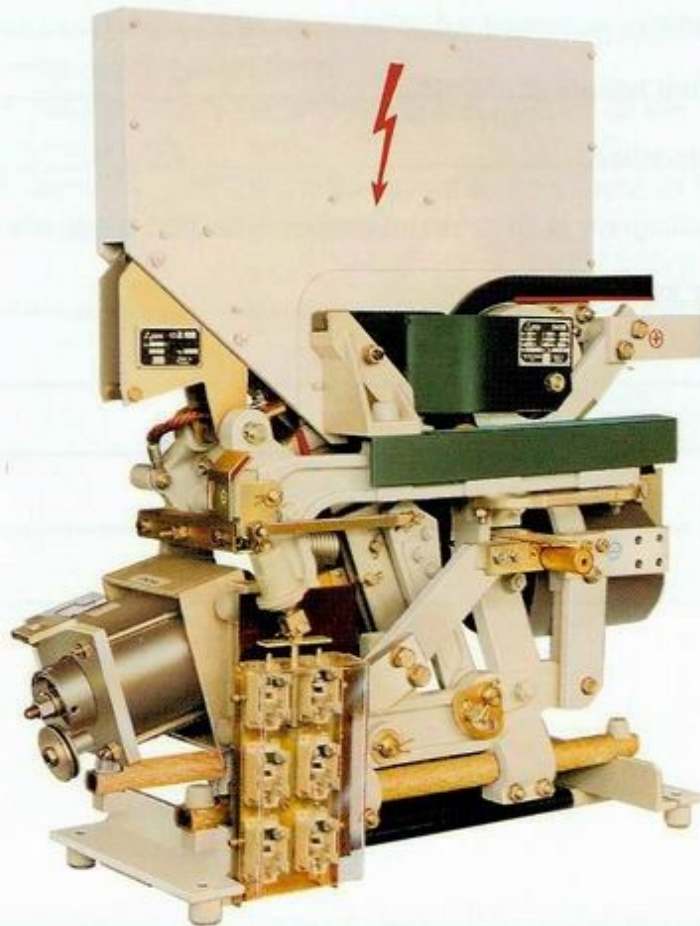


# DC HIGH SPEED CIRCUIT BREAKERS BWS



## Characteristic features:

- High electrical life and mechanical endurance
- High breaking capacity
- Reliability



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## BWS CIRCUIT-BREAKER

### APPLICATION

The BWS type single pole, polarised DC high speed circuit-breakers are designed for:

- Switching service and overload currents;
- Short-circuit protection in traction sub-stations and sectioning cabins for long distance trains, trams, suburban trains, underground and on traction vehicles;
- Short-circuit protection for rectifiers and thyristor converters in metallurgy, mining etc.

### CHARACTERISTICS

#### OPERATING CONDITIONS

The BWS circuit-breakers are designed for use in rooms at altitudes up to 2000 m above sea level, which are free from dust, gas and vapour, flammable or chemically active. The circuit-breakers are designed for operation in tropical and moderate climatic conditions.

#### CLIMATIC VERSIONS

The BWS circuit-breakers are made in two climatic versions:

- N - for use in the climates:
  - Cold moderate WT;
  - Warm moderate CT;
- T - for use in the climates:
  - Dry warm tropical WDr;
  - Dry cold tropical WDa;

according to the PN-E-045455-21, Std. idt. IEC 721-2-1.

Other climatic conditions: to be agreed.

#### COMPLIANCE WITH STANDARDS

- PN-EN-50123-1
- PN-EN-50123-2
- PN-EN-50163
- EN 50124-1

#### APPROVALS AND CERTIFICATES

- PKP - Polish State Railways
- RENFE - Spanish Railways
- Slovak Railways
- Hungarian Railways
- BBJ-SEP -  safety mark



