of the spring bridge. In this way the closing circuit is only closed when the breaker is in the open position and the closing springs are fully charged.

Based on the above interlocking design, the following operations are not possible when in service:

- Closing operation when the breaker is already closed (i.e. a "blind" stroke)
- Closing operation during an opening operation

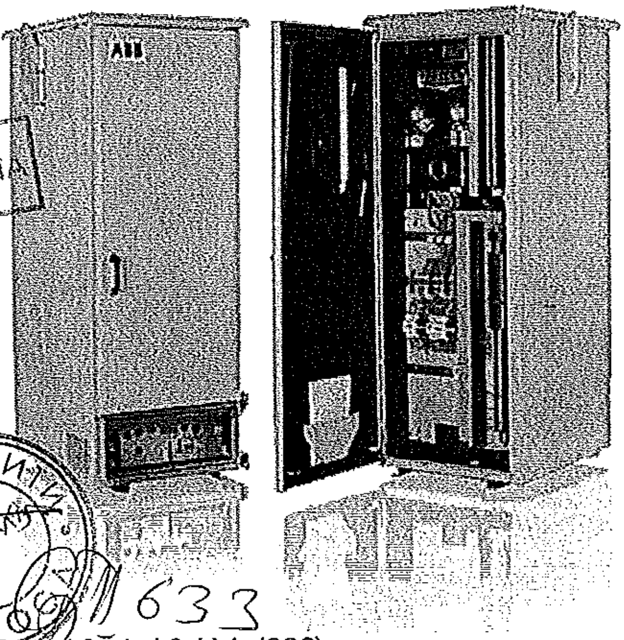
ВЯРНО С ОРИГИНАЛА

BLG housing
- Corrosion resistant housing of painted aluminum of 2 mm thickness.
- Front and back doors equipped with doorstops and provisions for padlock on door handles.
- Insulated doors and walls for low energy consumption and low noise level.

Panels
Below the front door there is a panel, with a transparent shutter, that may be equipped differently, depending on customer specific requirements. As a standard, the following equipment is included on the control panel:

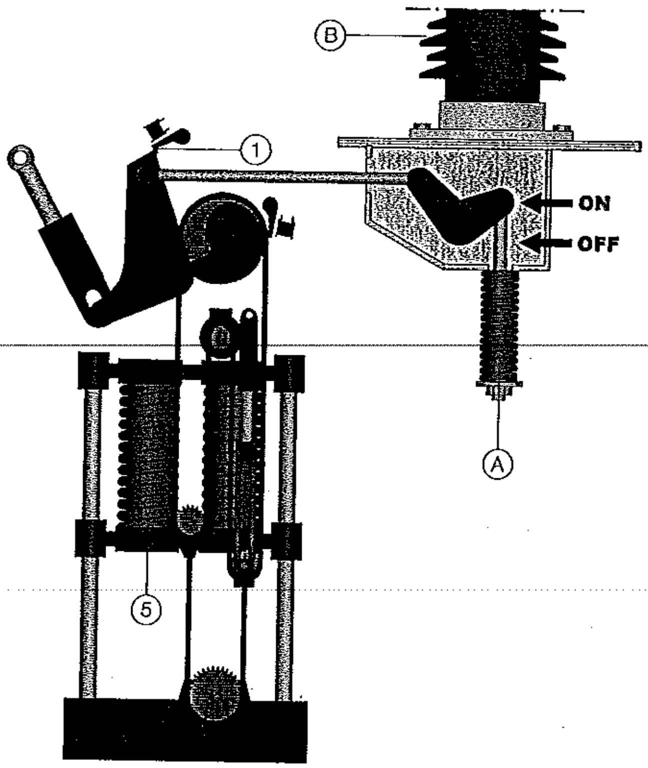
- Standard terminal blocks of compression type (in which a bare wire is compressed between two metallic plates in the terminal)
- Interlocking for hand spring charging
- Control equipment – such as relays, MCBs, contactors etc.
- Auxiliary contacts

On the backside of the rear door there is a compartment for documents with instruction manual and final drawings. A hand crank is also attached.



Central Control Cubicle (CCC)
When the circuit breaker is single-pole operated a Central Control Cubicle (CCC) is used when the circuit breaker is locally three-pole operated. The CCC will be delivered by ABB or arranged by the customer, from case to case. We are open for discussions how to arrange the solution.

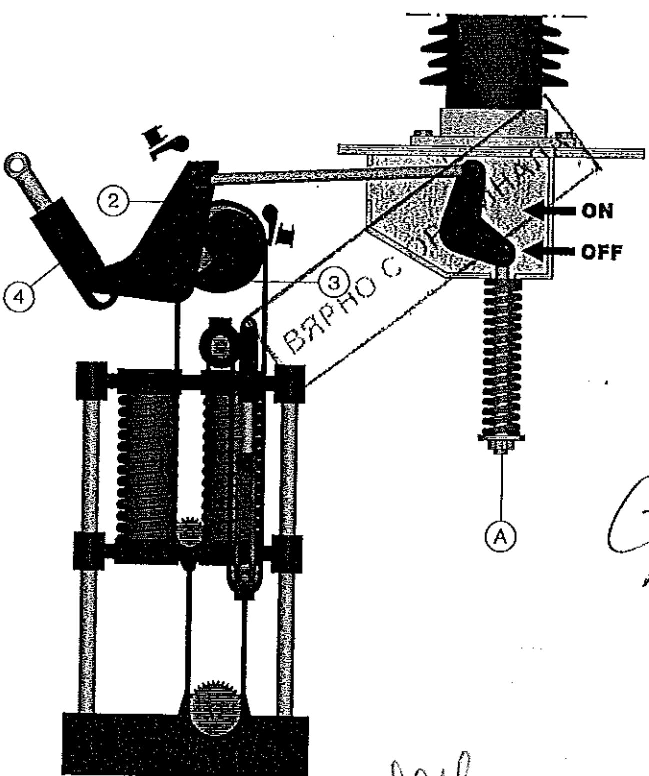
BLG
Operating principles



Closed position
In the normal service position of the circuit breaker (B), the contacts are in closed position, with closing- (5) and opening spring (A) charged.

The breaker is kept in the closed position by the opening latch (1), which takes up the force from the charged opening spring.

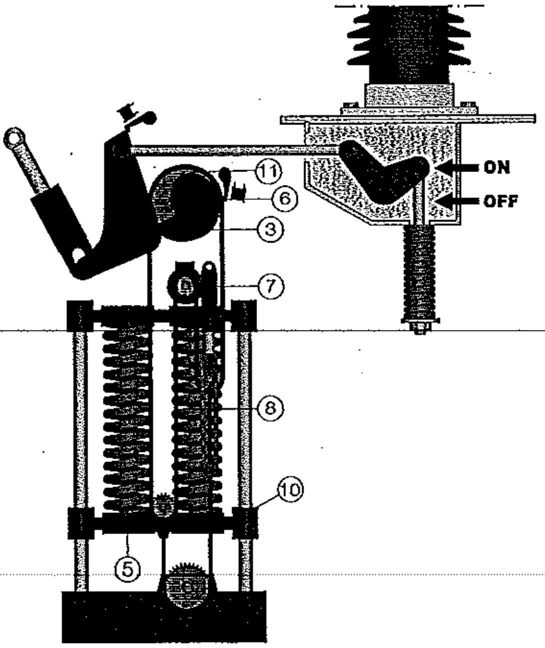
The mechanism is now ready to open upon an opening command and can carry out a complete fast auto-reclosing (O - 0.3 s - CO) cycle.

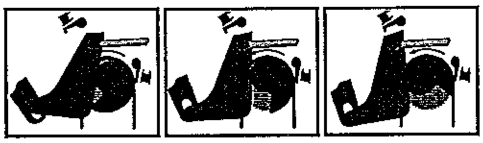


Opening operation
When the breaker is being opened, the latch (1) is released by the tripping coil.

The opening spring (A) pulls the breaker (B) towards the open position. The operating lever (2) moves to the right and finally rests against the cam disc (3).

The motion of the contact system is damped towards the end of the stroke by an oil-filled damping device (4).





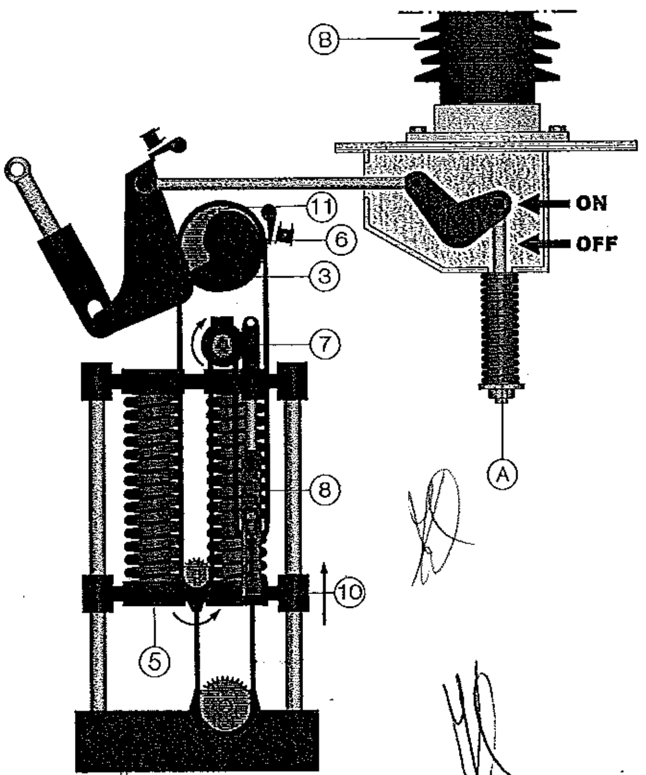
Closing operation

When the breaker is being closed, the closing latch (6) is released by the closing coil.

The sprocket (7) is locked to prevent rotation where upon the operating energy in the closing springs is transferred via section (8) of the endless chain to the sprocket (11) belonging to the cam disc (3).

The cam disc then pushes the operating lever (2) towards the left where it is locked in its end position by the tripping latch (1).

The last part of the rotation of the cam disc is damped by the damping device (9) and a locking latch on the sprocket (11) again takes up the initial position against the closing latch (6).



Charging of the closing springs

The breaker has closed; the motor starts and drives the sprocket (7).

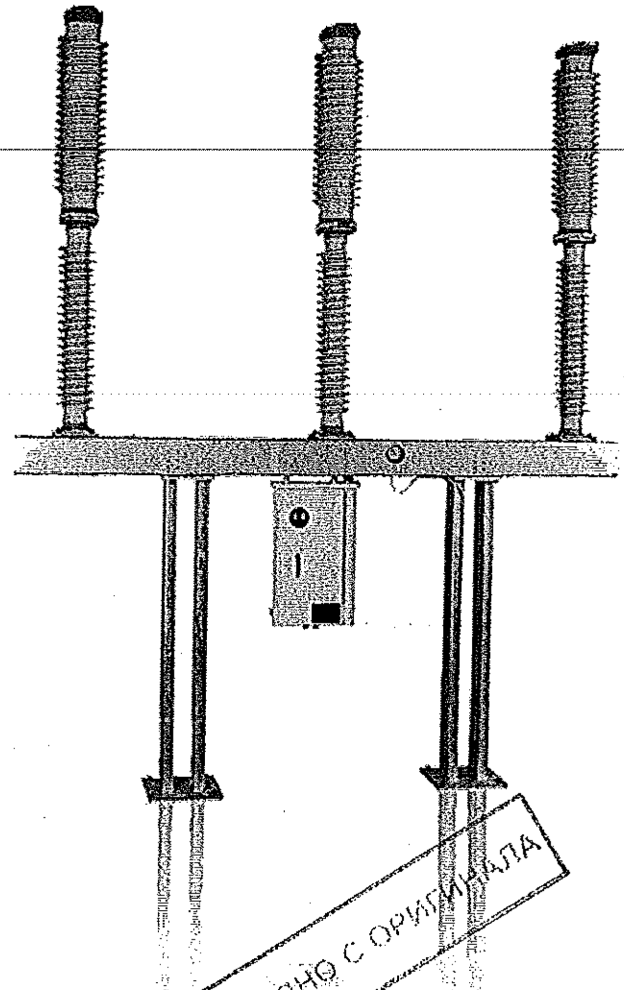
ВЯРНО С ОРИГИНАЛА

The sprocket (11) belonging to the cam disc (3), has its catch locked against the closing latch (6), whereupon the sections of the chain (8) raise the spring bridge (10).

The closing springs (5) are thereby charged and the mechanism again takes up its normal operating position.

FSA1
Design features and advantages

Introduction
Demands on the reliability of power transmission networks are increasing continuously. As such, today many customers strongly focus on the reliability and maintenance requirements of system equipment.



Circuit breakers are the last link in a chain of apparatus that form the protection equipment for a power supply system. Within a few milliseconds an operating mechanism must supply the energy needed to transform the circuit breaker from a perfect conductor to a perfect insulator. A failure in the operating mechanism often means a failure in the total breaking operation. Thus, operating mechanisms play a major role of the reliability of the circuit breaker and, thereby, of the total power supply system.

In addition, capacitor bank and reactor switching applications, which impose added requirements on operational endurance, are becoming more common.

In an international investigation it was shown that eighty percent (80%) of all failures in high voltage circuit breakers originated in the operating mechanism. Therefore, to achieve highest operational reliability, circuit breakers should be equipped with highly reliable operating mechanisms.

With thousands of FSA operating mechanisms in service, ABB is confident that the design is one of the most reliable on the market.

The design ensures a high degree of total reliability and minimal need for maintenance for the operating mechanism and, thus, the circuit breaker as a whole.

Applications
The FSA1 spring operating mechanisms are used for the following type of circuit breaker:

– LTB D1/B

Design features
The operating mechanism consists primary of two tension springs.

The closing spring generate the required driving force to close the circuit breaker and charge the opening spring.

The opening spring is directly connected to the circuit breakers link system. This means that the mechanical energy needed for the vital opening operation is always stored in the opening spring when the circuit breaker is in closed position. In other words, a closed circuit breaker is always prepared for immediate opening.

A universal motor drives the spring charging gear, which automatically charges the closing spring immediately after each closing operation.

The springs are kept in charged state by a latch that is released when the circuit breaker is being closed. This enables rapid reclosing of the circuit breaker after a dead time interval of 0.3 s.

The principle of the operating mechanism can be briefly described as follows:

Closing operation:
When the circuit breaker is being closed, the closing latch is released from the main shaft and the closing spring trips. This means that the cam disc rotates via the closing lever. The switching shaft is put in motion and the circuit breaker closes, at the same time as the trip spring in turn is charged and locked. The motor then charges the closing spring following each closing operation, via the main shaft and worm gear. When the spring is fully charged, the circuit is interrupted by the limit switch.

Opening operation:
When the signal indicating that the circuit breaker shall open is received, the tripping latch device releases from the switching shaft and the trip spring hereby opens the circuit breaker.

A damping device is included to retard the motion of the contact system in the end position at opening.

The auxiliary equipment is characterized by the following:

- Robust auxiliary contacts and limit switches
- Mechanical indication of charged or discharged closing spring.
- All electrical wiring used for external connections is brought to terminal blocks.

Interlocking against unintentional operation
Interlocking is achieved partly electrically and partly mechanically. Electrical interlocking is achieved by having the circuits of the operation coils connected through the auxiliary contacts of the operating mechanism. In addition, the closing coil is connected through a limit switch that is controlled by the position of the spring. In this way the closing circuit is only closed when the breaker is in the open position and the closing springs are fully charged.

Based on the above interlocking design, the following operations are not possible when in service:

- Closing operation when the breaker is already closed (i.e. a "blind" stroke)
- Closing operation during an opening operation

FSA1 housing
- Corrosion resistant housing of painted aluminum
- Front door equipped with doorstops and provisions for padlock on door handles.

Panels
Behind front door (master for single-pole operation SPO) and three-pole operation (TPO) there is a panel that may be equipped differently depending on customer specific requirements. As a standard, the following equipment is included on the control panel:

- Local open / close switch
- Local / remote / disconnect selector switch
- Pole selector switch (only for SPO)
- MCB for motor
- MCB for heater
- Thermostat
- Mechanical operations counter (Visible through an indication window in the cubicle door.)
- Mechanical spring charge indicator (Visible through an indication window in the cubicle door.)

Relays, limit switches and auxiliary contacts are accessibly behind covers or by removing the casing.

Terminal blocks of the SPO version are located behind a cover of the backside of master cubicle. For TPO direct behind the front door.

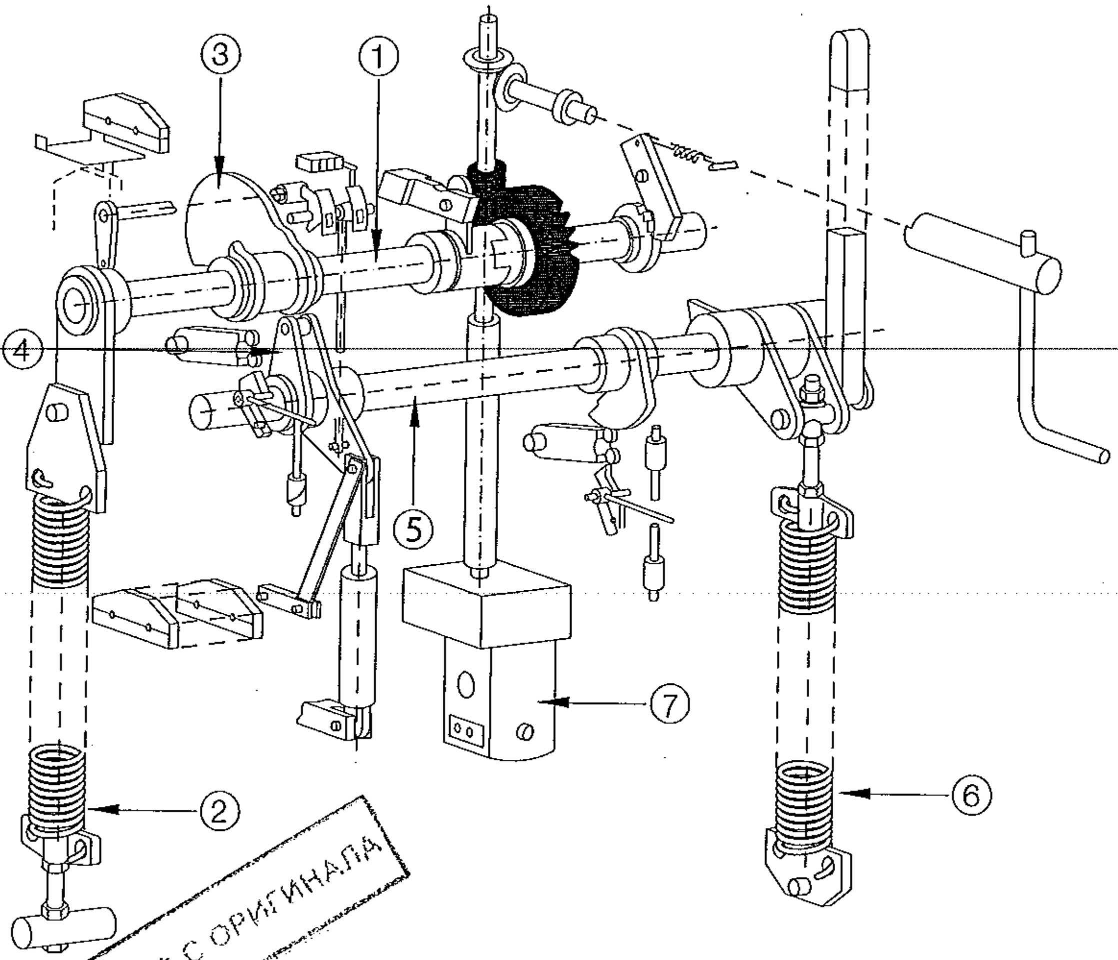
Standard terminal blocks of compression type (in which a bare wire is compressed between two metallic plates in the terminal).

On the backside of the front door there is a compartment for documents with instruction manual and final drawings. A hand crank, for manual charging of the springs, is also attached.

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД СОФИЯ

FSA1
Design

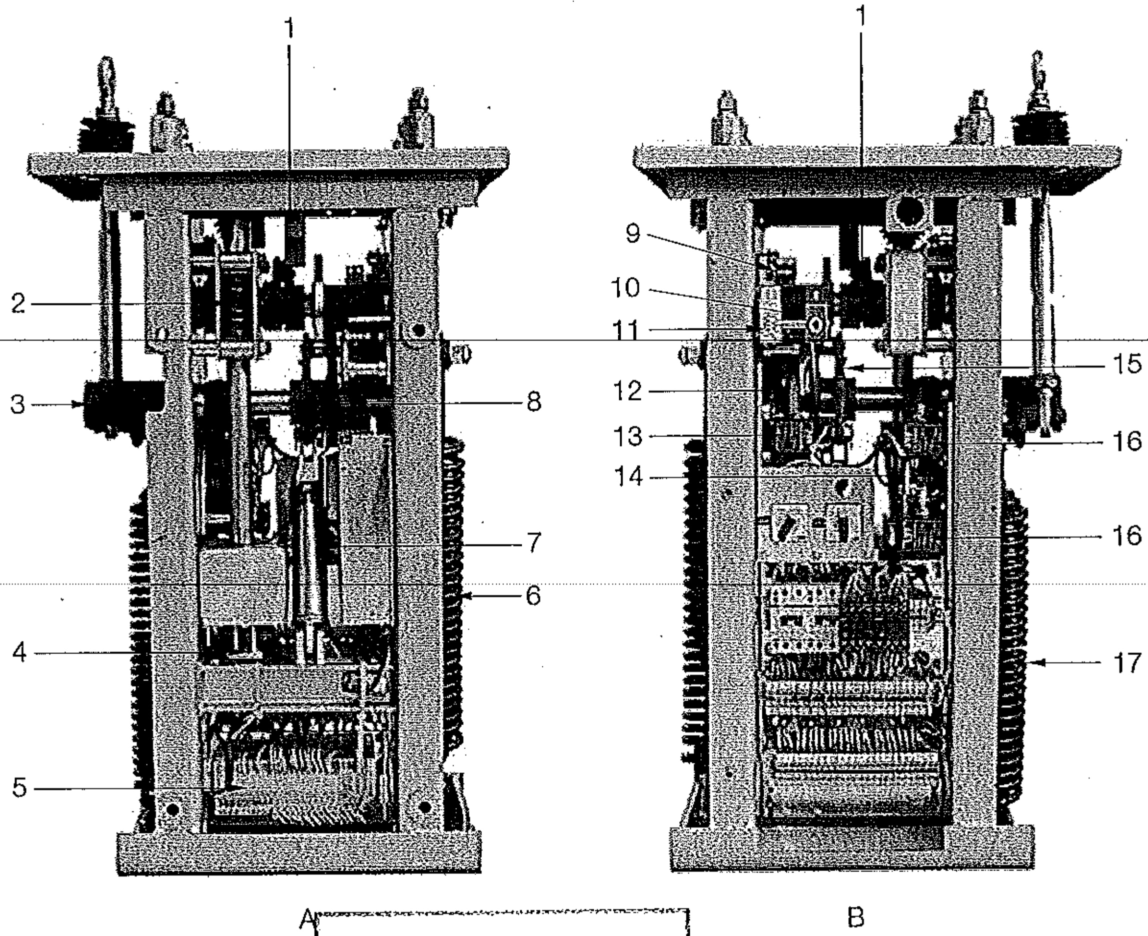


Operating mechanism type FSA1

1 Main shaft
2 Closing spring
3 Cam disc
4 Closing lever
5 Switching shaft
6 Trip spring
7 Motor

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСАТИ • ООД • СОФИЯ



ВЯРНО С ОРИГИНАЛА

Operating mechanism type FSA1

A	**View from behind**	**B**	**View from the front**
1	Main shaft	9	Counter for circuit breaker operations
2	Worm gear	10	Position indicator
3	Operating mechanism's opening lever	11	Spring charge indicator
4	Motor	12	Manual closing operation lever
5	Auxiliary contacts	13	Closing coil
6	Closing spring	14	Manual opening operation lever
7	Hydraulic damper	15	Operating mechanism's closing lever
8	Switching shaft	16	Trip coil 1 and 2
		17	Trip spring

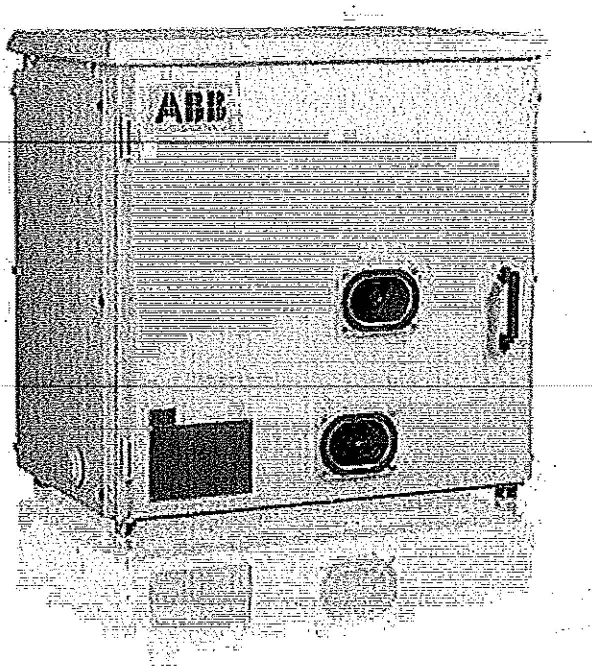
ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД СОФИЯ

Стр. II.640

MSD
Design features and advantages

Introduction
Demands on the reliability of power transmission networks are increasing continuously. As such, today many customers strongly focus on the reliability and maintenance requirements of system equipment.



Circuit breakers are the last link in a chain of apparatus that form the protection equipment for a power-supply system. Within a few milliseconds an operating mechanism must supply the energy needed to transform the circuit breaker from a perfect conductor to a perfect insulator. A failure in the operating mechanism often means a failure in the total breaking operation. Thus, operating mechanisms play a major role of the reliability of the circuit breaker and, thereby, of the total power supply system.

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ СОФИЯ ООД

In addition, capacitor bank and reactor switching applications, which impose added requirements on operational endurance, are becoming more common.

In an international investigation (CIGRÉ reliability survey) it was shown that eighty percent (80%) of all failures in high voltage circuit breakers originated in the operating mechanism. Therefore, to achieve highest operational reliability, circuit breakers should be equipped with highly reliable operating mechanisms.

In the light of the above, the new MSD motor charged spring operating mechanism was developed. The MSD spring operating mechanism is designed with a minimum of components. Such a design ensures a high degree of total reliability and minimal need for maintenance for the operating mechanism and, thus, the circuit breaker as a whole.

Applications
MSD spring operating mechanisms are used for the following types of ABB live tank circuit breakers:

- LTB D1/B
- LTB E1 (single-pole operated)

Design features
The MSD design incorporates proven design principles from ABB's earlier spring operating mechanisms, including stable, reliable low power operating latches and cam disc operation for closing operation control.

An important innovation of the MSD design is the use of the torsion springs for opening and closing energy storage. This allows for a very compact design, with both closing and opening springs contained within the operating mechanism.

In this ABB design, the opening and closing springs are contained inside the drive and is delivered as a completely tested unit.

The closing springs in the operating mechanism generates the required driving force to close the circuit breaker and charge the opening spring. As such, the mechanical energy needed for the vital opening operation is always stored in the opening spring when the circuit breaker is in the closed position. In other words, a closed breaker is always prepared for an immediate opening operation.

MSD
Design features and advantages

Immediately after each closing operation, a motor drives the spring charging gear to automatically charge the closing springs. After recharging the closing springs, the circuit breaker is capable of a rapid reclosing with a dead time interval of 0.3 s.

Both opening and closing springs are kept in the charged state by very reliable triple-action latches.

The power unit is characterized by the following robust main components:

- Helical torsion opening and closing springs, which drives the operating shaft of the circuit breaker.
- Direct drive to circuit breaker shaft connection, without any extra external linkage. Requires no setting or adjustments for LTB E. (Not applicable for LTB D1/B).
- Robust, universal charging motor
  - Operates after closing operation
  - Charges closing springs in ≤15 seconds
- Trip and close latches are fast acting and vibration proof.
- A damping device to retard the motion of the contact system at the end of an opening operation.
- A reliable closing spring charging system, requiring minimum maintenance.

The auxiliary equipment is characterized by the following:

- Robust auxiliary contacts and limit switches.
- Mechanical indication of charged or discharged closing spring.
- All electrical wiring used for external connections are wired up to terminal blocks.
- Good accessibility through large cubicle and a hinged control panel.
- Consistent operating times for all environmental conditions, making the circuit breaker very suitable for controlled switching.

Interlocking against unintentional operation

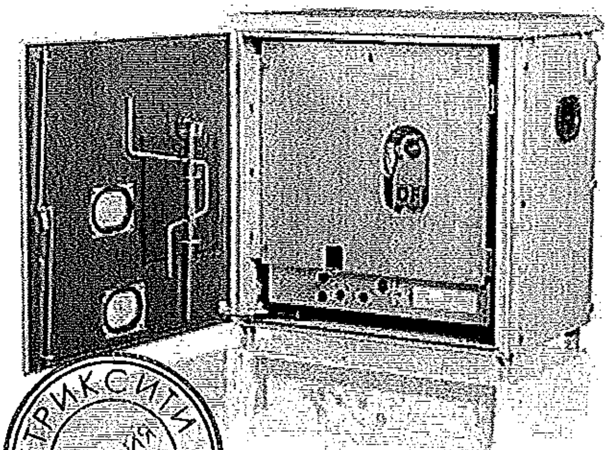
Electrical interlocking is achieved by having the circuits of the operation coils connected through the auxiliary contacts of the operating mechanism. In addition, the closing coil is connected through a limit switch that is controlled by the position of the charging gear wheel and cam support. In this way the closing circuit is only closed when the breaker is in the open position and the closing springs are fully charged.

Based on the above interlocking design, the following operations are not possible when in service:

- Closing operation when the breaker is already closed (i.e. a "blind" stroke)
- Closing operation during an opening operation.

MSD cubicle

- Corrosion resistant cubicle of painted aluminum of 2 mm thickness.
- Mechanical closing spring charge indicator
  - Located on the side of the cubicle behind a plastic cover.
- Front door is equipped with a doorstop and provisions for a padlock on the door handle.
- Insulated door and walls for low energy consumption and low noise level.



ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

Panels
Behind the door there is a panel that may be equipped differently, depending on customer specific requirements. As a standard, the following equipment is included on the control panel:

- Drawing pocket with product information and final drawings
- Local open / close switch
  Visible through the transparent shutter
- Local / remote / disconnect selector switch
- ~~Electromechanical operations counter – non-resettable~~
- Control equipment such as relay contactors MCB (Miniatüre Circuit Breaker) etc.
- Auxiliary contacts
- Position indicator OPEN/CLOSE
  Visible through the transparent shutter

There is easy access to relays and contactors, which are placed on the rear side of the hinged control panel (ICC application) or on the lower backside of the terminal plate (for CCC application).

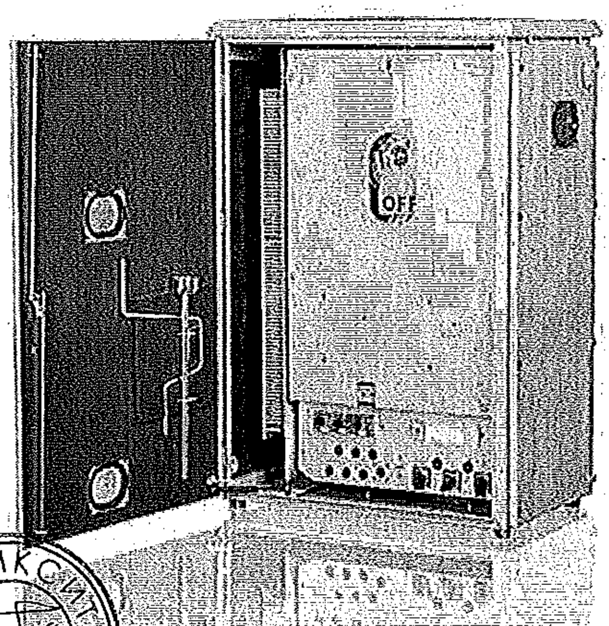
Behind the left cover on the cubicle there is an interface panel containing all necessary terminal blocks for customer connections. Standard terminal blocks are compression type in which a bare wire is compressed between two metallic plates in the terminal.

Behind the cover on the right side of the cubicle there is an indicator for mechanical spring charge, visible through the transparent shutter.

Tools
A compartment with tools is located on the backside of the front door.

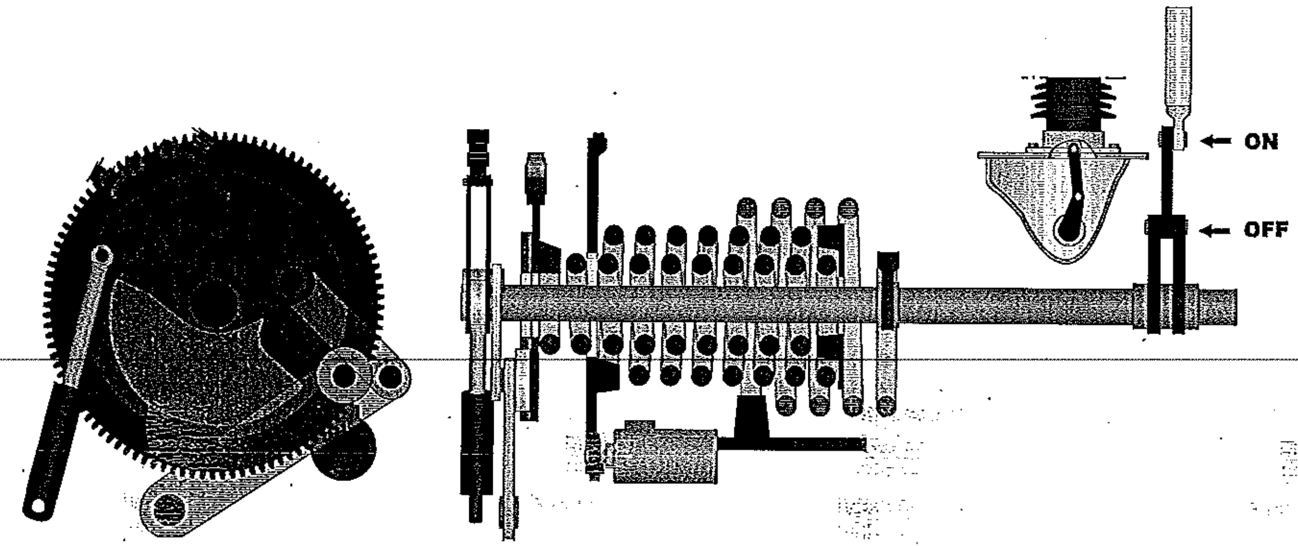
Central Control Cubicle (CCC) or Integrated Control Cubicle (ICC)
For local three-pole operation of a single-pole operated circuit breaker a Central Control Cubicle (CCC) can be used. The CCC can be delivered by ABB or arranged by the customer. As an alternative to the CCC we can also provide an Integrated Control Cubicle solution (ICC), which eliminates the need for the CCC. Integrated control means that the function and the components in the CCC have instead been incorporated in one of the three operating mechanisms wich is larger. This saves time for installation and cabling work.
We are open for discussions how to arrange the two alternatives.

Integrated Control Cubicle



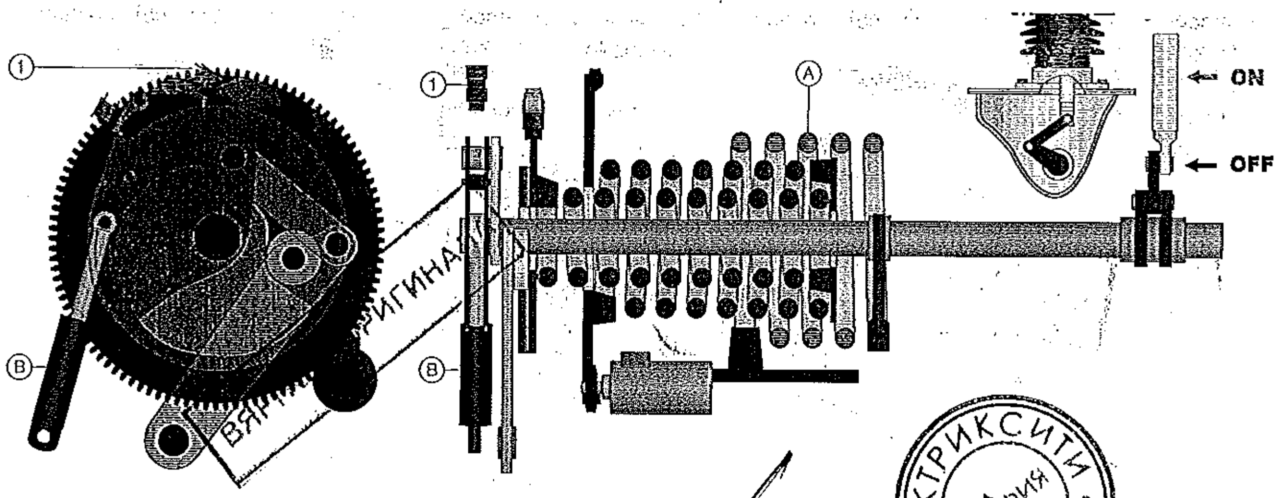
Integrated Control Cubicle - open door

MSD
Operating principles



Closed position

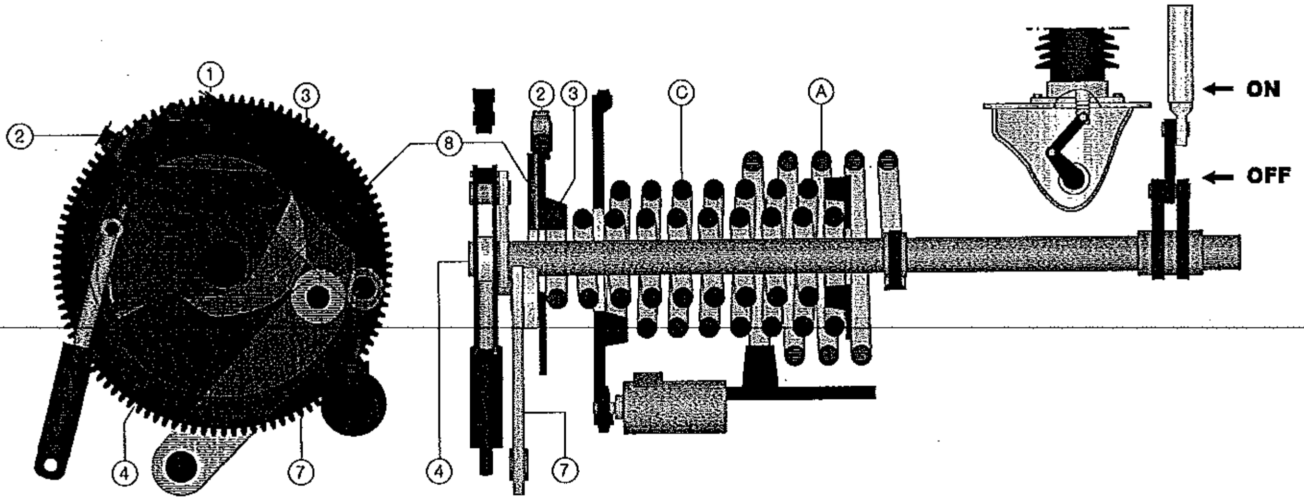
In the normal service position of the circuit breaker the contacts are closed and the opening and closing springs are charged. In this position the circuit breaker is always ready to perform an opening operation or a complete auto-reclosing (O - 0.3 s - CO).



ЕЛЕКТРИКСИТИ ООД София

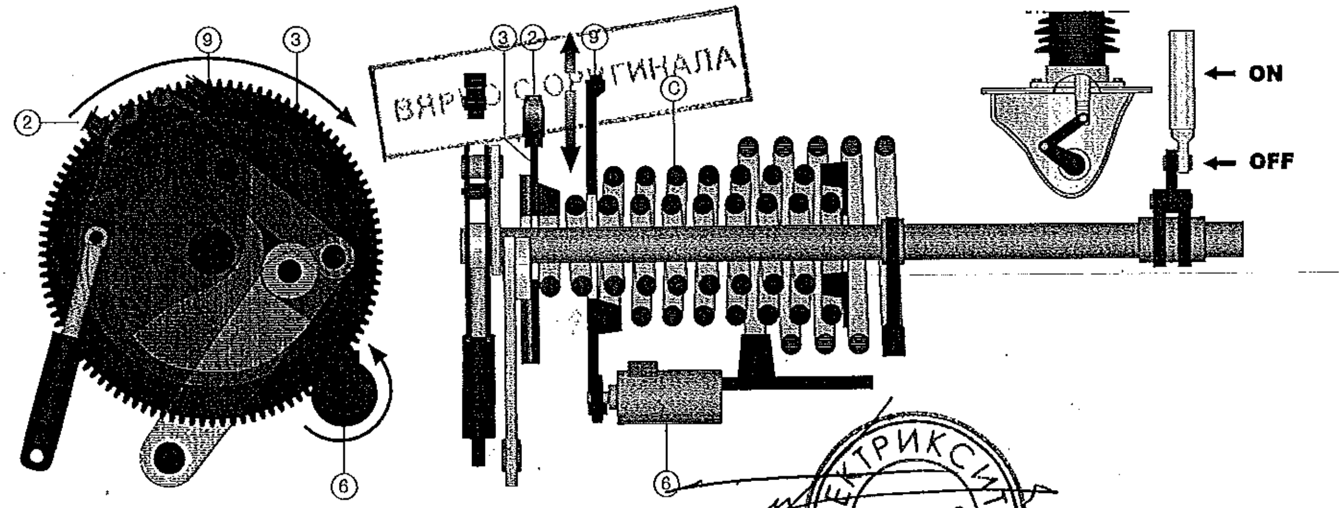
Opening operation

To open the circuit breaker, the opening latch (1) is released by the tripping coil, and the opening spring (A) of the circuit breaker carries out the operation. The motion of the contact system is retarded by a damping device (B).
With a spring operated circuit breaker the opening operation is extremely reliable as the operation is only dependent on the functioning of the opening latch and the opening spring.



Closing operation

Releasing of the closing latch (2) means an immediate response to close the circuit breaker. The cam support (3) is released, which enables the closing springs (C) to rotate the cam (8). The cam pushes the cam lever (7), which pulls the main operating lever (4) to the closed position. At the same time the opening spring (A) is charged. At the end of the stroke the main operating lever (4) connected to the circuit breaker is held by the opening latch (1) in the closed position.



ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ СОФИЯ ООД

Charging of the closing springs

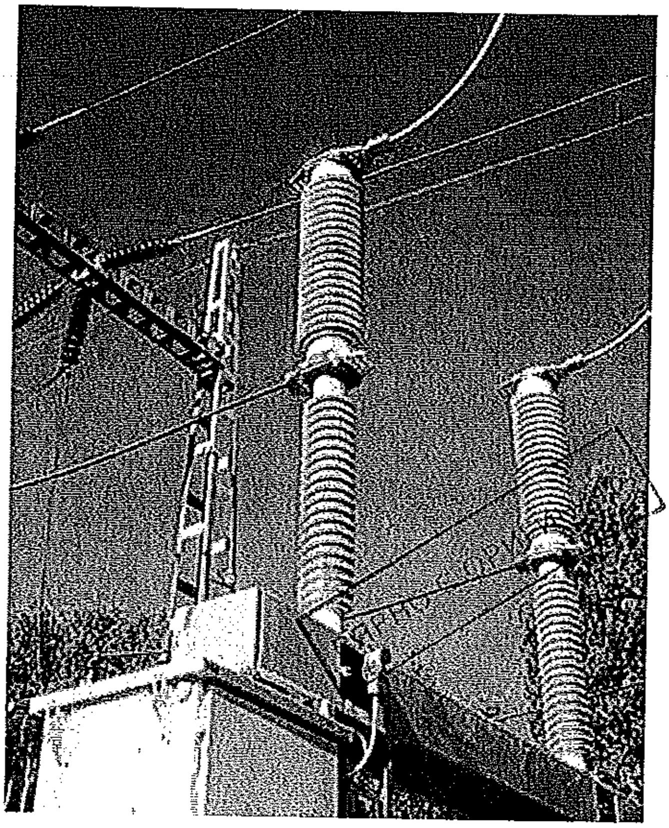
The circuit breaker has been closed. The motor circuit is closed by a limit switch. The motor (6) starts and charges the closing springs (C) by turning the charging gear wheel (9), while the cam support (3) is locked by the closing latch (2). When the closing springs are fully charged the limit switch will open the motor circuit.
In case of emergency, the closing springs can be charged by means of the hand crank enclosed in the cubicle.

Motor Drive
Design features and advantages

A revolutionary concept for the operation of high voltage circuit breakers

There is an increasing focus by power network operators to increase their operational returns on invested capital equipment. An important step in this direction is the shift towards condition-based maintenance in conjunction with utilizing a plant that has inherently low maintenance requirements.

ABB has concentrated its development on designing high performance, high voltage equipment that requires minimum of maintenance. The development has consequently focused on systems which predict a fault before it occurs and a warning is sent out. The warning can be used to avoid unplanned service interruptions and maintenance jobs can be carried out according to the planned schedule.



LTB Circuit Breaker with ABB's motor operated mechanism Motor Drive.

What is a Motor Drive™?
A Motor Drive is a digitally controlled motor directly moving the circuit breaker contacts.
ABB has developed a digital controlled servomotor system capable of direct driving circuit breaker contacts with high precision and reliability. The number of moving parts in the drive is reduced to just one – the rotating motor shaft.

Applications
At present available for:

- LTB D1/B (single- and three-pole operated)

Design features
Motor Drive is essentially a digital system. The required operating motions (trip & close) are programmed into a Control unit.

On command, the required operations are executed according to the stored contact travel program and the motor is controlled to move the circuit breaker primary contacts accordingly. Energy charging, buffering, release and transmission are essentially electrical and as such the mechanical system is reduced to a minimum of moving parts. The critical parts in the electrical operational chain are multiplied so that a redundant system is achieved.

The inherent mechanical simplicity of Motor Drive provides major advantages:
- Elimination of wearing components
- Reduction in operating forces
- Substantial reduction of the noise level during operation
- Inherent increased reliability by elimination of multiple-interacting mechanical components

References
So far approximately 300 LTB D1/B with Motor Drive have been installed in more than twenty countries all over the world.

Reference list can be presented on request.

ЕЛЕКТРИКСИТИ ООД София

The Motor Drive platform offers many advantages and new capabilities:

- Direct, active feedback control of contact motion
- Flexible permissive logic control of the circuit breaker
- Dramatic reduction of transients in substation auxiliary supply
- Increased operational security and improved asset management through advanced on-line monitoring

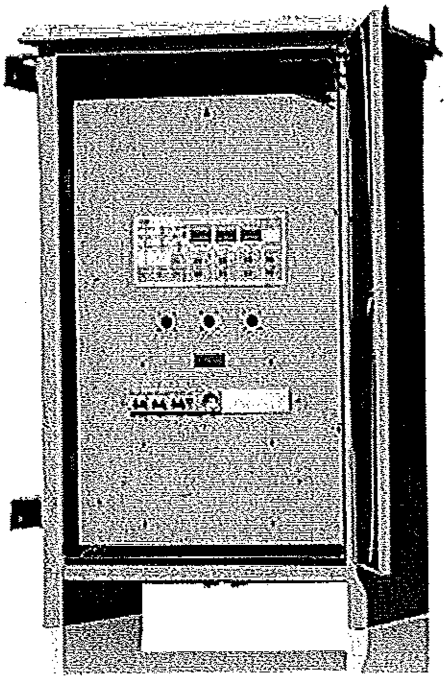
Robust modular design

The Motor Drive is designed for widely shifting conditions from polar to desert climate.

Reliability

A circuit breaker must operate safely and reliably at all times. This is further improved by:

- Eliminated multiple-interacting mechanical components.
- Inherent self-monitoring capability.
- Redundant critical systems.
  - Two independent voltage supplies.
  - Automatic switching to back-up supply.



Motor Drive™ control cubicle with open front door.

Motor Drive™ control cubicle

- Corrosion resistant housing of painted aluminum.
- Front and back doors equipped with doorstops and provisions for locking of door handles.
- Insulated roof, doors and walls.

Control panel

Behind the front door is a panel that may be equipped differently, depending on customer specific requirements. As a standard, the following equipment is included on the control panel:

- Casing with instruction manual and final drawings
- Local open / close control
- Local / remote / discharge selector control
- Electromechanical operations counter – non-resettable
- Indicators for charged/discharged capacitors
- Warning and alarm indicators
- Contact position indicator
- MCBs for voltage supplies, heaters and socket outlet

Behind the rear door of the control cubicle housing there is an cable interface panel containing all necessary terminal blocks for customer connections.

Simple erection

Installation and commissioning is easy.
Each motor drive is pre-tested together with the circuit breaker poles and shipped to installation site in the form of a few pre-assembled units. No adjustments necessary on site.

ВЯРНО С ОРИГИНАЛА

Condition monitoring

During normal operation of the circuit breaker the Motor Drive continuously runs diagnostic algorithms to check both the electrical and mechanical system. In event of problem a warning or fail signal will indicate to the substation control that service is needed.

For service purposes the Motor Drive collects and stores a wide array of data that can be retrieved either locally or from the control board or remotely through a modem. With the service software, MD Service installed on a laptop, the status of the circuit breaker can be further investigated; detailed information can also be downloaded and sent to ABB for detailed analysis and failure diagnostics.

СОФИЯ ООД

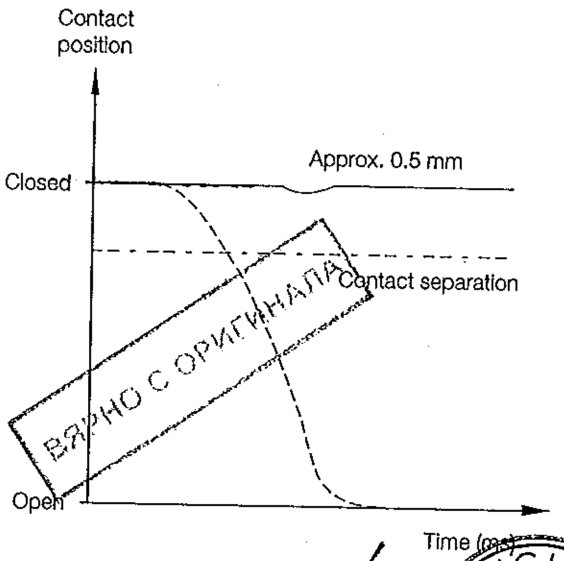
Motor Drive
Design features and advantages

The silent circuit breaker
During operation the control system feeds the motor with precise amount of energy needed to obtain the desired speed of the contacts. This smooth control together with the minimized mechanical system gives very low sound level of the circuit breaker operation. Sound levels of 87 dB(A) have been measured and can be compared to sound levels up to 100 dB(A) that have been registered for circuit breaker with spring drives.

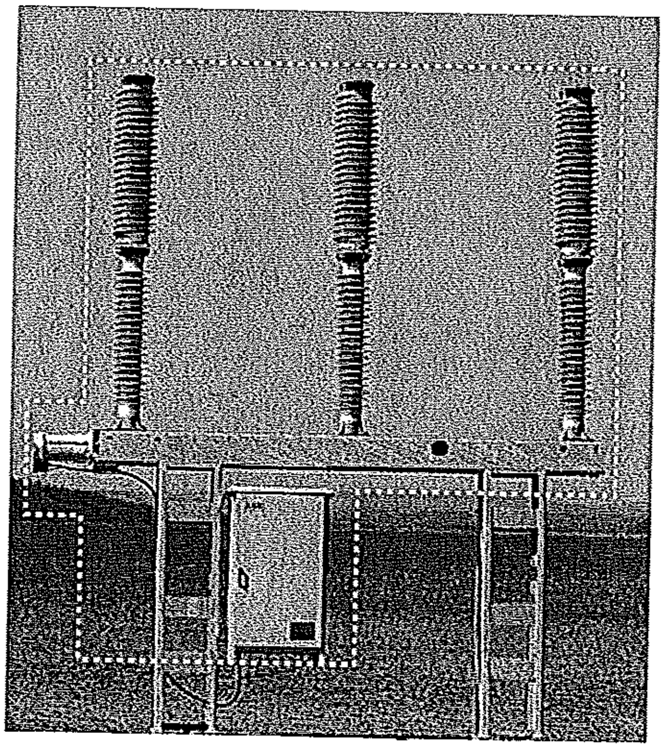
In service diagnostic test — Micro-motion
To obtain information about the condition of all the electrical and mechanical components in the system, the main contacts can be moved a short distance without separation. This can be executed automatically at programmed time intervals or by command via the *MD Service* serial communication interface.

The Micro-motion operates under service of the circuit breaker and does not interfere with the normal operation. If a trip command is initiated at the instant when a Micro-motion is performed the normal operation will override and an unaffected open operation will be executed.

Advantages
- Only one moving part, simple and reliable
- Optimal pre-programmed travel curve
- Contact travel is compensated against ageing and changes in ambient temperature by the adaptive control system
- Condition monitoring is inherently possible without need for additional sensors
- Low power requirement, no transient loads
- Low mechanical stress and low noise levels
- Redundant power supply
- Optical serial communication port for external connection
- Micro-motion – functional test
- Can be used in combination with Switchsync™ applications (single-pole operation).

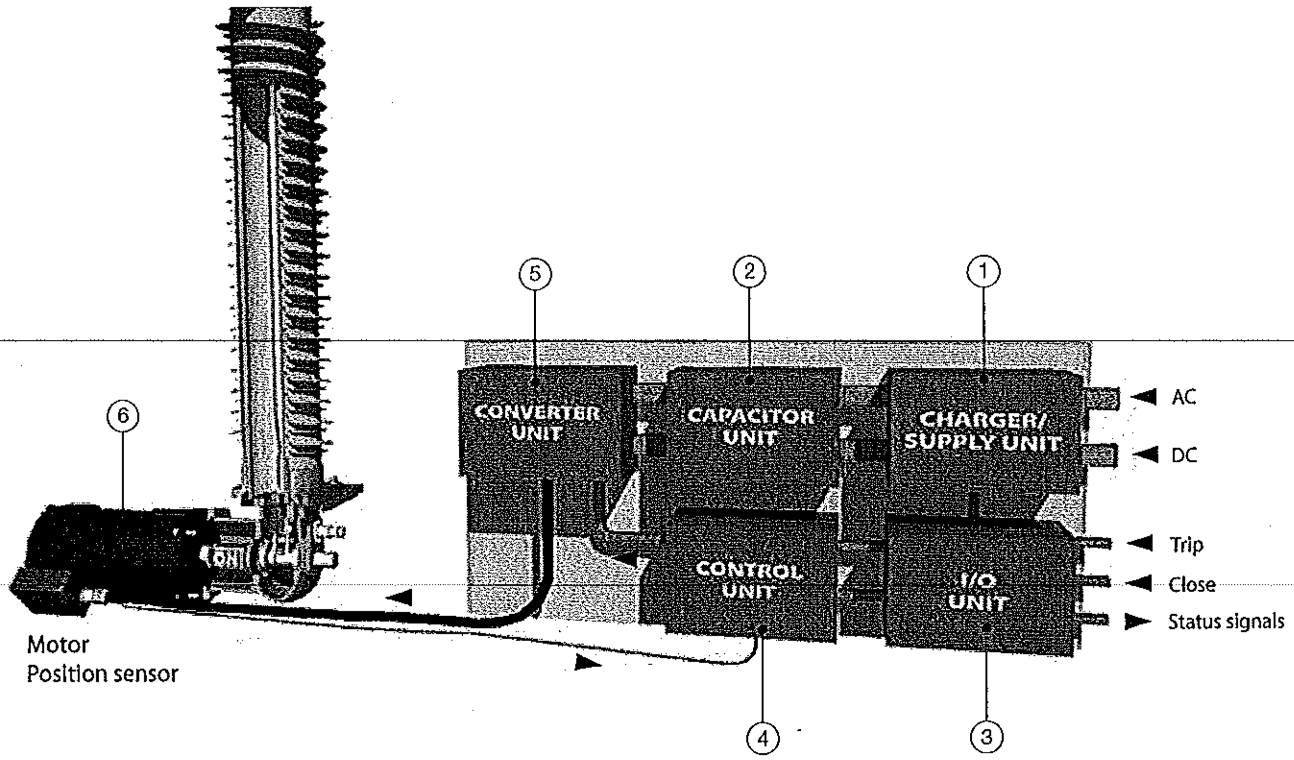


ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ СОФИЯ ООД



Micro-motion gives information about the condition of all the electrical and mechanical components in the system.

Motor Drive
Operating principle



Energy charging
(1) - Charger/Supply unit accepts redundant AC and DC supply inputs and provides internal power supply to Capacitor, I/O and Control Units. Supply load demands are very low (less than 1 A at normal operation) and with very low transient loads.

Energy buffering
(2) - Operating energy for the drive is buffered in a Capacitor Unit. The unit stores and provides the power needed for the motor during operation. The unit is monitored to ensure that operations are only permitted when sufficient energy is available. The unit is dimensioned to accommodate standard IEC and ANSI circuit breaker auto-reclosing demands.

Control & Signaling
(3) - The I/O unit receives all operating commands to the breaker and provides signaling indication back to the substation control system. The I/O unit contains bistable relays, which replaces the traditional mechanical auxiliary contacts.

Energy release & Transmission
Once an operation command (Trip or Close) is validated through the I/O Unit (3) it passes to the Control Unit (4). Permissive logic control of operating commands is regulated in the Control Unit. The Control Unit contains and executes the programmed travel curve for the circuit breaker. The Control Unit will access the relevant curve program (Trip or Close) and sends internal commands to the Converter Unit (5). Taking DC supply from the Capacitor Unit (2), the Converter Unit will then send digitally controlled AC voltage and current to the Motor Stator (6) to drive the Motor with the required motion.

The rotor of the Motor is directly connected to the operating drive shaft of the circuit breaker. The integrated Position Sensor in the Motor continuously monitors the Rotor position. This information is fed directly back to the Control Unit. The Control Unit verifies the measured position, compares it to the position required at that instant by the pre-programmed travel curve. It sends further control signals to the Converter Unit to continue the motion of the breaker. Thus the circuit breaker motion is precisely controlled by the feedback according to the pre-programmed travel curve stored in the Control Unit memory.

Motor Drive
Diagnostics

MD Service
MD Service is a User interface program, which provides data from the Motor Drive to check the status of the circuit breaker. MD Service can also be used to customize the function of the circuit breaker according to the customer needs. For example the Software can be used to:

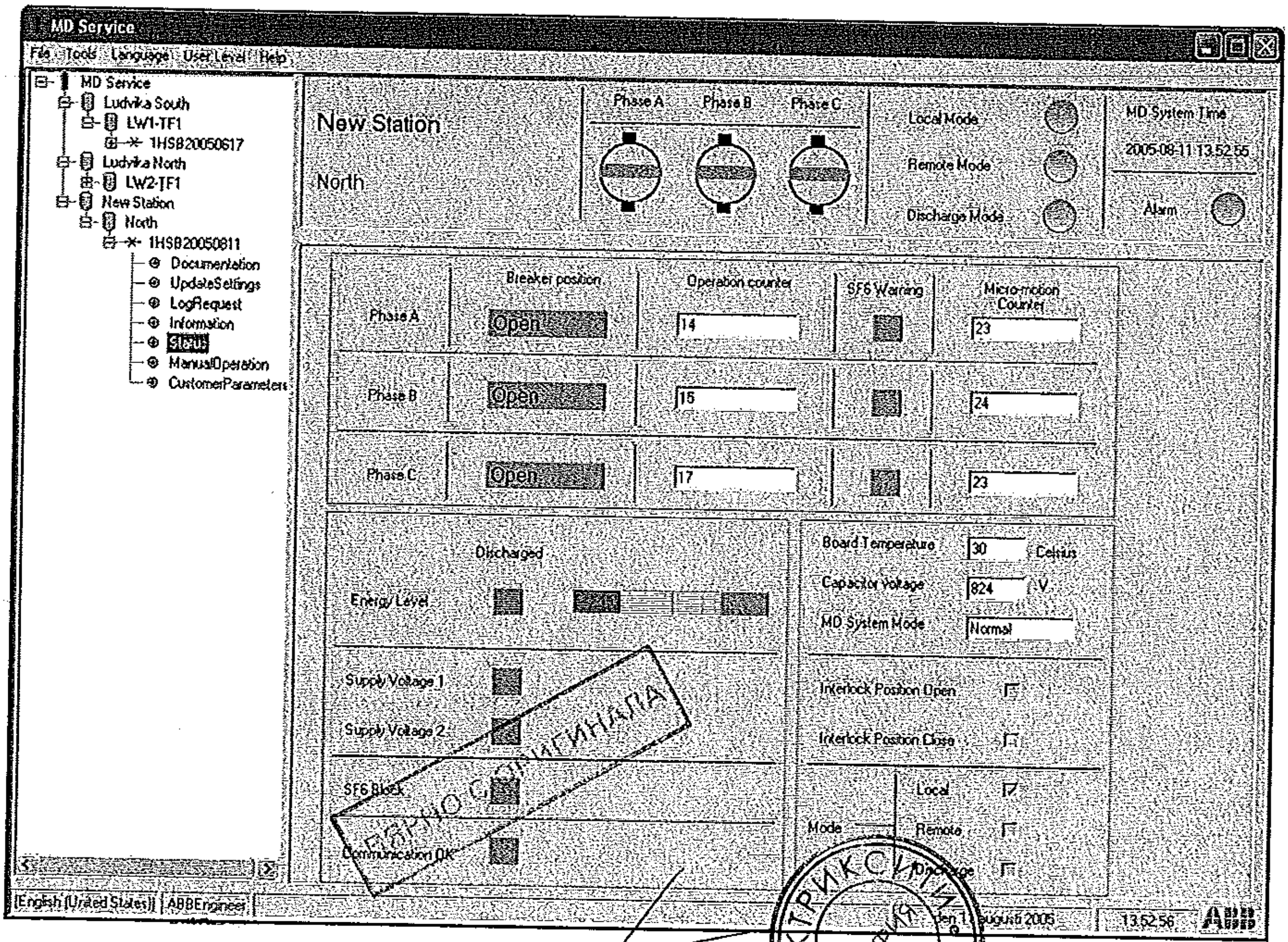
- Set the time intervals of the Micro-motion operations
- Configure automatic operations that can be performed in the event of low energy, low gas levels, phase discrepancies and loss off supplies.
- Change/upgrade of the drive software

The MD Service can also be used to gather and browse documents relevant for the application such as: Schematics, Operation logs and product manuals.

In the event of a warning or fail signal from the system the MD Service can be used to analyze the problem, detailed data can also be downloaded and send to ABB for further analyzes and remote failure diagnostic.

At installation and commissioning the software is used for local operation and verification of the system function.

The MD Service also includes a help function, which describes the different functions more in detail.
The following figure is an example of a MD Service view.



Example of MD Service view.

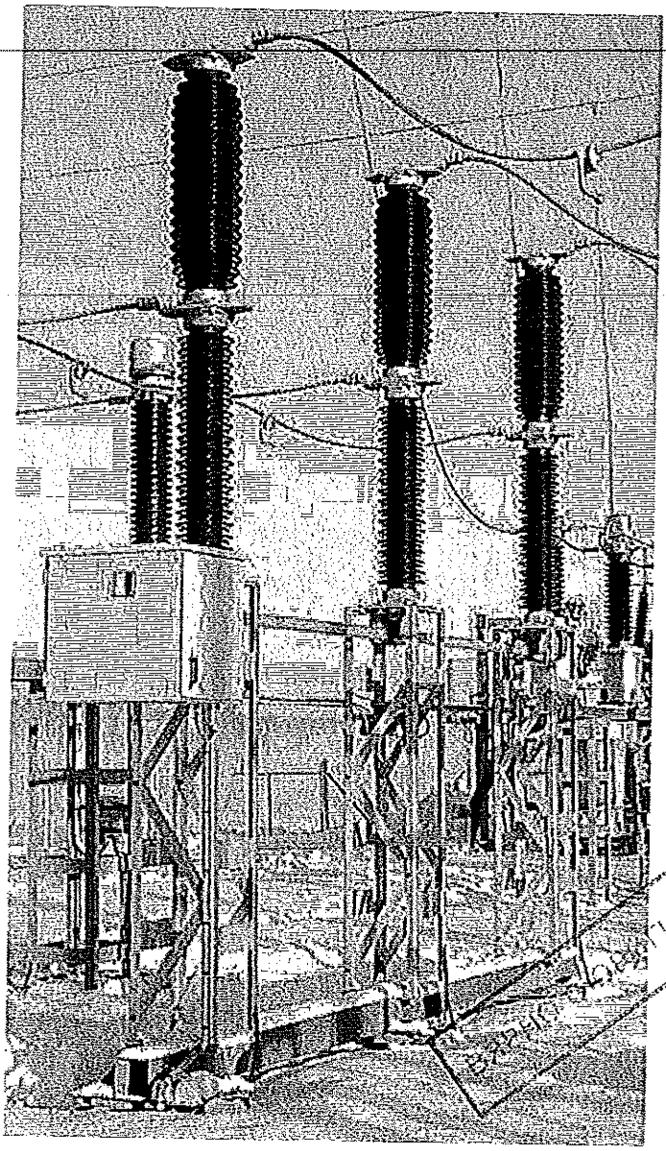
ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

LTB D and LTB E
Technical information

ABB produced the world's first SF_6 circuit breakers with arc-assisted interrupters in the mid-1980's.
The energy required for interrupting short circuit currents is partly taken from the arc itself, significantly reducing the energy required from the operating mechanism.
Lower operating energy inherently reduces mechanical stresses and increases circuit breaker reliability.

For many years, ABB has used operating mechanisms with energy mechanically stored in springs. This solution offers considerable advantages in that the energy in the tensioned springs is always available.
We have also introduced the latest technology for circuit breaker operation – Motor Drive



Brief performance data:

Installation	Outdoor / Indoor
Design	SF_6 Auto-Puffer™ interrupter Spring operating mechanisms or Motor Drive
Insulation	SF_6
Rated voltage	Up to 800 kV
Rated current	Up to 4 000 A
Breaking current	Up to 50 kA
Short-time current	Up to 50 kA/3 s
Insulators	Composite or porcelain
Creepage distance	25 mm/kV, phase - phase voltage (Longer on request)
Service conditions:	
Ambient temperature	-30 to +40 °C (Operation in temperatures down to -60 or up to +70 °C on request)
Design altitude	1 000 m.a.s.l. (Higher altitudes on request)
Type of operation	Single- or Three-pole

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД СОФИЯ

Material

The selected components of aluminum (mechanism housings, HV-terminals, cubicles) give a high degree of resistance to corrosion, without the need of extra protection. For use in extremely demanding environments LTB can be delivered with a protective painting.

The support structure and protective tubes for the pull rods are made of hot-dipped galvanized steel.

Insulators

LTB circuit breaker is as standard delivered with insulators that consist of high-grade brown-glazed porcelain or composite insulators (light gray).
LTB with light gray porcelain can be delivered on request.

LTB is available as standard with long creepage distances.

Longer creepage distances can be quoted on request.

More information about our composite insulators can be found on page 134.

Mechanical strength

The mechanical durability gives a sufficient safety margin for normal wind loads and static and dynamic forces from conductors.

Seismic withstand strength

All LTB circuit breakers can, in their standard versions, withstand seismic accelerations below 3 m/s^2 (0.3 g) in accordance with IEC 62271-300.

For higher acceleration see page 146 "Seismic Withstand Capability".

Rating plates

A rating plate, which includes data for the circuit breaker, is placed on the operating mechanism cubicle. The rating plate is made of stainless steel with engraved text.

Operating mechanism

The circuit breaker is operated by motor charged spring operating mechanism(s), which is installed in a compact splash-proof and corrosion resistant housing, attached to the structure.

LTB circuit breaker type	Operating mechanism				
	BLK	BLG	FSA1	MSD	MD
LTB D1/B 72.5 - 170 kV three-pole operation	X		X	X	X
LTB D1/B 72.5 - 170 kV single-pole operation			X		X
LTB E 72.5 - 245 kV three-pole operation		X			
LTB E 72.5 - 245 kV single-pole operation	X			X	
LTB E 420 - 800 kV single-pole operation		X			

More detailed information about the operating mechanisms can be found in their special chapters.

Sealing systems for SF_6 volume

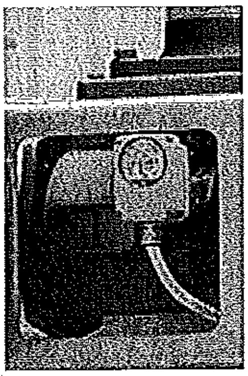
The sealing system consists of double nitrile rubber O-rings in all static seals and double X-rings in all dynamic seals.

This type of sealings has been used in our circuit breakers for more than 30 years with excellent service record at varying climatic conditions.

The SF_6 gas leakage is less than 0.5% per year.

SF_6 density monitoring

Since the interrupting capability is dependent on the density of the SF_6 gas, the LTB circuit breaker is provided with density monitor(s). The density monitor consists of a temperature compensated pressure switch. Therefore, alarm signal and blocking function are activated only if the pressure drops due to leakage.



The standard version of LTB D1/B for 72.5 – 170 kV has one common density monitor for all three poles.

Alternatively LTB D1/B can be provided with one density monitor per pole.

All LTB E circuit breakers have one density monitor per pole, except LTB E4 which has two density monitors per pole.

More information can be found in chapter "Explanations".

ЕЛЕКТРИКСИТИ СОФИЯ ООД

LTB D and LTB E
Technical information

Climatic withstand
The LTB circuit breakers are designed for, and are installed in, widely shifting conditions from polar to desert climate throughout the world.

For circuit breakers installed in areas with extreme low temperatures there is a risk of condensation of the SF_6 gas.

In order to avoid condensation consequences, one of the following gas-mixtures is used:

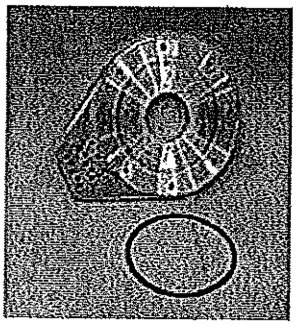
- SF_6 and N_2
- SF_6 and CF_4

Support structure
Support structures are included in the standard versions of the LTB circuit breakers. The support structures are made of hot-dipped galvanized steel.
The standard versions for structures are:

LTB D1/B 72.5 - 170 kV
One support column per pole, or one common pole beam with two support columns.
LTB E
One support column per pole for LTB E1 and LTB E2. (Up to 550 kV)
Two support columns for LTB E4. (Up to 800 kV)
For detailed information see "Dimensions"

The support structures are prepared for connection to ground by means of drilled holes on each leg.

High voltage terminals
The LTB circuit breakers are as standard equipped with flat aluminum terminals with thickness 20 mm for LTB D and 28 mm for LTB E.

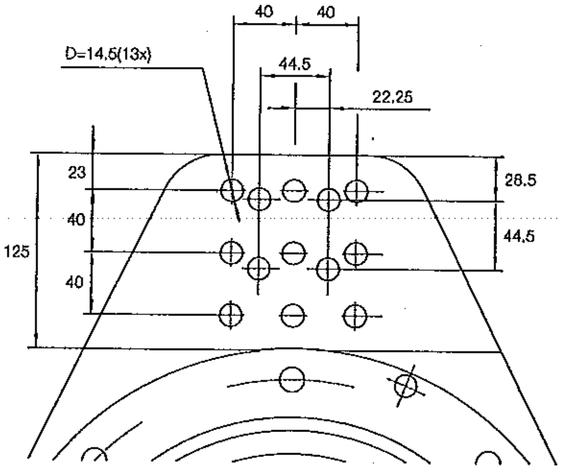


A flat aluminum terminal for LTB E2.

The drilling pattern is in accordance with IEC and NEMA standards.
Other dimensions (e.g. DIN) by means of adapters, are available on request.

Circuit breakers with vertically mounted breaking elements have terminals on both sides for connection in either direction.

Circuit breakers with horizontal breaking elements have one terminal per breaking element. The terminals are directed upwards.



Controlled switching devices
The goal for controlled switching is to increase power quality in the network systems by reducing switching transients.
All LTB circuit breakers are suitable for controlled switching with ABB:s Switchsync™ device.

In order to obtain optimum result the switching instants should be different for the three phases.

Since 1984 more than 3 400 Switchsync™ devices have been delivered.

For further information see page 136, "Controlled Switching".

Condition monitoring
As option we can offer supervisory control by means of our condition monitoring system.

This is described on page 142.

ВЯРНО С ОРИГИНАЛА

Type tests
The LTB circuit breakers have been type tested in accordance with IEC and/or IEEE standards.

Type test reports can be presented on request.

Routine tests
All LTB circuit breakers are routine tested before delivery. Our test program complies with IEC and IEEE standards.

For detailed information please see special chapter regarding "Quality Control and Testing" on page 148.

Transport
The LTB circuit breakers are normally packed and transported in seaworthy wooden crates.

The circuit breaker poles with one breaking element per pole are transported as complete units.

For circuit breakers with two breaking elements per pole, the breaking elements and the support insulators are transported in two separate cases.

For detailed information regarding weights and dimensions see "Shipping data".

Breaking elements as well as support insulators are filled with SF_6 gas at a slight overpressure.

Arrival inspection
On arrival the packaging and contents should be checked against packing list.

In the event of damage to the goods, contact ABB for advice, before further handling of the goods takes place.

Any damage ought to be documented (photographed).

Erection and commissioning
Assembly instructions are provided with each delivery.

Erection work at site can be done in 1–4 days depending on LTB type and size.

Filling of SF_6 gas to specified rated pressure is done by using the following pressurizing equipment, which can be delivered on request:

- One special control valve, for connection to the gas bottle, and a 40 m gas-filled hose with connectors.
- A complementary control valve for connection to CF_4 or N_2 gas bottle (for mixed gas filling).

When using above equipment gas filling can be carried out without gas being released into the atmosphere.

For illustration of gas filling equipment see page 63.

Maintenance
LTB is designed for a service life of more than 30 years or 10 000 mechanical operations. For current switching the number of operations before service is dependent on the interrupted current and type of application.

Inspection, maintenance and overhaul should be carried out at regular intervals depending on the ambient conditions and the number of operations.

The general actions are described below:

- 1–2 years:
  Ocular inspection
- After 15 years or 5 000 mechanical operations:
  Preventive maintenance including general inspection of the circuit breaker and operating mechanism.
  Operation test including measurement of operating times and possible adjustments.

ЕЛЕКТРИКСИТИ СОФИЯ ООД

LTB D and LTB E
Technical information

- 30 years or 10 000 mechanical operations:
  A comprehensive inspection is recommended to give increased safety and continued problem-free operation. The inspection methods and scope depend very much on the local conditions.

For circuit breakers for special switching duties such as switching of reactor banks overhaul of the breaking chamber should be carried out more frequently.

Overhaul and repair work must be performed by authorized personnel only.

The instructions in the manual for operation and maintenance should be observed.

ABB is available for discussions and advice.

Recommended spare parts
High operation frequency (e.g. circuit breakers for reactor or capacitor switching) and/or large quantities of circuit breakers:

- Complete poles
- Complete operating mechanisms
- Sets of contacts
- Sets of gaskets
- Density switches
- SF_6 gas

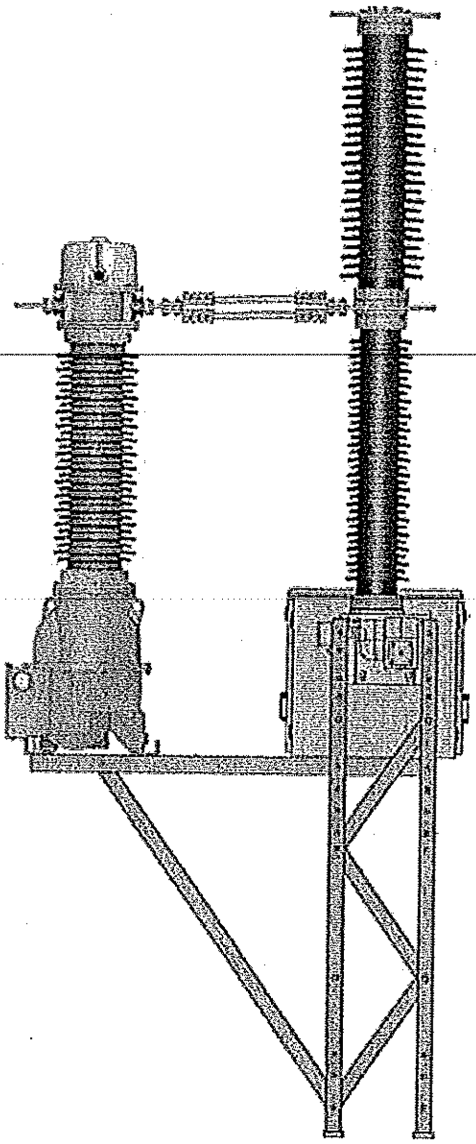
Spare parts for the operating mechanisms FSA, MSD, BLK and BLG; see their special chapters.

SF_6 gas
Gas for filling up to rated pressure can be delivered in bottles, each containing 40 kg gas.

The quantity required for each type of LTB varies from one circuit breaker type to another. This information is given in the tender.

The pressurizing equipment can be delivered on request, and is described under "Erection and Commissioning".

Brackets and primary connections
As optional equipment, LTB 72.5 – 170 D1/B can be delivered with cantilever support brackets for current transformer IMB, and primary connections between the circuit breaker and the current transformers mounted on the brackets.



Disposal
The disposal of wasted parts should be carried out in accordance with local legal provisions.

The SF_6 gas shall **not** be released into the atmosphere when the circuit breaker is disposed.

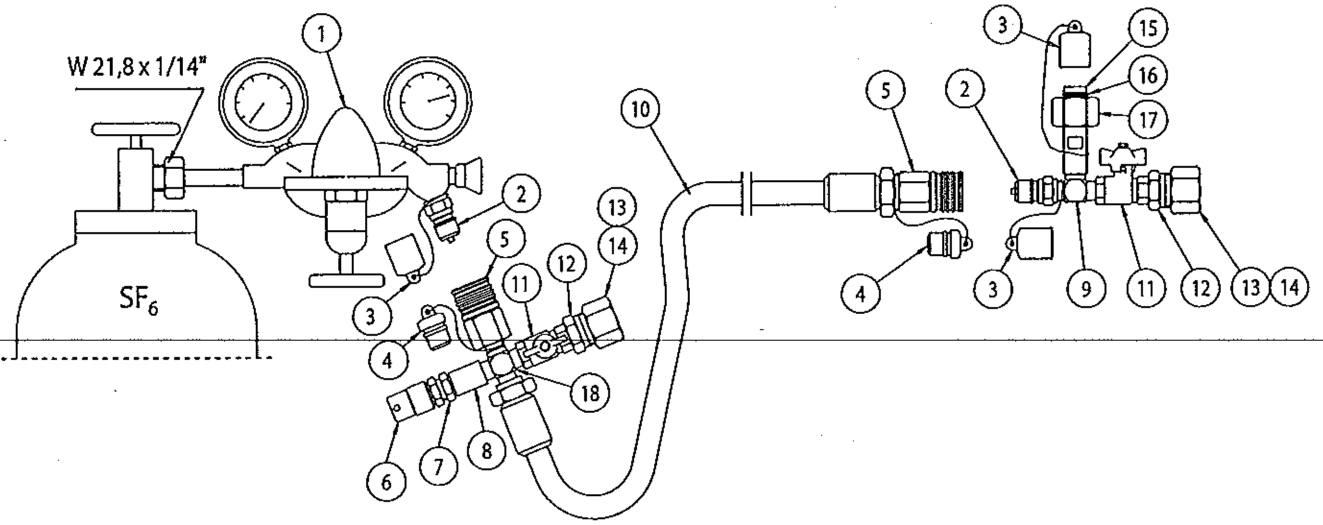
The SF_6 gas can be recycled.

The porcelain can, after it has been crushed, be used as fill.

The metals used in the circuit breaker can be recycled.

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

Gas filling equipment



1. Regulator for SF_6 gas
2. Plug in nipple
3. Protective rubber sleeve
4. Protective rubber plug
5. Coupling body
6. Deflector cap
7. Relief valve
8. Socket
9. T-union
10. Hydraulic hose
11. Ball plug valve
12. Nipple
13. Cover nut
14. O-ring
15. Nipple
16. O-ring
17. Connection nut
18. Equal union cross

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

LTB D and LTB E

Technical data according to IEEE (General data, deviations may occur)

		LTB 72.5D1/B	LTB 123D1/B	LTB 145D1/B	LTB 170D1/B	LTB 72.5E1	LTB 170E1	LTB 245E1	LTB 420E2	LTB 550E2
Number of breaks per pole		1	1	1	1	1	1	1	2	2
Rated voltage	kV	72.5	123	145	170	72.5	170	245	362	550
Rated frequency	Hz	60	60	60	60	60	60	60	60	60
Power frequency withstand voltage[1]										
- To earth (Dry/Wet)	kV	160/140	260/230	310/275	365/315	160/140	365/315	425/350	555/-	860/-
- Across open pole (Dry/Wet)	kV	160/140	260/230	310/275	365/315	160/140	365/315	425/350	555/-	860/-
Lightning Impulse Withstand Voltage										
- To earth	kV	350	550	650	750	350	750	900	1300	1800
- Across open pole	kV	350	550	650	750	350	750	900	1300	1800
Chopped Wave Impulse Withstand Voltage										
- To earth (2 μs)	kV	452	710	838	968	452	968	1160	1680	2320
- Across open pole (2 μs)	kV	452	710	838	968	452	968	1160	1680	2320
Switching Impulse Withstand Voltage										
- To earth	kV	-	-	-	-	-	-	-	825	1175
- Across open pole	kV	-	-	-	-	-	-	-	900	1300
Rated continuous current	A	3000	3000	3000	3000	4000	4000	4000	4000	4000
Rated s.c current	kA	40	40	40	40	40	40	40	40	40
First-pole-to-clear factor		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.3	1.3
Rated closing and latching current	kA	104	104	104	104	104	104	104	104	104
Duration of short-time withstand current	s	3	3	3	3	3	3	3	3	3
Closing time[2]	ms	< 40	< 40	< 40	< 40	< 55	< 70	< 55	< 70	< 70
Opening time[2]	ms	22	22	22	22	17	19	17	18	18
Interrupting time[2]	ms	40	40	40	40	40	40	40	40	40
Dead time	ms	300	300	300	300	300	300	300	300	300
Rated standard operating duty	-	O-0.3 s-CO-3 min-CO or CO-15 s-CO								

[1] Up to and including 245 kV, power frequency withstand voltage ratings apply for both wet and dry conditions

[2] Depending on operating mechanism

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

LTB D and LTB E

Technical data according to IEC (General data, deviations may occur)

		LTB 72.5D1/B	LTB 123D1/B	LTB 145D1/B	LTB 170D1/B	LTB 72.5E1	LTB 170E1	LTB 245E1	LTB 420E2	LTB 550E2	LTB 800E4
Number of breaks per pole		1	1	1	1	1	1	1	2	2	4
Rated voltage	kV	72.5	123	145	170	72.5	170	245	420	550	800
Rated frequency	Hz	50/60	50/60	50/60	50/60	50 60	50 60	50 60	50 60	50 60	50
Power frequency withstand voltage[1]											
- To earth and between phases	kV	140	230	275	325	140	325	460	520	620	830
- Across open pole	kV	140	230	275	325	140	325	460	610	800	1150
Lightning Impulse Withstand Level (LIWL)											
- To earth and between phases	kV	325	550	650	750	325	750	1050	1425	1550	2100
- Across open pole	kV	325	550	650	750	325	750	1050	1425 (+240)	1550 (+315)	2100 (+455)
Switching Impulse Withstand Level (SIWL)											
- To earth / Between phases	kV	-	-	-	-	-	-	-	1050/1575	1175/1760	1550/2480
- Across open pole	kV	-	-	-	-	-	-	-	900 (+345)	1300 (+450)	1175 (+650)
Rated normal current	A	3150	3150	3150	3150	4000	4000	4000	4000	4000	4000
Rated s.c breaking current	kA	40	40	40	40	50 40	50 40	50 40	50 40	50 40	50
First-pole-to-clear factor	-	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.3	1.3	1.3
Making current peak	kA	100/104	100/104	100/104	100/104	125 104	125 104	125 104	125 104	125 104	125
Duration of short-circuit	s	3	3	3	3	3	3	3	3	3	3
Closing time[2]	ms	< 40	< 40	< 40	< 40	< 65	< 65	< 65	< 70	< 70	< 65
Opening time[2]	ms	22	22	22	22	17	17	17	18	18	20
Break time[2]	ms	40	40	40	40	40	40	40	40	40	40
Dead time	ms	300	300	300	300	300	300	300	300	300	300
Rated operating sequence	-	O-0.3 s-CO-3 min-CO or CO-15 s-CO									

[1] Up to and including 245 kV, power frequency withstand voltage ratings apply for both wet and dry conditions
[2] Depending on operating mechanism

ВЯРНО С ОРИГИНАЛА

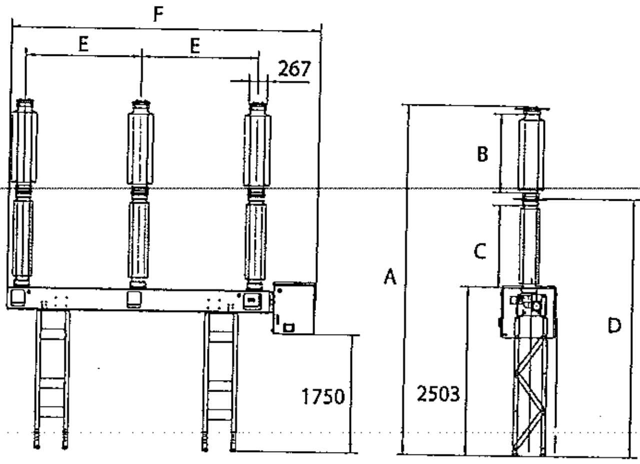
ЕЛЕКТРИКСИТИ СОФИЯ ООД

LTB D
Dimensions

LTB D1/B, Two-column stand, Three-pole operation, BLK mechanism
Rated voltage: 72.5 - 170 kV

Dimensions (mm)

Rated voltage	A	B	C	D	E	F
72.5 kV	4647	1164	670	3283	1050	3230
145 kV	5197	1164	1220	3833	1750	4630
170 kV	5808	1475	1520	4133	1750	4630



Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage	Phase distance				
72.5 kV	1050**	1500	1750*	2000	2500
145 kV	-	1500	1750*	2000	2500
170 kV	-	-	1750*	2000	2500

*) Standard **) BIL 550 kV

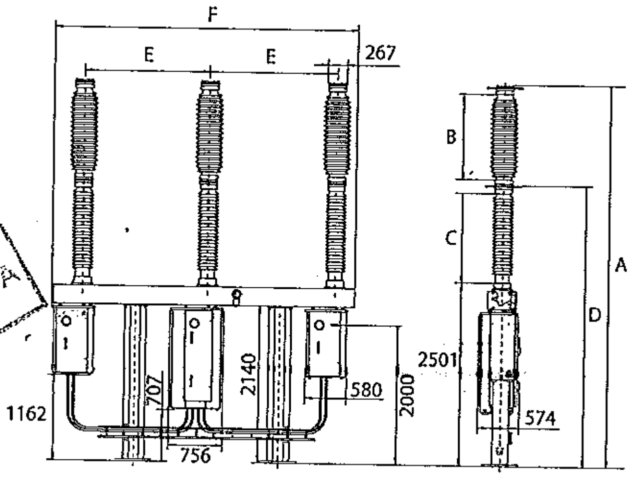
Rated voltage	Height to lowest part of insulator **			
72.5-170 kV	1123	2503*	2945	3528

*) Standard **) Other dimensions can be provided

LTB D1/B, Two-column stand, Single-pole operation, FSA1 mechanism
Rated voltage: 72.5 - 170 kV

Dimensions (mm)

Rated voltage	A	B	C	D	E	F
72.5 kV	4647	1164	670	3280	1750	4189
145 kV	5197	1164	1220	3830	1750	4189
170 kV	5808	1475	1520	4130	1750	4189



Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage	Phase distance			
72.5 kV	1500	1750*	2000	2500
145 kV	-	1750*	2000	2500
170 kV	-	1750*	2000	2500

*) Standard

ВЯРНО С ОРИГИНАЛА

Dimensions between stands. Centre to centre (mm)

Phase distance	Stand distance
1500	1500
1750	2000
2000	2530
2500	2530

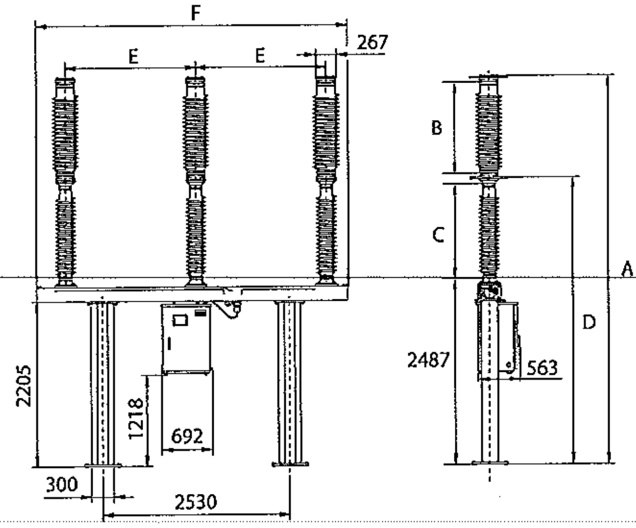
Rated voltage	Height to lowest part of insulator **		
72.5-170 kV	2501*	2946	3529

*) Standard **) Other dimensions can be provided

ЕЛЕКТРИКС СИТИ ООД СОФИЯ

LTB D
Dimensions

LTB D1/B, Two-column stand, Three-pole operation, FSA1 mechanism
Rated voltage: 72.5 - 170 kV



Dimensions (mm)

Rated voltage	A	B	C	D	E	F
72.5 kV	4647	1164	670	3280	1750	4189
145 kV	5197	1164	1220	3830	1750	4189
170 kV	5808	1475	1520	4130	1750	4189

Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage	Phase distance			
72.5 kV	1500	1750*	2000	2500
145 kV	-	1750*	2000	2500
170 kV	-	1750*	2000	2500

*) Standard

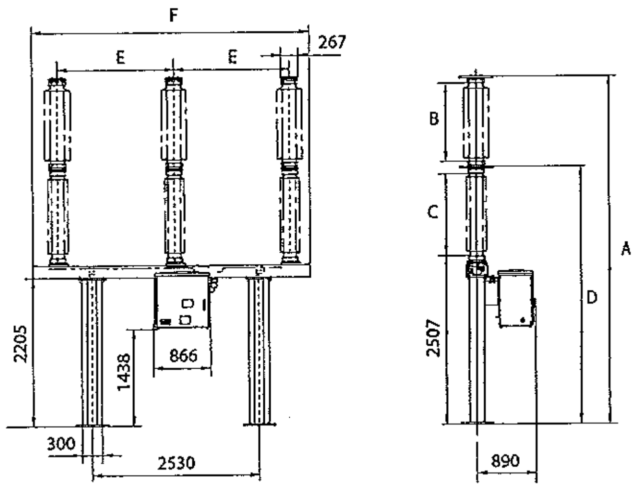
Rated voltage	Height to lowest part of insulator **		
72.5-170 kV	2501*	2946	3529

*) Standard **) Other dimensions can be provided

Dimensions between stands. Centre to centre (mm)

Phase distance	Stand distance
1500	2530
1750	2530
2000	2530
2500	2530

LTB D1/B, Two-column stand, Three-pole operation, MSD mechanism
Rated voltage: 72.5 - 170 kV



Dimensions (mm)

Rated voltage	A	B	C	D	E	F
72.5 kV	4647	1164	670	3280	1750	4174
123 kV	5201	1164	1220	3837	1750	4174
145 kV	5201	1164	1220	3837	1750	4174
170 kV	5812	1475	1520	4137	1750	4174

ВЯРНО С ОРИГИНАЛА

Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage	Phase distance				
72.5 kV	1050	1500	1750*	2000	2500
123 kV	-	1500	1750*	2000	2500
145 kV	-	-	1750*	2000	2500
170 kV	-	-	1750*	2000	2500

*) Standard

Rated voltage	Height to lowest part of insulator **		
72.5-170 kV	2501	2946*	3529

*) Standard
**) Other dimensions can be provided

ЕЛЕКТРИКСИТИ СОФИЯ ООД

Dimensions between stands. Centre to centre (mm)

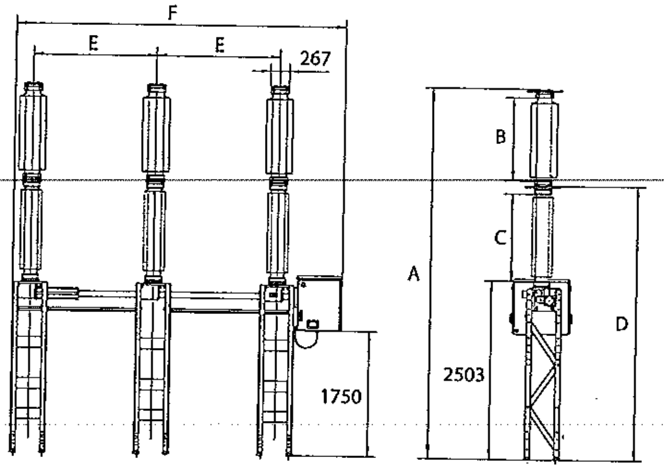
Phase distance	Stand distance
1500	2530
1750	2530
2000	2530
2500	2530

LTB D
Dimensions

LTB D1/B, Three-column stand, Three-pole operation, BLK mechanism
Rated voltage: 72.5 - 170 kV

Dimensions (mm)

Rated voltage	A	B	C	D	E	F
72.5 kV	4647	1164	670	3283	1050	3266
145 kV	5197	1164	1220	3833	1750	4666
170 kV	5808	1475	1520	4133	1750	4666



Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage	Phase distance				
72.5 kV	1050	1500	1750*	2500	3000
145 kV	-	1500**	1750*	2500	3000
170 kV	-	-	1750*	2500	3000

*) Standard **) BIL 550 kV

Rated voltage	Height to lowest part of insulator **			
72.5-170 kV	800	2503*	2950	3203

*) Standard **) Other dimensions can be provided

ВЯРНО С ОРИГИНАЛА

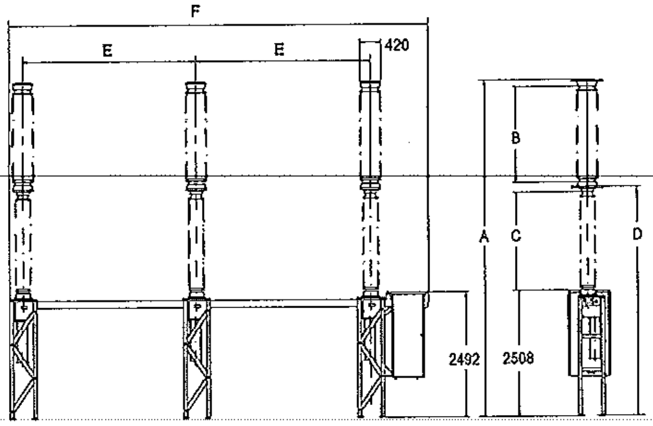
ЕЛЕКТРИКСИТИ СОФИЯ ООД

LTB E
Dimensions

LTB E1, Three-pole operation, BLG mechanism
Rated voltage: 72.5 - 245 kV

Dimensions (mm)

Rated voltage	A	B	C	D	E	F
72.5 kV	4790	1292	655	3244	1100	3590
170 kV	5400	1292	1265	3854	2500	6390
245 kV	6703	1914	1955	4544	3500	8390



Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage	Phase distance					
72.5 kV	1100*	1500	2500	3000	3500	4000
170 kV	-	-	2500*	3000	3500	4000
245 kV	-	-	2500	3000	3500*	4000

*) Standard

Rated voltage	Height to lowest part of insulator				
72.5-245 kV	1950	2508*	2992	3642	4142

*) Standard

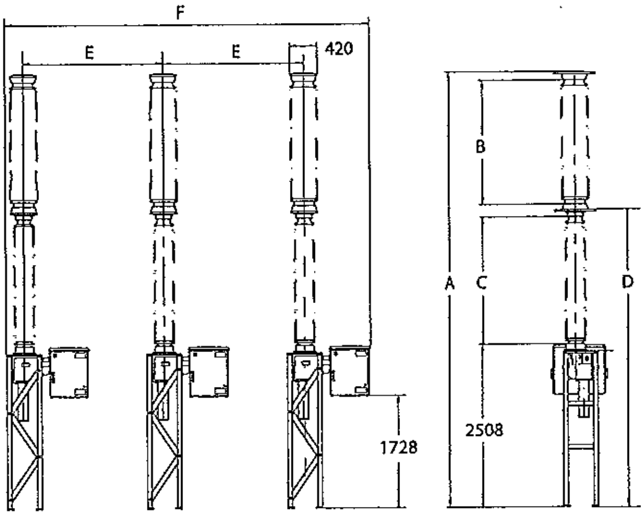
LTB E1, Single-pole operation, BLK mechanism
Rated voltage: 72.5 - 245 kV

Dimensions (mm)

Rated voltage	A	B	C	D	E*	F
72.5 kV	4790	1292	655	3244	2500	6298
170 kV	5400	1292	1265	3854	2500	6298
245 kV	6703	1914	1955	4544	3500	8298

*) Recommended phase distances

ВЯРНО С ОРИГИНАЛА



Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage	Height to lowest part of insulator				
72.5-245 kV	1442	2508*	2992	3642	4142

*) Standard

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ЕЛЕКТРИКСИТИ СОФИЯ ООД

LTB E
Dimensions

LTB E1, Single-pole operation with ICC , BLK mechanism
Rated voltage: 72.5 - 245 kV

Dimensions (mm)

Rated voltage	A	B	C	D	E*	F
72.5 kV	4790	1292	655	3244	2500	6298
170 kV	5400	1292	1265	3854	2500	6298
245 kV	6703	1914	1955	4544	3500	8298

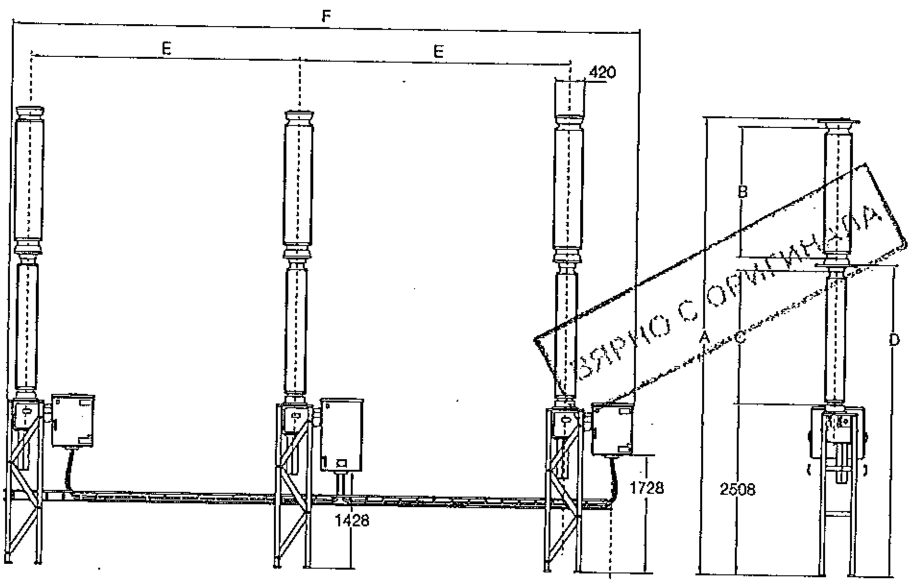
Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage			
72.5 kV	2500*	3500	4000
170 kV	2500*	3500	4000
245 kV	2500	3500*	4000

*) Standard

Rated voltage	Height to lowest part of insulator				
72.5-245 kV	1442	2508*	2992	3642	4142

*) Standard



ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

LTB E
Dimensions

LTB E1, Single-pole operation with CCC, MSD mechanism
Rated voltage: 72.5 - 245 kV

Dimensions (mm)

Rated voltage	A	B	C	D	E*	F
72.5 kV	4790	1292	655	3244	2500	4874
170 kV	5400	1292	1265	3854	2500	6874
245 kV	6703	1914	1955	4544	3500	7874

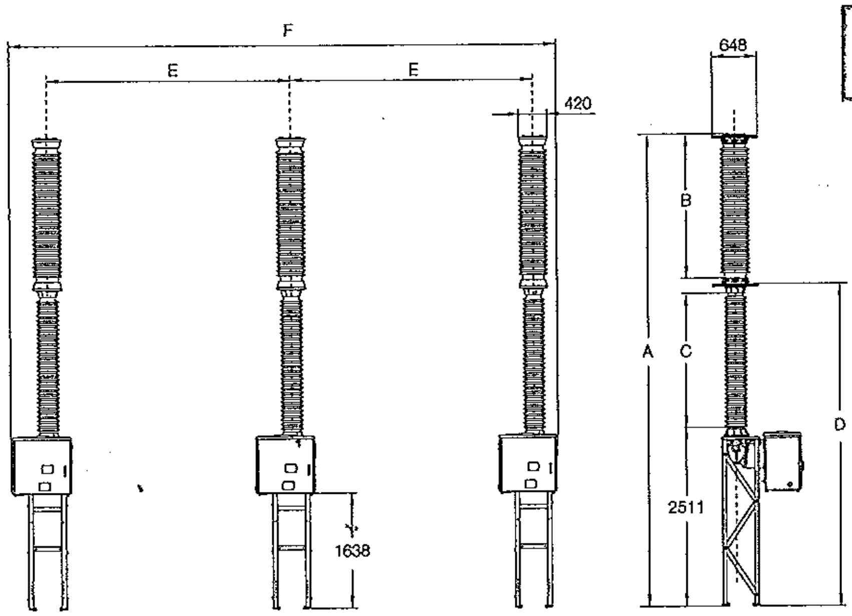
Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage			
72.5 kV	2500*	3500	4000
170 kV	2500*	3500	4000
245 kV	2500	3500*	4000

*) Standard

Rated voltage	Height to lowest part of insulator				
72.5-245 kV	1442	2511*	2992	3642	4142

*) Standard



ВЯРНО С ОРИГИНАЛА

LTB E
Dimensions

LTB E1, Single-pole operation with ICC, MSD mechanism
Rated voltage: 72.5 - 245 kV

Dimensions (mm)

Rated voltage	A	B	C	D	E*	F
72.5 kV	4790	1292	655	3244	2500	4874
170 kV	5400	1292	1265	3854	2500	6874
245 kV	6703	1914	1955	4544	3500	7874

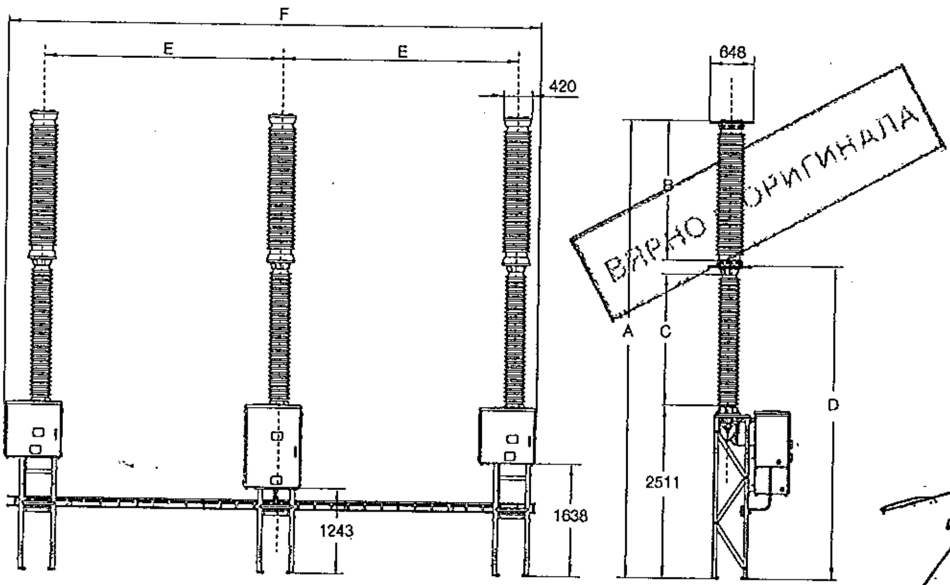
Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage			
72.5 kV	2500*	3500	4000
170 kV	2500*	3500	4000
245 kV	2500	3500*	4000

*) Standard

Rated voltage	Height to lowest part of insulator				
72.5-245 kV	1442	2511*	2992	3642	4142

*) Standard



ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

LTB E
Dimensions

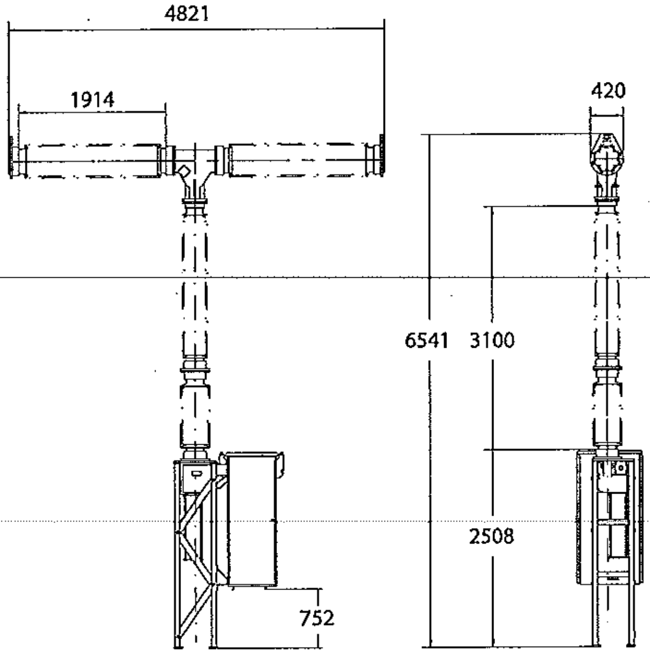
LTB 420E2, Single-pole operation, BLG mechanism
Rated voltage: 362 - 420 kV

Dimensions (mm)

Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage	Height to lowest part of insulator				
420 kV	1950	2508*	2992	3642	4142

*) Standard



LTB 550E2, Single-pole operation, BLG mechanism
Rated voltage: 550 kV

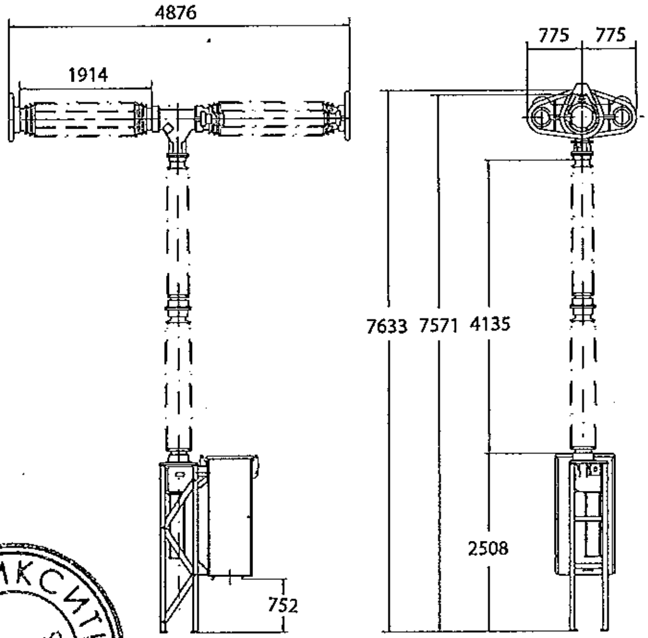
Dimensions (mm)

Available dimensions for phase distances and heights to lowest part of insulator (mm)

ВЯРНО С ОРИГИНАЛА

Rated voltage	Height to lowest part of insulator				
550 kV	1950	2508*	2992	3642	4142

*) Standard



ЕЛЕКТРИКСИТИ
СОФИЯ
ООД

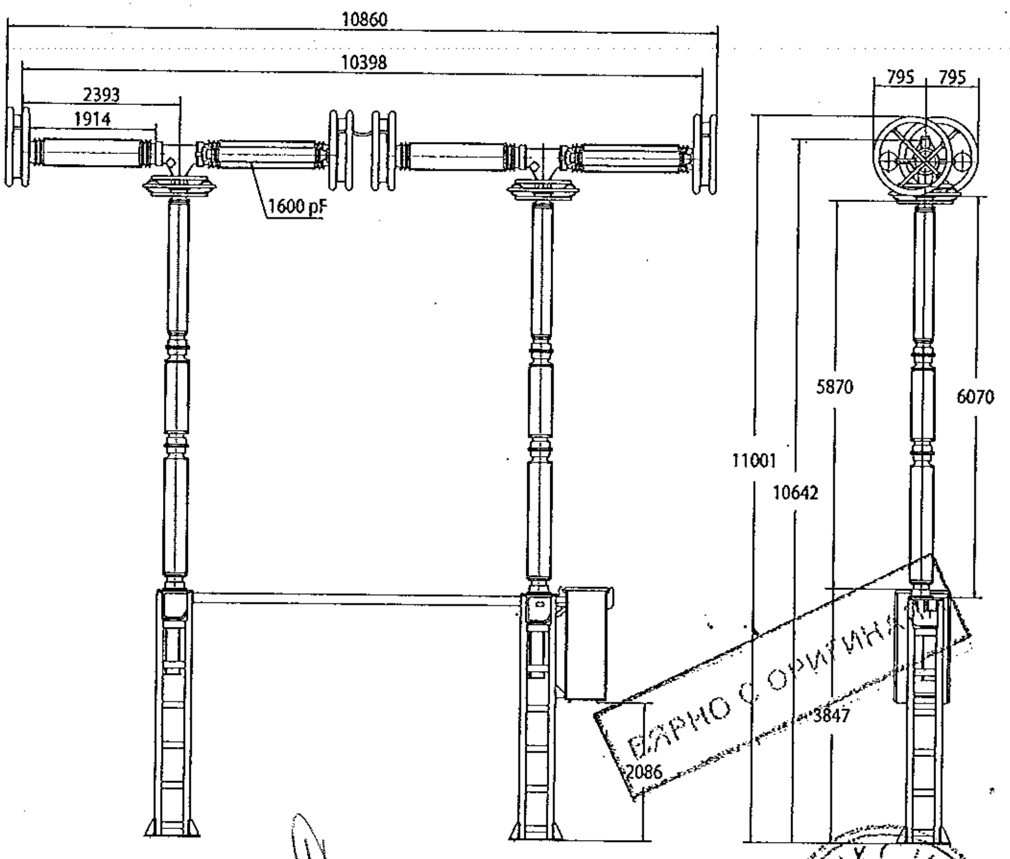
LTB E
Dimensions

LTB 800E4, Single-pole operation, BLG mechanism
Rated voltage: 800 kV

Dimensions (mm)

Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage	Height to lowest part of insulator
800 kV	3847



Shipping data
Typical for standard LTB D

LTB 72.5D1/B, Three-pole operated, Pole beam, BLK

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	3.32 x 1.78 x 0.75	1200
Operating mechanism	1	1.22 x 1.17 x 1.13	345
Pole beam	1	2.60 x 0.46 x 0.46	115
Support structure	1	2.10 x 0.60 x 0.44	220
Total	**4**	**7.3 m³**	**1880**

LTB 145D1/B, Three-pole operated, Pole beam, BLK

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	3.32 x 1.78 x 0.75	1270
Operating mechanism	1	1.22 x 1.17 x 1.13	345
Pole beam	1	4.00 x 0.46 x 0.46	220
Support structure	1	2.10 x 0.60 x 0.33	200
Total	**4**	**7.3 m³**	**2035**

LTB 170D1/B, Three-pole operated, Pole beam, BLK

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	3.87 x 1.78 x 0.75	1350
Operating mechanism	1	1.22 x 1.17 x 1.13	345
Pole beam	1	4.00 x 0.46 x 0.46	220
Support structure	1	2.10 x 0.60 x 0.33	200
Total	**4**	**8.1 m³**	**2115**

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

Shipping data
Typical for standard LTB D

LTB 72.5 - 170D1/B, Single-pole operated (FSA1), Two-column stand

Type	Circuit breaker poles		Support structure		Pole-beam with operating mechanism	
	Dimension	Gross weight Porcelain / Composite	Dimension	Gross weight	Dimension	Gross weight
	m	kg	m	kg	m	kg
LTB 72.5 D1/B	3.26 x 1.78 x 0.72	1130 / 710	2.17 x 0.90 x 0.53	370	4.41 x 1.11 x 2.25	1100
LTB 145 D1/B	3.26 x 1.78 x 0.72	1250 / 740	2.17 x 0.90 x 0.53	370	4.41 x 1.11 x 2.25	1100
LTB 170 D1/B	3.90 x 1.78 x 0.72	1500 / 840	2.17 x 0.90 x 0.53	370	4.41 x 1.11 x 2.25	1100

LTB 72.5 - 170D1/B, Three-pole operated (MSD), Two-column stand (Four packages per circuit breaker)

Type	Circuit breaker poles		Support structure		Pole-beam with operating mechanism	
	Dimension	Gross weight Porcelain / Composite	Dimension	Gross weight	Dimension	Gross weight
	m	kg	m	kg	m	kg
LTB 72.5 D1/B	3.37 x 1.78 x 0.75	1130 / 710	2.24 x 0.90 x 0.56	370	4.20 x 0.34 x 0.31 / 1.23 x 1.30 x 1.17	150 / 290
LTB 145 D1/B	3.26 x 1.78 x 0.72	1250 / 740	2.24 x 0.90 x 0.56	370	4.20 x 0.34 x 0.31 / 1.23 x 1.30 x 1.17	150 / 290
LTB 170 D1/B	3.90 x 1.78 x 0.75	1545 / 870	2.24 x 0.90 x 0.56	370	4.20 x 0.34 x 0.31 / 1.23 x 1.30 x 1.17	150 / 290

LTB 72.5 - 170D1/B, Three-pole operated (FSA1), Two-column stand (Four packages per circuit breaker)

Type	Circuit breaker poles		Support structure		Pole-beam with operating mechanism	
	Dimension	Gross weight Porcelain / Composite	Dimension	Gross weight	Dimension	Gross weight
	m	kg	m	kg	m	kg
LTB 72.5 D1/B	3.26 x 1.78 x 0.72	1130 / 710	2.17 x 0.90 x 0.53	370	4.09 x 0.57 x 1.0 / 0.77 x 0.55 x 1.26	150 / 170
LTB 145 D1/B	3.26 x 1.78 x 0.72	1250 / 740	2.17 x 0.90 x 0.53	370	4.09 x 0.57 x 1.0 / 0.77 x 0.55 x 1.26	150 / 170

Shipping data
Typical for standard LTB D

LTB 72.5D1/B, Three-pole operated (BLK), Three-column stand

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	3.32 x 1.78 x 0.75	1050
Operating mechanism	1	1.22 x 1.17 x 1.13	345
Support structure	1	2.42 x 0.60 x 0.44	330
Total	**3**	**6.7 m³**	**1725**

LTB 145D1/B, Three-pole operated (BLK), Three-column stand,

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	3.32 x 1.78 x 0.75	1150
Operating mechanism	1	1.22 x 1.17 x 1.13	345
Support structure	1	2.42 x 0.60 x 0.44	330
Total	**3**	**6.7 m³**	**1825**

LTB 170D1/B, Three-pole operated (BLK), Three-column stand

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	3.87 x 1.78 x 0.75	1270
Operating mechanism	1	1.22 x 1.17 x 1.13	345
Support structure	1	2.42 x 0.60 x 0.44	330
Total	**3**	**7.4 m³**	**1945**

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

Shipping data
Typical for standard LTB E

LTB 72.5 - 170E1, Three-pole operated (BLG), Three-column stand

Equipment	Number of cases	Dimensions L x W x H	Gross weight	
			72.5	170
		m	kg	
LTB 72.5 Breaker poles	1	On request	On request	-
LTB 170 Breaker poles	1	4.54 x 1.90 x 0.97	-	3100
Operating mechanism	1	1.89 x 1.05 x 1.12	-	680
Support structure	1	2.38 x 1.10 x 0.36	-	280
Total LTB 72.5	3	On request	On request	-
Total LTB 170	3	11.5 m³	-	4 060

LTB 72.5 - 170E1, Single-pole operated (BLK), Three-column stand

Equipment	Number of cases	Dimensions L x W x H	Gross weight	
			72.5	170
		m	kg	
LTB 72.5 Breaker poles	1	On request	On request	-
LTB 170 Breaker poles	1	4.54 x 1.90 x 0.97	-	3100
Operating mechanism	1	2.84 x 1.18 x 1.14	-	950
Support structure	1	3.15 x 1.14 x 1.10	-	280
Total LTB 72.5	3	On request	On request	-
Total LTB 170	3	13.1 m³	-	4 330

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД СОФИЯ

Shipping data
Typical for standard LTB E

LTB 245E1 - Three-pole operated, BLG mechanism

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	5.90 x 1.90 x 0.97	3600
Operating mechanism	1	1.89 x 1.05 x 1.12	680
Support structure	1	2.38 x 1.10 x 0.36	280
Total	**3**	**14.0 m³**	**4 560**

LTB 245E1 - Single-pole operated with CCC, BLK mechanism

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	5.27 x 1.90 x 0.97	3600
Operating mechanism	1	3.15 x 1.14 x 1.10	950
Support structure	1	2.38 x 1.10 x 0.36	280
Total	**3**	**14.6 m³**	**4 830**

LTB 245E1 - Single-pole operated with ICC, BLK mechanism

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	5.27 x 1.90 x 0.97	3600
Operating mechanism	1	3.15 x 1.14 x 1.49	1000
Support structure	1	2.38 x 1.10 x 0.36	280
Total	**3**	**16.0 m³**	**4 880**

ВЯРНО С ОРИГИНАЛА

LTB 245E1 - Single-pole operated with CCC, MSD mechanism

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	5.27 x 1.90 x 0.97	2900
Operating mechanism	1	3.15 x 1.14 x 1.10	795
Support structure	1	2.38 x 1.10 x 0.36	280
Total	**3**	**14.6 m³**	**3 975**

ЕЛЕКТРИКСИТИ СОФИЯ ООД

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LTB 245E1 - Single-pole operated with ICC, MSD mechanism

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	5.27 x 1.90 x 0.97	2900
Operating mechanism	1	3.15 x 1.14 x 1.49	900
Support structure	1	2.38 x 1.10 x 0.36	280
Total	**3**	**16.0 m³**	**4 080**

Shipping data
Typical for standard LTB E

LTB 420E2 - Single-pole operated, BLG mechanism
44 mm/kV, (25 mm/kV phase-phase voltage).

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker units	1	5.14 x 1.99 x 1.12	3600
Support column	1	5.22 x 1.90 x 0.90	2400
Operating mechanism	3	3 x (1.89 x 1.05 x 1.12)	3 x (680)
Support structure	1	2.40 x 1.10 x 0.40	480
(Capacitors if included)	(1)	(2.33 x 1.21 x 1.03)	(1112)
Total	6 (7)	28.0 (30.9) m³	8520 (9632)

LTB 420E2 - Single-pole operated, BLG mechanism
55 mm/kV, (31 mm/kV phase-phase voltage).

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker units	1	5.14 x 1.99 x 1.12	3600
Support column	1	6.07 x 1.90 x 0.90	2800
Operating mechanism	3	3 x (1.89 x 1.05 x 1.12)	3 x (680)
Support structure	1	2.40 x 1.10 x 0.40	480
(Capacitors if included)	(1)	(2.33 x 1.21 x 1.03)	(1112)
Total	6 (7)	29.5 (32.4) m³	8 920 (10 032)

LTB 550E2 - Single-pole operated, BLG mechanism
44 mm/kV, (25 mm/kV phase-phase voltage).

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker units	1	5.14 x 1.99 x 1.12	3600
Support column	1	6.07 x 1.90 x 0.90	2800
Operating mechanism	3	3 x (1.89 x 1.05 x 1.12)	3 x (680)
Support structure	1	2.40 x 1.10 x 0.40	480
Capacitors	1	2.33 x 1.21 x 1.03	1112
Total	7	32.4 m³	10 032

LTB 800E4 - Single-pole operated, (without PIR), BLG mechanism

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaking units	2	2 x (5.12 x 1.96 x 1.20)	2 x (3600)
Support column	2	2 x (7.79 x 1.90 x 0.90)	2 x (3500)
Operating mechanism	3	3 x (1.80 x 0.97 x 1.07)	3 x ([illegible]50)
Support structure	6	6 x (3.71 x 0.80 x 0.84)	6 x (42[illegible])
Corona rings	2	2 x (2.18 x 1.28 x 1.40)	2 x (325)
Corona rings	2	2 x (1.30 x 1.30 x 1.34)	2 x (170)
Capacitors	2	2 x (2.33 x 1.21 x 1.03)	2 x (1060)
Total	19	87.6 m³	21 805

HPL B
Technical information

Performance
The well proven HPL designs provide unmatched switching performance. The circuit breakers can handle high breaking currents and are dielectrically tested for levels exceeding IEC and IEEE/ANSI requirements.

The HPL has recently been verified, by type tests, to handle 420 and 550 kV without grading capacitors. The benefit is a reliable circuit breaker with less components and less required maintenance.

Material
The selected components of aluminum (mechanism housings, HV-terminals, cubicles) give a high degree of resistance to corrosion, without the need of extra protection. For use in extreme trying environments HPL can be delivered with a protective painting.

The support structure and protective tubes for the pull rods are made of hot-dipped galvanized steel.

Insulators
HPL circuit breaker is as standard delivered with insulators that consist of high-grade brown-glazed porcelain or composite insulators (light gray).

HPL with light gray porcelain can be delivered on request.

HPL is available as standard with long or extra long creepage distances.

Longer creepage distances can be quoted on request.

More information about our composite insulators can be found on page 134.

Mechanical strength
The mechanical durability gives a sufficient safety margin for normal wind loads and static and dynamic forces from conductors.

Seismic withstand strength
All HPL circuit breakers can, in their standard versions, withstand seismic accelerations below 3 m/s² (0.3 g) in accordance with IEC 62271-300.

For higher acceleration see page 146 "Seismic Withstand Capability".

Rating plates
A rating plate, which includes data for the circuit breaker, is placed on the side of the operating mechanism cubicle. The rating plate is made of stainless steel with engraved text.

Operating mechanism
The circuit breaker is operated by motor charged spring operating mechanism(s), type BLG, which is installed in a compact splash proof and corrosion resistant housing, attached to the structure.

- One operating mechanism is used for three-pole operation for HPL 72.5 – 300 kV (B1)
- Three operating mechanisms are used for single-pole operation for HPL 72.5 – 550 kV (B1/B2)
- Six operating mechanisms (two per pole) for single-pole operation for HPL 800 kV (B4).

More detailed information about the operating mechanism type BLG can be found in special chapters in this Buyer's Guide.

Sealing systems for SF_6 volume
The sealing system consists of double nitrile rubber O-rings in all static seals and double X-rings in all dynamic seals.

This type of sealings has been used in our circuit breakers for more than 30 years with excellent service record at varying climatic conditions.

The SF_6 gas leakage is less than 0.5% per year.

SF_6 density monitoring
Since the interrupting capability is dependent on the density of the SF_6 gas, the HPL circuit breaker is provided with density monitor(s). The density monitor consists of a temperature compensated pressure switch. Therefore, alarm signal and blocking function are activated only if the pressure drops due to leakage.

All HPL circuit breakers have one density monitor per pole.

More information can be found in chapter "Explanations"

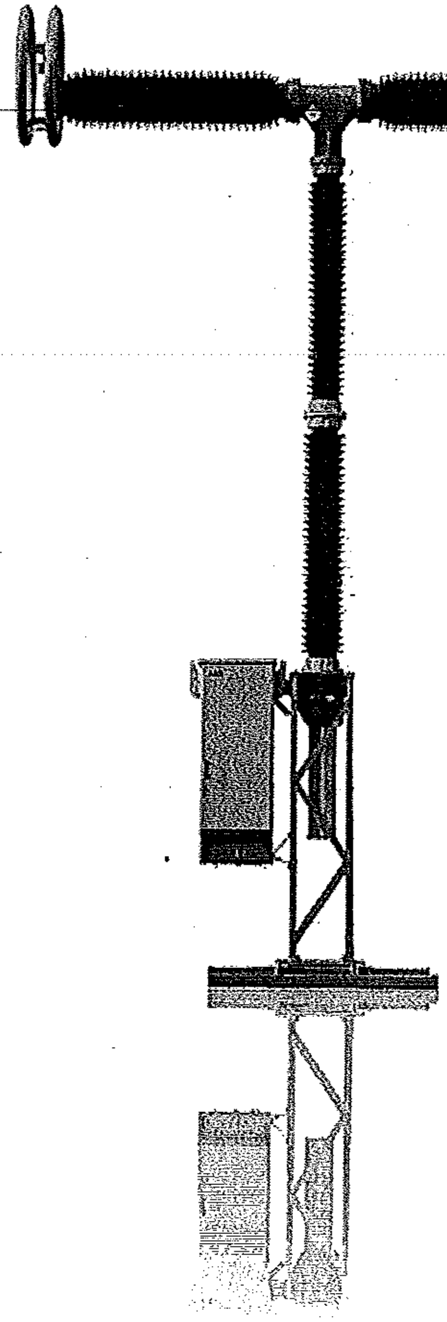
ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИК СИТИ СОФИЯ ООД

HPL B
Technical information

Single pressure puffer interrupters fully utilize mechanical energy for both contact movement and generation of SF_6 gas flow to cool and interrupt the arc.

Deliveries of our pure puffer SF_6 interrupter date back to 1970's. ABB refined this technology to produce the world's highest performance interrupter, the HPL B, providing unmatched switching security under all system conditions from small reactive currents up to 80 kA full short-circuits.

For many years, ABB has used operating mechanisms with energy mechanically stored in springs. This solution offers considerable advantages in that the energy in the tensioned springs is always available.



Brief performance data:

Installation	Outdoor / (Indoor)
Design	SF_6 Puffer interrupter Spring operating mechanisms
Insulation	SF_6
Rated voltage	Up to 800 kV
Rated current	Up to 5 000 A
Breaking current	Up to 80 kA
Short-time current	Up to 63 kA/3 s 80 kA/1 s
Insulators	Composite or porcelain
Creepage distance	25 mm/kV, phase - phase voltage (Longer on request)
Service conditions:	
Ambient temperature	-30 to +40 °C (Operation in temperatures down to -60 or up to +70 °C on request)
Design altitude	1 000 m.a.s.l. (Higher altitudes on request)
Type of operation	Single- or Three-pole

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

Climatic withstand
The HPL circuit breakers are designed for, and are installed in, widely shifting conditions from polar to desert climate throughout the world.

For circuit breakers installed in areas with extreme low temperatures there is a risk of condensation of the SF_6 gas.
In order to avoid condensation consequences, one of the following gas-mixtures is used:

- SF_6 and N_2
- SF_6 and CF_4

Support structure
Support structures are included in the standard versions of the HPL circuit breakers. The support structure(s) is made of hot-dipped galvanized steel.

Up to 550 kV the HPL circuit breakers are mounted on one support column per pole.

For HPL 800 kV two support columns per pole are necessary.

For detailed information see "Dimensions"

The support structures are prepared for connection to ground by means of drilled holes on each leg.

High voltage terminals
The HPL circuit breakers are as standard equipped with flat aluminum terminals with thickness 28 mm and drilling pattern in accordance with IEC and NEMA standards. Other dimensions (e.g. DIN) by means of adapters are available on request.

Circuit breakers with vertically mounted breaking elements have terminals on both sides for connection in either direction.

Circuit breakers with horizontal breaking elements have one terminal per breaking element. The terminals are directed upwards.

Preinsertion Resistors (PIR)
HPL circuit breakers with more than one breaking element per pole can be provided with preinsertion resistors for switching of no-load lines.

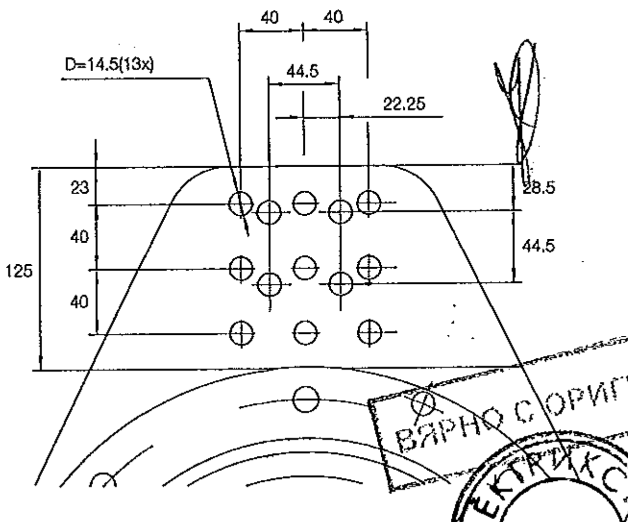
Controlled switching devices
The goal for controlled switching is to increase power quality in the network systems by reducing switching transients.
All HPL circuit breakers are suitable for controlled switching with ABB:s Switchsync™ device.

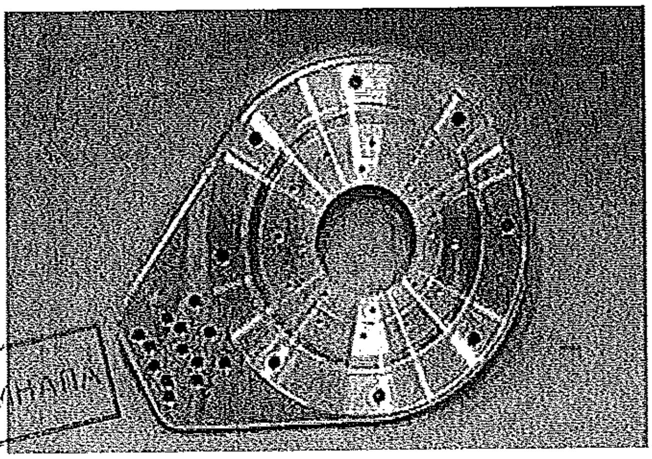
In order to obtain optimum result the switching instants should be different for the three phases. For three-pole operated circuit breakers this is achieved with mechanically staggered poles. Since 1984 more than 3 400 Switchsync™ devices have been delivered.