## CONSTRUCTION AND PRINCIPLE OF OPERATION

### CONSTRUCTION

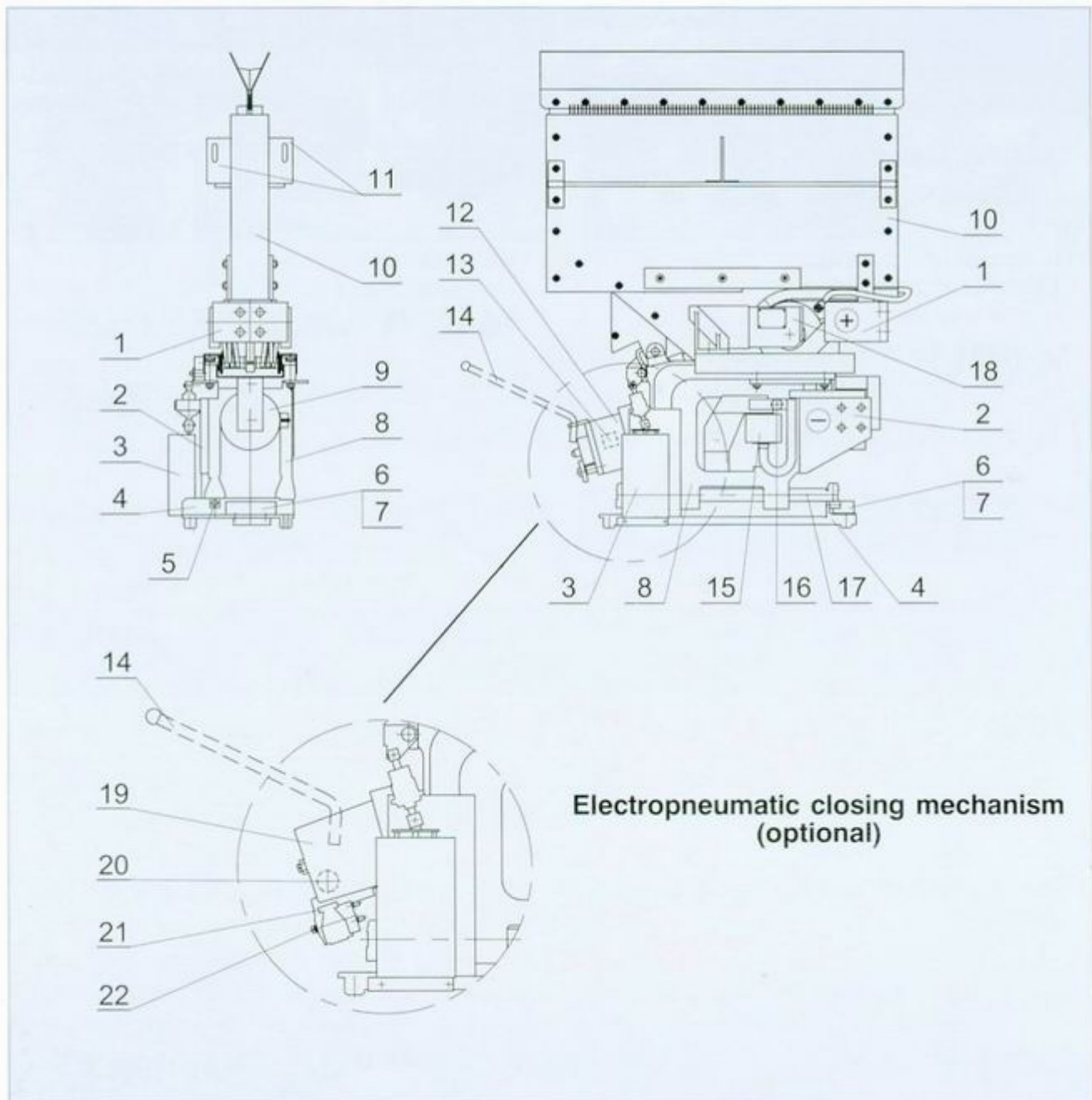
The BWS circuit-breaker consists of the following basic parts: base /4/, frame /8/, keeper magnetic circuit, moving contact /23/, fixed contact /29/, over-current release /28/ (optionally with inductive shunt /15/), magnetic blow-out unit /18/, circuit-breaker closing mechanism /12(19)/, set of auxiliary switches /3/, arc chute /10/.

The frame has the potential of the negative terminal /2/. It is insulated from the base with two insulation

beams /17/. The positive terminal /1/ with the magnetic blow-out unit and the fixed contact are insulated from the frame with insulation beams. The circuit breaker closing mechanism is insulated from the frame with insulation moulding. At the base of the circuit-breaker there are: an earth terminal /5/, and terminal strip of holding coil /6/, or optionally stabilizer of the holding coil current /7/.

### CONTACT SET

The circuit-breaker has easily exchangeable main contacts. The circuit-breakers for currents up to 2500A have copper contacts whereas those for 3150A have copper contacts with silver alloy tips. The contact materials do not contain cadmium.





### KEEPER MAGNETIC CIRCUIT

It consists of a core /27/ and keeper /25/ as well as a holding coil /9/. The coil can be supplied either by a current stabilizer /45W/ or directly /100W/.

The circuit-breaker can be intentionally open by switching-off the current of the holding coil.

### CLOSING MECHANISM

There are two options available: an electromagnetic closing mechanism /12/ or an electro-pneumatic one /19/. The terminal strip /13/ of the electromagnetic mechanism is placed directly on its body. The compressed air terminal (hole G 1/4") /20/, valve /22/ including the connection terminals /21/ are placed directly on the electro-pneumatic mechanism.

A removable lever /14/ is used for manually closing the circuit breaker. The circuit-breaker can be closed manually only when there is no voltage in the main circuit.

### ARC CHUTES

The 600 and 825V arc chutes are gap chutes with wedges for arc elongation.

The 1500V arc chute is a single chute with de-ionising plates.

The 3000V arc chutes are double chutes with de-ionising and insulation plates.

When switching-off the electric arc, both parts of the arc chute are connected in series, creating two windings with a strong magnetic blow-out.

The arc chutes are made of materials that do not contain asbestos.

### PRINCIPLE OF OPERATION

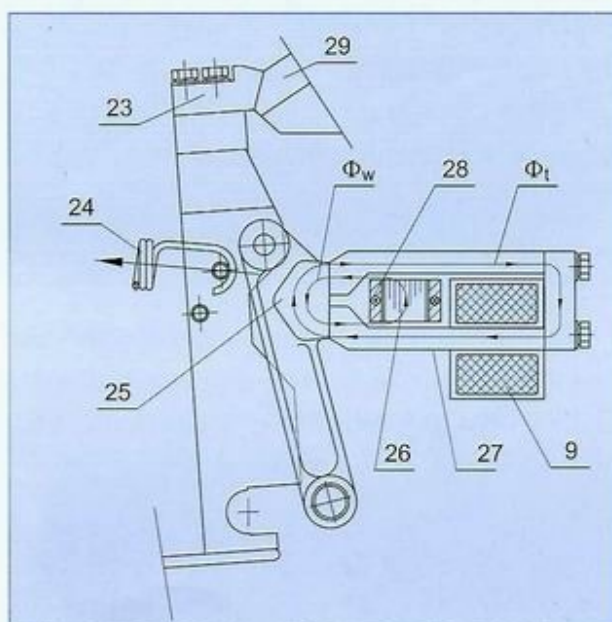
The operation of the BWS circuit-breaker is based on the principle of magnetic holding keeper - that is automatic opening takes place when the magnetic flux  $\Phi_w$  generated by the current flowing through the coil of the over-current release /28/ sufficiently weakens the magnetic flux of the holding coil  $\Phi_t$ .