For further information see chapter "Controlled Switching".

Condition monitoring
As an option we can offer supervisory control by means of our condition monitoring system.

This is described in chapter "On-Line Monitoring System" on page 142.





Flat aluminum terminal for HPL.

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

HPL B
Technical information

Type tests
The HPL circuit breakers have been type tested in accordance with IEC and/or IEEE standards. Type test reports can be presented on request.

Routine tests
All HPL circuit breakers are routine tested before delivery. Our test program complies with IEC and ANSI/IEEE standards.

For detailed information please see the special chapter regarding "Quality Control and Testing".

Transport
The HPL circuit breakers are normally packed and transported in seaworthy wooden crates.

The circuit breaker poles with one breaking element per pole are transported as complete units.

For circuit breakers with two or more breaking elements per pole, the number of cases depends on the circuit breaker type.

For detailed information regarding weights and dimensions see "Shipping data".

Breaking elements as well as support insulators are filled with SF_6 gas at a slight overpressure.

Arrival inspection
On arrival the packaging and contents should be checked against packing list.

In the event of damage to the goods, contact ABB for advice, before further handling of the goods takes place.

Any damage ought to be documented (photographed).

Erection and commissioning
Assembly instructions are provided with each delivery.

Erection work at site can be done in 1–7 days depending on HPL type and size.

Filling of SF_6 gas to specified rated pressure is done by using the following pressurizing equipment, which can be delivered on request:

- One special control valve, for connection to the gas bottle, and a 40 m gas-filled hose with connectors.
- A complementary control valve for connection to CF_4 or N_2 gas bottle (for mixed gas filling).

When using the above gas equipment, filling can be done without gas being released into the atmosphere.

For illustration of gas filling equipment see page 63.

Maintenance
HPL is designed for a service life of more than 30 years or 10 000 mechanical (no load) operations. For current switching the number of operations before service is dependent on the interrupted current.

Inspection, maintenance and overhaul should be carried out at regular intervals depending on the ambient conditions and the number of operations.

The general actions are described below:

- 1–2 years:
  Ocular inspection
- After 15 years or 5 000 mechanical operations:
  Preventive maintenance including general inspection of the circuit breaker and operating mechanism.
  Operation test including measurement of operating times and possible adjustments.

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

- 30 years or 10 000 mechanical operations:
  A comprehensive inspection is recommended to give increased safety and continued problem-free operation. The inspection methods and scope depend very much on the local conditions.

For circuit breakers for special switching duties such as switching of reactor banks overhaul of the breaking chamber should be carried out more frequently.

Overhaul and repair work must be performed by authorized personnel only.

The instructions in the manual for operation and maintenance should be observed.

ABB is available for discussions and advice.

Recommended spare parts
High operation frequency (e.g. circuit breakers for reactor or capacitor switching) and/or large quantities of circuit breakers:

- Complete poles
- Complete operating mechanisms
- Sets of contacts
- Sets of gaskets
- Density switches
- SF_6 gas

Spare parts for the operating mechanisms BLG; see page 103.

SF_6 gas
Gas for filling up to rated pressure can be delivered in bottles, each containing 40 kg gas.

The quantity required for each type of HPL varies from one circuit breaker type to another. This information is given in the tender.

The pressurizing equipment can be delivered on request, and is described under "Erection and Commissioning".

Brackets and primary connections
As optional equipment, HPL 72.5 – 170B1 can be delivered with cantilever support brackets for current transformer IMB, and primary connections between the circuit breaker and the current transformers mounted on the brackets.

Disposal
The disposal of wasted parts should be carried out in accordance with local legal provisions.

The SF_6 gas shall **not** be released into the atmosphere when the circuit breaker is disposed.

The SF_6 gas can be recycled.

The porcelain can, after it has been crushed, be used as fill.

The metals used in the circuit breaker can be recycled.

ВЯРНО С ОРИГИНАЛА

HPL B

Technical data according to IEEE (General data, deviations may occur)

		HPL 72.5B1	HPL 170B1	HPL 245B1	HPL 420B2	HPL 550B2	HPL 800B4
Number of breaks per pole		1	1	1	2	2	4
Rated voltage	kV	72.5	170	245	362	550	800
Rated frequency	Hz	50/60	50/60	50/60	50/60	50/60	50/60
Power frequency withstand voltage[1]							
- To earth (Dry/Wet)	kV	160/140	365/315	425/350	555/-	860/-	960/-
- Across open pole (Dry/Wet)	kV	160/140	365/315	425/350	555/-	860/-	960/-
Lightning Impulse Withstand Voltage (LIWL)							
- To earth	kV	350	750	900	1300	1800	2050
- Across open pole	kV	350	750	900	1300	1800	2050
Chopped Wave Impulse Withstand Voltage							
- To earth (2 μs)	kV	452	968	1160	1680	2320	2640
- Across open pole (2 μs)	kV	452	968	1160	1680	2320	2640
Switching Impulse Withstand Voltage (SIWL)							
- To earth	kV	-	-	-	825	1175	1425
- Across open pole	kV	-	-	-	900	1300	1550
Rated continuous current	A	4000	4000	4000	4000	4000	4000
Rated s.c current	kA	63 [2]	63 [2]	63 [2]	63 [2]	63 [2]	63 [2]
First-pole-to-clear factor		1.5	1.5	1.5	1.3	1.3	1.3
Rated closing and latching current	kA	158/164	158/164	158/164	158/164	158/164	158/164
Duration of short-time withstand current	s	3	3	3	3	3	3
Closing time	ms	< 65	< 65	< 65	< 65	< 65	< 65
Opening time	ms	< 22	< 22	< 22	< 22	< 22	< 22
Interrupting time	ms	33	33	33	33	33	33
Dead time	ms	300	300	300	300	300	300
Rated standard operating duty	-	O-0.3 s-CO-3 min-CO or CO-15 s-CO					

[1] Up to and including 245 kV, power frequency withstand voltage ratings apply for both wet and dry conditions

[2] Short-circuit current ratings up to 80 kA available on request

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКОМ ООД СОФИЯ

HPL B

Technical data according to IEC
(General data, deviations may occur)

		HPL 72.5B1	HPL 170B1	HPL 245B1	HPL 300B1	HPL 420B2	HPL 550B2	HPL 800B4
Number of breaks per pole		1	1	1	1	2	2	4
Rated voltage	kV	72.5	170	245	300	420	550	800
Rated frequency	Hz	50/60	50/60	50/60	50/60	50/60	50/60	50/60
Power frequency withstand voltage[1]								
- To earth and between phases	kV	140	325	460	380	520	620	830
- Across open pole	kV	140	325	460	435	610	800	1150
Lightning Impulse Withstand Level (LIWL)								
- To earth and between phases	kV	325	750	1050	1050	1425	1550	2100
- Across open pole	kV	325	750	1050	1050 (+170)	1425 (+240)	1550 (+315)	2100 (+455)
Switching Impulse Withstand Level (SIWL)								
- To earth / Between phases	kV	-	-	-	850/1275	1050/1575	1175/1760	1550/2480
- Across open pole	kV	-	-	-	700/(+245)	900 (+345)	900 (+450)	1175 (+650)
Rated normal current	A	4000	4000	4000	4000	4000	4000	4000
Rated s.c breaking current	kA	63 [2]	63 [2]	63 [2]	63 [2]	63 [2]	63 [2]	63 [2]
First-pole-to-clear factor	-	1.5	1.5	1.5	1.3	1.3	1.3	1.3
Making current peak	kA	158/164	158/164	158/164	158/164	158/164	158/164	158/164
Duration of short-circuit	s	3	3	3		3	3	3
Closing time	ms	< 65	< 65	< 65	< 65	< 65	< 65	< 65
Opening time	ms	< 22	< 22	< 22	< 22	< 22	< 22	< 22
Break time	ms	33	33	33	33	33	33	33
Dead time	ms	300	300	300	300	300	300	300
Rated operating sequence	-	O-0.3 s-CO-3 min-CO or CO-15 s-CO						

[1] Up to and including 245 kV, power frequency withstand voltage ratings apply for both wet and dry conditions
[2] Short-circuit current ratings up to 80 kA available on request

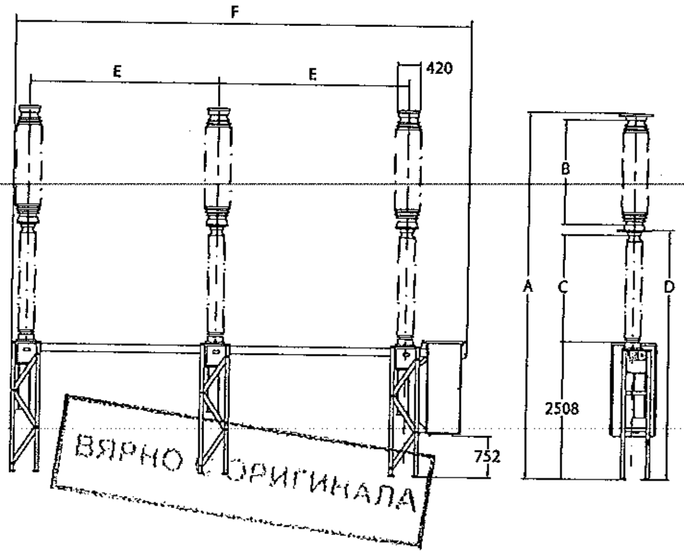
ЕЛЕКТРИКСИТИ СОФИЯ ООД
ВЯРНО С ОРИГИНАЛА

HPL B
Dimensions

HPL B1, Three-pole operation
Rated voltage: 72.5 - 300 kV

Dimensions (mm)

Rated voltage	A	B	C	D	E	F
72.5 kV	5213	1724	655	3270	1100	3600
170 kV	6063	1724	1505	4120	2500	6400
245 kV	6703	1914	1955	4570	3500	8400
300 kV	7163	2124	2205	4820	3500	8400



Available dimensions for phase distances and heights to lowest part of insulator (mm)

Rated voltage	Phase distance					
72.5 kV	1100*	1500	2500	3000	3500	4000
170 kV	-	-	2500*	3000	3500	4000
245 kV	-	-	2500	3000	3500*	4000
300 kV	-	-	-	3000	3500*	4000

*) Standard

Rated voltage	Height to lowest part of insulator				
72.5-300 kV	1950	2508*	2992	3642	4142

*) Standard

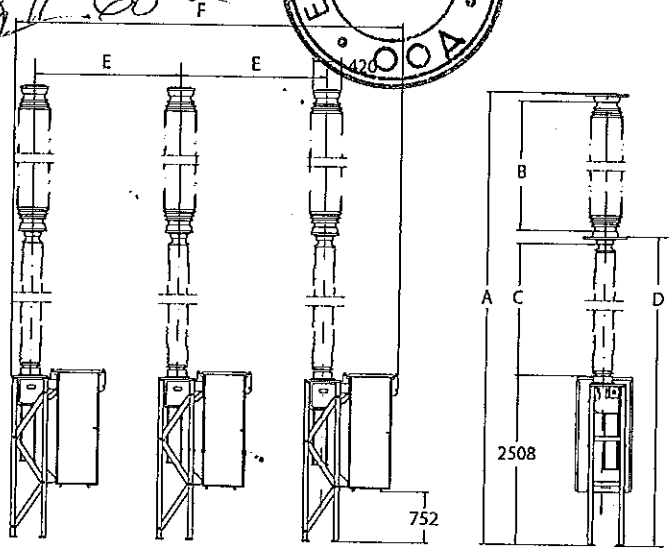
ВЯРНО С ОРИГИНАЛА

HPL B1, Single-pole operation
Rated voltage: 72.5 - 300 kV

Dimensions (mm)

Rated voltage	A	B	C	D	E*	F
72.5 kV	5213	1724	655	3270	2500	6400
170 kV	6063	1724	1505	4120	2500	6400
245 kV	6703	1914	1955	4570	3500	8400
300 kV	7163	2124	2205	4820	3500	8400

*) Recommended phase distances



Available dimensions (mm)

Rated voltage	Height to lowest part of insulator				
72.5-300 kV	1950	2508*	2992	3642	4142

*) Standard

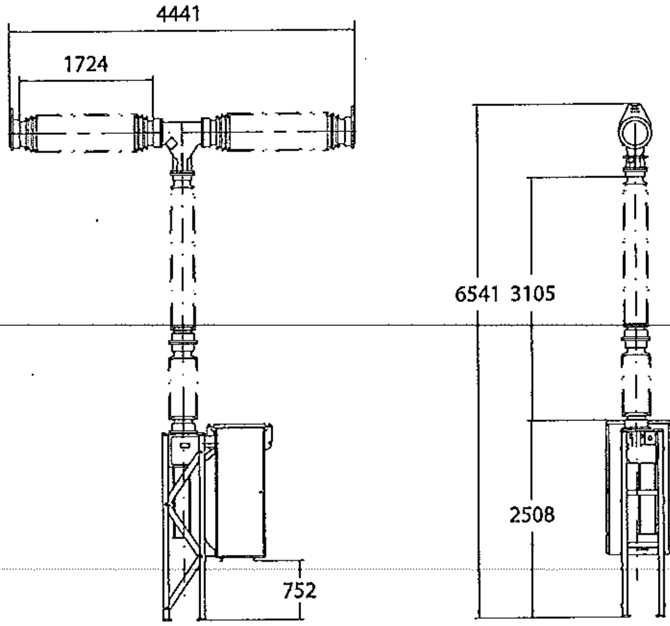
ЕЛЕКТРИКСИТИ СОФИЯ ООД

HPL 420B2, Single-pole operation
Rated voltage: 362 - 420 kV

Available dimensions for heights to lowest part of insulator (mm)

Rated voltage	Height to lowest part of insulator				
420 kV	1950	2508*	2992	3642	4142

*) Standard

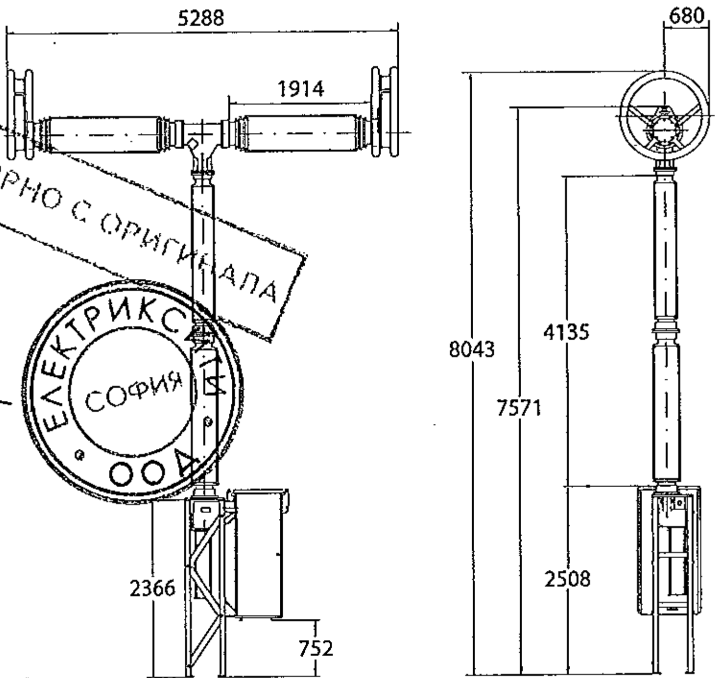


HPL 550B2, Single-pole operation
Rated voltage: 550 kV
(Without grading capacitors)

Available dimensions for heights to lowest part of insulator (mm)

Rated voltage	Height to lowest part of insulator				
550 kV	1950	2508*	2992	3642	4142

*) Standard



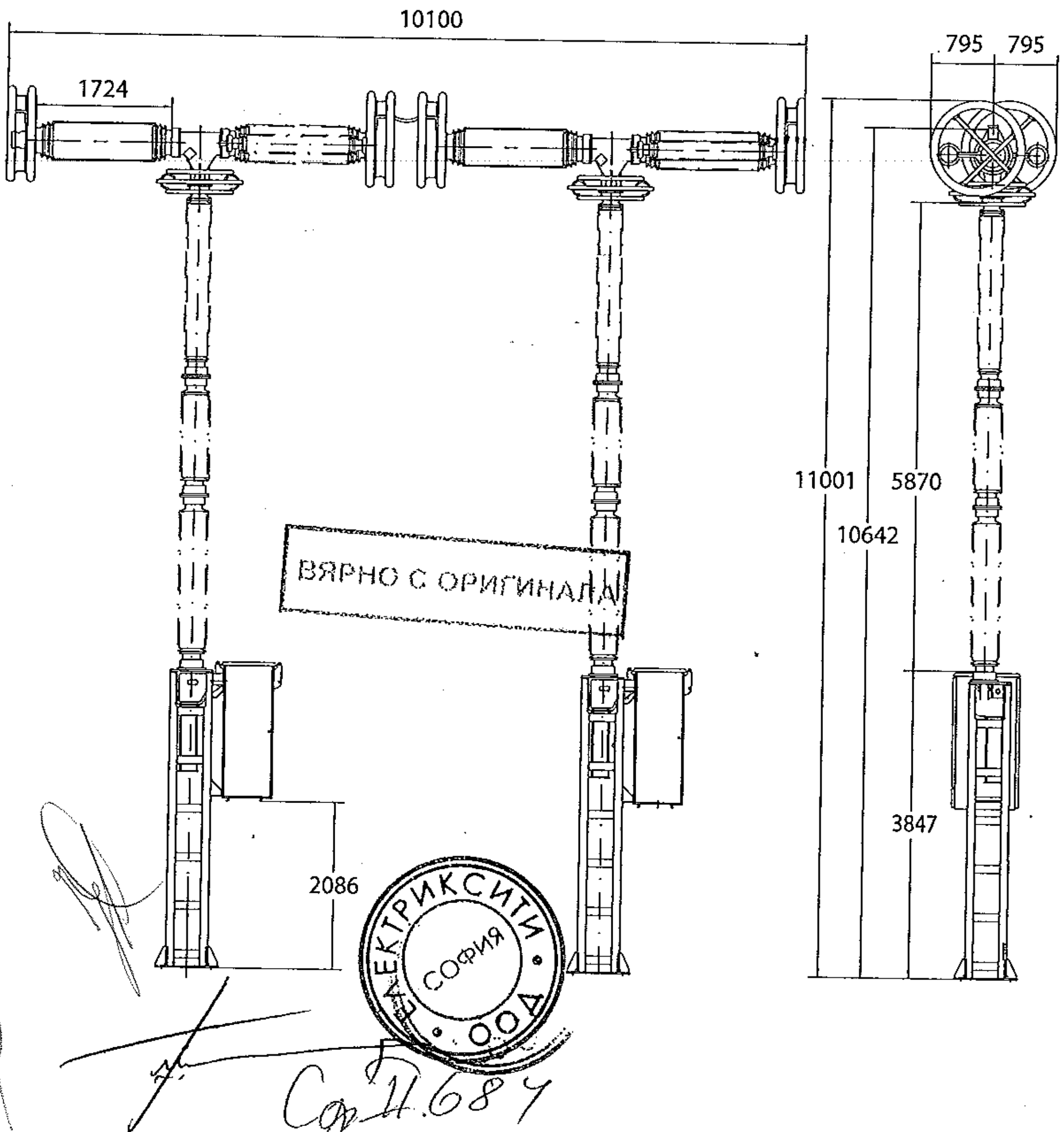
ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКС ООД СОФИЯ

HPL B
Dimensions

HPL 800B4, Single-pole operation
Rated voltage: 800 kV

Available dimensions for heights to lowest part of insulator (mm)

Rated voltage	Height to lowest part of insulator
800 kV	3847



Shipping data
Typical for standard HPL B

HPL 72.5B1, Three-pole operated and Single-pole operated

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	4.38 x 1.90 x 0.90	2800
Operating mechanism, Three-pole operated	1	1.89 x 1.05 x 1.12	680
Operating mechanism, Single-pole operated	3	(3) x 1.89 x 1.05 x 1.12	(3) x 680
Support structure	1	2.38 x 1.10 x 0.36	280
Total, Three-pole operated	3	10.7 m^3	3 760
Total, Single-pole operated	5	15.1 m^3	5 120

HPL 170B1, Three-pole operated and Single-pole operated

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker Poles	1	5.23 x 1.90 x 0.90	2980
Operating mechanism, Three-pole operated	1	1.89 x 1.05 x 1.12	680
Operating mechanism, Single-pole operated	3	3 x (1.89 x 1.05 x 1.12)	3 x (680)
Support structure	1	2.38 x 1.10 x 0.36	280
Total, Three-pole operated	3	12.1 m^3	3 940
Total, Single-pole operated	5	16.5 m^3	5 300

ВЯРНО С ОРИГИНАЛА

HPL 245B1, Three-pole operated and Single-pole operated

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	5.92 x 1.90 x 0.97	3320
Operating mechanism, Three-pole operated	1	1.89 x 1.05 x 1.12	680
Operating mechanism, Single-pole operated	3	3 x (1.89 x 1.05 x 1.12)	3 x (680)
Support structure	1	2.38 x 1.10 x 0.36	280
Total, Three-pole operated	3	14.1 m^3	4 280
Total, Single-pole operated	5	18.5 m^3	5 640

ЕЛЕКТРИКСИТИ СОФИЯ ООД

Shipping data
Typical for standard HPL B

HPL 300B1, Three-pole operated and Single-pole operated

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaker poles	1	6.38 x 1.90 x 0.97	4300
Operating mechanism, Three-pole operated	1	1.89 x 1.05 x 0.97	680
Operating mechanism, Single-pole operated	3	3 x (1.89 x 1.05 x 1.12)	3 x (680)
Support structure	1	2.38 x 1.10 x 0.36	280
Total, Three-pole operated	3	15 m³	5 260
Total, Single-pole operated	5	19 m³	6 620

HPL 362-420B2, Single-pole operated,
44 mm/kV, (25 mm/kV phase-phase voltage)

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaking elements	1	4.72 x 1.99 x 1.20	3500
Support column	1	5.22 x 1.90 x 0.90	2400
Operating mechanism	3	3 x (1.89 x 0.97 x 1.07)	3 x (680)
Support structure	1	2.40 x 1.10 x 0.38	480
(Capacitors if included)	(1)	(1.98 x 1.21 x 0.91)	(840)
Total	6 (7)	41 (43) m³	8 420 (9 260)

HPL 362-420TB2, Single-pole operated,
44 mm/kV, (25 mm/kV phase-phase voltage). (With PIR)

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaking elements incl. PIR	3	3 x (4.74 x 1.85 x 1.22)	3 x (2150)
Support column	1	5.22 x 1.90 x 0.90	2400
Operating mechanism	3	3 x (1.89 x 1.05 x 1.12)	3 x (680)
Support structure	1	2.40 x 1.10 x 0.38	480
(Capacitors if included)	(1)	(1.98 x 1.21 x 0.91)	(840)
Total	8 (9)	49 (51) m³	11 370 (12 210)

PIR = Preinsertion Resistors

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

Shipping data
Typical for standard HPL B

HPL 362-420B2, Single-pole operated,
55 mm/kV, (31 mm/kV phase-phase voltage). (Without PIR)

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaking elements	1	4.72 x 1.99 x 1.20	3500
Support column	1	6.07 x 1.90 x 0.90	2800
Operating mechanism	3	3 x (1.89 x 1.05 x 1.12)	3 x (680)
Support structure	1	2.40 x 1.10 x 0.38	480
(Capacitors if included)	(1)	(1.98 x 1.21 x 0.91)	(840)
Total	6 (7)	28.3 (31.2) m³	8 820 (9 660)

HPL 362-420TB2, Single-pole operated,
55 mm/kV, (31 mm/kV phase-phase voltage). (With PIR)

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaking elements incl. PIR	3	3 x (5.28 x 1.85 x 1.22)	3 x (2600)
Support column	1	6.07 x 1.90 x 0.90	2800
Operating mechanism	3	3 x (1.89 x 1.05 x 1.12)	3 x (680)
Support structure	1	2.40 x 1.10 x 0.38	480
(Capacitors if included)	(1)	(1.98 x 1.21 x 0.91)	(840)
Total	8 (9)	48.5 (51.4) m³	13 120 (13 960)

HPL 550B2, Single-pole operated.
(Without PIR)

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaking elements	1	5.14 x 1.99 x 1.12	3600
Support column	1	6.07 x 1.90 x 0.90	2800
Operating mechanism	3	3 x (1.89 x 1.05 x 1.12)	3 x (680)
Support structure	1	2.40 x 1.10 x 0.38	480
(Capacitors if included)	(1)	(1.98 x 1.21 x 0.91)	(1192)
(Corona rings if included)	(1)	(2.6 x 1.33 x 1.22)	(320)
Total	6 (8)*	29.5 (35.9) m³	8 920 (10 482)

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКС СИТИ СОФИЯ ООД

Shipping data
Typical for standard HPL B

HPL 550TB2, Single-pole operated
(With PIR)

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaking elements incl. PIR	3	3 x (5.28 x 1.85 x 1.22)	3 x (2600)
Support column	1	6.07 x 1.90 x 0.90	2800
Operating mechanism	3	3 x (1.89 x 1.05 x 1.12)	3 x (680)
Support structure	1	2.40 x 1.10 x 0.38	480
Capacitors	1	2.36 x 1.29 x 1.12	1192
Total	9	57.2 m³	14 312

HPL 800B4, Single-pole operated
(Without PIR)

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaking elements	2	2 x (4.72 x 1.99 x 1.20)	2 x (3500)
Support column	2	2 x (7.81 x 1.90 x 0.90)	2 x (3500)
Operating mechanism	6	6 x (1.89 x 1.05 x 1.12)	6 x (680)
Support structure	3	3 x (4.65 x 2.10 x 1.05)	3 x (420)
Corona rings	2	2 x (2.18 x 1.28 x 1.40)	2 x (230)
Corona rings	2	2 x (1.21 x 1.21 x 1.13)	2 x (130)
Capacitors	2	2 x (1.98 x 1.21 x 0.91	2 x (840)
Total	19	108.8 m³	21 740

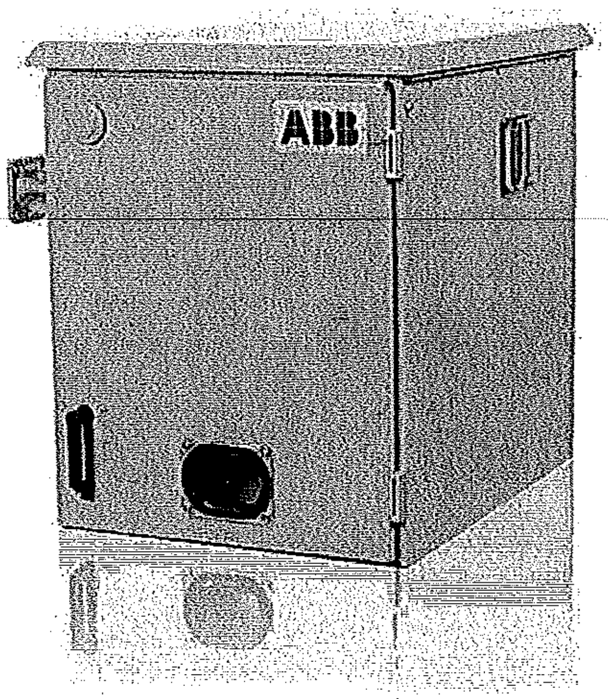
HPL 800TB4, Single-pole operated
(With PIR)

Equipment	Number of cases	Dimensions L x W x H	Gross weight
		m	kg
Breaking elements incl. PIR	6	6 x (4.74 x 1.85 x 1.22)	6 x (2150)
Support column	2	2 x (7.81 x 1.90 x 0.90)	2 x (3500)
Operating mechanism	6	6 x (1.89 x 1.05 x 1.12)	6 x (680)
Support structure	3	3 x (4.65 x 2.10 x 1.05)	3 x (420)
Corona rings	2	2 x (2.18 x 1.28 x 1.40)	2 x (230)
Capacitors	2	2 x (1.98 x 1.21 x 0.91	2 x (840)
Total	21	147.16 m³	27 380

ВЯРНО С ОРИГИНАЛА

BLK Spring Operating Mechanism
Technical information

BLK is characterized by a well-proven technology (more than 40 000 units are in service). This proven technology is efficiently combined with modern manufacturing methods and a low number of mechanical components. This ensures a high degree of total reliability for the circuit breaker and a minimal need of maintenance. Mechanical life tests have been performed with 10 000 operations. BLK is designed for widely shifting conditions, from polar to desert climate.



Brief performance data

Installation	Outdoor
Design	Spring operated
For circuit breaker	LTB D1/B LTB E1 (Single-pole operated)
Service conditions:	
Ambient temperature	-55 °C to +40 °C (Other on request)

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД СОФИЯ

BLK Spring Operating Mechanism
Technical information

Material
The housing is made of corrosion resistant, painted aluminum.

Front and back doors are equipped with doorstops and pad lock provisions on door handles.

The doors and walls are insulated for low heat energy consumption and low noise level.

Rating plates
A rating plate, which includes data for the circuit breaker, is placed on the front door. The rating plate is made of stainless steel with engraved text.

Instructions
With each delivery of circuit breakers, there is an extensive product manual that will guide the user how to assemble and handle the apparatus during its lifetime.

Instructions, product manual, circuit diagram and other documents are placed in a compartment inside the front door of the operating mechanism.

Transport
BLK for single- and three-pole operation is normally packed and transported in a separate seaworthy wooden crate.

Arrival inspection - unpacking
Please check the contents and packaging with regard to transport damage immediately on arrival. In the event of any material missing or damage to the goods, contact ABB for advice, before further handling of the goods takes place. Any damage should be documented (photographed).

The operating mechanism must be lifted using the lifting eyes on top of the cabinet. Slings must not be placed around the cabinet when lifting.

All packing material can be recycled.

Storage
The operating mechanism shall preferably be stored indoors in a dry building. When stored outdoors the internal heater should be used to prevent condensation.

If it is planned to store the unit, an external connection to the internal heater is provided.

Tools
Special tools for assembling and service are placed on the inner side of the rear door.

Maintenance
The maintenance requirements are small, as BLK is designed for a service life of more than 30 years.

Normally it is sufficient with ocular inspection every 1–2 years and some lubrication after 15 years or 5 000 operations.

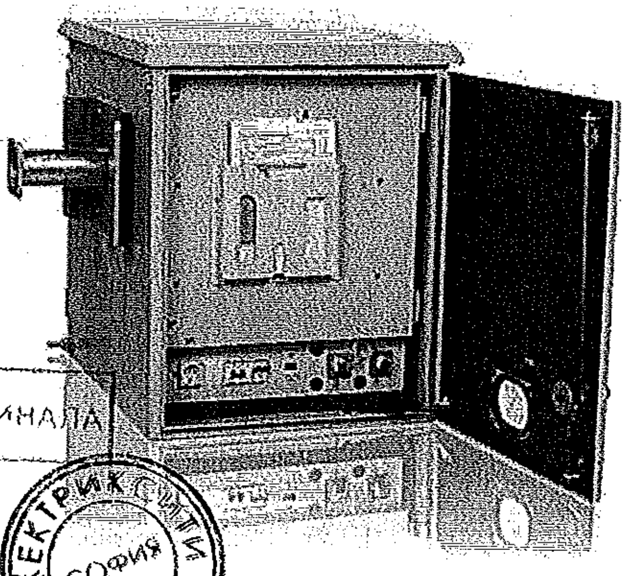
A more detailed check is recommended after 30 years of service or 10 000 operations.

Overhaul and repair work must be performed by authorized personnel only.

The instructions in the manual for operation and maintenance should be observed. This ensures a continued problem-free operation.

Disposal
The disposal should be carried out in accordance with local legal provisions.

The operating mechanism is easy to dismantle and the metal parts can be recycled.



A BLK operating mechanism with open front door.

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИК СИТИ СОФИЯ ООД

Ф-ТI-690

BLK
Electrical functions

The principle function of the mechanism's electrical components is shown in the elementary diagram on next page.

Closing circuit
The closing coil (Y3) can be activated electrically by means of local or remote control. When the circuit breaker is in closed position, the closing circuit is interrupted by the auxiliary contact (BG).

Tripping circuits
The mechanism is provided with two independent trip coils (Y1 and Y2). The mechanism can be operated electrically through local or remote control. With the circuit breaker in the open position, the tripping circuits are interrupted by the auxiliary contact (BG).

Interlocks
The contact on the density switch (BD) actuates the auxiliary relays (K9, K10), which block the operating impulse if the density of the SF_6 gas is too low. The antipumping relay (K3) blocks any remaining closing impulse after the breaker has completed a closing operation.

The density of the SF_6 gas and condition of the operating mechanism is monitored electrically, given the following (remote) indications:

- Topping up of SF_6 gas is recommended (alarm level)
- Density of the SF_6 gas is too low (blocking level)
- Indication of charged spring

Heater circuits
The operating mechanism is provided with an anti-condensation heater.

To ensure reliable operation at low temperatures the mechanism is provided with a thermostat-controlled heater unit (BT1, E2).

Alternatively, in climatic conditions with high humidity, the mechanism can be provided with moisture detector.

Terminal blocks
The terminal blocks are the user's interface to the control circuits and connect the internal wiring.

Standard terminal blocks are compression type in which a bare wire end is compressed between two metallic plates in the terminal.

Circuits for supply to motor and AC auxiliaries are normally connected to 6 mm² through-terminals. (Entrelec M6/8)

The signal circuits are connected to 4 mm² through-terminals. (Entrelec M4/6)

As options the 6 mm² terminals can be of the disconnectable type. (Entrelec M6/8.STA)

All terminals can be protected with a transparent cover.

Internal wiring
The cabling in the operating mechanism is normally carried out with PVC-insulated cables.
Dimensions are 1.5 mm² for control and auxiliary circuits and 2.5 mm² for motor circuits.

ВЯРНО

ЕЛЕКТРИКСИТИ ООД СОФИЯ

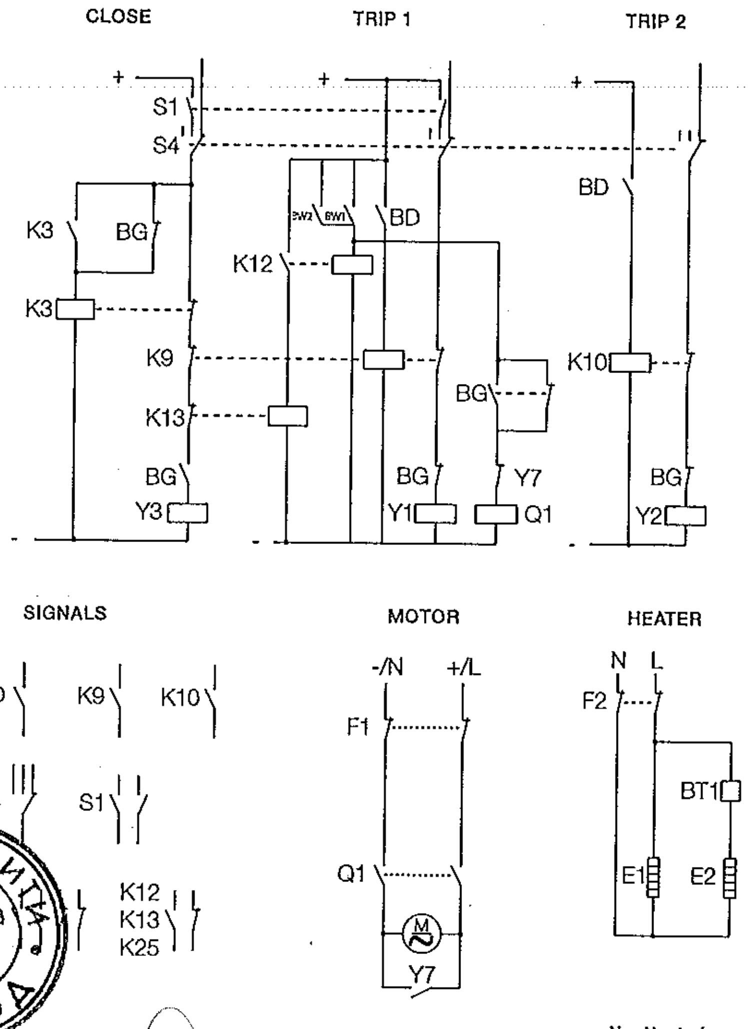
BLK
Electrical functions

Control circuits		BLK	CCC
BD	Signal contact of density switch	X	
BG	Auxiliary contact	X	
BT1	Thermostat	X	
BW	Limit switch	X	
E	Heater		X
E1	Heater	X	
E2	Heater	X	
F1	Direct-on-line motor starter (MCB)	X	
F1.A-C	Direct-on-line motorstarter (MCB)		X
F2	Miniature circuit breaker, AC auxiliary circuit	X	X
K3	Anti-pumping relay	X	X
K9, K10	Interlocking relay, trip	X	X
K11	Interlocking relay, close		X

Control circuits		BLK	CCC
K12	Auxiliary relay (spring uncharged)	X	
K13	Auxiliary relay (spring charged)	X	
M	Motor	X	
Q1	Contactor	X	
Q1.A-C	Contactor		X
S1	Control switch (trip/close)	X	X
S3	Selector switch (pole select)		X
S4	Selector switch (local/remote/disconn.)	X	X
Y1, Y2	Tripping coil	X	
Y3	Closing coil	X	
Y7	Blocking contact (Hand crank adapted)	X	
K25	Signal relay, low gas	X	

CCC = Central Control Cubicle is only applicable on single-pole operated circuit breakers.

Circuit diagram shows operating mechanism when circuit breaker is in normal service condition, i.e. pressurized, closing spring charged, in closed position, in motor charging position, and with selector switch in remote position.

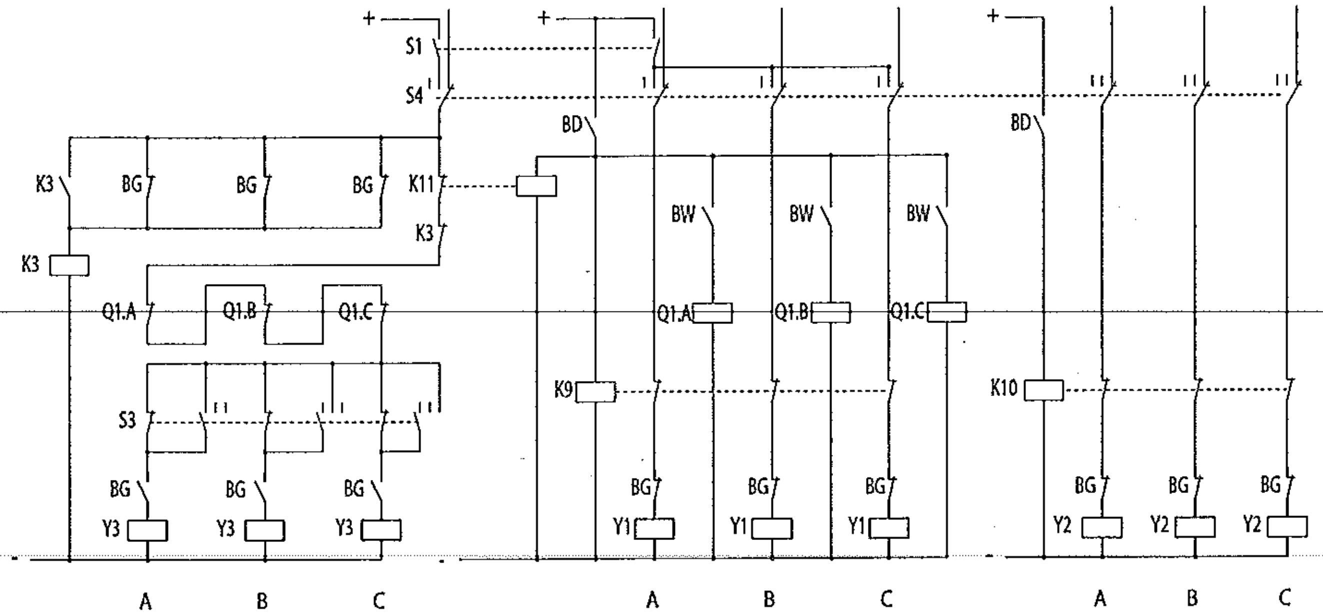


BLK Circuit diagram

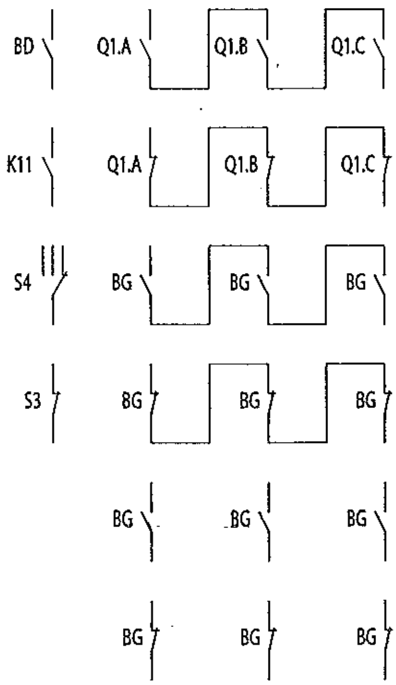
N = Neutral
L = Live

ВЯРНО С ОРИГИНАЛА

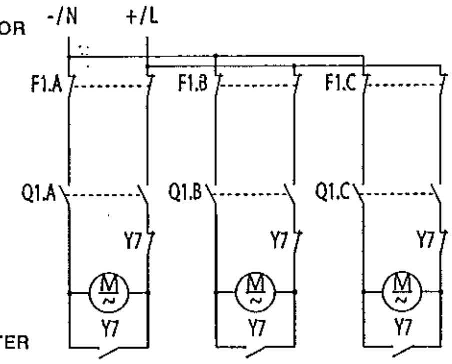
CONTROL CIRCUITS



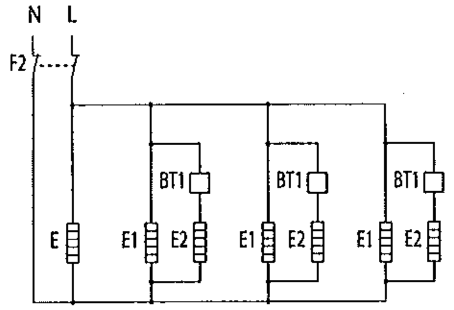
SIGNALS



MOTOR



HEATER



N = Neutral
L = Live
Fine line shows Central Control Cubicle

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ
СОФИЯ
ООД

Circuit diagram shows three operating mechanisms BLK with one control cubicle.

Circuit diagram shows operating mechanism when circuit breaker is in normal service condition, i.e. pressurized, closing spring charged, in closed position, in motor charging position, and with selector switch in remote position.

BLK
Technical data

Motor

Universal motor*) for 110 – 125 or 220 – 250 V, AC or DC

Rated voltage	Starting current peak value (max)	Normal Current at DC (approximately)
V	A	A
110	60**)	16
220	30**)	8

*) Please note that the motor contactor is either AC or DC type.
**) Depending on power source.

Power consumption (approximately)	900 W
Spring charging time	≤ 15 s

Operating coils

Operating coils	Rated voltage	Power consumption (approximately)
	V (DC)	W
Closing	110 - 125	200
	220 - 250	
Tripping	110 - 125	200
	220 - 250	

ЕЛЕКТРИКСИТИ СОФИЯ ООД

Auxiliary contacts

Rated voltage	Rated current	Making current	Breaking current DC L/R = 40 ms	Breaking current AC Cos φ = 0.95
V	A	A	A	A
110	25	20	4	25
220	25	10	2	25

The operating mechanism normally includes 8 NO and 8 NC spare auxiliary contacts.

ВЯРНО С ОРИГИНАЛА

Heating elements

Rated voltage	Power consumption: Continuously connected BLK	Power consumption: Continuously connected CCC	Power consumption: Thermostatically controlled BLK/CCC
V (AC)	W	W	W
110 - 127	70	140	140
220 - 254	70	140	140

The voltage range for motor, control and auxiliaries fulfills the requirements according to IEC and ANSI C37 standards.

Other ratings for motor, coils, auxiliary contacts and heating elements can be provided.

BLK

Design data

	BLK	CCC
Dimensions (mm)	640 x 770 x 880	850 x 1015 x 497
Weight (kg)	205	195
Material of housing	Aluminium	
Thickness (mm)	2	
Color	Grey, RAL 7032	
Temperature range (°C)	-55 to +40	
Degree of protection	As per IEC 60529: IP 55	
Terminal blocks	Supply, control, motor and AC circuits through 6 mm² block. Signal circuits through 4 mm² block	
Cable entry flange (mm)	Size FL 33: 102 x 306	
Earthing clamp	For conductors with maximum 13 mm diameter	
Internal cable	1.5 mm² PVC insulated cable	

Fig. 1. BLK

Front View

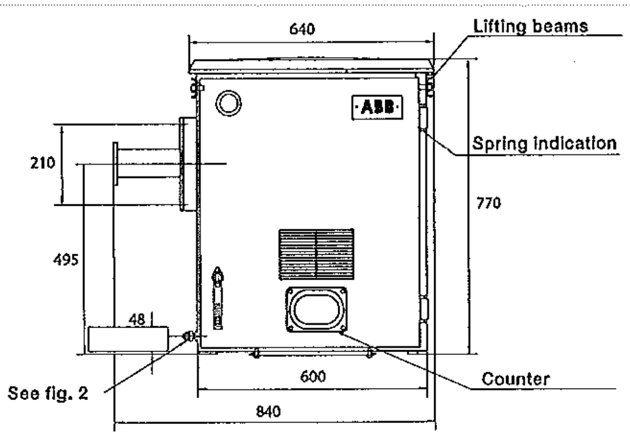
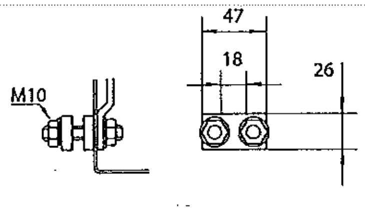


Fig. 2. Earthing Clamp



Bottom View

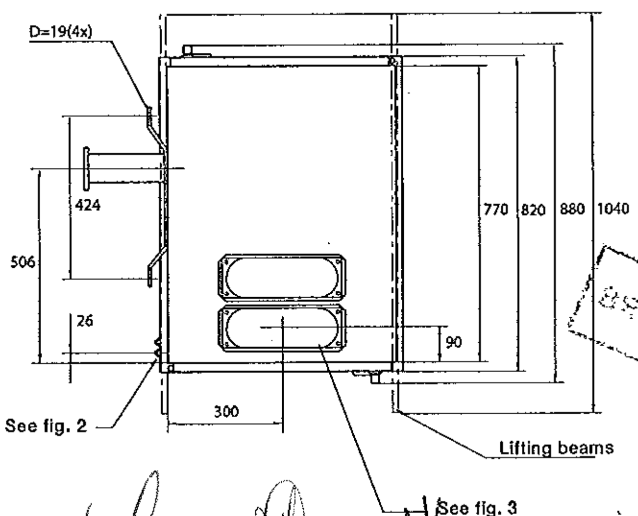
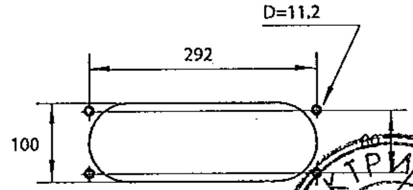


Fig. 3. Cable Entry Flange (FL 33)



ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ СОФИЯ ООД

BLK
Design data

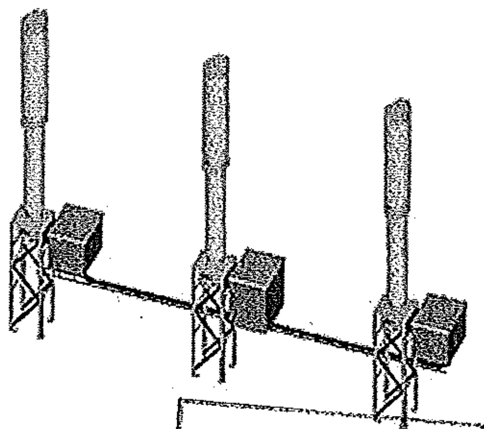
Integrated Control Cubicle (ICC)
Single pole operated circuit breakers using BLK operating mechanisms can be offered with an Integrated Control Cubicle solution (ICC). This solution has all connections to the control room and local operation of the different phases integrated in the B-phase operating mechanism.

For better access the panel in the B-phase is lowered.

All the cablings fitted with fast connectors between the phases are tested in the factory before delivery. The interphase cablings are mounted on ladders (see picture below), which are transported in the same box as the circuit breaker poles.

The design of the cabling is made so the fitting of the cabling at site can only be made in one way, mistakes are eliminated. The advantage of this solution is the simple and fast installation at site.

The circuit breaker poles and their operating mechanisms are routine tested together before leaving our workshop.



Integrated Control Cubicle (ICC).

Optional equipment
- Manual mechanical trip push-button - Inside or outside cubicle
- Additional auxiliary contacts - 6 NO + 6 NC
- Trip circuit supervision
- Internal light with door switch
- Socket outlet
- Position indicating lights
- Extra heater with MCB - Moisture detector control
- Provision for key interlock (Castell, Fortress or Kirk)
- Extra closing coil
- Lockable operating switches
- Protective cover for terminal block

Tests
The BLK mechanism has together with the corresponding circuit breaker, passed type tests in accordance with applicable IEC and ANSI standards.

Mechanical life tests have been performed with 10 000 operations.

Before delivery each operating mechanism together with the corresponding circuit breaker has to pass routine tests according to current standards.

For each circuit breaker together with its operating mechanism a routine test report is issued showing the actual test result.

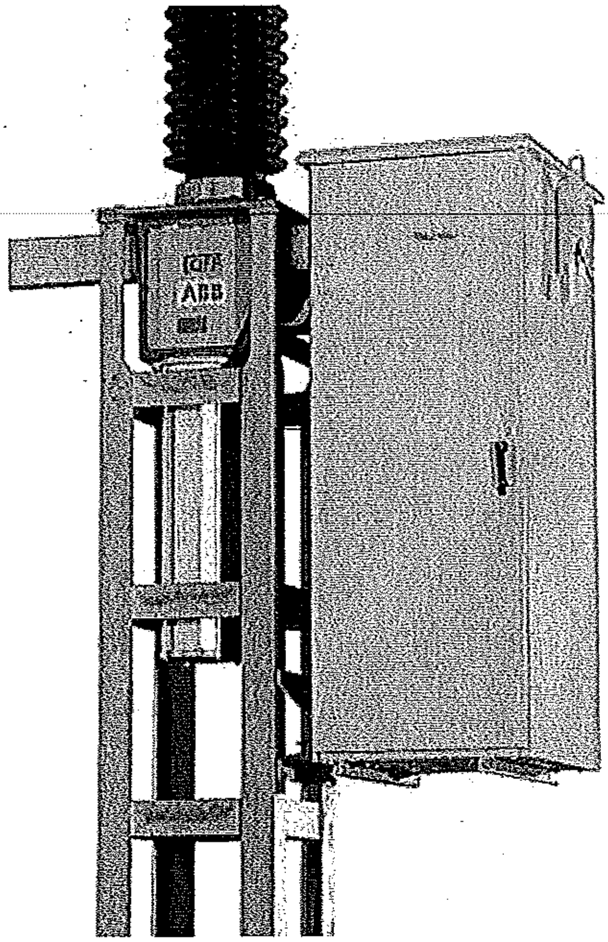
Recommended spare parts for BLK
Applicable for circuit breakers for frequent switching duty, e.g. switching capacitor- or reactor-banks.

- Catchgear with closing coil (or separate coil)
- Catchgear with tripping coils (or separate coil)
- Heater
- Motor contactor
- Auxiliary relays

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ЕООД СОФИЯ

BLG Spring Operating Mechanism
Technical information

The design of BLG is a well-proven technology (more than 55 000 units are in service). This proven technology is efficiently combined with modern manufacturing methods. This ensures a high degree of total reliability for the circuit breaker and a minimal need of maintenance. Mechanical life tests have been performed with 10 000 operations.
BLG is the answer to the demands of today and tomorrow and designed for widely shifting conditions, from polar to desert climate.



Brief performance data

Installation	Outdoor
Design	Spring operated
For circuit breaker	LTB E1 (Three-pole operated) LTB E2 LTB E4 HPL B
Service conditions:	
Ambient temperature	-55 °C to +40 °C (Other on request)

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ СОФИЯ ООД

BLG Spring Operating Mechanism
Technical information

Material
The housing is made of corrosion resistant, painted aluminum.

Front and back doors are equipped with doorstops and pad lock provisions on door handles.

The doors and walls are insulated for low heat energy consumption and low noise level.

Rating plates
A rating plate, which includes data for the circuit breaker, is placed on the side of the cabinet.

The rating plate is made of stainless steel with engraved text.

Instructions
With each delivery of circuit breakers, there is an extensive product manual that will guide the user how to handle the apparatus during its lifetime. Instructions, product manual, circuit diagram and other documents are placed in a compartment inside the back door of the operating mechanism.

Transport
BLG is normally packed and transported in a separate seaworthy wooden box.

Arrival Inspection - Unpacking
Please check the contents and packaging with regard to transport damage immediately on arrival. In the event of any material missing or damage to the goods, contact ABB for advice, before further handling of the goods takes place. Any damage should be documented (photographed).

The operating mechanism must be lifted using the lifting eyes on top of the cabinet. Slings must not be placed around the cabinet when lifting.

All packing material can be recycled.

Storage
The operating mechanism shall preferably be stored indoors in a dry building. When stored outdoors the internal heater should be used to prevent condensation.

If it is planned to store the unit, an external connection to the internal heater is provided.

Tools
Special tools for assembling and service are placed on the backside of the rear door.

Maintenance
The maintenance requirements are small, as BLG is designed for a service life of more than 30 years.
Normally it is sufficient with ocular inspection every 1–2 years.

Preventive inspection is recommended after 15 years or 5 000 operations.

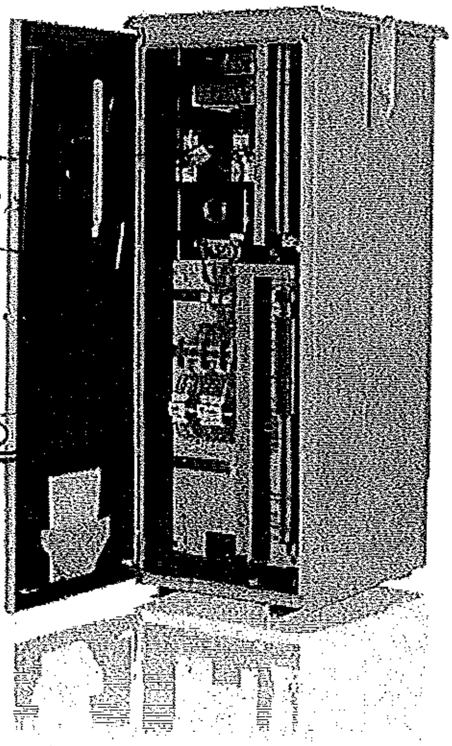
A more detailed check is recommended after 30 years of service or 10 000 operations.

Overhaul and repair work must be performed by authorized personnel only.

The instructions in the manual for operation and maintenance should be observed. This ensures a continued problem-free operation.

Disposal
The disposal should be carried out in accordance with local legal provisions.

The metals used in BLG can be recycled.



A BLG operating mechanism with rear door open.

BLG
Electrical functions

The principle function of the mechanism's electrical components is shown in the elementary diagram on next page.

Closing circuit
The closing coil (Y3) can be activated electrically by means of local or remote control. When the circuit breaker is in closed position, the closing circuit is interrupted by the auxiliary contact (BG).

Tripping circuits
The mechanism is provided with two independent trip coils (Y1 and Y2). The mechanism can be operated electrically through local or remote control. With the circuit breaker in the open position, the tripping circuits are interrupted by the auxiliary contact (BG).

Interlocks
The contact on the density switch (BD) actuates the auxiliary relays (K9, K10), which block the operating impulse if the density of the SF_6 gas is too low. The antipumping relay (K3) blocks any remaining closing impulse after the breaker has completed a closing operation.

The density of the SF_6 gas and condition of the operating mechanism is monitored electrically, given the following (remote) indications:

- Topping up of SF_6 gas is recommended (alarm level)
- Density of the SF_6 gas is too low (blocking level)
- Indication of charged springs

Heater circuits
The operating mechanism is provided with an anti-condensation heater.

To ensure reliable operation at low temperatures the mechanism is provided with a thermostat-controlled heater unit (BT1, E2).

Alternatively, in climatic conditions with high humidity, the mechanism can be provided with moisture detector.

Terminal blocks
The terminal blocks are the user's interface to the control circuits and connect the internal wiring.
Standard terminal blocks are compression type in which a bare wire end is compressed between two metallic plates in the terminal.

Circuits for supply to control, motor and AC auxiliaries are normally connected to 6 mm² disconnectable terminals. (Entrelec M6/8.STA)

The signal circuits are connected to 4 mm² through-terminals. (Entrelec M4/6)

All terminals can be protected with a transparent cover.

Internal wiring
The cabling in the operating mechanism is normally carried out with PVC-insulated cables.

The dimensions are 2.5 mm² for motor-circuits and 1.5 mm² for control- and auxiliary-circuits.

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

ЕП 699

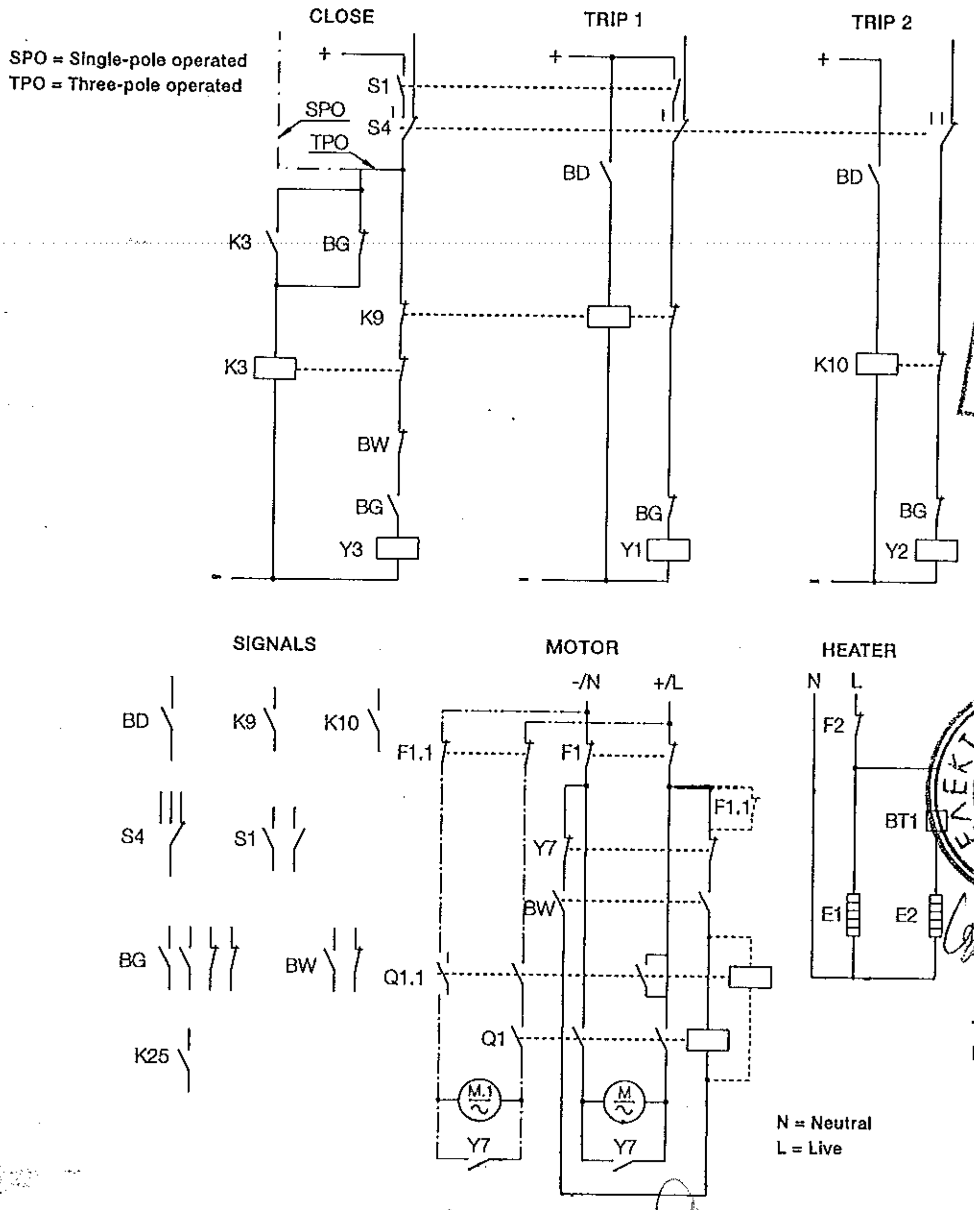
BLG
Electrical functions

Control circuits

BD	Signal contact of density switch
BG	Auxiliary contact
BT1	Thermostat
BW	Limit switch
E1, E2	Heater
F1, F1.1	Direct-on-line motor starter (MCB)
F2	Miniature circuit breaker, AC auxiliary circuit
K3	Anti-pumping relay
K9, K10	Interlocking relay, trip, close

Control circuits

K25	Signal relay, low gas
M, M.1	Motor
Q1, Q1.1	Contactor
S1	Switch, trip/close
S4	Selector switch (local/remote/disconn.)
Y1, Y2	Tripping coil
Y3	Closing coil
Y7	Blocking contact (Hand crank adapted)



Circuit diagram shows operating mechanism when circuit breaker is in normal service condition, i.e. pressurized, closing spring charged, in closed position, in motor charging position, and with selector switch in remote position.

Two motors are used in the BLG when larger spring energy is required.

BLG circuit diagram

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

BLG
Technical data

Motor

Universal motor*) for 110 – 125 or 220 – 250 V, AC or DC

Rated voltage	Starting current peak value (max)	Normal Current at DC (approximately)
V	A	A
110	20 - 40 **)	12 - 30 ***)
220	10 - 30 **)	6 - 15 ***)

*) Please note that the motor contactor is either AC or DC type.
**) Depending on power source. Peak value during first 0.1 s is in general 3 times charge current.
***) Depending on spring setup.

Spring charging time	≤ 15 s

Operating coils

Operating coils	Rated voltage	Power consumption (approximately)
	V (DC)	W
Closing	110 - 125	200
	220 - 250	
Tripping	110 - 125	200
	220 - 250	

ВЯРНО С ОРИГИНАЛА

Auxiliary contacts

Rated voltage	Rated current	Making current	Breaking current	
			DC	AC
			L/R = 40 ms	Cos φ = 0.95
V	A	A	A	A
110	25	20	4	25
220	25	10	2	25

The operating mechanism normally includes 9 NO and 11 NC spare auxiliary contacts.
If TCS is provided the operating mechanism normally includes 9 NO and 9 NC spare auxiliary contacts.

ЕЛЕКТРИКСИТИ СОФИЯ ООД

Heating elements

Rated voltage	Power consumption -40 °C	
	Continuously connected	Thermostatically controlled
V (AC)	W	W
110 - 127	70	140 *)
220 - 254	70	140 *)

*) 2 x 140 W for -55 °C

The voltage range for motor, control and auxiliaries fulfills the requirements according to IEC and ANSI C37 standards.

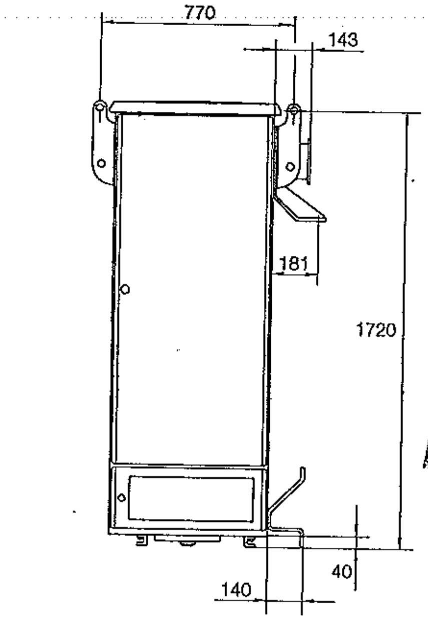
Other ratings for motor, coils, auxiliary contacts and heating elements can be provided.

BLG
Design data

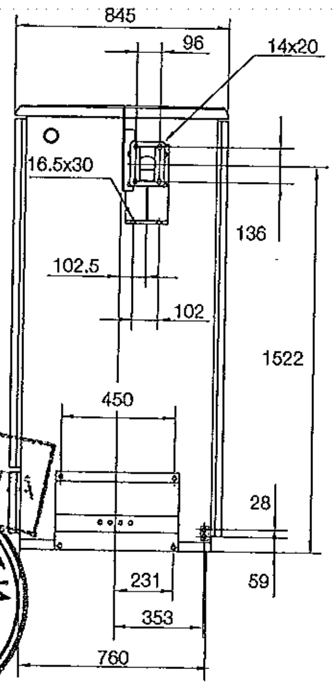
Dimensions (mm)	682 x 760 x 1747
Weight (kg)	465
Material of housing	Aluminium
Thickness (mm)	2
Color	Grey, RAL 7032
Temperature range (°C)	-55 to +40
Degree of protection	As per IEC 60529: IP 55
Terminal blocks	Supply, motor and AC circuits, disconnectable 6 mm² block. Signal circuits through 4 mm² block.
Cable connection (mm)	Size FL 33: 102 x 306
Earthing clamp	For conductors with maximum 13 mm diameter
Internal cable	Motor circuits 2.5 mm² PVC-insulated cable. Otherwise 1.5 mm² PVC-insulated cable.

BLG

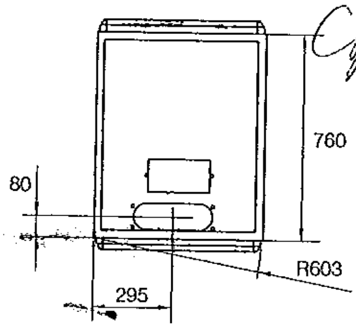
Front View



Side View



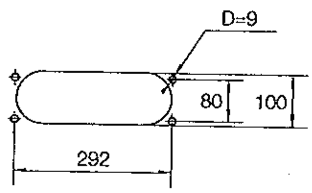
Bottom View



ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

Cable Entry Flange (FL 33)



BLG
Design data

Optional equipment
- Manual mechanical trip push-button - Inside or outside cubicle
- Additional auxiliary contacts - 6 NO + 6 NC
- Trip circuit supervision
- Internal light with door switch
- Socket outlet
- Position indicating lights
- Extra heater - Moisture detector control
- Provision for key interlock (Castell, Fortress or Kirk)
- Extra closing coil
- Lockable operating switches
- Protective cover for terminal block

Tests
The BLG mechanism has together with the corresponding circuit breaker, passed type tests in accordance with applicable IEC and ANSI standards.

Mechanical life tests have been performed with 10000 operations.

Before delivery each operating mechanism together with the corresponding circuit breaker has to pass routine tests according to current standards.

For each circuit breaker together with its operating mechanism a routine test report is issued showing the actual test result.

Recommended spare parts for BLG
Applicable for circuit breakers for frequent switching duty, e.g. switching capacitor- or reactor-banks.

- Catchgear with closing coil (or separate coil)
- Catchgear with tripping coils (or separate coil)
- Heater
- Motor with driving unit
- Motor contactor
- Auxiliary relays

ЕЛЕКТРИКСИТИ
СОФИЯ
ООД
...НО С ОРИГИНАЛА

ВЯРНО С ОРИГИНАЛА

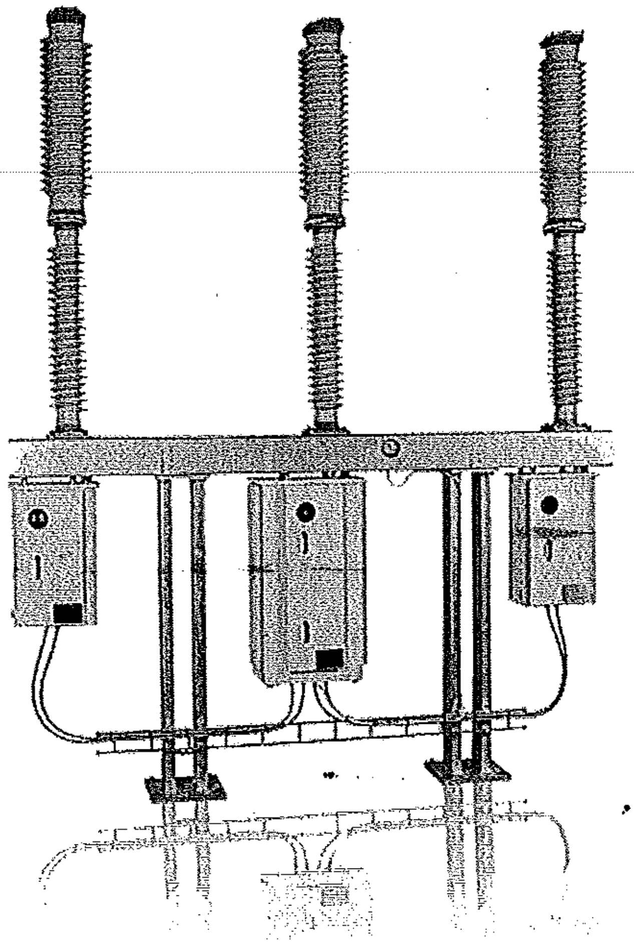
ЕЛЕКТРИКСИТИ ООД
СОФИЯ

FSA1 Spring Operating Mechanism
Technical information

The design of FSA1 is a well-proven technology (thousands of units are in service). This proven technology is efficiently combined with modern manufacturing methods.
This ensures a high degree of total reliability for the circuit breaker and a minimal need of maintenance.
Mechanical life tests have been performed with 10 000 operations.
FSA1 is the answer to the demands of today and tomorrow and designed for widely shifting conditions, from polar to desert climate.

Brief performance data

Installation	Outdoor
Design	Spring operated
For circuit breaker	LTB D1/B
Service conditions:	
Ambient temperature	-55 °C to +40 °C (Other on request)



ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

FSA1
Technical information

Material
The housing is made of corrosion resistant, painted aluminum.

The doors are equipped with doorstops and pad lock provisions on door handles.

Rating plates
A rating plate, which includes data for the circuit breaker, is placed on the front door.

The rating plate is made of stainless steel with engraved text.

Instructions
With each delivery of circuit breakers, there is an extensive product manual that will guide the user how to handle the apparatus during its lifetime. Instructions, product manual, circuit diagram and other documents are placed in a compartment inside the front door of the operating mechanism.

Transport
FSA1 is packed assembled on polebeam or in separate box. Both alternatives in sea worthy wooden boxes for transport.

Arrival inspection - unpacking
Please check the contents and packaging with regard to transport damage immediately on arrival. In the event of any material missing or damage to the goods, contact ABB for advice, before further handling of the goods takes place. Any damage should be documented (photographed).

If the FSA1 is packed separately the operating mechanism must be lifted using the lifting eyes on top of the cabinet. Slings must not be placed around the cabinet when lifting.

All packing material can be recycled.

Storage
The operating mechanism shall preferably be stored indoors in a dry building. When stored outdoors the internal heater should be used to prevent condensation.

If it is planned to store the unit, an external connection to the internal heater is provided.

Tools
Special tools for assembling and service are placed on the backside of the front door.

Maintenance
The maintenance requirements are small, as FSA1 is designed for a service life of more than 30 years.
Normally it is sufficient with ocular inspection every 1–2 years.

Preventive inspection is recommended after 15 years or 5 000 operations.

A more detailed check is recommended after 30 years of service or 10 000 operations.

Overhaul and repair work must be performed by authorized personnel only.

The instructions in the manual for operation and maintenance should be observed. This ensures a continued problem-free operation.

Disposal
The disposal should be carried out in accordance with local legal provisions.

The metals used in FSA1 can be recycled.

FSA1
Electrical functions

The principle function of the mechanism's electrical components is shown in the elementary diagram on next page.

Central Control Cubicle, CCC
Local operation and connections from the control room are made at the central control cubicle, CCC. The single-pole operated LTB D with FSA1 has a CCC that is integrated with the B-phase operating mechanism. This solution is referred to as "Integrated Control" solution. The cabling from the CCC out to the operating mechanisms are as standard assembled and tested together with the circuit breaker in the factory. This gives an optimized solution, that saves time for cabling and installation work at site.

Closing circuit
The closing coil (Y3) can be activated electrically by means of local or remote control. When the circuit breaker is in closed position, the closing circuit is interrupted by the auxiliary contact (BG).

Tripping circuits
The mechanism is provided with two independent trip coils (Y1 and Y2). The mechanism can be operated electrically through local or remote control. With the circuit breaker in the open position, the tripping circuits are interrupted by the auxiliary contact (BG).

Interlocks
The contact on the density switch (BD) actuates the auxiliary relays (K9, K10, K11), which block the operating impulse if the density of the SF_6 gas is too low. The antipumping relay (K3) blocks any remaining closing impulse after the breaker has completed a closing operation.

The density of the SF_6 gas and condition of the operating mechanism is monitored electrically, given the following (remote) indications:

- Topping up of SF_6 gas is recommended (alarm level)
- Density of the SF_6 gas is too low (blocking level)
- Indication of charged springs

Heater circuits
The operating mechanism is provided with an anti-condensation heater.

To ensure reliable operation at low temperatures the mechanism is provided with a thermostat-controlled heater unit (BT1, E2).

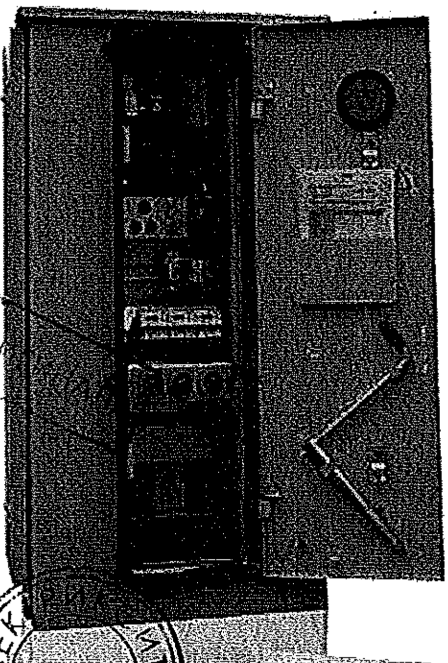
Terminal blocks
The terminal blocks are the user's interface to the control circuits and connect the internal wiring.
Standard terminal blocks are compression type in which a bare wire end is compressed between two metallic plates in the terminal.

Circuits for supply to motor and AC auxiliaries are normally connected to 6 mm² disconnectable terminals. (Entrelec M6/8.STA)

The signal circuits are connected to 4 mm² through-terminals. (Entrelec M4/6)

All terminals can be protected with a transparent cover.

Internal wiring
The cabling in the operating mechanism is normally carried out with PVC-insulated 1.5 mm² cables.



Combined CCC and operating mechanism for single-pole operation with FSA1.

FSA1
Electrical functions

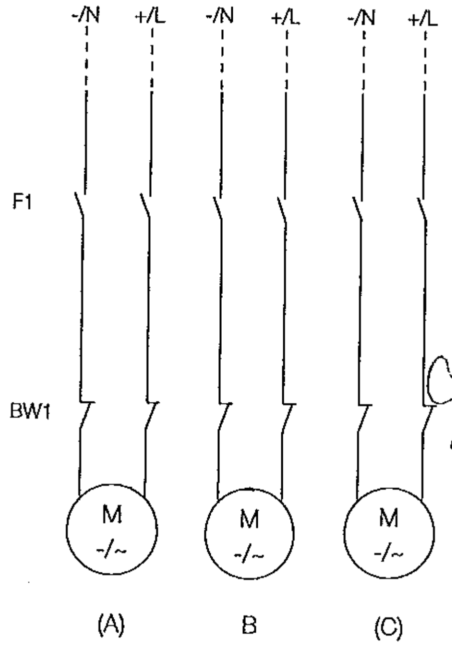
Control	Description	Circuits
BD	Density switch	Signal contact of density switch in trip and close circuit
BG	Auxiliary contact	Interrupting contact, close and trip circuit
BT1	Thermostat	AC auxiliary circuit
BW	Limit switch	Signal contact
E1, E2	Heater	AC auxiliary circuit
F1.A-C	Miniature circuit breaker (MCB)	Direct on-line motor starter. Motor circuit
F2	Miniature circuit breaker (MCB)	AC auxiliary circuit
K3	Anti-pumping relay	Close circuit
K9, K10	Interlocking relay, trip	Trip circuit
K11	Interlocking relay, close	Close circuit
K25	Auxiliary relay	Gas supervision, Alarm signal
M1	Motor	Motor circuit
S1	Control switch	Close and trip circuit
S3	Selector switch	Close circuit
S4	Selector switch	Close and trip circuit
Y1, Y2	Tripping coil	Trip circuit
Y3	Closing coil	Close circuit

Circuit diagrams shows operating mechanism when circuit breaker is in "off" position, not pressurised, closing springs uncharged, no power supply connected and selector switch in position LOCAL.

Electrical functions for single-pole operation is shown.

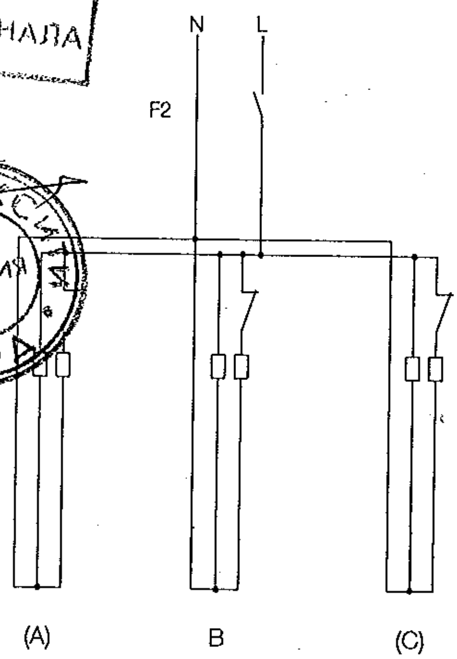
At three-pole operation only the circuits marked with B are used.

Motor circuit, standard

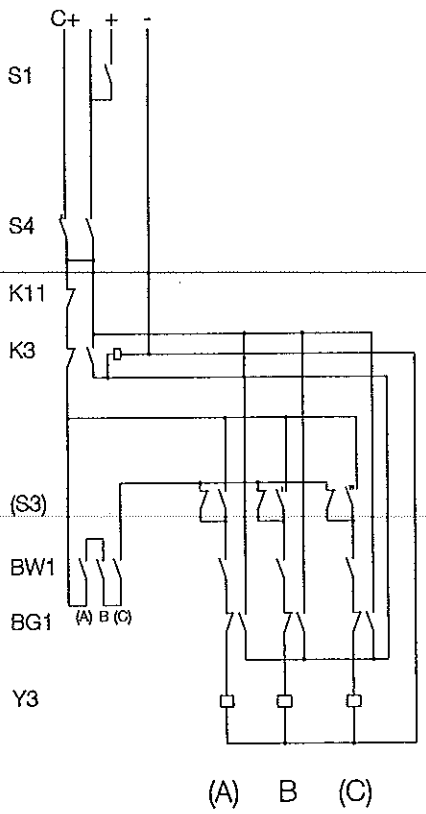


AC Auxiliary circuit, standard

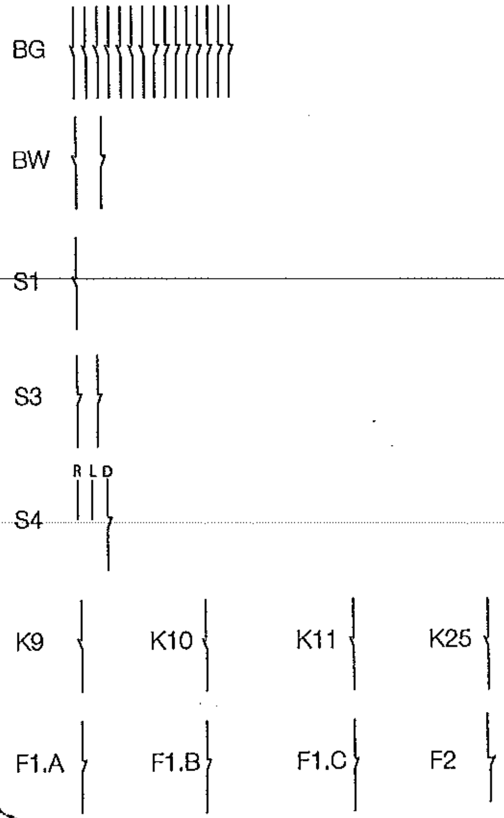
ВЯРНО С ОРИГИНАЛА



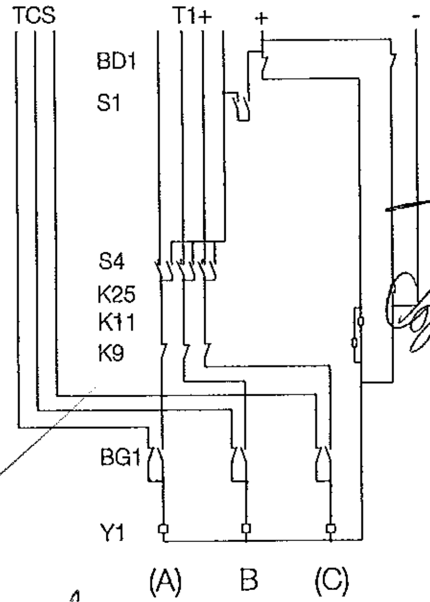
Close circuit, standard



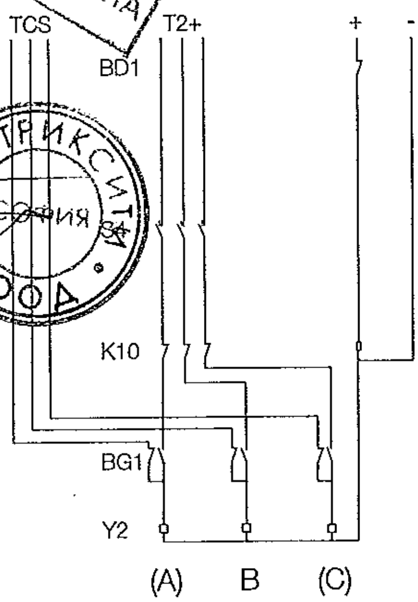
Signals, standard



Trip circuit 1, standard



Trip circuit 2, standard



ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКС ИТ
СОФИЯ
ООД

FSA1
Technical data

Motor

Universal motor for 110 – 125 or 220 – 250 V, AC or DC

Rated voltage	Starting current peak value (max)	Normal current at DC (approximately)
V	A	A
110	20 *)	18 **)
220	10 *)	4.5 **)

*) Depending on power source.
**) Depending on spring setup.

Spring charging time	≤ 15 s

Operating coils

Operating coils	Rated voltage	Power consumption (approximately)
	V (DC)	W
Closing	110 - 125	500
	220 - 250	
Tripping	110 - 125	500
	220 - 250	

ВЯРНО С ОРИГИНАЛА

Auxiliary contacts

Rated voltage	Rated current	Making current	Breaking current	
			DC L/R = 40 ms	AC Cos φ = 0.95
V	A	A	A	A
110	25	20	4	25
220	25	10	2	25

The operating mechanism normally includes 7 NO and 7 NC spare auxiliary contacts.

Heating elements

Rated voltage	Power consumption -40 °C	
	Continuously connected	Thermostatically controlled
V (AC)	W	W
110 - 127	70	140
220 - 254	70	140

The voltage range for motor, control and auxiliaries fulfills the requirements according to IEC and ANSI C37 standards.

ЕЛЕКТРИКСИТИ ООД СОФИЯ

FSA1
Design data

Dimensions (mm)	
Single-pole operated	Central Control Cubicle: 770 x 575 x 1473, A-, C-mechanism: 595 x 453 x 1023
Three-pole operated	701 x 605 x 1022
Weight (kg)	
Single-pole operated	Central Control Cubicle: 177, A-, C-mechanism: 142
Three-pole operated	150
Material of housing	Aluminium
Thickness (mm)	2
Color	Grey, RAL 7035
Temperature range (°C)	-55 to +40 (Other on request)
Degree of protection	As per IEC 60529: IP 55
Terminal blocks	Supply, motor and AC circuits, disconnectable 6 mm² block. Signal circuits through 4 mm² block.
Cable connection	
Single-pole operated master	2 x (218 x 76)
Three-pole operated	2 x (180 x 80)
Earthing clamp	For conductors with maximum 13 mm diameter
Internal cable	1.5 mm² PVC-insulated cable.

Optional equipment
- Manual mechanical trip - inside cubicle
- Trip circuit supervision
- Internal light with door switch
- Socket outlet
- Position indicating lights
- Extra closing coil
- Lockable operating switches
- Protective cover for terminal block
- Under voltage relay
- Pole discrepancy

Tests
The FSA1 mechanism has together with the corresponding circuit breaker, passed type tests in accordance with applicable IEC and ANSI standards.

Mechanical life tests have been performed with 10 000 operations.

Before delivery each operating mechanism together with the corresponding circuit breaker has to pass routine tests according to current standards.

For each circuit breaker together with its operating mechanism a routine test report is issued showing the actual test result.

Recommended spare parts for FSA1
Applicable for circuit breakers for frequent switching duty, e.g. switching capacitor- or reactor-banks.