When closed the keeper adheres tightly to the core of the holding electromagnet. The holding coil generates a magnetic flux flowing through the core and keeper. The main current flows through the over-current release coil (or part of it in the case of the inductive shunt circuit-breaker), which generates a flux going through the keeper, however its direction is opposite to that of the holding flux. The difference between the fluxes determines the holding force of the keeper, which is pulled off by a spring /24/. If the holding force drops below the force from the spring, the keeper is pulled off the core and the contacts are opened.

For the higher ranges of over-current releases an inductive shunt is used. In a steady state it causes a current flow which is dependent on the resistance of the shunt and release circuit, whereas in a dynamic state of current rise is dependent of their inductances.

The operating current of the over-current release is set by means of a moving core /26/, adjusted with an adjusting handwheel /16/.

The BWS circuit-breaker is polarised. It means, that automatic opening of the circuit breaker resulting from a current, higher than the current set on the over-current release, takes place only when the direction of the main current flow corresponds to the polarity marked on the circuit-breaker terminals and the voltage at the holding coil has the polarity that corresponds to the markings at its terminals. In the case of current flow in the opposite direction or change in the supply voltage polarity at the holding coil, the circuit breaker will not open automatically.







## TECHNICAL DATA

1	Circuit breaker type	-		BWS	
2	Rated voltage $U_{Ne}$	V		600, 825, 1500, 3000 DC	
3	Rated insulation voltage	main circuit	V	4000	
		auxiliary circuits	V	500 (800) <sup>1)</sup>	
4	Dielectric strength of main circuit insulation	50 Hz, 1 min	kV	15	
		1,2 / 50 $\mu$ s	kV	35	
5	Rated service current $I_{Ne}$	A		630; 1000; 1600; 2000; 2500; 3150	
6	Elektrical life at $U_e = 1,25 U_{Ne}$ , $I_e = 1,5 I_{Ne}$	-		1000 operating cycles <sup>2)</sup>	
7	Mechanical endurance	-		50 000 cycles	
8	Making capacity for overload currents	-		$\leq 70$ % of release setting current	
9	Rated short-circuit breaking capacity	-		see table page 7	
10	Opening time ( $di/dt \geq 0,5$ kA/ms)	ms		$\leq 5$	
11	Voltage of holdig coil	with holding current stabilizer	V	110, 220 DC; 220 AC	
		without holding current stabilizer	V	55, 110, 220 DC; 220 AC	
12	Voltage range of holding coil	-		$0,8 \div 1,1$ <sup>3)</sup>	
13	Time from holding current break to circuit opening	w/o holding current stabilizer (DC-supp.)	ms	$\leq 80$	
		w/o holding current stabilizer (AC-supp.)		$\leq 250$	
		with holding current stabilizer		$\leq 150$	
14	Power consumption of holding coil	with holding current stabilizer	W	45	
		without holding current stabilizer	W	100	
15	Supply of closing mechanism	Electromagnetic	V	55, 110, 220, 600 DC; 220 AC	
		electro-pneumatic	valve coil	V	24, 48, 55, 110, 220 DC
			air pressure	MPa	0,5
16	Supply range of closing mechanism	electromagnetic - voltage	-	$0,8 \div 1,1$	
		elektro-pneumatic	voltage	-	$0,7 \div 1,25$
			air pressure	-	$0,7 \div 1,2$
17	Duration of switching pulse for closing coil	s		$\geq 0,6$	
18	Time from pulse decay to contact closure	s		$\leq 0,6$	
19	Power consumption of closing coil	electromagnetic	W	1600	
		electropneumatic	W	12	
20	Number of auxiliary switches	-		6a + 6b or 7a + 7b	
21	Parameters of auxiliary switches	-		$I_U = 16A$ , $U_I = 500V$ $I_e = 4A$ $U_e = 500V$ AC-15 $I_e = 0,5A$ $U_e = 220V$ DC-13	

1) 800V - without holding current stabilizer, 500V - with holding current stabilizer

2) for the 3150A circuit-breaker - 500 operating cycles

3) for the circuit-breaker with an electro-pneumatic closing mechanism  $0,7 \div 1,25$



## RELEASE SETTING RANGES

Circuit breaker rated current	Current setting range			
630 A	360 - 720 A	480 - 960 A	600 - 1200 A	675 - 1350 A
1000 A	600 - 1200 A	800 - 1600 A	1000 - 2000 A	
1600 A	960 - 1920 A	1200 - 2400 A	1600 - 3200 A	2000 - 4000 A
2000 A	1200 - 2400 A	1500 - 4000 A	1600 - 3200 A	2000 - 4000 A
2500 A	1800 - 4000 A	2400 - 4800 A	3000 - 6000 A	4000 - 8500 A
3150 A	1800 - 4000 A	2400 - 4800 A	3000 - 6000 A	4000 - 8500 A

Over-current releases - operation tolerances:

- $\pm 15\%$  without holding current stabilizer;
- $\pm 2\%$  with holding current stabilizer

## OVERLOAD CAPABILITY

The table below shows the times for reaching the permissible temperature-rise limits of the most hot parts, with the following over-currents:  $1.2 \times I_{Ne}$ ,  $2 \times I_{Ne}$ ,  $3 \times I_{Ne}$ . The overload tests were made for the circuit breakers with the rated currents 2000, 2500 and 3150 A for two operating modes:

- temperature rise test from a cold state - the circuit breaker had not been working before the overload test.

- temperature rise test from a steady state - the circuit breaker had been loaded with rated current before the overload test.

Circuit breaker rated current $I_{Ne}$	A	2000	2500	3150	
Overload from cold state					
Time	$1,2 \times I_{Ne}$	h	2	2	2
	$2 \times I_{Ne}$	min	10	6	10
	$3 \times I_{Ne}$	s	40	30	35
Overload from steady state					
Time	$1,2 \times I_{Ne}$	min	20	75	40
	$2 \times I_{Ne}$	s	10	30	60
	$3 \times I_{Ne}$	s	4	7	9

## RATED SHORT-CIRCUIT BREAKING CAPACITY

The tests for short-circuit breaking capacity were carried out in the cells of switchboards manufactured by FAE Apena S.A.

Type of arc shute	Test voltage	Time constant	Max switching over-voltage	Prospective short-circuit current
KBS - 0,6	750 V	20 ms	1800 V	100 kA
KBS - 0,8	1030 V	20 ms	2200 V	80 kA
KBD - 1,5	1875 V	20 ms	3000 V	50 kA
KBD - 3/50b	3900 V	10 ms	7000 V	50 kA
KBDk - 3/50b				
KBDd - 3/50b				
KBDp - 3/50b				



## OVERALL DIMENSIONS

### TYPES OF ARC CHUTES

KBS-0,6; KBS-0,8 - gap arc chutes for tram and underground switchboards;

KBD-1,5 - arc chutes for use in power supply systems for suburban railways, hoisting machines, etc.;

KBD-3/50b - arc chute for typical sub-stations and sectioning cabins;

KBDk-3/50b - arc chute with a lower height for sectioning cabins with draw-out switchboards with insulated cell walls;

KBDd-3/50b - arc chute with the lowest height for RPS/K switchboards with insulated cell walls manufactured by FAE APENA S.A.

KBDp-3/50b - arc chute for vehicles with additional fixed support /11/ (see page 4) for mounting in vehicles.

### DIMENSIONS OF CIRCUIT BREAKERS WITH ARC CHUTES AND ARC ZONES

Arc chute type	Rated voltage	A mm	A1 mm	R1 mm	R2 mm	X1 mm	X2 mm	Y1 mm	Y2 mm	Z1 mm	Z2 mm
KBS - 0,6	600 V	850	-	425	615	-	200	-	500	-	600
KBS - 0,8	825 V	850	-	425	615	-	200	-	500	-	600
KBD - 1,5	1500 V	930	-	510	720	-	600	-	800	-	900
KBD - 3/50b	3000 V	1365	435	965	1120	150	350	300	500	700	700
KBDk - 3/50b	3000 V	1285	355	890	1055	150	350	300	600	700	1000
KBDd - 3/50b	3000 V	1210	280	820	1000	150	350	300	600	700	900
KBDp - 3/50b	3000 V	1210	280	820	1000	50	350	300	600	500	1000