- Catchgear with closing coil (or separate coil)
- Catchgear with tripping coils (or separate coil)
- Heater
- Motor with driving unit
- Auxiliary relays
- Limit switches

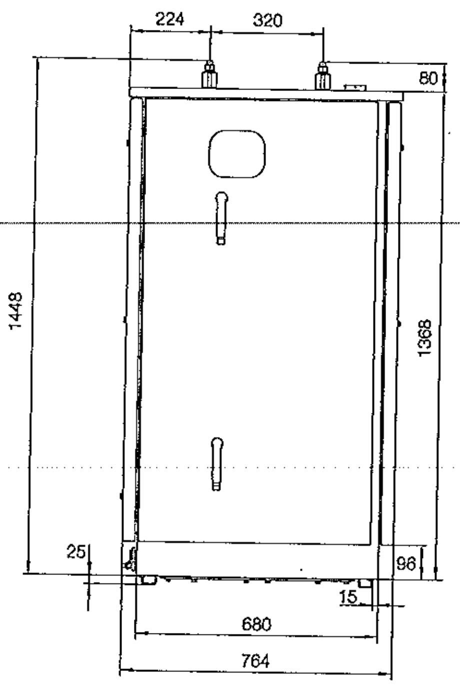
ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД СОФИЯ

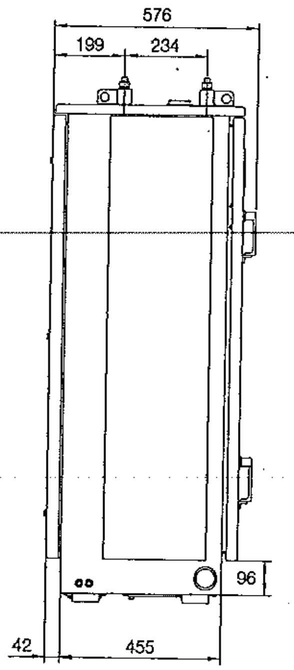
FSA1 Single-pole operated
Design data

Integtrated Control Cubicle

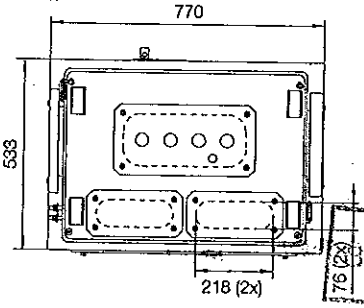
Front view



Side view

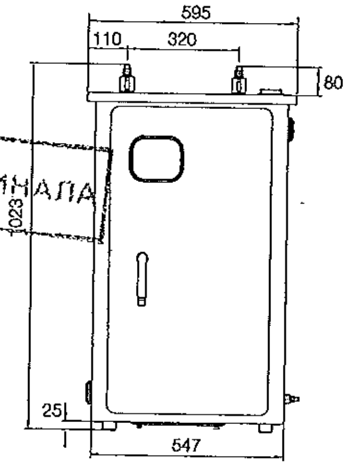


Bottom view

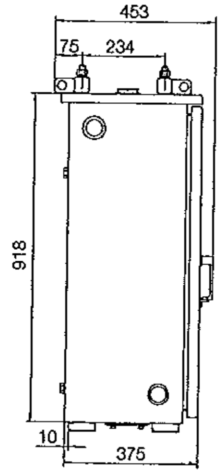


A-, C-phase operating mechanism

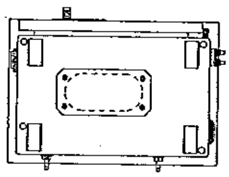
Front view



Side view



Bottom view



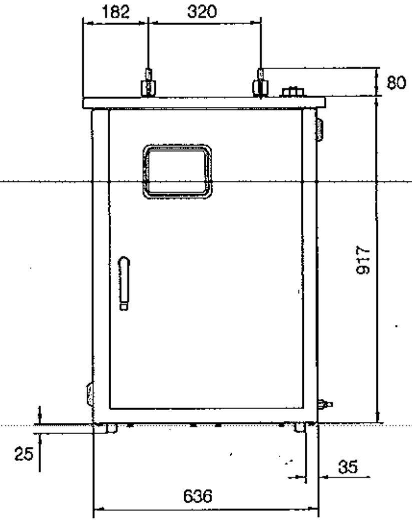
ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

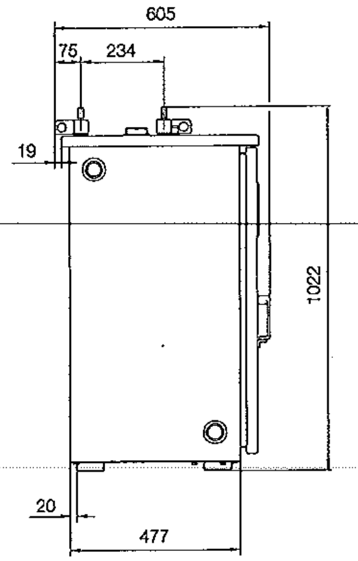
FSA1 Three-pole operated

Design data

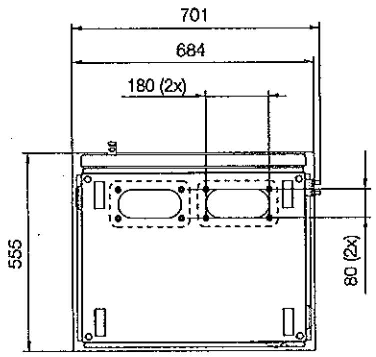
Front view



Side view



Bottom view



ВЯРНО С ОРИГИНАЛА

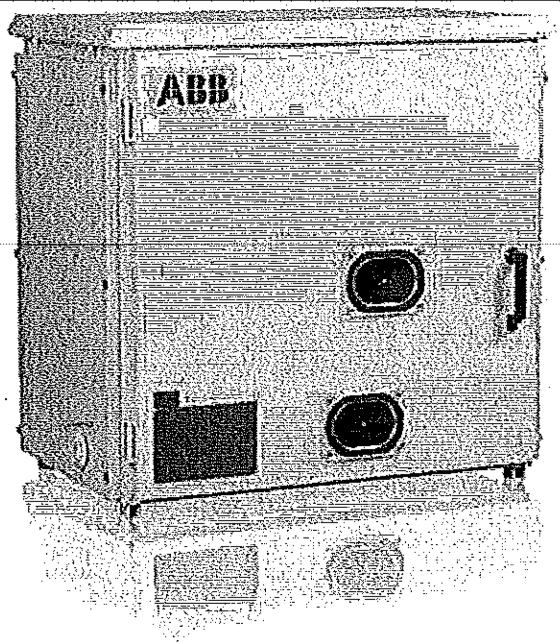
ЕЛЕКТРИКСИТИ СОФИЯ ООД

MSD Spring Operating Mechanism
Technical information

MSD is characterized by a well-proven technology. This proven technology is efficiently combined with modern manufacturing methods and a low number of mechanical components.
This ensures a high degree of total reliability for the circuit breaker and a minimal need of maintenance. Mechanical life tests have been performed with 10 000 operations.
MSD is designed for widely shifting conditions, from polar to desert climate.

Brief performance data

Installation	Outdoor
Design	Spring operated
For circuit breaker	LTB D1/B LTB E1 (Single-pole operated)
Service conditions:	
Ambient temperature	-40 °C to +40 °C (Other on request)



ВЯРНО С ОРИГИН...
ЕЛЕКТРИКСИТИ СОФИЯ ООД

MSD Spring Operating Mechanism
Technical information

Material
The housing is made of corrosion resistant, painted aluminum.

The front door is equipped with doorstop and pad lock provision on door handle.

The door and walls are insulated for low heat energy consumption and low noise level.

Rating plates
A rating plate, which includes data for the circuit breaker, is placed on the front door. The rating plate is made of stainless steel with engraved text.

Instructions
With each delivery of circuit breakers, there is an extensive product manual that will guide the user how to assemble and handle the apparatus during its lifetime.

Instructions, product manual, circuit diagram and other documents are placed in a compartment inside the front door of the operating mechanism.

Transport
MSD for single- and three-pole operation is normally packed and transported in a separate seaworthy wooden crate.

Arrival inspection - unpacking
Please check the contents and packaging with regard to transport damage immediately on arrival. In the event of any material missing or damage to the goods, contact ABB for advice, before further handling of the goods takes place. Any damage should be documented (photographed).

The operating mechanism must be lifted using the lifting eyes on top of the cabinet. Slings must not be placed around the cabinet when lifting.

All packing material can be recycled.

Storage
The operating mechanism shall preferably be stored indoors in a dry building. When stored outdoors the internal heater should be used to prevent condensation.

If it is planned to store the unit, an external connection to the internal heater is provided.

Tools
Special tools for assembling and service are placed on the inner side of the rear door.

Maintenance
The maintenance requirements are small, as MSD is designed for a service life of more than 30 years.

Normally it is sufficient with ocular inspection every 1-2 years and some lubrication after 15 years or 5 000 operations.

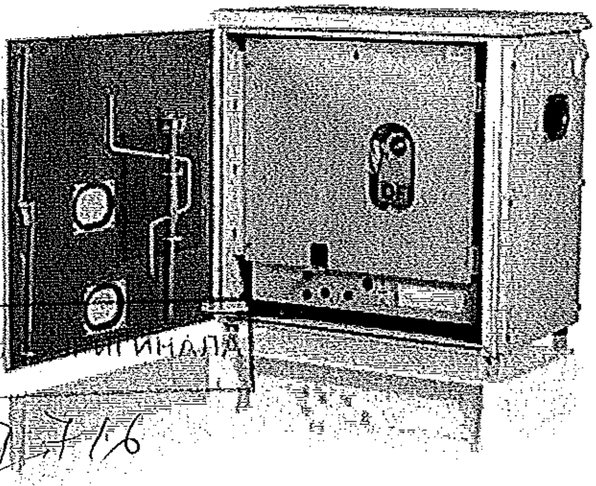
A more detailed check is recommended after 30 years of service or 10 000 operations.

Overhaul and repair work must be performed by authorized personnel only.

The instructions in the manual for operation and maintenance should be observed. This ensures a continued problem-free operation.

Disposal
The disposal should be carried out in accordance with local legal provisions.

The operating mechanism is easy to dismantle and the metal parts can be recycled.



MSD operating mechanism with open front door.

ЕЛЕКТРИКС СИТИ СОФИЯ ООД

MSD
Electrical functions

The principle function of the mechanism's electrical components is shown in the elementary diagram on next page.

Closing circuit
The closing coil (Y3) can be activated electrically by means of local or remote control. When the circuit breaker is in closed position, the closing circuit is interrupted by the auxiliary contact (BG).

Tripping circuits
The mechanism is provided with two independent trip coils (Y1 and Y2). The mechanism can be operated electrically through local or remote control. With the circuit breaker in the open position, the tripping circuits are interrupted by the auxiliary contact (BG).

Interlocks
The contact on the density switch (BD) actuates the auxiliary relays (K9, K10), which block the operating impulse if the density of the SF_6 gas is too low. The antipumping relay (K3) blocks any remaining closing impulse after the breaker has completed a closing operation.

The density of the SF_6 gas and condition of the operating mechanism is monitored electrically, given the following (remote) indications:

- Topping up of SF_6 gas is recommended (alarm level)
- Density of the SF_6 gas is too low (blocking level)
- Indication of charged spring

Heater circuits
The operating mechanism is provided with an anti-condensation heater.

To ensure reliable operation at low temperatures the mechanism is provided with a thermostat-controlled heater unit (BT1, E2).

Alternatively, in climatic conditions with high humidity, the mechanism can be provided with moisture detector.

Terminal blocks
The terminal blocks are the user's interface to the control circuits and connect the internal wiring.

Standard terminal blocks are compression type in which a bare wire end is compressed between two metallic plates in the terminal.

Circuits for supply to motor and AC auxiliaries are normally connected to 6 mm² through-terminals. (Entrelec M6/8)

The signal circuits are connected to 4 mm² through-terminals. (Entrelec M4/6)

As options the 6 mm² terminals can be of the disconnectable type. (Entrelec M6/8.STA)

All terminals can be protected with a transparent cover.

Internal wiring
The cabling in the operating mechanism is normally carried out with PVC-insulated cables.
Dimensions are 1.5 mm² for control and auxiliary circuits and 2.5 mm² for motor circuits.

ЕЛЕКТРИКСИТИ СОФИЯ ООД

ВЯРНО С ОРИГИНАЛА

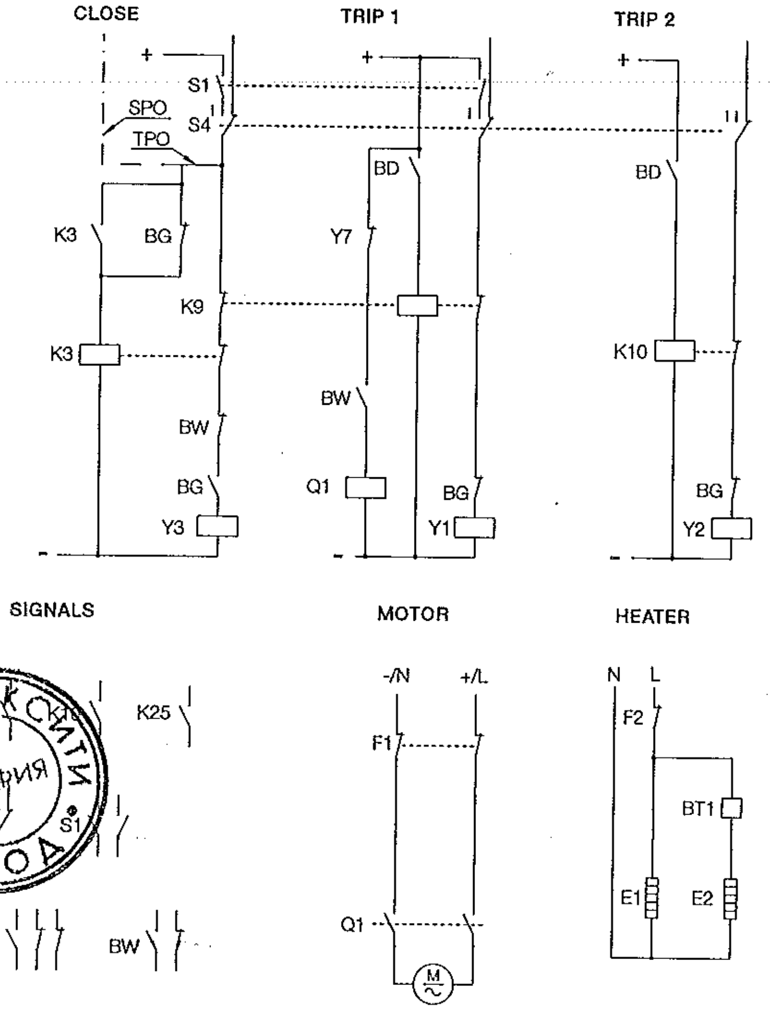
MSD
Electrical functions

Control circuits		MSD	ICC
BD	Signal contact of density switch	X	X
BG	Auxiliary contact	X	X
BT1	Thermostat	X	X
BW	Limit switch	X	X
E1	Heater	X	X
E2	Heater	X	X
F1	Direct-on-line motor starter	X	
F1.A-C	Direct-on-line motor starter		X
F2	Miniature circuit breaker, AC auxiliary circuit	X	X
K3	Anti-pumping relay	X	X
K9, K10	Interlocking relay, trip	X	X
K11	Interlocking relay, close		X

Control circuits		MSD	ICC
K13	Auxiliary relay (spring charged)		X
M1	Motor	X	X
Q1	Contactor	X	
Q1.A-C	Contactor		X
S1	Control switch (trip/close)	X	X
S3	Selector switch (pole select)		X
S4	Selector switch (local/remote/disconn.)	X	X
Y1, Y2	Tripping coil	X	X
Y3	Closing coil	X	X
Y7	Blocking contact (Hand crank adapted)	X	X
K25	Signal relay, low gas	X	X

CCC = Central Control Cubicle is only applicable on single-pole operated circuit breakers.

Circuit diagram shows operating mechanism when circuit breaker is in normal service condition, i.e. pressurized, closing spring charged, in closed position, in motor charging position, and with selector switch in remote position.

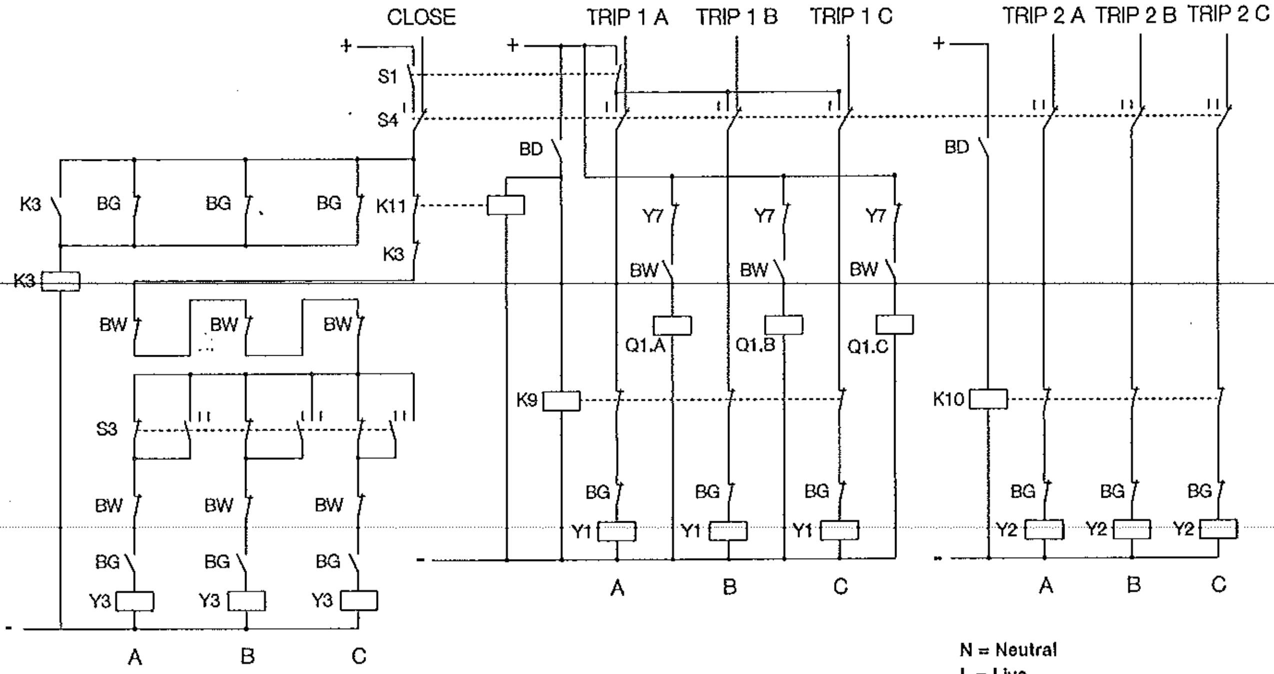


ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИК СИТИ ООД СОФИЯ

MSD Circuit diagram

N = Neutral
L = Live

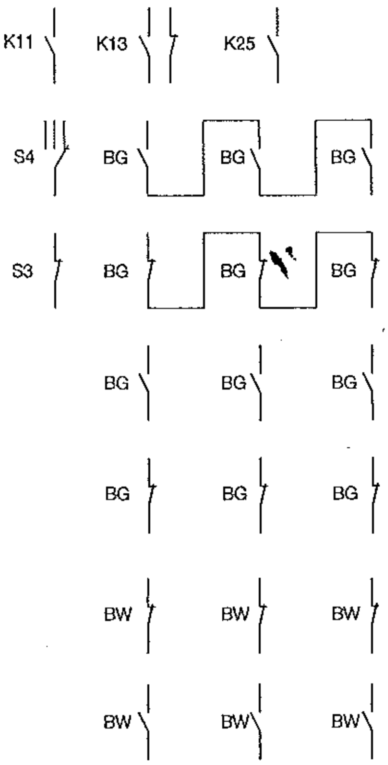
CONTROL CIRCUITS



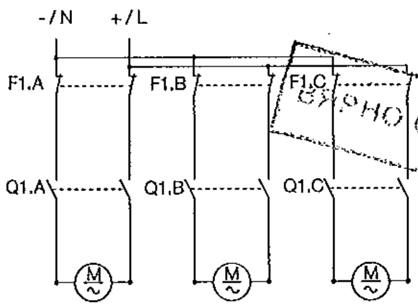
N = Neutral
L = Live

Fine line shows Central Control Cubicle

SIGNALS



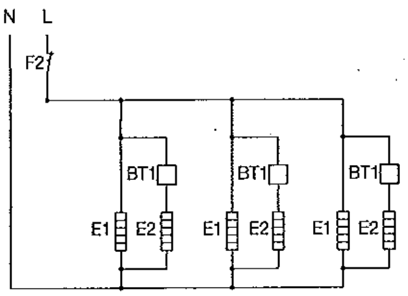
MOTOR



ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

HEATER



Circuit diagram shows operating mechanism when circuit breaker is in normal service condition, i.e. pressurized, closing spring charged, in closed position, in motor charging position, and with selector switch in remote position.

Circuit diagram shows integrated control cubicle (ICC).

MSD
Technical data

Motor

Universal motor*) for 110 – 125 or 220 – 250 V, AC or DC

Rated voltage	Starting current peak value (max)	Normal Current at DC (approximately)
V	A	A
110	50**)	12
220	25**)	6

*) Please note that the motor contactor is either AC or DC type.
**) Depending on power source.

Power consumption (approximately)	900 W
Spring charging time	≤ 15 s

Operating coils

Operating coils	Rated voltage	Power consumption (approximately)
	V (DC)	W
Closing	110 - 125	200
	220 - 250	
Tripping	110 - 125	200
	220 - 250	

Auxiliary contacts

Rated voltage	Rated current	Making current	Breaking current	
			DC	AC
			L/R = 40 ms	Cos φ = 0.95
V	A	A	A	A
110	25	20	4	25
220	25	10	2	25

The operating mechanism normally includes 8 NO and 8 NC spare auxiliary contacts.

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ СОФИЯ ООД

Heating elements

Rated voltage	Power consumption		
	Continuously connected		Thermostatically controlled
	MSD	CCC	MSD/CCC
V (AC)	W	W	W
110 - 127	70	140	140
220 - 254	70	140	140

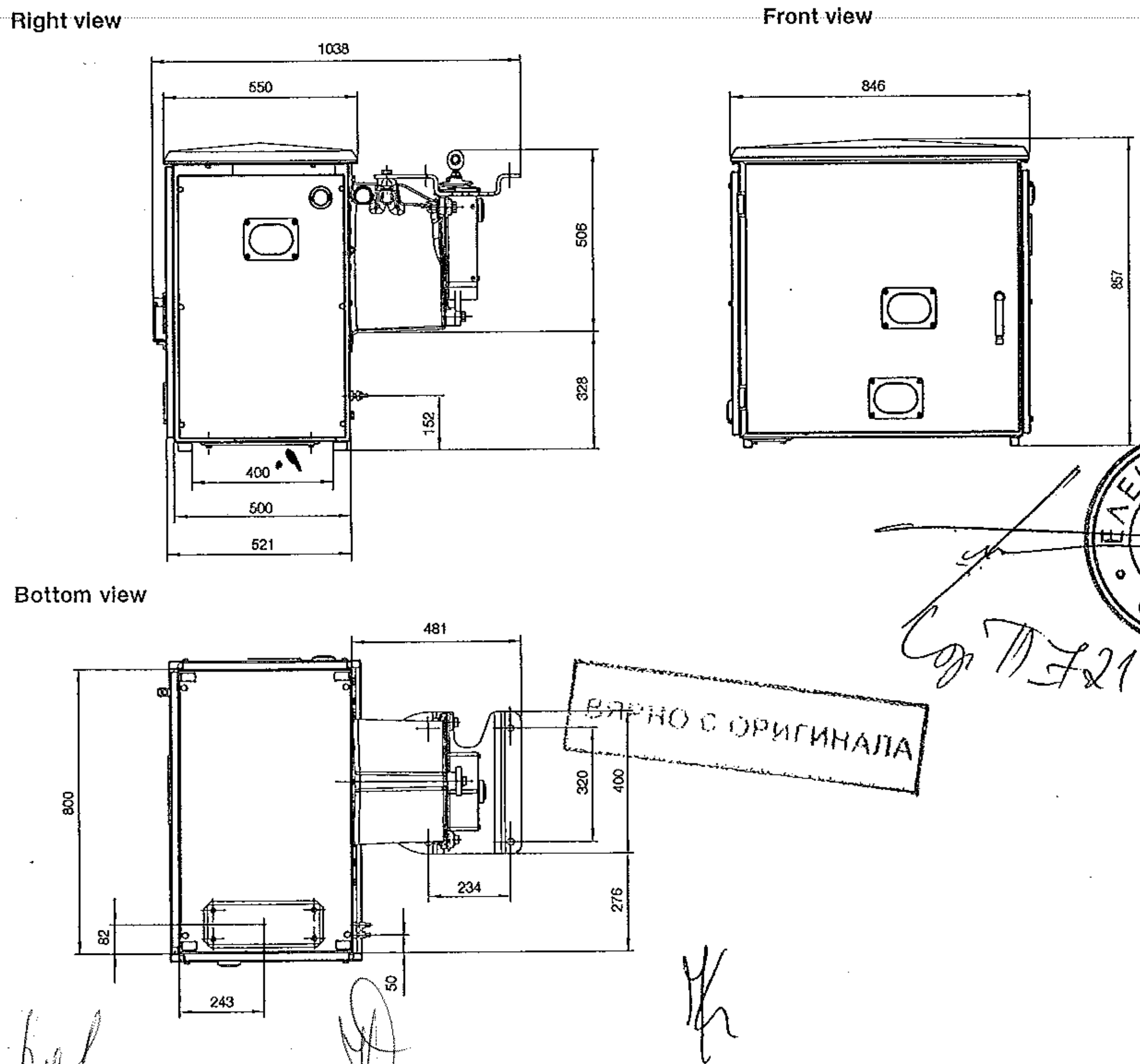
The voltage range for motor, control and auxiliaries fulfills the requirements according to IEC and ANSI C37 standards.

Other ratings for motor, coils, auxiliary contacts and heating elements can be provided.

MSD
Design data

	MSD for LTB D	MSD for LTB E	ICC
Dimensions (mm)	846 x 857 x 1038	846 x 857 x 853	846 x 1252 x 853
Weight (kg)	190/230		250
Material of housing	Aluminium		
Thickness (mm)	2		
Color	Grey, RAL 7032		
Temperature range (°C)	-40 to +40	-30 to +40	
Degree of protection	As per IEC 60529: IP 55		
Terminal blocks	Supply, control, motor and AC circuits through 6 mm² block. Signal circuits through 4 mm² block		
Cable entry flange (mm)	Size FL 33: 102 x 306		
Earthing clamp	For conductors with maximum 13 mm diameter		
Internal cable	1.5 mm² PVC insulated cable		

Fig. 1. MSD for three-pole operated LTB D

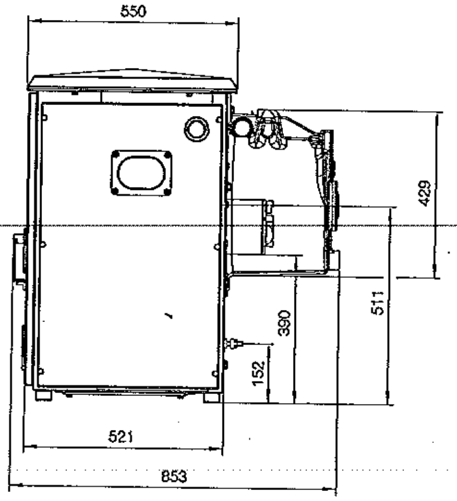


ЕЛЕКТРИКСИТИ СОФИЯ ООД
ВЯРНО С ОРИГИНАЛА

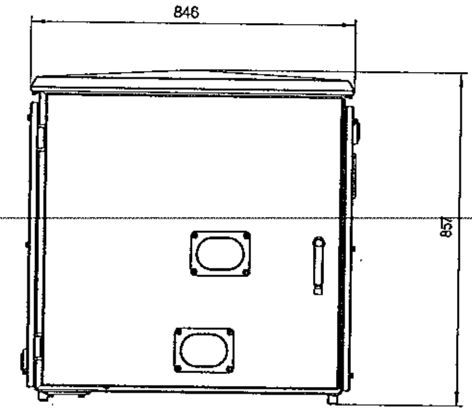
MSD Single-pole operated
Design data

Fig. 1. MSD with CCC for single-pole operated LTB E

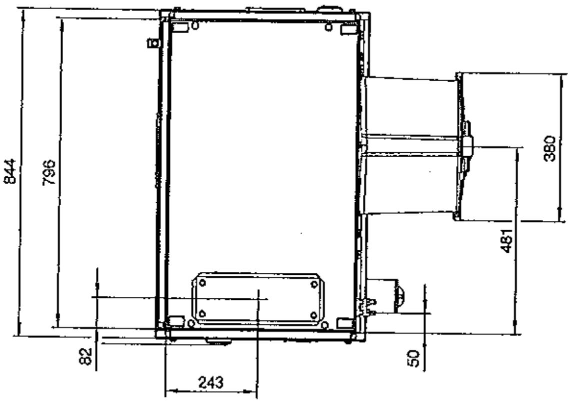
Right view



Front view



Bottom view



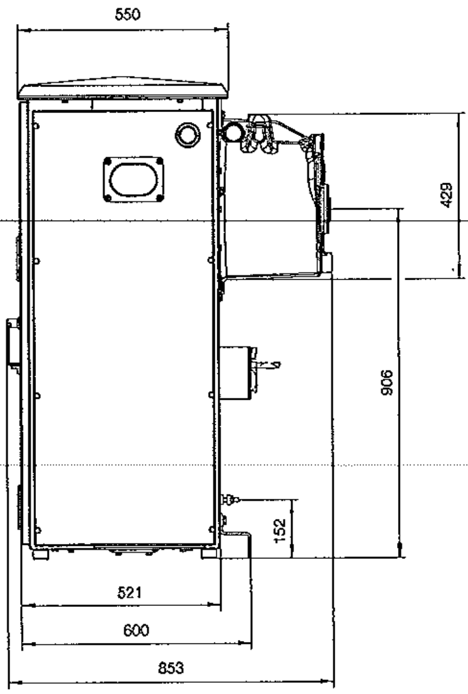
ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИК СИТИ СОФИЯ ООД

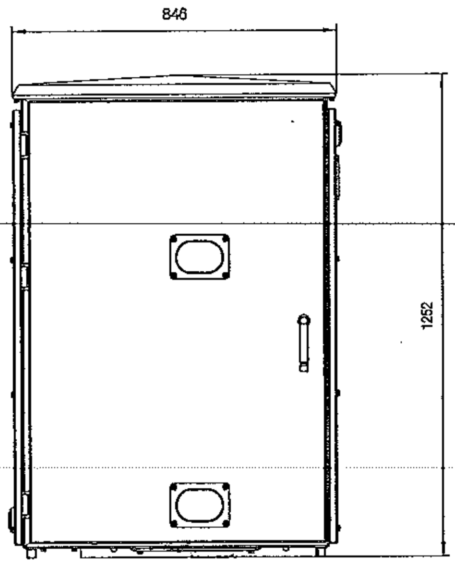
MSD Single-pole operated
Design data

Fig. 3. MSD with integrated Control Cubicle (ICC) for single-pole operated LTB E

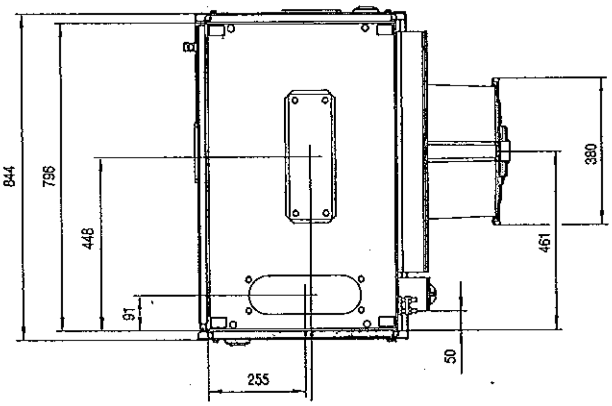
Right view



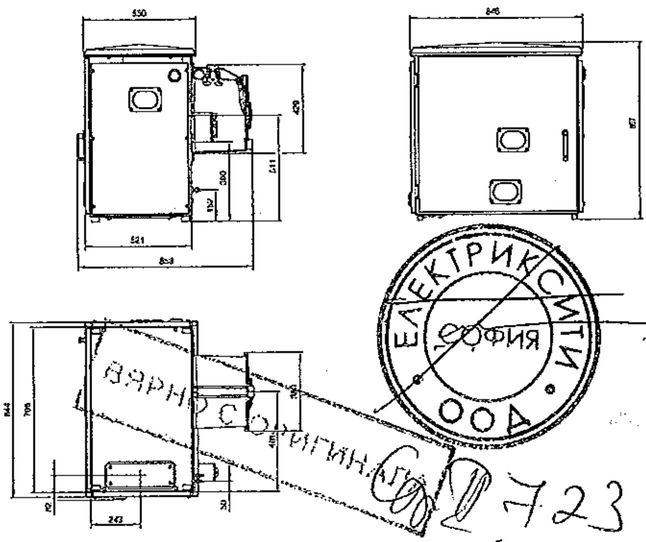
Front view



Bottom view



A-, C-phase operating mechanism



ЕЛЕКТРИК СИТИ ООД СОФИЯ
ВЯРНО С ОРИГИНАЛА

MSD
Design data

Integrated Control Cubicle (ICC)

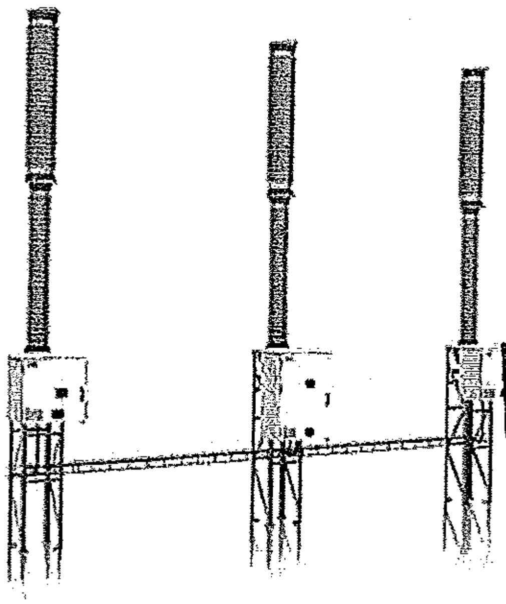
Single pole operated circuit breakers using MSD operating mechanisms can be offered with an Integrated Control Cubicle solution (ICC). This solution has all connections to the control room and local operation of the different phases integrated in the B-phase operating mechanism.

For better access the panel in the B-phase is lowered.

All the cablings between the phases are tested in the factory before delivery. The interphase cablings are mounted on ladders (see picture below), which are transported in the same box as the circuit breaker poles.

The design of the cabling is made so the fitting of the cabling at site can only be made in one way, mistakes are eliminated. The advantage of this solution is the simple and fast installation at site.

The circuit breaker poles and their operating mechanisms are routine tested together before leaving our workshop.



CCC and operating mechanisms MSD for single-pole operation.

Optional equipment

- Manual mechanical trip push-button - inside or outside cubicle
- Additional auxiliary contacts - 6 NO + 6 NC
- Trip circuit supervision
- Internal light with door switch
- Socket outlet
- Position indicating lights
- Extra heater with MCB - Moisture detector control
- Provision for key interlock (Castell, Fortress or Kirk)
- Extra closing coil
- Lockable operating switches
- Protective cover for terminal block

Tests

The MSD mechanism has together with the corresponding circuit breaker, passed type tests in accordance with applicable IEC and ANSI standards.

Mechanical life tests have been performed with 10 000 operations.

Before delivery each operating mechanism together with the corresponding circuit breaker has to pass routine tests according to current standards.

For each circuit breaker together with its operating mechanism a routine test report is issued showing the actual test result.

Recommended spare parts for MSD

Applicable for circuit breakers for frequent switching duty, e.g. switching capacitor- or reactor-banks.

- Catchgear with closing coil (or separate coil)
- Catchgear with tripping coils (or separate coil)
- Heater
- Motor contactor
- Auxiliary relays

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

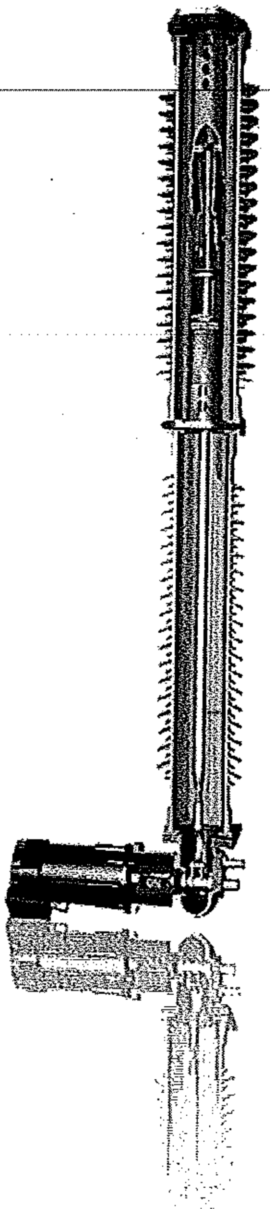
ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

Motor Drive, Motor Operated Mechanism
Technical information

Focusing on our customers' needs for the new millennium ABB introduces a revolutionary new solution for operation of high voltage circuit breakers: Motor Drive™.

- Only one (1) moving part in the drive
- Low stable power consumption
- Extremely low noise level



Motor Drive™ sets new standards in circuit breaker technology and function. Increased operational endurance.
10 000 operations or 30 years of service with minimum inspection and maintenance.

- Low operation forces
- Simple installation without adjustment
- Advanced self-monitoring system

Brief performance data

Installation	Outdoor / Indoor
Design	Digitally controlled motor
For circuit breaker	At present available for: LTB D1/B
Service conditions:	
Ambient temperature	-50 °C to +40 °C (Other temperatures on request)

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИКСИТИ ООД СОФИЯ

Motor Drive
Technical data

Power supply

Input	Rated voltage[1] (V)
1 and 2	110 - 250 V DC (70% – 110%)
	220 - 240 V AC (70% – 110%)

[1] There is one supply which has priority (supply 1) which will be used if it is present, the change to secondary supply (supply 2) is automatically done without interruption.

Maximum power required at rated supply voltage

During startup of the system	On-line without operations	During and immediately following a single operation < 10 s
< 100 ms, 550 W	< 100 W	< 400 W
< 60 s, 350 W		

Control circuits

Control circuit	Rated voltage (V DC)	Current or power
Close input	110	160 mA during the first 3 ms,
	220 on request	then 3 mA
Trip input	110	160 mA during the first 3 ms,
	220 on request	then 3 mA
Others	110	160 mA during the first 3 ms,
	220 on request	then 3 mA

Outputs

Output	Nom. rated current (A)	Breaking capacity Resistive load (V DC)	Max. breaking current (A)
Indication closed	16	110	0.45
position		250	0.35
Indication open	16	110	0.45
position		250	0.35
Indication circuit	16	110	0.45
breaker fault		250	0.35
Others	16	110	0.45
		250	0.35

Contacts Class 2 according to IEC.
The operating mechanism normally includes 6 NO and 6 NC spare auxiliary contacts.

Serial communication port

Output	Connector type	Compatible optical fibre
Fibre output	ST	62.5/125 µm
		nom. 820 nm

Heating element

Rated voltage (V, AC/DC)	Power consumption
	Thermostatically controlled
	Placed in Control cubicle
110 - 230	2 x 100 W (at 20 °C)

Test voltage 1 min. 50 Hz

Circuit	Voltage (kV)
Voltage supply	2
Control circuits	2
Outputs	2
Heating element	2

Operating times

Opening times	22 ms
Closing times	45 ms
Rated operating sequence	O - 0.3 s - CO - 3 min - CO
	CO - 15 s - CO

Dimensions

	Control cubicle
Dimension (mm)	885 x 1345 x 787
Weight (kg)	190
Thickness	2 mm aluminium
Color	Grey (RAL 7032)
Temperature range	-50 °C to +40 °C
Degree of protection	As per IEC 60529: IP 55
Terminal blocks	Supply, control and AC-circuits isolatable 6 mm² block. Signal circuits through 4 mm² block.
Cable-entry flange (mm)	Size FL33, two flanges 2 x (102 x 306)
Earthing clamp	For conductor with max. 13 mm diameter
Internal cable	1.5 mm² PVC insulated cable

Testing

The motor drive has successfully passed the following type tests
Mechanical, High/Low temperature and power according IEC and ANSI
EMC according IEC and EN

Mechanical life tests have been performed with 10000 operations.

Before delivery each motor drive has to pass routine tests conforming to current standards. For each circuit breaker a routine test report is issued showing the actual test result.

Вярно с оригинала

Composite insulators

ABB has developed a full range of high voltage equipment including surge arresters, instrument transformers and circuit breakers with high performance and robust composite insulation as an alternative to porcelain. Use of composite insulators provides new possibilities for substation designers to improve safety and availability.

General
Composite insulators with silicone rubber sheds (SIR) offer many advantages over traditional porcelain insulators:

Improved safety
- Lower transport and handling risk
- Lower in-service risks
- Low risk for damages by vandalism

Low weight
- Easier handling
- Reduced foundation loads
- Excellent seismic withstand

Hydrophobic
- Less maintenance
- Suppressed leakage currents

Demands on composite insulator
Demands on insulators used for gas insulated live tank circuit breakers are high with respect to mechanical loads as well as electrical stresses. The insulator shall also withstand the decomposed SF_6 gas and the heat developed during current interruption.

ABB manufacturing techniques
The supporting part of the insulator consists of a cross-laminated fiberglass reinforced epoxy tube, joined to metal end flanges. The glass fibers on the inner surface of the hollow insulator are protected against the influence of the SF_6 decomposition products by a liner of epoxy, reinforced with polyester fibers.

The patented helical extrusion moulded silicone rubber insulator without joints (chemical bonds between spirals) is attached to the tube by the spiral winding process, developed by ABB. It minimizes electrical field concentrations and reduces build up of contamination.

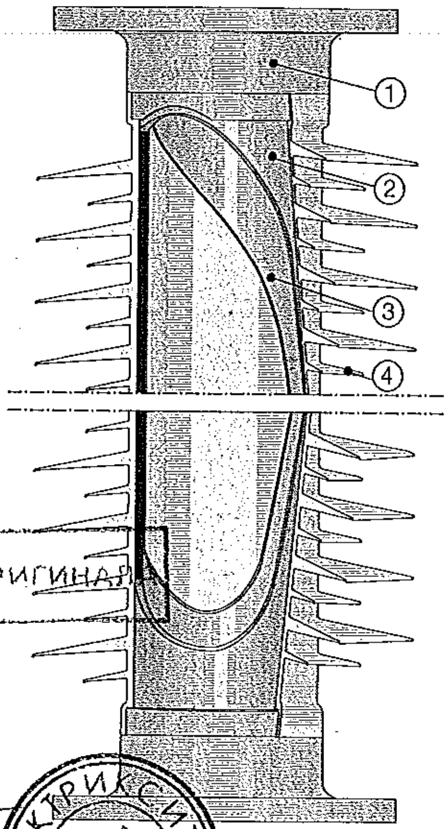
Color
The insulators for the circuit breakers are delivered in light gray color.

Applications
Composite insulators are used for the following types of ABB live tank circuit breakers:

- LTB 72.5 – 800 kV
- HPL 72.5 – 800 kV

Completed tests performed

On insulator	On circuit breaker
Accelerated ageing test (1 000 h)	Seismic test
UV radiation tests	Overpressure test
Natural pollution test	Shatter test
	Dielectric test
	Short-time current test
	High and low temperature test



Main parts of ABB's composite insulator:
1. Metal flange | 2. Glass fiber reinforced epoxy tube | 3. Liner | 4. Silicone rubber shed

ВЯРНО С ОРИГИНАЛА

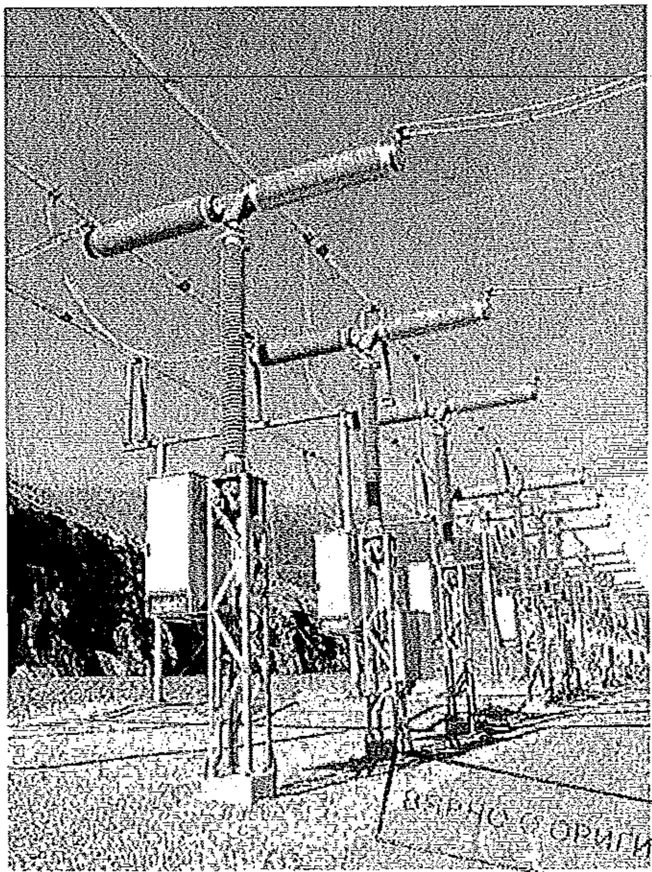
ЕЛЕКТРИКСИТИ СОФИЯ

Composite insulators Silicone Rubber

Flashover resistant
The chemical nature of silicone makes the insulator surface hydrophobic. The leakage currents are suppressed because the water on the surface stays as droplets and does not form a continuous film. Silicone rubber has the unique ability to maintain its hydrophobicity during the lifetime of the insulator.