### VARIABLE TERMINAL DIMENSIONS

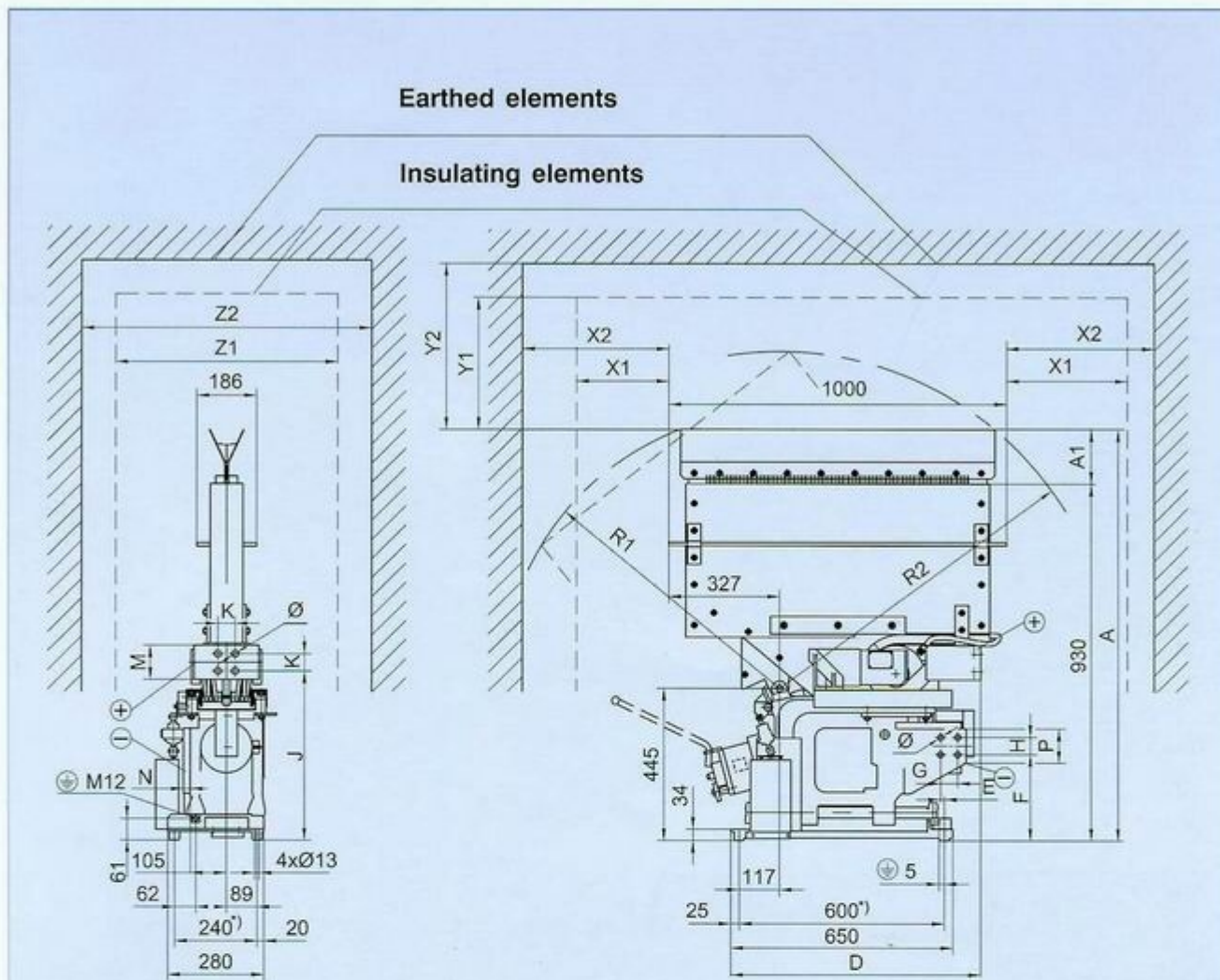
Rated current	D	E	F	G	H	J	K	L	M	N	P	S	Ø
630 A	575	30	290	30	26	520	-	-	-	8	50	7	11
1000 A	575	30	290	30	26	520	-	-	-	10	50	13	11
1600 i 2000 A	720	30	290	30	26	515	26	10	50	15	50	-	11
2500 i 3150 A	706	10	252	50	50	495	50	20	100	20	100	-	17

### WEIGHTS OF CIRCUIT BREAKERS AND ARC CHUTES

Circuit breaker weight without arc chute	kg	Arc chute weight	kg
630 A	125	KBS 0,6; KBS 0,8	12
1000 A	130	KBD 1,5	18
1600 A i 2000 A	140	KBD-3/50b; KBDk-3/50b; KBDp-3/50b	72
2500 A i 3150 A	150		



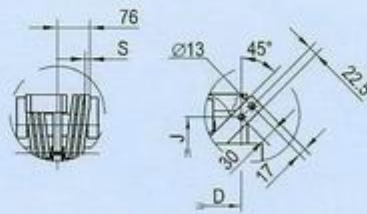
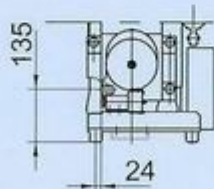
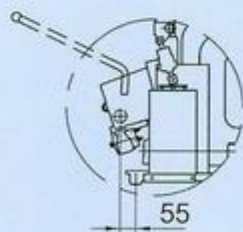
**BWS CIRCUIT BREAKER WITH ARC CHUTES: KBD-3/50b, KBDk-3/50b, KBDd-3/50b**



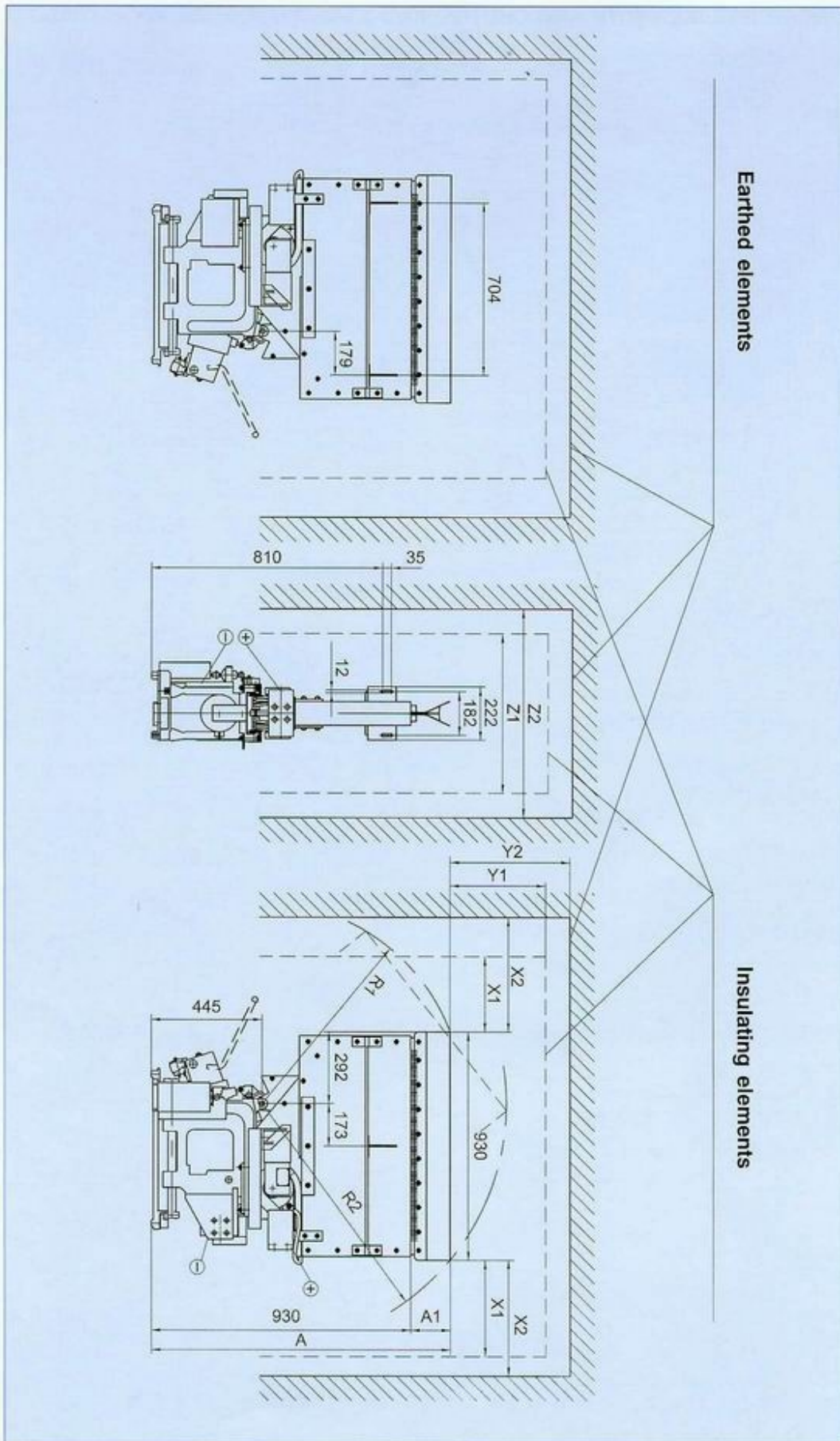
<sup>\*)</sup> spacing of circuit-breaker mounting holes