Ageing withstand
As a consequence of the hydrophobicity and the suppression of leakage currents, the discharge activity is negligible even in areas with severe pollution.

Non-hydrophobic materials like porcelain and EP-rubber do not possess this property and are therefore affected by pollution to a greater extent.



HPL 420 circuit breaker with composite insulator.

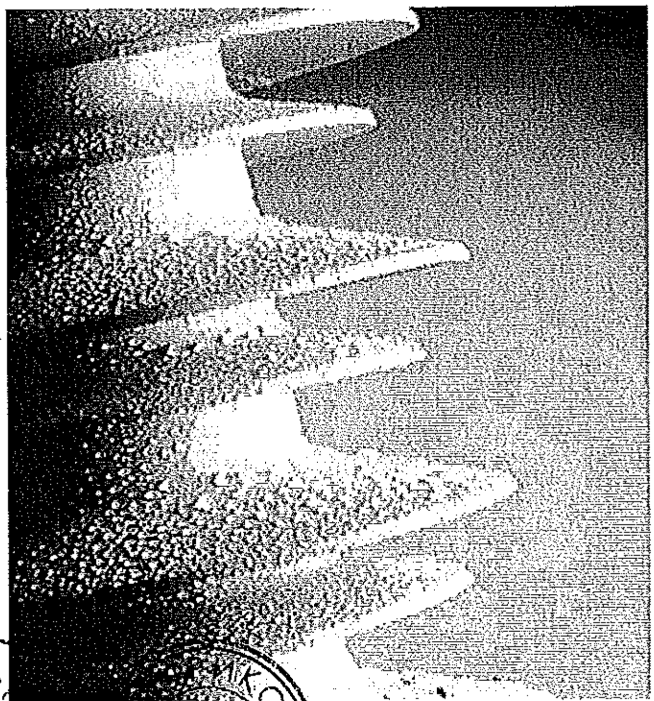
Stability when exposed to UV light
Silicone rubber UV absorption wavelength is below those naturally occurring - over 300 nanometers. This means that it has inherent UV stability, and a higher resistance against breakdown than other polymers like EP-rubber and epoxies.

Deliveries
In addition to extensive type tests conducted on its composite silicone rubber insulators, ABB has a long list of field references worldwide, verifying the expected high performance and reliability of the insulation system.

ABB in Ludvika has delivered live tank circuit breakers with composite insulators for the most severe conditions, from marine climate to desert and/or industrial polluted areas.

Reference list can be presented on request.

Composite insulators with silicone rubber sheds
Because there is no need to compromise on safety and performance.



The non-wetting surface of a silicone rubber insulator.

Controlled Switching with Switchsync™

Suppression of switching transients
There are several important circuit breaker applications where random closing or opening instants may lead to severe voltage and current switching transients. These transients occur in the main circuits, but may also induce transients in control and auxiliary circuits, as well as in adjacent low voltage systems. The switching transients are associated with a variety of dielectric and mechanical stresses on the high-voltage equipment, and may cause gradual or immediate damage to the system or the equipment. Induced transients may lead to a variety of disturbances, e.g. in substation control and protection systems, computers and processors, or telecommunications.

Normal energizing of shunt capacitors, shunt reactors and power transformers may cause severe transients - high overvoltages, under-voltages, or high inrush currents. Upon de-energizing of shunt reactors, reignitions will occur, resulting in steep voltage surges. The magnitude of the transients depends on the point-on-wave where closing or opening of the circuit breaker contacts occur. In a situation without controlled switching, sooner or later the switching instant will occur at the worst possible phase angle.

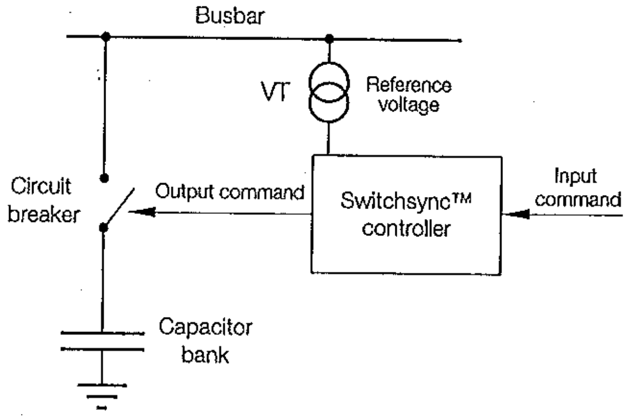
Even though a modern circuit breaker will have very low restrike probability at switching of capacitive loads or harmonic filters, for statistical reasons a few occasional restrikes may occur during the course of a large number of switching operations. This risk of occasional restrikes may be eliminated by means of controlled opening operations.

Conventional countermeasures such as pre-insertion resistors, damping reactors or resistors, or arresters are used to limit the magnitude and effect of the switching transients, after they have occurred. In addition, system and equipment insulation may be upgraded to withstand the stresses. These methods, however, may be inefficient, unreliable or expensive, and do not treat the root of the problem.

Principle of Controlled switching
Controlled switching is a method for eliminating harmful transients via time controlled switching operations. Closing or opening commands to the circuit breaker are delayed in such a way that making or contact separation will occur at the optimum time instant related to the phase angle.

By means of Switchsync™ controllers, both energizing and de-energizing operations can be controlled with regard to the point-on-wave position, and no harmful transients will be generated.

The following example illustrates the general operating principle of a Switchsync™ controller, for energizing of a capacitor bank. In order to avoid switching transients, the making instant in this case shall be at voltage zero. For simplicity, only a single phase is considered.



Suitable circuit breakers
ABB live tank circuit breakers and disconnecting circuit breakers have spring operating mechanisms. For some of the variants, a motor drive is incorporated as an alternative. All these circuit breakers have stable operating times, which vary only to a limited extent with factors such as ambient temperature and control voltage.

For good results, and appropriate limitation of the switching transients, we recommend use of Switchsync™ controllers only with ABB's SF_6 live tank circuit breakers.

Switching of Capacitor banks and Harmonic filters

Switchsync™ circuit breaker controllers for shunt capacitor banks and harmonic filters are normally used for control of closing operations.

A discharged capacitor is similar to a momentary short-circuit when connected to a power source. If energized when the source voltage is high, the connection results in voltage and current transients that may cause serious problems. Depending on the network configuration, the voltage surge may cause dielectric breakdown somewhere in the high voltage network, and low voltage equipment may suffer insulation damage or malfunction. With back-to-back capacitor banks, the inrush current may have high frequency and high amplitude. In extreme cases, it may threaten the mechanical integrity of both the capacitor bank and circuit breaker. Controlling the circuit breaker to energize a capacitive load at zero voltage across the contacts will eliminate harmful transients.

Figure 3 shows by means of an example how efficiently controlled switching eliminates the harmful switching transients related to energizing of a capacitor bank.

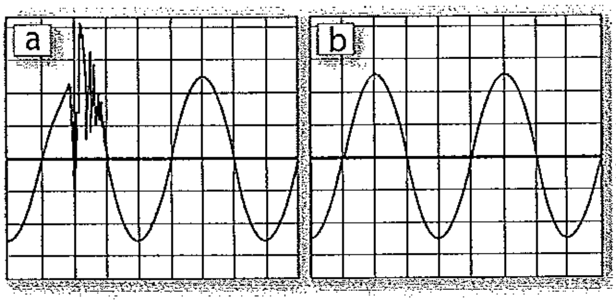


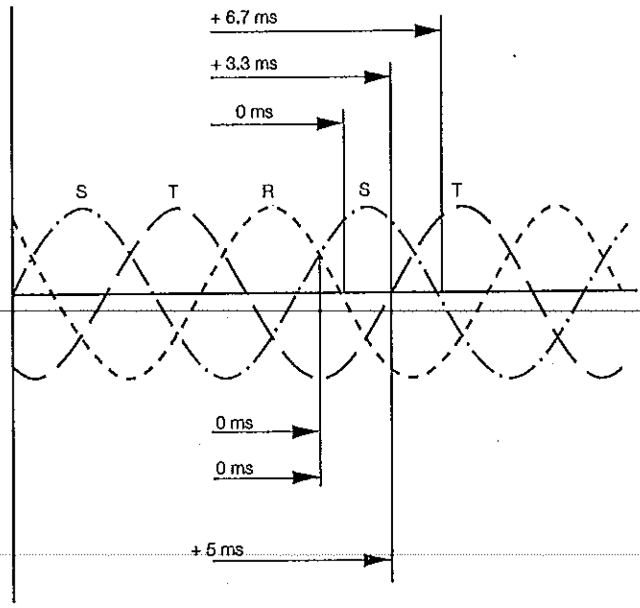
Figure 3.
Voltage transients when energizing one phase of a 72 kV capacitor bank.
a. At an unsuitable point-on-wave position, close to the power frequency voltage peak, a high voltage transient is generated.
b. With Switchsync™ controller, energizing occurs close to voltage zero, and no transient is generated.

In a normal three-phase situation, the three circuit breaker poles should close at different time instants. The time differences depend on the application.

For capacitor banks with grounded neutral, the three poles should close in succession with a time separation of 1/6 cycle (3.3 ms at 50 Hz or 2.8 ms at 60 Hz).

For capacitor banks with ungrounded neutral, two poles should close simultaneously at phase - phase voltage zero, and the last one 1/4 cycle later (5 ms at 50 Hz or 4.2 ms at 60 Hz).

Required time staggering for grounded shunt capacitor bank



Required time staggering for ungrounded shunt capacitor bank.

Figure 4.
Examples of making sequences for a 50 Hz shunt capacitor bank.
The minor time deviations from voltage zero across contacts, have been disregarded.

In case of a single-pole operated circuit breaker, Switchsync™ will control each pole individually to make it close at the right time. For a three-pole operated circuit breaker, with only one operating mechanism, the poles are mechanically adjusted (staggered) in order to close at the right instant. For switching of a shunt capacitor bank or harmonic filter, the actual choice of staggering depends on:

- Connection of the neutral of the load - grounded or ungrounded
- System frequency - 50 or 60 Hz

Opening of capacitor bank circuit breakers generally does not lead to any significant switching transients. The major reason is that the circuit breakers are designed to have very low risk of restrikes upon interruption of capacitive current. However, in special cases with severe conditions, the Switchsync™ may be utilized in controlled opening of capacitor bank circuit breakers. The aim is then to eliminate the small statistical risk that a re-strike may still occur, and the circuit breaker is controlled in such a manner that short arcing times are avoided.

Controlled Switching with Switchsync™

Suitable Switchsync™ controllers for capacitor bank circuit breakers are:

- Three-pole operated breaker:
  For only closing; Switchsync™ E213
  For both closing and opening; Switchsync™ E213

- Single-pole operated circuit breaker:
  For only closing or for both closing and opening;
  Switchsync™ F236

Switching of Shunt reactors

Switchsync™ for shunt reactor breakers are normally used for control of the opening operations. Uncontrolled de-energizing will cause re-ignition in at least one circuit breaker pole. The very steep voltage transients caused by reignitions will be unevenly distributed across the reactor winding, with the highest stress on the initial turns. There is a risk that the voltage stress will lead to puncture of the winding insulation in the reactor, which in the long run may lead to complete breakdown. Insulation of nearby equipment may also be damaged. By controlling the contact separation to be sufficiently early before current zero, re-ignitions can be eliminated. The remaining voltage transient is a chopping overvoltage with relatively low frequency which is normally quite harmless. Controlled closing of shunt reactor circuit breakers is also applied in several cases. The switching case is similar to energizing of no-load transformers, and may cause high inrush and zero sequence current with associated electromechanical stresses. With controlled closing of the circuit breaker these phenomena are minimized.
Shunt reactor circuit breakers are normally single-pole operated due to the high rated voltages.

Suitable Switchsync™ controllers for shunt reactor circuit breakers are:

- Three-pole operated circuit breaker:
  For only opening; Switchsync™ E213

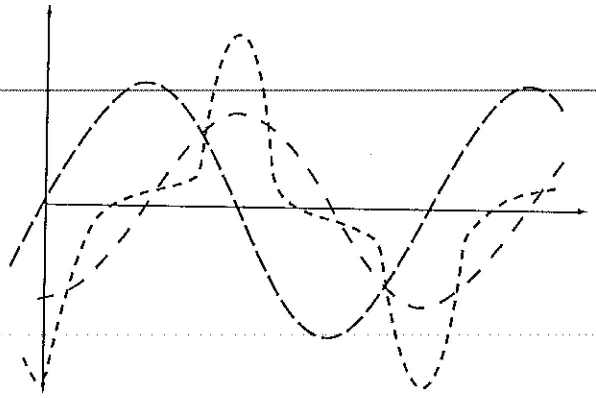
- Single-pole operated circuit breaker:
  For only opening or for both opening and closing;
  Switchsync™ F236

ВЯРНО С ОРИГИНАЛА

СОФИЯ ООД

Switching of Power transformers

Switchsync™ for transformer circuit breakers are used for control of the closing operations, in order to limit inrush currents. Uncontrolled energizing, at unfortunate points-on-wave, causes high and slowly damped inrush currents. The result is mechanical stress on the windings, interference on secondary circuits from high zero-sequence current, and network disturbances by current harmonics.



— — — Source voltage
— — — Steady-state magnetic flux
- - - - - Steady-state no-load current (a few Amperes)

Figure 5.
Power transformer in steady state no-load conditions.

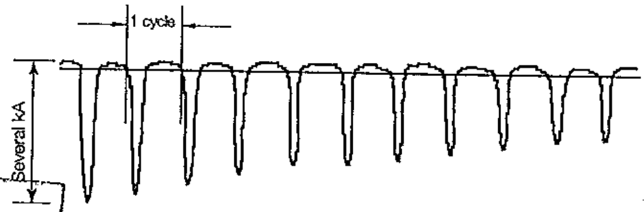


Figure 6.
Conditions with uncontrolled energizing of power transformer.

With symmetrical magnetic flux in the transformer core the current is small, but it increases rapidly even with moderate asymmetry due to increasing core saturation. Controlled energizing makes the flux symmetrical from the start.

The making operation should be made at an appropriate time instant, under consideration of the residual flux of the transformer core.

There are basically three ways to operate the circuit breaker:

1. When residual flux may be disregarded, it is sufficient to control the closing operations. This straight-forward method will limit the highest inrush current magnitudes even if there should be residual flux.
A suitable controller is Switchsync E213.

2. The opening operations of the circuit breaker are controlled in order to achieve a defined and repeatable residual magnetic flux in the transformer core. The procedure is normally to interrupt the no-load current close to a natural zero passage, which results in minimum flux in the core. The subsequent closing operation is then controlled in order to minimize the inrush current, based on this knowledge. Sometimes, however, a higher value of residual flux is chosen, as this will be associated with lower pre-arcing stress of the circuit breaker at the subsequent closing operation. This also improves the precision of the targeting process.

The method is suitable for regular planned switching of transformers under no-load conditions. It is applicable in situations where the same circuit breaker will always perform the making and breaking operations.
A suitable controller is Switchsync™ F236.

3. Opening operations are performed at random, while the resulting residual flux is determined by integration of the transformer voltage. The voltage signals to the controller for this process may be taken from normal VTs or CVTs adjacent to the transformer.

Based on the calculated residual flux, the subsequent closing operation is then controlled in such a manner that the inrush current is minimized. In this mode of operation, the residual flux may vary considerably from one operation to another and the actual controlled making operations will take place at varying time instants in relation to the supply (reference) voltage.

The method is mainly suitable for situations with unplanned operations, under varying switching conditions and also works when opening operations occur in connection with faults in the system. Since each pole needs to be controlled independently, the method requires single-pole operation of the circuit breaker.
A suitable controller is Switchsync™ T183.

Switching of EHV lines
The traditional method for limitation of switching overvoltages during closing or reclosing operations of unloaded EHV lines is to use circuit breakers equipped with closing resistors. However, controlled switching of the line circuit breakers is increasingly considered as an alternative, and then often as part of a solution where surge arresters are also applied for optimal limitation of the switching overvoltages. Circuit breakers at this voltage level are generally single-pole operated.

For uncompensated lines, controlled switching of the circuit breakers may be arranged in two different ways:

1. Trapped charge on the line, resulting from the opening operation, is not recorded. When closing, the circuit breaker is controlled to make the current approximately when the instantaneous voltage in the substation is zero. In this manner limitation of high overvoltages is achieved irrespective of the actual trapped charge. This is a straightforward method, and often the resulting overvoltage level is acceptable, especially when applied in combination with surge arresters. In many cases the trapped charge will actually be zero or close to zero. This will be the case when sufficient time has elapsed from the opening operation, or even at rapid reclosing operations, if the line is equipped with magnetic voltage transformers.
A suitable controller is Switchsync™ F236.

2. More efficient limitation of the switching overvoltages is achieved when the trapped charge on the line is recorded, and taken into consideration by the controlling device. This solution is especially useful in situations when considerable trapped charge is to be expected; i.e. for rapid reclosing operations in situations when CVTs are used. The initial magnitude of the trapped charge can be recorded by the CVTs.
A suitable controller is Switchsync™ L183.

For shunt compensated lines, the interaction between line capacitance and reactor inductance will lead to voltage oscillations of the healthy phases after interruption. In this case, due to the oscillating voltage shape on the line, the voltage transformers connected to the line will provide correct voltage signals.

Controlled switching requires use of single-pole operated line circuit breakers. Reclosing may be set to occur slightly after phase-to-ground supply side voltage zero.
A suitable controller is the Switchsync™ F236, connected in the same manner as for uncompensated line.

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКС ... ООД СОФИЯ

Controlled Switching with Switchsync™

Adaptation control

All Switchsync™ controllers are equipped with special functions to control the result of a controlled switching operation.

The adaptation control can be arranged in different ways and for both controlled closing and controlled opening.

Deviations from the intended targets may be caused by variations in the operating conditions. The operating conditions that may cause changes of the circuit breaker operating times are, for example, gradually increasing contact burn-off caused by many switching operations, change of ambient temperature and variations of the auxiliary voltage.

The functioning principle of the adaptation control is that a detected error from the target will be compensated for in the next controlled operation.

If the circuit breaker should have a change in operating time from the value assumed by the Switchsync™ controller, then the adaptation feedback signal from a sensor or transducer will appear either slightly later or earlier than expected. When an error has been observed by the controller, the internally created waiting time will be modified for the next operation in such a way that the circuit breaker will be guided back to the intended target.
A typical arrangement for detection of current start is shown in Figure 7.

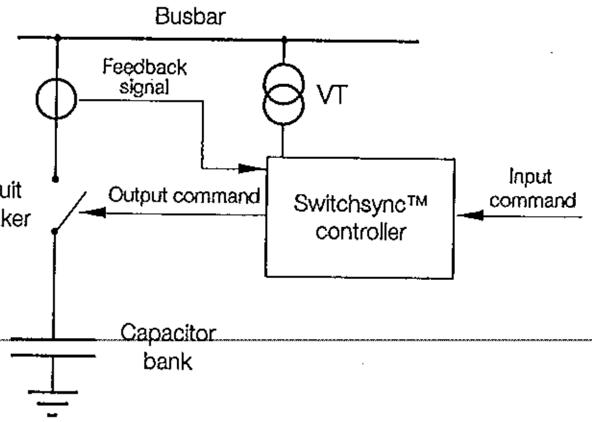


Figure 7.
Example of shunt capacitor bank energizing with current start feedback loop.

For single-pole operated circuit breakers, the adaptation control can be arranged for each pole individually.

In the case of three-pole operated circuit breakers with mechanical staggering, only one pole will be supervised. The other two poles are mechanically linked to the controlled one.

ЕЛЕКТРИКСИТИ СОФИЯ ООД
ВЯРНО С ОРИГИНАЛА

Range of Switchsync™ controllers

The Family of Switchsync™ controllers consists of:

Switchsync™ controller	Main application	Controls circuit breaker operation	Circuit breaker operation
E213	Shunt Capacitor Banks, Shunt Reactors	Open and/or Close	Three-pole
F236	Shunt Capacitor Banks, Shunt Reactors, Transformers	Open and Close	Single-pole
T183	Transformers	Close	Single-pole
L183	Uncompensated Transmission Lines	Close	Single-pole

All controllers have provisions for adaptive input to compensate for systematic variations in operating time of the circuit breaker. In addition, Switchsync™ F236, T183, and L183 have provisions for two external, predictive inputs (e.g. temperature variation, control voltage). These functions make it possible to achieve added precision in the timing of the controlled circuit breaker. They also have a data memory that stores information on switching times, thus permitting condition monitoring of the circuit breaker. Sensors for compensation purposes and communication software for all controllers except E-model are accessories that are ordered separately.

Type designation

The type designation of a Switchsync™ controller gives information about its functionality.
The letter is a generation and application identification, while the subsequent numbers provide the following information:

F 2 3 6

- **Type designation** — F
- **Number of command inputs (open or close)** — 2
- **Number of adaptive channels** — 3
- **Number of command outputs to controlled circuit breaker** — 6

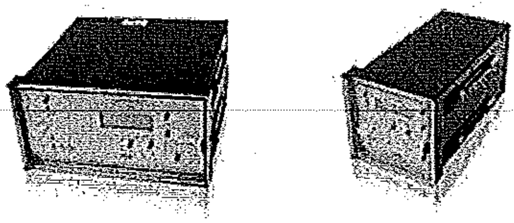


Figure 10. Switchsync™ F236 and E213 controllers.

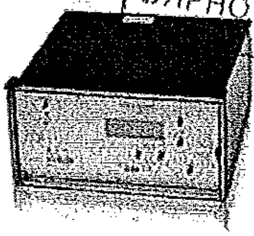


Figure 11. Switchsync™ T183 controller.

ВЯРНО С ОРИГИНАЛА

Installation

The point-on-wave controllers type SWITCHSYNC are type-tested with respect to immunity against vibrations with normal severity. The controllers shall NOT be installed in a cubicle directly attached to the circuit breaker frame work.
The recommended location for installation of the POW-controllers is in a control cubicle in a control room or in a relay house.

More information

Further information about controlled switching applications and Switchsync™ controllers is found in "Controlled Switching, Buyer's Guide/Application Guide".
Catalogue publication 1HSM 9543 22-01en.

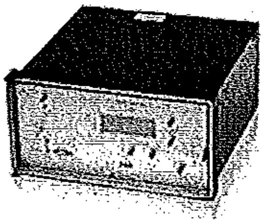
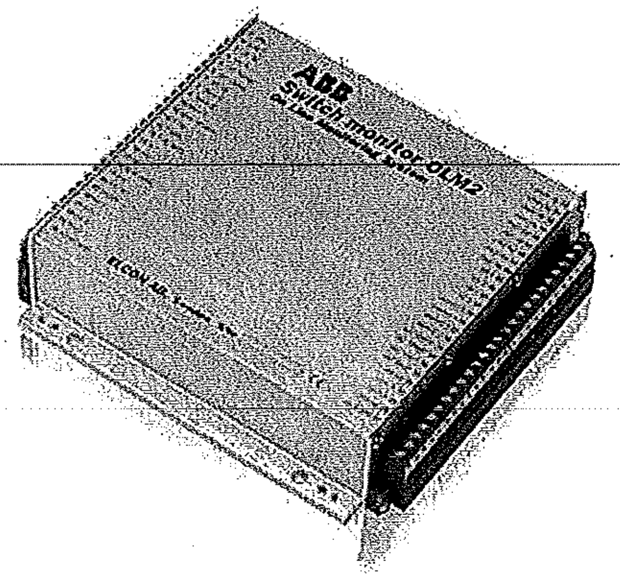


Figure 12. Switchsync™ L183 controller.

OLM2
On-Line Monitoring System

The OLM2 monitor is a measuring data acquisition unit optimized for on-line analysis of high-voltage circuit breakers. The electronic circuit is fitted into an EMC shielded aluminum profile housing. The aluminum housing has screw terminals for all external connections.



The OLM2 units have a limited data storage capacity. To fully use the flexibility of the OLM System, a data storage device (server computer) is required at the substation level. Communication to and from the monitoring units within a substation is done using an OLM-bus (a modified RS 485 bus), using a twisted pair shielded cable suitable for RS 485. Another option is using optic fiber, this requires optical modems at both ends.

From the server computer in the substation to the location where detailed analysis is performed, data can be transmitted using any existing communication means supported by Windows®. External systems, such as SCADA can easily make use of the data obtained through the OLM.

Data acquisition starts when an OLM2 is triggered by either a coil input (trip or close), an input to the motor of the operating mechanism or an alarm. For each operation of the circuit breaker a complete image of the recorded parameters is stored into the unit, including local time and temperature (ambient and inside operating mechanism).

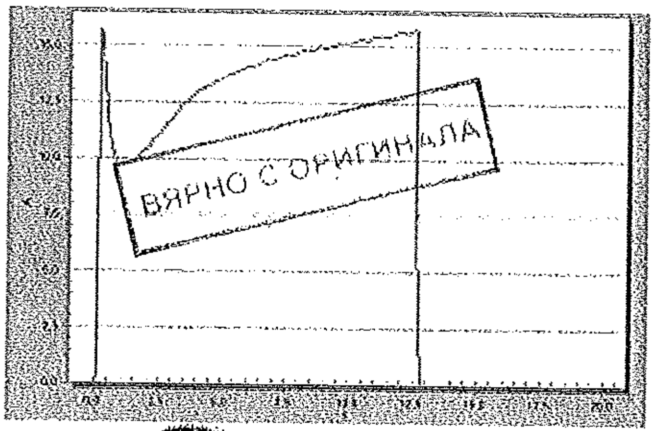
The stored data is then transferred to the server computer and is then accessible for remote analysis using the OLM Explorer software. With this software a detailed analysis of all circuit breaker parameters is possible including trend analysis.

The following parameters may be monitored: operating times, coil currents, contact travel (giving information about speed, overtravel and damping), motor current including spring charging time, SF_6-density. Phase currents can be measured as an option to determine the contact erosion.

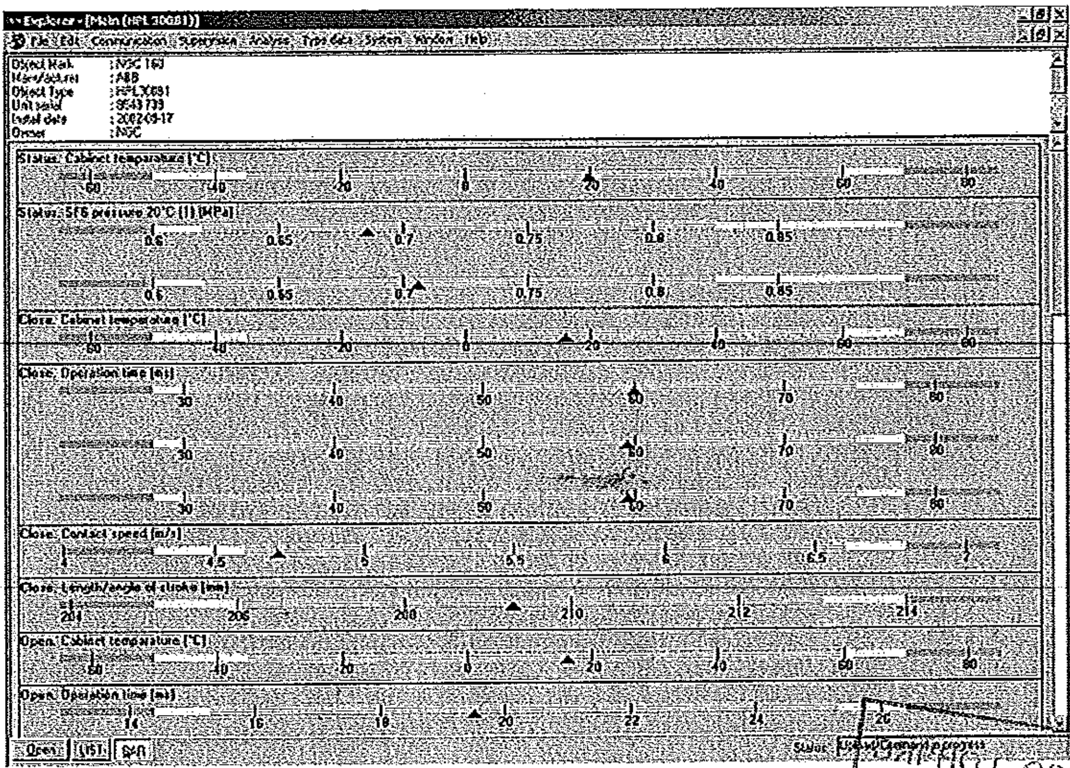
Design
An OLM2 unit consists of a signal processor with programmable logic. Most internal functions can be modified by firmware or software changes, which means that it can easily be adapted to any type of equipment. The OLM2 units have their own internal watchdog with alarm function.

The software provided together with the OLM consists of three parts:

- **OLM Installer**, used for installation of the individual units
- **OLM Server**, used for communication with the individual OLM2 units on a bus and the server computer (usually a PC) in the substation;
- **OLM Explorer**, the data analysis and supervision tool. The OLM Explorer software also hosts a server engine that communicates with server computers.



Example of the presentation of the motor current.



Example of the presentation of different parameters.

Monitored data

OLM2-unit:

Internal temperature
Power supply voltage and current
Coil circuit and operating currents
Motor circuit, operation current and time
Operating times
Time between operations
Monitoring equipment functions (watchdog)

Storage capacity OLM2-unit:

Last 32 alarm status records
Last 8 contact status records
Last 16 motor operation records

Monitored function categories through OLM Explorer:

Status signals (circuit breaker open or closed)
Closing operation
Opening operation
Close-open operation
Motor operation

From the function categories the following parameters are derived and supervised:

Operating times
Operating speeds
Coil armature time
Coil peak current
Damping time
Overtravel and rebound
Counters recording the number of operations and number of motor operations
Motor peak current and spring charging time
Internal temperature of the operating mechanism
Ambient temperature;
Power supply voltages and currents (OLM2 unit and heaters)
SF_6 density, with trend analysis
Contact wear (optional)
Contact stroke and contact position

The software is delivered with the OLM System and it contains a feature for automatic update of the software free of charge.

OLM2
On-Line Monitoring System

1. Scope of supply
The following components are included in the delivery of the OLM System.

1.1 Hardware
1.1.1 OLM cubicle
The cubicle containing the OLM2 unit as well as the wiring of all hardware included in the cubicle.

Cable glands for cable entry in the operating mechanism are included.

1.1.2 Current transformers for trip and close coil currents
2 pcs. current transformers, one for measurement of close coil current and one for measurement of trip coil current, located in the OLM cubicle.

1.1.3 Shunt for motor current
1 shunt for measurement of motor current is located in the OLM cubicle.

1.1.4 Travel transducer
Incremental transducer for measurement of contact travel including hardware for fixing and cable. The travel transducer is fitted to the circuit breaker during installation of the OLM System.

1.1.5 Temperature sensors
Two PT 100 (including cable) for measurement of ambient temperature internal temperature of the operating mechanism.

The temperature sensor for the ambient temperature is fitted to the underside of the OLM cubicle and connected to the OLM2 unit. The temperature sensor for the internal temperature needs to be fitted during installation of the OLM System.

1.1.6 SF_6 density sensor
One or three SF_6 density sensors depending on whether the circuit breaker is three-pole or single-pole operated.

The density sensors are fitted during installation of the OLM System.

1.2 Software
The OLM2 System is delivered with a CD-ROM containing the following software:

- The OLM software with user manuals;
- Configuration file for the individual OLM2 units;
- Parameter file for OLM Explorer;
- The installation manual.

1.3 Drawings
When the OLM System is delivered together with the circuit breaker, the circuit diagram and wiring table are adapted to the receive the wiring from the OLM cubicle.

2. Items not included in the delivery
2.1 Current transformers for line current measurement
Line current measurement is an option and the current transformers necessary are not included in the standard delivery.

2.2 Server computer
Necessary for storage of data retrieved from OLM units.

2.3 Field bus converter
Connection of the server computer to the OLM bus (RS 485 bus) requires a converter. There are two ways to connect the converter, through a serial RS 232 port or through a USB port.

2.3.1 RS converter
Connection of a PC to the OLM bus requires a RS-422/486 to RS-232 converter.

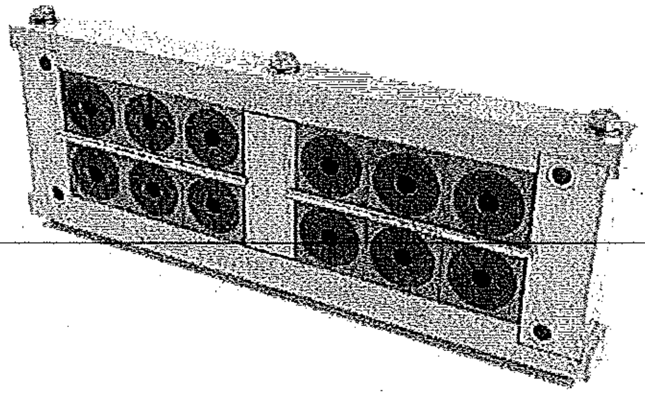
2.3.2 USB to RS converter
When connection of the OLM-bus to a PC is done through a USB port, a USB to RS converter should be used.

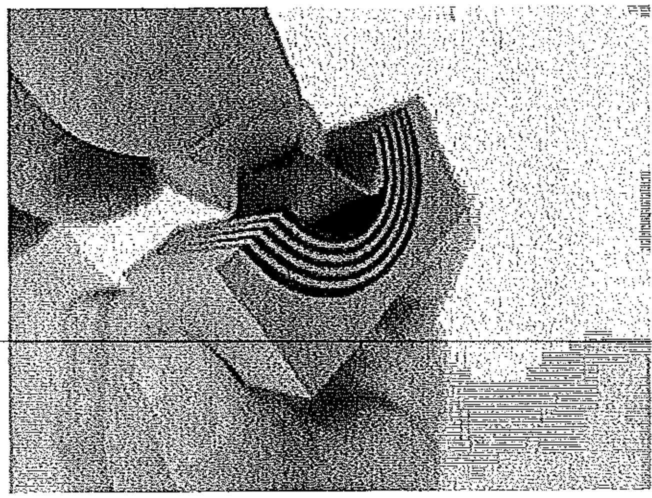
2.4 Connection between OLM and server computer
A shielded, twisted pair cable suitable for RS-485 is recommended.

Alternative: optical fiber (requires optical modems at both ends).

ЕЛЕКТРИКС СИТИ СОФИЯ ООД

Optional
Accessories for cable installation





Easy installations for cables
A Roxtec CF (Compact Frame) cable entry kit combines reliable sealing of cables in cabinets with easy installation. The CF can handle several even pre routed cables through the same opening.

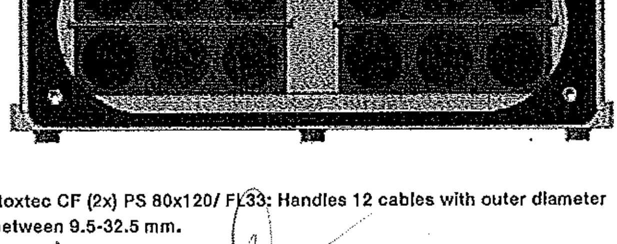
Multidiameter
The CF uses adaptable Multidiameter technology. This enables cables of a wide range of diameters to be sealed with a perfect fit, even when tolerances and deviations from nominal dimensions are considered. The modules are delivered with a center core as a substitute for a cable. This means the entry kit is adaptable to different cable sizes, and to different numbers of penetrations.

Kit supplied
This Roxtec CF kit are designed following the flange standard FL33 with a customized set of sealing modules to suit the most common cables sizes on up to 12 cables in the cabinet (as shown below).

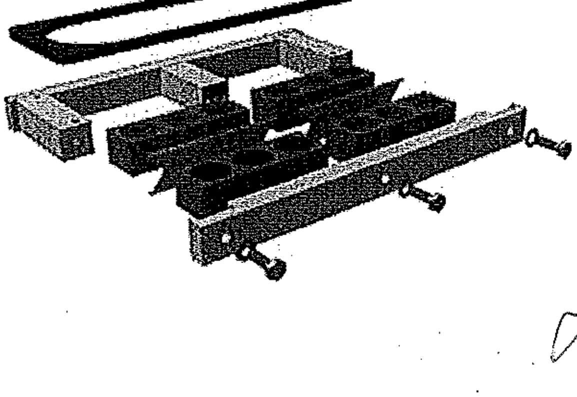
For other dimensions, please contact:
ABB, High Voltage Breakers, Ludvika, Sweden.

Simple maintenance
A Roxtec CF can be opened and closed repeatedly for easy installations and simple maintenance. Another benefit is a built in spare capacity for possible new cables in the future.

Benefit summary
- Seals several cables and diameters
- Openable frame for pre routed cables
- Quick and easy installation
- Cable retention
- Small footprint in cabinet
- Rodent proof
- Halogen-free



Roxtec CF (2x) PS 80x120/ FL33: Handles 12 cables with outer diameter between 9.5-32.5 mm.



Seismic withstand capability

Seismic stress
There are many zones in the world where earthquakes may occur, and where circuit breakers should be designed to withstand the corresponding stresses. When an earthquake occurs the acceleration and amplitude of the motion of the ground will vary in a statistical manner. The stress conditions are normally most severe in the horizontal direction. The type of soil (sand, clay, rock, etc) has a strong influence on the actual local severity of an earthquake and the damage it may inflict.

For technical purposes earthquake stresses are normally defined by the maximum value of the horizontal acceleration. IEC 62271-300 specifies three values of maximum horizontal acceleration, 2, 3, and 5 m/s^2, corresponding to 0.2, 0.3, and 0.5 g, while IEEE 693 specifies 2.5 and 5 m/s^2, corresponding to 0.25 and 0.5 g.

When a HV circuit breaker is subjected to an earthquake, the motion of the ground will induce oscillations in the circuit breaker with corresponding mechanical stress. The mechanical stress will normally be most severe at the lower end of the support column.

The circuit breaker will have one or more natural oscillation frequencies, eigenfrequencies, where the predominant one is typically a few Hz. Since the frequency of typical earth quake oscillations is also of the order of a few Hz, the actual stress on the breaker will be amplified due to mechanical resonance. The degree of amplification depends on the eigenfrequency and damping of the circuit breaker, and is given by the response spectra, specified by IEC 62271-300 or IEEE 693. Sometimes also other response spectra are used, e.g. from Endesa or Edelca.

For the same maximum ground acceleration, the requirements of IEEE 693 are more stringent than those of IEC 62271-300. The major reason is that IEEE applies a safety factor 2 for the mechanical strength of the insulators, while IEC uses a factor 1. In addition the IEEE response spectra are more severe than those of IEC.

Seismic capability of LTB and HPL circuit breakers
All standard versions of HPL- and LTB-circuit breakers can withstand seismic accelerations below 0.3 g in accordance with IEC 62271-300 and below 0.25 g in accordance with IEEE 693 (see page 59 and 82). In order to withstand higher earthquake stresses the circuit breakers may be provided with reinforced support structures and/or reinforced insulators. In addition, and in order to handle the highest stresses, earthquake dampers may be applied on large circuit breakers.

ВЯРНО С ОРИГИНАЛА
ЕЛЕКТРИК СИТИ СОФИЯ ООД

Earthquake dampers

An earthquake damper will increase the damping of the natural oscillations of the circuit breaker. In this way the amplification of earthquake stresses due to resonance is significantly decreased, and the maximum mechanical stress on the circuit breaker significantly reduced.

Fig. 1. illustrates the principle of a damping unit. The support frame (1) is mounted on the bottom plate (3) on which four damping cylinders (2) are assembled. The piston rods (4) are fixed to the foundation bolts. Between the piston rod and the cylinder there is a piston system working, which is absorbing friction energy during motion. This provides damping for the complete circuit breaker.

Since the circuit breaker is hanging in the dampers, the forces of inertia during an earthquake can easily initialize the motion of the dampers without having to overcome the forces of gravity.

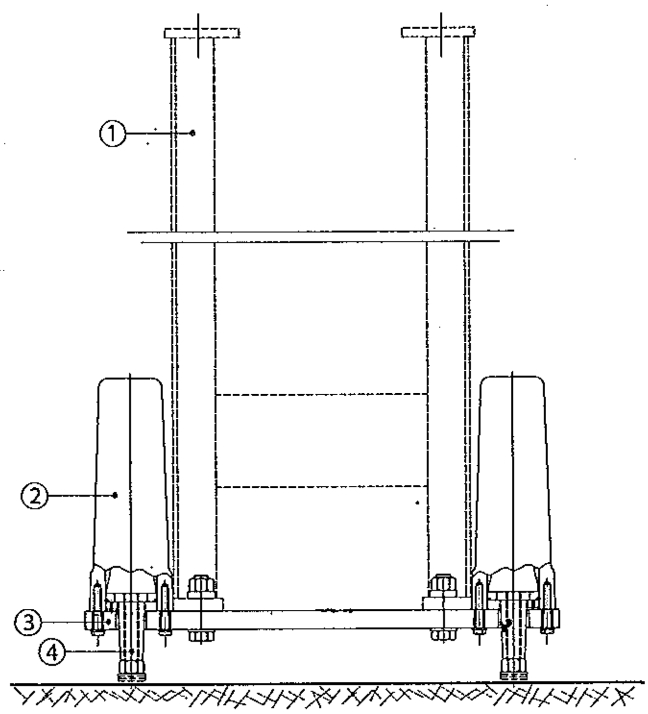


Fig. 1. Support column of HV circuit breaker with earthquake damping unit.

Verification of seismic capability

The seismic capability of a circuit breaker may be verified by a direct test, where a complete circuit breaker, or pole, is subjected to simulated earthquake stress on a shaker table. See Fig. 2.

An alternative method is to determine the eigenfrequencies and damping of the circuit breaker. This can be done e.g. by a snap-back test, where a mechanical stress is applied to the breaker, and suddenly released. Based on eigenfrequencies and damping, the resulting mechanical stress in critical parts of the breaker may be determined by means of calculations.

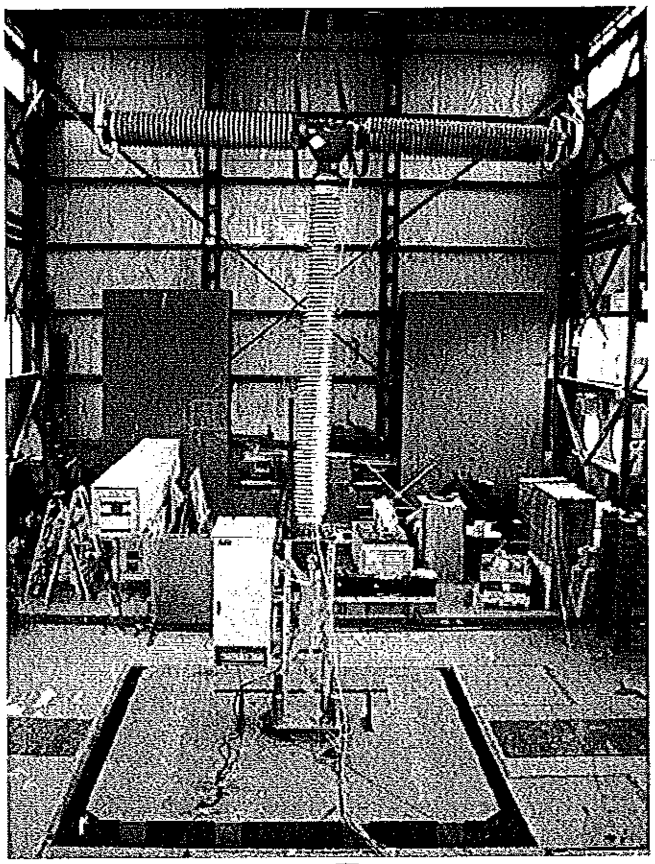


Fig. 2. 550 kV circuit breaker subjected to earthquake test on a shaker table. The highest mechanical stress occurs in the lower end of the vertical support column. The circuit breaker is equipped with composite insulators.