**Version with electro-pneumatic closing mechanism**

**⊕ terminal 630 and 1000 A**

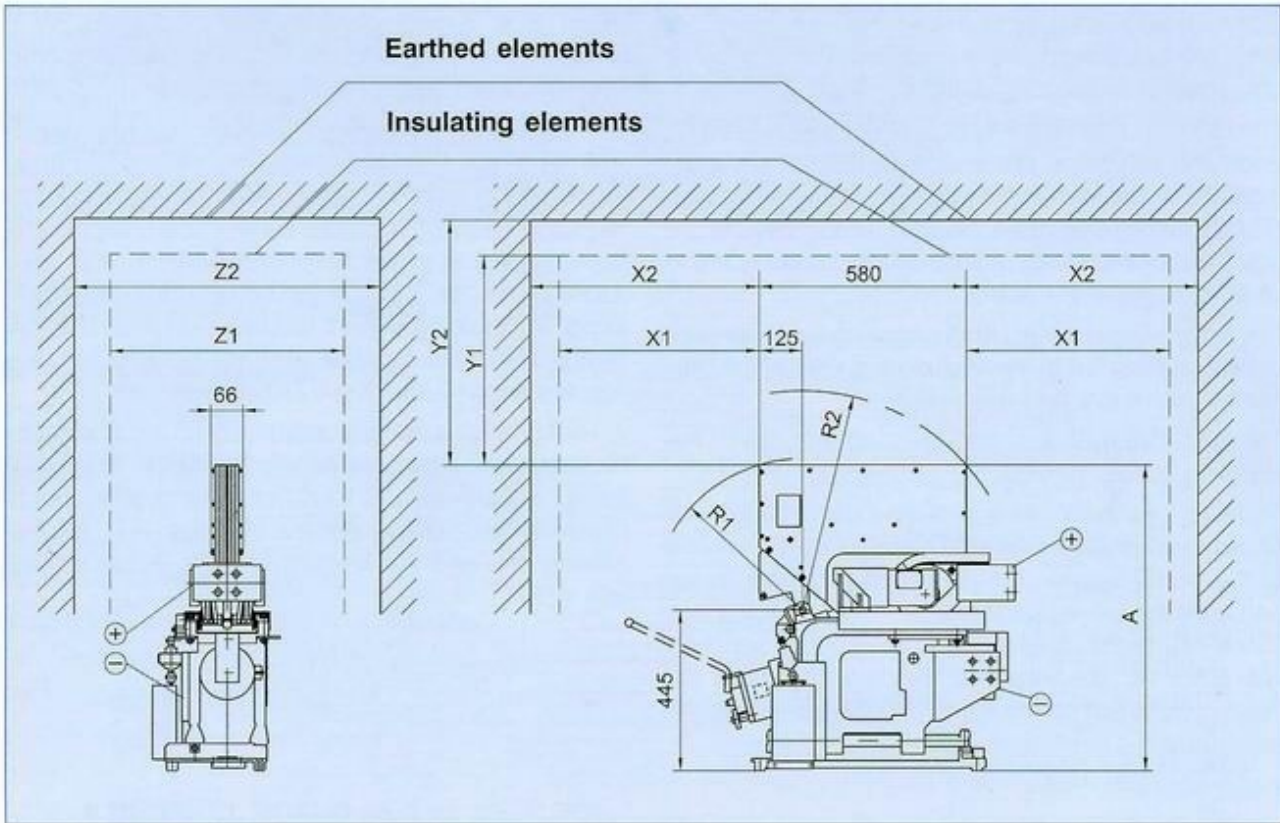


**BWS CIRCUIT BREAKER WITH KBDP-3/50b ARC CHUTE**

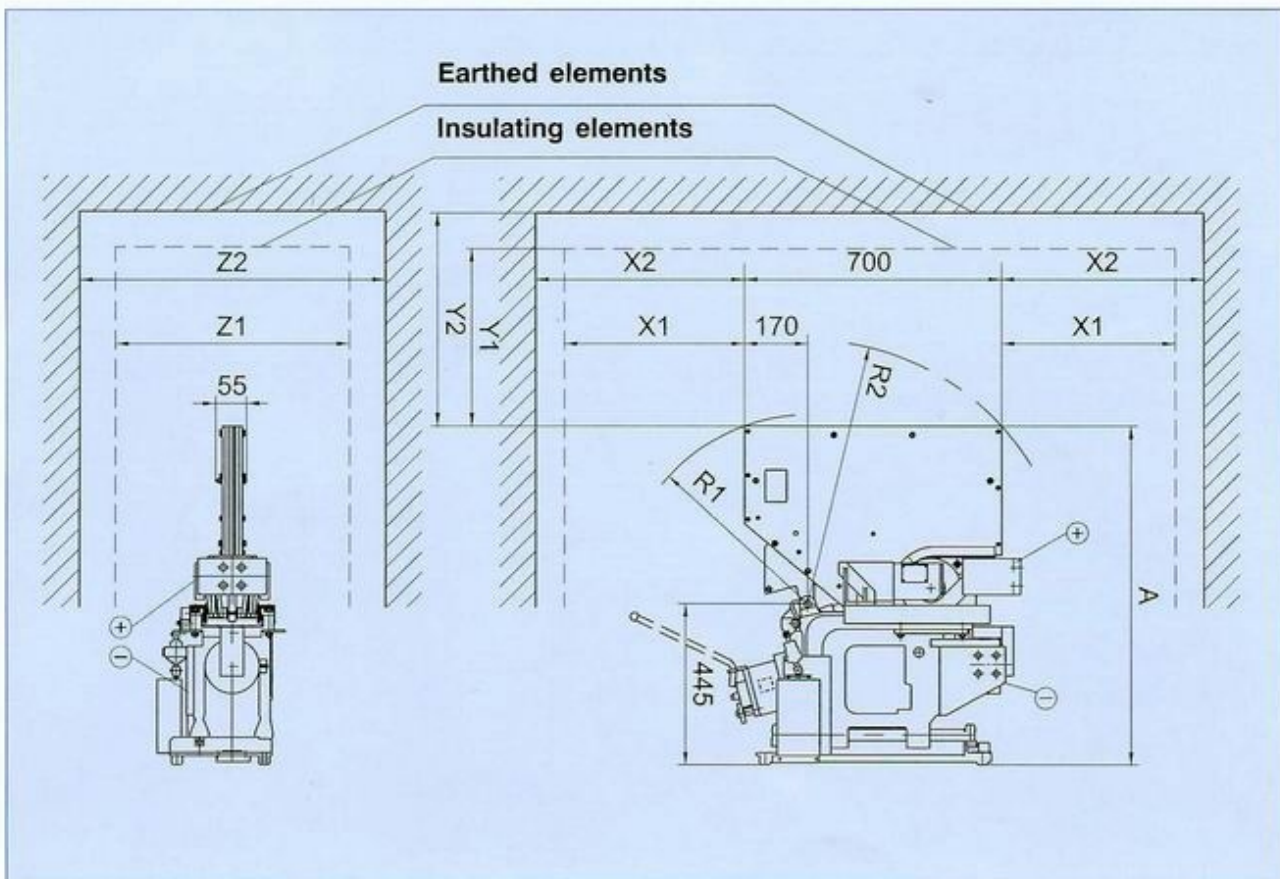




**BWS CIRCUIT-BREAKER WITH KBS-0,6 OR KBS 0,8 ARC CHUTE**



**BWS CIRCUIT-BREAKER WITH KBD-1,5 ARC CHUTE**



## TYPES OF CONTROL BOARDS USED WITH BWS CIRCUIT-BREAKERS

Control boards are used to control circuit-breakers and have the function to protect against "pumping" and also against overheating of the closing coil.

The BWTS-B and BWTS/N-B control boards have an additional protection feature that in case of a current increase in the stabilizer switches it off and switches on the holding coil into a by-pass supply circuit. The operation of this safety feature will not cause opening of a working circuit-breaker.

For all the boards the external switching-on pulse should last at least 0,8 s, the total closing time of the breaker is then less than 1,4 s.