ВЯРНО С ОРИГИНАЛА

Quality control and testing

Quality
ABB High Voltage Products in Ludvika has an advanced quality management system for development, design, manufacturing, testing, sales and after sales service as well as for environmental standards, and is certified by Bureau Veritas Certification for ISO 9001 and ISO 14001.

Testing resources
ABB has the facilities for carrying out development tests, type tests and routine tests on the circuit breakers. The laboratories for testing are located in Ludvika close to the factories and the offices for development, design and planning.

With these testing resources ABB is in the forefront in developing new and safe products for the 21st century.

Type tests
The High Power Laboratory is owned by ABB and has facilities for high power tests, temperature rise tests and mechanical tests. It is also accredited by SWEDAC (Swedish Board for Technical Accreditation).
In the STRI AB laboratory, mainly high voltage tests, environmental and special long time duration tests are carried out.

In both laboratories tests in accordance with the requirements stipulated in the international standards IEEE and IEC can be performed. It is also possible to carry out special tests specified by our customers.

The High Power Laboratory as well as STRI has status of independent laboratory and both are members of SATS (Scandinavian Association for Testing of Electric Power Equipment), which in turn is a member of STL (Short Circuit Testing Liaison).

STL provides a forum for international collaboration between testing organizations.

Routine tests
The routine tests are part of the process of producing the circuit breakers and are always performed with the same test procedures, irrespective whether or not the tests are witnessed by the client's representative.

The circuit breaker pole or poles are tested together with the corresponding operating mechanism.

For single-pole operated circuit breakers type HPL B and LTB E, the routine tests are always individually performed for each pole.

Circuit breakers type LTB D and three-pole operated circuit breakers type HPL and LTB E are always routine tested as complete three-phase units.

In general, the routine tests are performed according to IEC or ANSI/IEEE standards.

The main routine tests steps with respect to IEC, IEEE and ABB standards are summarized in the table below.

The entire routine tests for each circuit breaker is documented in a detailed routine test report, generated by the computerized testing system. After verification by the ABB certified test supervisor, this report is provided to the customer as part of the order documentation.

Summary of routine tests

	IEC	IEEE	ABB
Nameplate and design check	X	X	X
Resistance measurement (Components in auxiliary and control circuits)	X	X	X
Function check of auxiliary and control circuits	X	X	X
Mechanical operating test	X	X	X
Resistance measurement (Main circuit)	X	X	X
Dielectric test (Auxiliary and control circuit)	X	X	X
Overpressure test			X
Dielectric test (Main circuit)			X
Tighness test	X		X

Description
A summary description of the ABB production and routine tests process is provided in the brochure 1HSM 9543 21-03. A detailed description of the routine tests is given in the document 1HSB 4154 09-646.

ЕЛЕКТРИКСИТИ ООД София

ВЯРНО С ОРИГИНАЛА

Processes and support

The circuit breaker organization is process-oriented with focus on deliveries to customers. The process is continuously optimized with respect to time and quality.

Sales and Order handling

In order to assure that the deliveries fulfill the requirements in the Purchase Order (P.O.) special attention is focused on:

- Assuring the hand over of the P.O. from the Sales to the Order department.
- Order clarification, assuring the particular tasks of order, order design, purchasing and production departments.
- Possible order modifications.

The tools to monitor the orders are continuously improved in order to give our customers the best possible service.

Supply management and Purchasing

The circuit breaker unit has well defined processes for selection and approval of suppliers.

Special attention is addressed to audits at the suppliers plant, the manufacturing, Inspection and Test Plan (ITP) and the On Time Delivery (OTD) monitoring.

The suppliers are evaluated continuously with respect to quality and ODT.

Production and Assembly

All employees are trained and certified with respect to their responsibilities.
Inspections and test plans together with inspection records and control cards have been prepared for all circuit breakers in order to assure that all activities and the assembly are performed according to the specification.

Service and Spares

The circuit breaker unit takes care of the customer's requirements with respect to service and spare parts. Certified travelling service engineers are available at the plant in Ludvika. Also, in order to be able to assist our customers as fast as possible, local service centers are established in several parts of the world.

In case of emergencies a 24-hour telephone support is available **(ph.: +46 70 3505350).**

By calling this number customers will get in touch with one of our representatives for immediate consultation and action planning.

Research and Development

The R&D process is utilizing a project management model with well-defined gates in order to assure that all customer requirements and technical issues are addressed.

ЕЛЕКТРИКСИТИ ООД София

ВЯРНО С ОРИГИНАЛА

Inquiry data
Live tank circuit breaker

As a minimum the following information is required and can preferably be copied and sent along with your inquiry.

PROJECT DATA

End customer
Name of project
Standard / Customer specification
Number of circuit breakers
Delivery time

APPLICATION

Line
Transformer
Reactor banks
Capacitor banks
Other service duty
Number of operations per year

SYSTEM PARAMETERS

Rated voltage
Rated frequency
Rated normal current
Maximum breaking current
LIWL (Lightning impulse 1.2/50 μs)
SIWL (Switching impulse 25/2500 μs, for $U_m \geq 300$ kV)
Power frequency withstand voltage
Grounded / Ungrounded neutral

AMBIENT CONDITIONS

Ambient temperature (max - min)
Altitude (m.a.s.l.)
Earthquake withstand requirements

BASIC MECHANICAL PARAMETERS

Three-pole / Single-pole operation
Preinsertion resistors (PIR) for line circuit breakers
Type of high voltage terminal (IEC/NEMA/DIN)
Insulator material (porcelain or composite)
Insulator color
(Porcelain: brown or gray)
(Composite: only gray)
Minimum creepage distance mm or mm/kV
Phase distance (center-to-center)
Support structure (height)

ЕЛЕКТРИКСИТИ ООД София
ВЯРНО С ОРИГИНАЛА

As a minimum the following information is required and can preferably be copied and sent along with your inquiry.

OPTIONAL MECHANICAL PARAMETERS
Bursting discs
Bracket for CT
Primary connections CB – CT
Manual trip

DATA FOR OPERATING MECHANISM
Control voltage (Coils and relays)
Motor voltage
AC-voltage (heaters, etc.)
Number of free auxiliary contacts
Special requirements

ACCESSORIES
SF_6 gas for pressurizing
Gas filling equipment
Controlled Switching (Switchsync™)
Condition monitoring (OLM)
Test equipment
- SA10
- Programma
Tools
Spare parts

NOTE! For information regarding the parameters asked for see chapter "Explanation".

ЕЛЕКТРИКСИТИ ООД София

ВЯРНО С ОРИГИНАЛА

Contact us

ABB AB
High Voltage Products
SE-771 80 LUDVIKA, SWEDEN
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www.abb.com/highvoltage

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NOTE! ABB AB is working continuously to improve the products. We therefore reserve the right to change designs, dimensions and data without prior notice.

Publication 1HSM 9543 22-00en, Edition 6, 2014-04, Live Tank Circuit Breakers, Buyer's Guide

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ СОФИЯ ООД

Стр. 746

Power and productivity
for a better world™

Приложение № 17 – Техническа документация (включително каталози), даваща пълно описание, технически данни и характеристики на предлаганото оборудване по Приложение № 11 – Технически данни за токови измервателни трансформатори 110kV за силов трансформатор в ПС „Боримечка“;

ЕЛЕКТРИКСИТИ ООД
София

ABB

Data Schedule : Current Transformer

Date :	2016-01-08	Name :	bozena.trajer@pl.abb.com
Our ref :	KU 17/16	Revision :	A
Project :	CEZ project		

General data

Quantity	3
Type	PA 123
Standards	IEC 61869-2
Design	Outdoor
Insulation	Oil / paper hermetic
Manufacturer, country	ABB, Poland

Service conditions

Highest voltage of a system (phase-to-phase) U_{sys}	kV r.m.s.	123
Rated frequency f_R	Hz	50
Ambient air temperature (Temperature category)	°C	-40/+40
~~Average ambient air temp. (period 24h)~~	~~°C ≤~~	~~35~~
Altitude	m	1000
Seismic activity		Negligible

Rated insulation level

Highest voltage for equipment (phase-to-phase) U_m	kV r.m.s.	123
Rated lightning impulse withstand voltage 1,2/50 µs	kV peak	550
Rated power-frequency withstand voltage, dry	kV r.m.s.	230
Rated power-frequency withstand voltage, wet	kV r.m.s.	230

Current ratings

Rated primary current I_{pr}	A r.m.s.	200 - 400 - 800
Rated continuous thermal current I_{cth}	A r.m.s.	240-480-960
Rated short-time thermal current I_{th} / time	kA r.m.s./s	20-31,5-31,5/1
Rated dynamic current I_{dyn}	kA peak	50 - 80 - 80
Reconnection		Primary 1:2:4

ВЯРНО С ОРИГИНАЛА

Accuracy ratings

Core No.	Terminals	Ratio A / A	Accuracy	Rct75	No. of terminal box	Cover for sealing
1	S1-S2	200-400-800/5	1-10VA 0,2S* FS10	-		-
2	S1-S2	200-400-800/5	1-10VA 0,5* FS10	-		-
3, 4	S1-S2	200-400-800/5	10VA 5P30	-		-

*) Calibrated winding

Calibration certificate will be issued by OUM Ostrołęka (Local Verification Office in Ostrołęka), the local unit of GUM (Polish National Metrology Institute). Calibration certificate language – English/Polish.

Product data

Dimension drawing		2GKA614516A0017;rev.A
Rating plate language		Bulgarian
Insulator type / colour		Porcelain / brown
Minimum creepage distance	mm	3075
Minimum arcing distance	mm	1005
Primary terminal type		Al flat pad 100x120 T=20 mm; 4xD=14/50x50mm
Earthing terminals type		2 x ø14 / 50-60mm
Secondary terminal type		Phoenix rail terminal blocks; spring, type ST 10
Cable glands – terminal box No. 1		Polyamide; 2xM40 M40 (cable diam. 19-28 mm), with strain relief;

Withstand test load on primary terminal FR	(Static/Dyn)N	3600/5000
Painting (colour)		
Housing above insulator		RAL 7035 Light grey
Housing below insulator		RAL 7035 Light grey
Total weight	kg	420
Weight of oil	kg	120
Insulating oil type		Nynas Nytro 10XN – Inhibited mineral insulating oil acc. to IEC 60296
Packing		Vertical -3-pack wooden crate
Shipping weight	kg/units	1500
Shipping volume	m3/units	6,4

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД София

ABB

Токов трансформатор

Тип	PA 123				
Изолационно ниво	123/230/550 kV	Стандарт	IEC 61869-2	fn	50 Hz
Тип на маслото	Nytro 10XN	Тегло / Тегло на маслото	420 / 120 kg	Темп. диапазон	-40°C → +40°C
Сериен №	S/N				

K_n: 200-400-800/5-5-5-5 A/A

$I_{th}/1s$: 20-31,5-31,5 kA I_{dyn}: 50-80-80 kA

I_{cth}: 240-480-960 A

	1S1-1S2	2S1-2S2	3S1-3S2	4S1-4S2	5S1-5S2	6S1-6S2
A	5	5	5	5		
VA	1-10	1-10	10	10		
Kl.	0,2S	0,5	5P	5P		
FS/ALF	10	10	30	30		
Ext.%						

Транспортиране: Вертикално / Хоризонтално

180 / 135

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИК СИТИ ООД СОФИЯ

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Aluminium sheet/ Blacha aluminiowa: EN AW-5754(AlMg3) Material standard/ Standard materiału: EN 485-1/EN 573-3	Anodizing/ Anodowanie ISO 7599 Layer thisckness/ Grubość warstwy 20μm	Black/ Czarny
Material: /Materiał:	Coating: /Powłoka:	Colour: / Kolor:

Prepared by: Przygotował:	Ł.Lubieniecki	Date: / Data: 13.01.2016	Replacement of:/Zastępuje rys. nr.: -----
Checked by: Sprawdził:	-------	Date: / Data: --.--.----	Name of item:/Grupa mat.:
Approved by: Zatwierdził:	-------	Date: / Data: --.--.----	Mass:/Masa:
Revision:/Rewizja: A	Responsible department:/ Dział odpowiedzialny: PPHV	Take over department:/ Dział przejmujący:	Scale:/Skala: 1:1

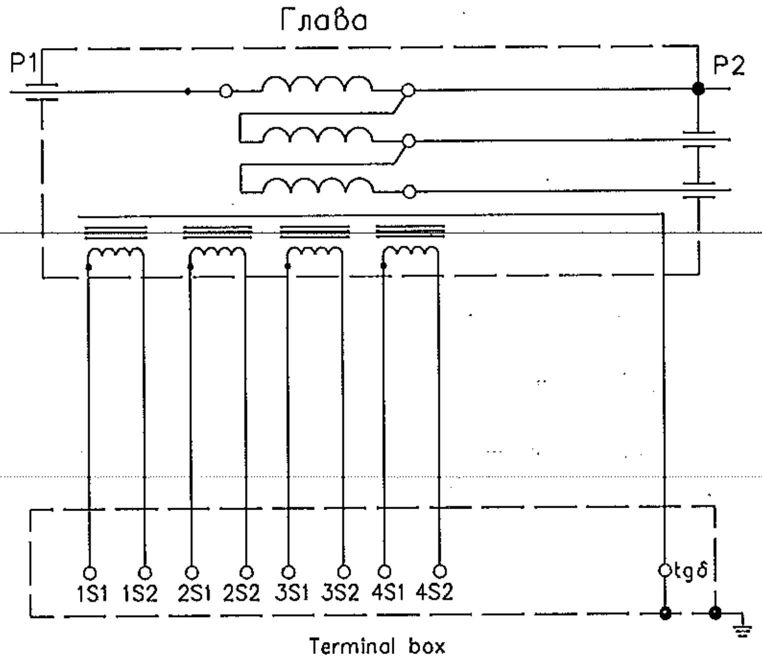
Application:/Zastosowanie: -----

Title:/Tytuł: Name plate/ Tabliczka znamionowa

Document no.:/Dokument nr: 2GKK614003/ KU17/16

Page size: A4 | Language: EN/PL | Sheet no. 1 | No. Shts. 1

ABB ABB Sp z o.o. Power Products



Електрическа схема на измервателен трансформатор

ВНИМАНИЕ!

1. ВИСОКО НАПРЕЖЕНИЕ ПРИ ОТВОРЕНИ ТОКОВИ ВТОРИЧНИ КЛЕМИ XS1 – XS2
2. ПО ВРЕМЕ НА РАБОТА НА ИЗМЕРВАТЕЛНИЯ ТРАНСФОРМАТОР КЛЕМА tgδ ТРЯБВА ДА БЪДЕ ЗАЗЕМЕНА

180

135

ВЯРНО С ОРИГИНАЛА

Aluminium sheet/ Blacha aluminiowa: EN AW-5754(AlMg3) Material standard/ Standard materiału: EN 485-1/EN 573-3		Anodizing/ Anodowanie ISO 7599 Layer thisckness/ Grubość warstwy 20μm	Black/ Czarny
Material: /Materiał:		Coating: /Powłoka:	Colour: / Kolor:
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Checked by: Sprawdził: --------	Date: / Data:	Name of item:/Grupa mat.:	Title:/Tytuł: Diagram plate/ Tabliczka schematowa
Approved by: Zatwierdził: --------	Date: / Data:	Mass:/Masa:	
Revision:/Rewizja: A	Responsible department:/ Dział odpowiedzialny: PPHV	Take over department:/ Dział przejmujący:	Scale:/Skala: 1:1
ABB	ABB Sp z o.o. Power Products		Document no.:/Dokument nr: 2GKK614004/KU 17/16

Page size: A4

Language: EN/PL

Sheet no.: 1

No. Shts.: 1

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IEN

PCA
POLSKIE CENTRUM AKREDYTACJI
CERTYFIKACJA WYROBÓW
AC 117

INSTYTUT ENERGETYKI
Research Institute
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phone. +48 22 34 51 299
fax. +48 22 836 63 63
instytut.energetyki@ien.com.pl

CERTIFICATE OF CONFORMITY

No. 095/2015

Issue No. 01 of 30.11.2015 r.

Name and address of the Certificate Holder: ABB Sp. z o.o.
1 Żegańska Str.
04-713 Warsaw, Poland

Name of the product: Current transformer

Type: PA 123

Manufacturer: ABB Sp. z o.o.
Branch Office in Przasnysz
59 Leszno Str.
06-300 Przasnysz, Poland

Parameters and application of product: According to appendix
Current transformer assigned for power systems of rated voltages 110 kV

The product meets requirements of the: IEC 61869-2 ed. 1.0 (2012) and IEC 61869-1 ed. 1.0 (2007)

According to the report made by: Instytut Energetyki

Number of the assessment report: DZC/145c/E/2015

Period of validity: from 30th of November 2015 until 30th of November 2018

The right to use the certificate of conformity within its validity period applies only to:

- these copies that meet the requirements specified above and have the same characteristics (parameters) as the model / product samples submitted for testing,
- certificate owner or his authorized representative.

The list of evidenced parameters is included in the appendices to the certificate of conformity.
Number of appendices: 1

THE SYSTEM OF PRODUCT CERTIFICATION 1a (PN-EN ISO/IEC 17067:2014-01)
(product parameters confirmed by type test)

ВЯРНО С ОРИГИНАЛА

Warsaw, 2015.11.30

DIRECTOR OF
INSTYTUT ENERGETYKI

prof. dr hab. inż. Jacek Wańkowicz

PCA
POLSKIE CENTRUM AKREDYTACJI
CERTYFIKACJA WYROBÓW
AC 117

APPENDIX TO THE CERTIFICATE OF CONFORMITY
No. 095/2015
Issue No. 01 of 2015.11.30
LIST OF EVIDENCED PARAMETERS

Current transformer type	PA 123
Highest voltage for the CT U_m	≤ 123 kV
Rated insulation level	AC 230 kV / LI 550 kV
Rated frequency f_R	50 Hz
Creepage distance of the insulator • porcelain • composite	 3075 mm, 3640 mm 3800 mm
Static withstand load	3600 N [1)]
Degree of protection of the secondary terminals enclosure	IP55
Rated primary current I_{pr}	50 ÷ 3000 A
Rated secondary current I_{sr}	1 A; 5 A
Extended current rating	≤ 200%
Rated continuous thermal current I_{cth}	≤ 3600 A
Rated short-time thermal current I_{th}	≤ 63 kA
Rated dynamic current I_{dyn}	≤ 158 kA
Parameters of measurement cores • rated power S_r • accuracy class • FS	 2,5 ÷ 90 VA 0.2S, 0.2, 0.5S, 0.5, 1 FS5; FS10
Parameters of protection cores • rated power S_r • accuracy class • ALF	 2,5 ÷ 90 VA 5P; 10P ≤ 30

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД СОФИЯ

REMARKS:

1. [1)] According to IEC 61869-1 ed. 1.0 (2007) cl. 6.7 F_R = 3000 N for the load class II.
2. The degree of protection against external mechanical impacts provided by enclosure was not verified.

High Voltage Products

PA 123/PA 145 Current transformer
Installation and operation manual

Your safety first!

This is the reason why our instruction begins with the following guidelines:

- Use the transformer for its intended purpose.
- Observe the technical data given in the rating plate and in the specification.
- To facilitate and ensure high quality standards, the installation should be carried out by trained personnel or supervised by the service department of ABB.
- Operations have to be carried out by specially trained electricians who are familiar with the following instructions.
- It is recommended to observe the standards (DIN VDE/IEC) and local H&S regulations as well as the requirements of the local electric authority.
- Transformer work should be changed over in accordance with the instructions in the manual.
- All documentation should be available to all persons involved in installation, maintenance and operation.
- Operating personnel shall bear all responsibility for all aspects related to the operational safety as stated in EN 50110 (VDE 0105) and national regulations.
- Observe the safety rules, which are compliant with EN 50110 (VDE 0105) standard on ensuring a dead state at the site of works carried out on a transformer.

If you have any questions regarding the information contained in this manual, our organisation will provide the necessary information.

ЕЛЕКТРИКСИТИ СОФИЯ ООД

ВЯРНО С ОРИГИНАЛА

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Important information

This manual is intended to explain the mode of operation and installation of the product.

> ⚠ **NOTE:**
> All descriptions contained in this document are for general information only and do not include specific design requirements. Please refer to the exact design documentation while connecting the device.

Operating the device without reading the manual may entail property damage, serious injury or death. The person responsible for the installation of the device should read the following instructions and follow the recommendations contained herein.

For your own safety:

- Make sure that all installation, service and maintenance works are performed by professionals.
- Make sure that during all the phases (installation, service, upkeeping) all applicable regulations will be preserved.
- Ensure that the guidelines contained in this manual are followed.

Basic guidelines for this manual

Read the relevant chapters of this manual to provide adequate operation. Chapters are marked according to their significance.

> ⚠ **For the purposes of this manual, failure to follow the instructions concerning the dangers could result in death or serious injury.**

ЕЛЕКТРИКСИТИ ООД
СОФИЯ
ВЯРНО С ОРИГИНАЛА

Table of contents

ВЯРНО С ОРИГИНАЛА

PA 123/PA 145 Current transformer

1. Introduction

The subject of this manual are type PA 123 and PA 145 overhead current transformers. These transformers are used for feeding measurement and protection systems in power networks with maximum system voltage of 123 kV and 145 kV or lower (the greatest effective value of phase-to-phase voltage) and 50 Hz frequency. They are designed either to operate in grids with effectively earthed or insulated neutral points or in compensated networks.

2. Transformer delivery

Typically, the transformers are delivered in bulk packaging (3 pcs) where they are stacked vertically. The packaging is in the form of a complete crate.

The delivered transformers are fully assembled, tested and ready for direct use. Product testing protocols are delivered together with the transformers.

Immediately after delivery, check whether the transformer has not been damaged during transportation. Check the transport packaging. Damaged packing may point out to careless handling of the transformer. Next, check the transformer itself. Special attention should be paid to possible damage of sheds and binder at insulator flanges, to the tightness of the transformer and the correct oil level indication in the device.

One should ensure that technical parameters of the transformer given in the rating plate are in accordance with the parameters given when submitting the order and in accordance with the design documentation parameters.

Any damage found or other error should be immediately notified to the manufacturer, and, if appropriate, the carrier. Sending photos of damage will be helpful in its assessment.

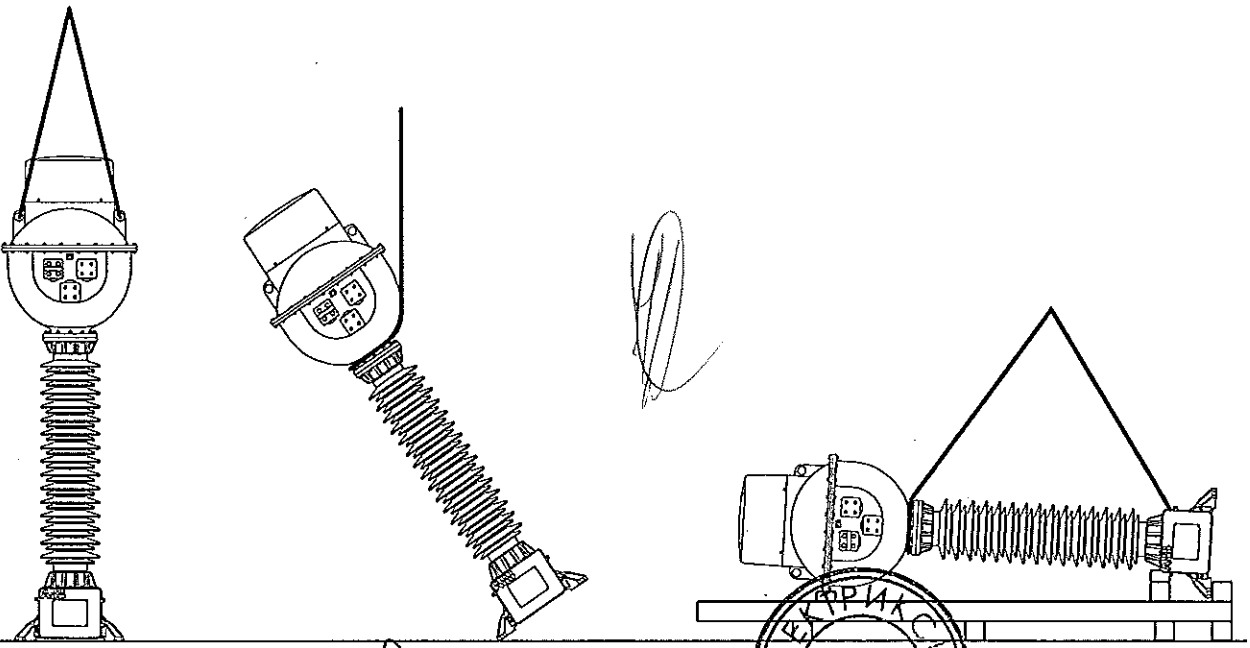
3. Transportation, unpacking, lifting

Transformers may be transported in either vertical or horizontal position.

In the case of horizontal transportation, transformers should be transported on a special bed in accordance with the method as shown in Figure 1. Additionally, before laying the transformer, restrain its compensation bellows by inserting a flexible disc made of, for example, polyurethane foam, under the bellows cover. During horizontal transportation, the compensation bellows cannot have any freedom of movement due to their flexibility and possibility of damage.

In vertical transportation, due to the high position of the centre of gravity, the transformer should be transported on arms or platforms expanding spacing of the base. Those elements shall be removed before setting the transformer on the support structure (in the working location).

Transformers should be lifted with a crane with appropriate load capacity using two slings of the same length (min. 1.5 m). Hooks should be attached to the openings designed for that purpose located in the transformer head enclosure (see Fig. 1).



Packing method for horizontal transformer transport

ВЯРНО С ОРИГИНАЛА

4. Storage

Transformers should be stored on a levelled and hardened surface, preferably in the original packaging. In the case of long-term storage, it is recommended to protect contact surfaces against corrosion.

Transformers can be stored in the open air for up to two years. If this period is exceeded, it is recommended to place transformers in a well-ventilated room or under a roof, and to insert silica gel or another moisture absorbent into terminal boxes.

5. Installation

The support structure should be flat and horizontal. Levelling correction can be performed using distance washers, placing them between the transformer and the structure. Observe the notes given in item 3 while shifting the transformer. It should be fastened to the structure with screw elements of an adequate size. The support structure and fastening elements are not included in the delivery.

The transformer should be placed in the vertical position at least 24 h before energising.

5.1. Earthing terminals

Two earthing terminals are found on the base of the transformer across its diagonal. Prior to connection, the contact surface of the terminals should be thoroughly cleaned from oxide layers so it becomes uniform and smooth. Additionally, a thin layer of conducting grease can be applied in order to improve contact. The earthing should be connected with stainless bolts.

5.2. Primary terminals

Primary terminals of the transformer, marked as P1 and P2, are placed on the opposite sides of the head. In the case of reconnectable transformer, up to 3 P2 terminals can be found on the primary side, marked with respective values of the rated primary current.

Reconnection of the primary winding to the required current range is performed by placing a detachable terminal (bolt or flat) in the location marked with the respective current value. These terminals should be fastened to the transformer with four supplied M12 bolts. Contact surfaces should be cleaned beforehand.

All contact surfaces of the primary terminals should be even and cleaned from the oxide layer before connecting. In the case of copper terminals, use of extraction naphtha is usually sufficient. Conducting grease can be applied in order to improve contact. The line cable terminals should be tightened with M12 bolts (stainless bolts are recommended) to such prepared terminals. An incorrectly performed primary connection will lead to excessive heating of the transformer, which can cause its damaging. Primary connections should be made in such a way so as to minimise mechanical static loads of the transformer terminals. It is recommended to use flexible elements as rigid connections may cause damage of the transformer. The maximum allowable static load of each transformer terminal is equal to 3,600 N in any direction. At the same time, only one terminal can be loaded with such force. Also, it is recommended to maintain the sum of the loads acting on the primary terminals during normal operation of the transformer below 50% of such a value.

5.3. Secondary terminals

Secondary windings are connected to terminal blocks placed in the terminal box on the bottom of the transformer. These are typically Phoenix ST spring connectors with terminals adapted to connection of cables of cross-section up to 10 mm2 or up to 6 mm2. Each terminal is described in accordance with winding markings given on the rating and schematic diagram plates.

Yellow-green terminals (with the earthing mark) are intended for earthing secondary windings with the use of pushed crosswise bridges. The crosswise bridge can be removed with a screwdriver, by inserting it in the slit and levering.

Optionally, the connectors to which metering windings are led may be adapted for sealing with use of a transparent cover.

The current coil screen is led out with a pin through the resin bushing (tg δ terminal).

A rating plate is placed on the external side of the door, while the schematic diagram plate is placed inside.

In the bottom wall of the terminal box, there is a plate with openings for glands for secondary circuits' connection cables. In the typical execution, they are two M40 glands with the choking range of Φ19 mm – Φ28 mm.

An example of a terminal box for secondary windings of the transformer is shown in Figure 2.

ЕЛЕКТРИКСИТИ СОФИЯ ООД

ВЯРНО С ОРИГИНАЛА

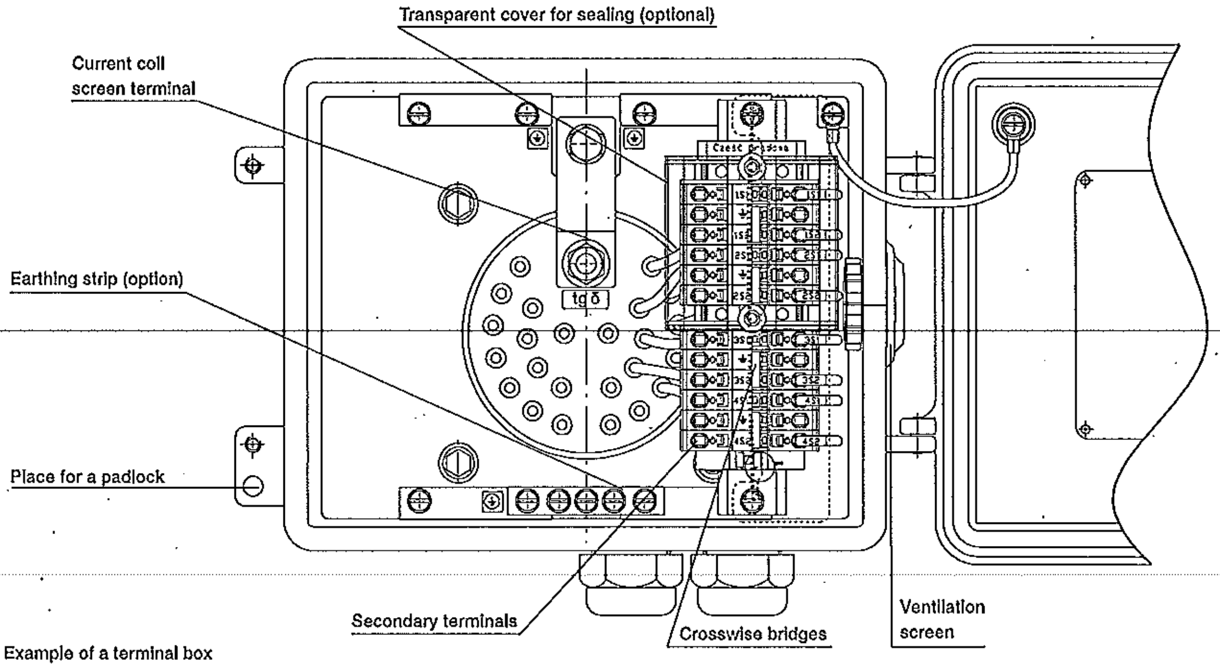


Fig. 2. Example of a terminal box

Connect external circuits to secondary terminals of the current transformer of the transformer pursuant to the design documents and wiring shown on the schematic diagram plate.
The current coil screen terminal (tg δ) should be earthed with a jumper during normal transformer operation.
Connectors inside the terminal box are arranged so that, when using crosswise bridges, earthing is possible for any secondary terminal of a given winding.

- Transformer with taps on the secondary side:
  In the case of a transformer with reconnection on the secondary side, unused taps should remain unearthed, and only one of the terminals, to which circuits are connected for a given secondary winding, should be earthed.
- Unused windings:
  Utmost terminals (with reconnection on the secondary site, these are terminals corresponding to the highest ratio) of the unused secondary winding should be shorted with each other (with a cable of minimum cross section of 6 mm^2) and earthed with a crosswise bridge. Each unused winding should be earthed in only one point.

NOTE:
Opening of the secondary circuit of the transformer during normal operation causes appearance of high voltage on terminals of this circuit, which is dangerous for personnel and may cause damage of the transformer insulation.

6. Bolt tightening torques

Primary terminal bolts M12	60 Nm
Bolts fastening the transformer to the support structure	280 Nm

7. Operation and maintenance

NOTE:
Combined transformers are HV equipment, hence appropriate safety precautions shall be observed during their operation.
The metrological range of the transformer is guaranteed exclusively in the field determined by the applicable standard on the basis of rated data. The standard is given on the rating plate of the transformer. The metrological range of the transformer is also shown in the record of the test of product, which is supplied with the transformer. Metrological values of the transformer are not guaranteed in any way beyond this field.

7.1. Operation

Transformers do not require special servicing. Visual inspection is usually sufficient. The check-list is placed at the end of this manual.

ЕЛЕКТРИКСИТИ СОФИЯ ООД
ВЯРНО С ОРИГИНАЛА

Visual inspection:

Visual inspection should be based on:
- the position of the oil level indicator,
- tightness of the transformer,
- lack of mechanical damage,
- condition of the insulator and binder connecting the insulator with flanges.

Occasionally, check the tightening degree of the primary terminals.

The transformer tightness is a particularly important criterion as in the case of oil leaks moisture can penetrate the device. Small insulator damage may be repaired on site.

Oil level indicator:

Changes of the position of the oil level indicator depend on oil temperature in the transformer. The position of the indicator should be in the green field range. Shifting of the indicator to the upper or bottom red field points out to incorrect transformer operation. In such a case, the transformer should be put out of service, and the manufacturer should be contacted.

On the lid covering the head stainless steel expansion bellows (1) are placed, used for compensation of oil volume thermal changes in the transformer. The oil level indicator (2) is placed on the upper surface of the bellows. The bellows are placed in a metal cover (3) equipped with a view-finder (4). Cover removal does not result is unsealing of the transformer. The whole compensation system is shown in Figure 3.

Position of the oil level indicator	Interpretation
Indicator in the green area	Correct transformer operation
Indicator on the upper red field	Oil pressure too high Transformer over heating Oil gasification (insulation failure) Further inspection necessary
Indicator on the lower red field	Oil level too low Suspicion of oil leakage (moisture may penetrate inside) Further inspection necessary

NOTE:
Oil level indication for all three transformers installed on adjacent phases should be almost equal.

Measurement of the dielectric loss factor tg δ:

During measurement of the dielectric loss factor tg δ, the measuring bridge should be connected to the correct terminal marked with the tg δ symbol. One should remember to earth it after performing the measurement. Usually, the test voltage should equal 10 kV RMS, and it should be applied across transformer primary terminals and earth.

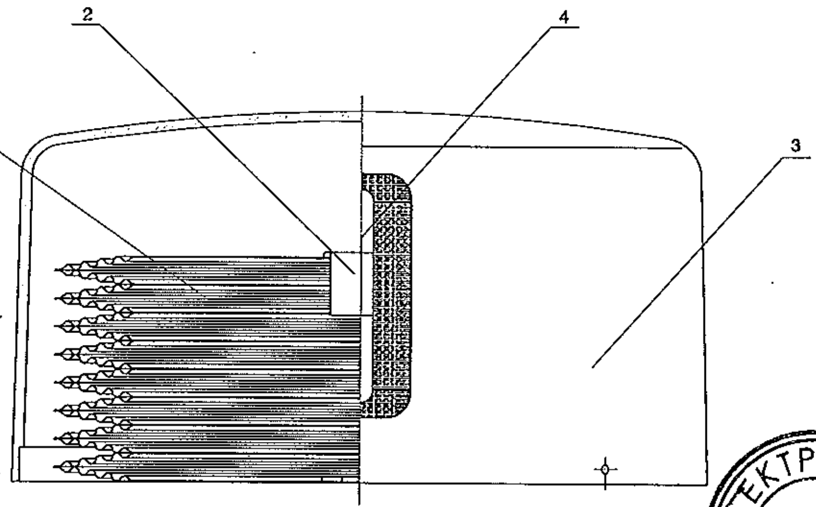


Fig. 3. Construction of the compensation system

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Oil sampling:

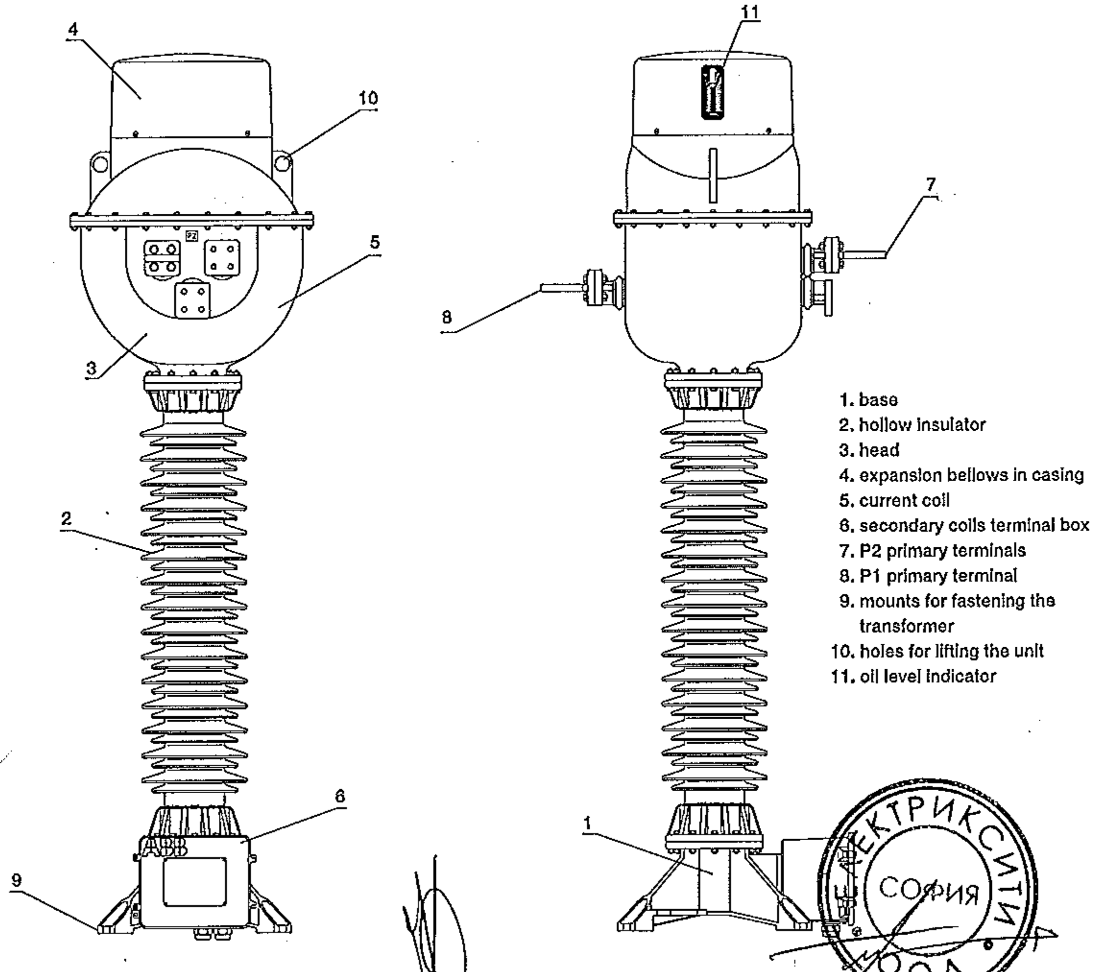
Due to the fact that transformers are air-tight, they do not require periodical oil checking. Oil used in the transformer meets the requirements of the PN-EN 60296 (IEC 60296) standard.
It is recommended to check the oil after 15–20 years of operation or after a non-conformity state if there are suspicions as to transformer efficiency.
Contact the manufacturer in order to obtain necessary instructions concerning oil sampling. If oil samples are taken during the guarantee period without the manufacturer's permission, the device loses its guarantee.

7.2. Corrosion protection

External elements of the transformer casing are made in the form of aluminium alloy casts, resistant to corrosion. Casts can be unpainted or painted. Typical colours in the case of painted casts include light-grey (RAL 7035) or grey-green (RAL 7033). While remaining metal elements, such as bolts, are made of stainless steel.

8. Transformer construction

PA 123 or PA 145 type current transformer comprises a current coil in a tight enclosure filled with transformer oil.
This is a "top core" type structure where the magnetic toroidal cores are located in the transformer head. The cores with secondary windings are additionally encapsulated in a metal can connected via a tube to terminal box tg δ terminal. Both the metal can as well as the tube are insulated with oil impregnated electrical grade paper. The distribution of electric stresses in the paper insulation is capacitor controlled. En exterior screen is located external to the coil, connected to the primary terminal inside the head.
Such a coil structure provides the following advantages: protection of devices connected to the terminal in the event of primary insulation perforation, equalisation of electrical stresses in primary insulation and a facility for measuring the tg δ coefficient on the primary insulation only.



1. base
2. hollow insulator
3. head
4. expansion bellows in casing
5. current coil
6. secondary coils terminal box
7. P2 primary terminals
8. P1 primary terminal
9. mounts for fastening the transformer
10. holes for lifting the unit
11. oil level indicator

Fig. 4. PA 123 and PA 145 current transformers structure

The transformer primary insulation constitutes electric grade paper dried at a high temperature and high vacuum impregnated with transformer oil. The free spaces inside the transformer are filled with transformer oil.
External insulation comprises a hollow insulator made out of electrical porcelain with brown enamel or a glass reinforced plastic (FRP) tube coated with grey silicon rubber.
The seals in the transformer are of the o-ring type, and they are made of NBR oil-resistant rubber.

If calibration of measuring windings has been performed, additional respective markings (designations) have been placed on the transformer and the rating plate (where required).

9. Disposal

During correct operation and when no mechanical damage occurs, the transformer should operate over 30 years. Once this period of time has expired or if operation is no longer required, it is recommended to dispose of the transformer.

Primary materials used in the transformer:

Item	Material	Quantity [kg]
1	Copper (Cu – ETP)	20
2	Aluminium alloy AC-Al Si10Mg (Cu)	80
3	Steel	20
4	Transformer plate	50 – 150
5.	Permalloy (iron-nickel alloy)	10
6	Mineral transformer oil	120
7	Electrical grade paper	25
8	Solid insulation materials (epoxy resin, bakelite paper)	10
9	Porcelain	80
10	Composite insulator	20

Items 9 and 10 alternatively.
Above values are approximate.

9.1. Recycling and disposal proceedings

Recycling and disposal should meet national (or local) regulations. On the territory of the Republic of Poland, the manner by which the transformer should be recycled and disposed is defined in the Waste Act of 14 December 2012, published in Journal of Laws, 2013, item 21, as amended.

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