The BWS circuit-breaker can be used with one of the following control boards:

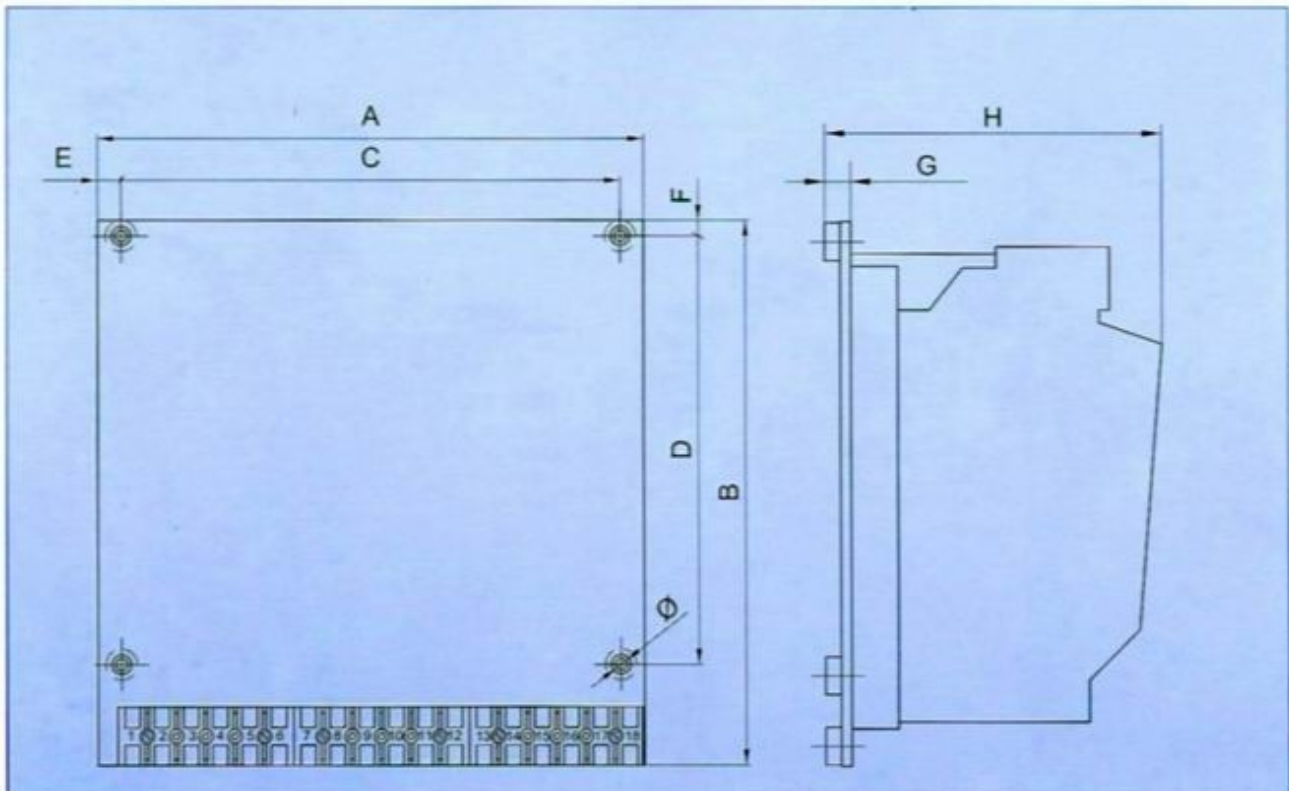
1. BWTS - the basic version of the control board with electromechanical relays, can be used for all versions of the circuit-breaker, control board supply voltages can have the following values: 55, 110, 220 V DC and 220 V AC. In the case of the control board supplied with 220 V AC, the voltage of the closing coil and the holding coil must be the same 220 V AC.

2. BWTS/N - a control board using a set of electronic relays, the supply voltage of the control board is 220 V DC and it can be used for circuit breakers in which the voltages of the closing coil and the holding coil are also 220 V DC.

3. BWTS-B - a control board with electromechanical relays and a by-pass circuit, control board supply voltages can have the following values: 110 and 220 V DC or 220 V AC. It can be used for circuit-breakers with holding current stabilizer, in which the voltages of the closing coil and the holding coil are respectively 110 and 220 V DC or 220 V AC.

4. BWTS/N-B - a control board using a set of electronic relays and a by-pass circuit, the supply voltage for the control panel is 220 V DC. It can be used for circuit breakers with holding current stabilizer, in which the closing coil and the holding coil are supplied with 220 V DC.

## OVERALL DIMENSIONS OF CONTROL BOARDS





Control board	A mm	B mm	C mm	D mm	E mm	F mm	G mm	H mm	Ø mm
BWTS direct current	168	270	240	250	12	8	13	168	6,5
BWTS alternating current	250	230	230	210	10	8	13	92	6,5
BWTS-B	280	280	256	220	12	8	13	145	6,5
BWTS/N-B	280	280	256	220	12	8	13	145	6,5
BWTS/N	280	280	256	220	12	10	13	145	6,5

## CONTROL BOARD DIAGRAMS

### MARKINGS USED IN DIAGRAMS

1 ÷ 18 – terminal strip

CT – holding coil

CZ – closing coil

ST – current stabilizer

Q1 – auxiliary switch of BWS

QF – MCB

K1 – contactor

K2, K3 – relays

KF – thermal relay

S1 – push-button with NO contact

S2 – push-button with NC contact

RF – varistor

BPE-31A – block of electronic relays

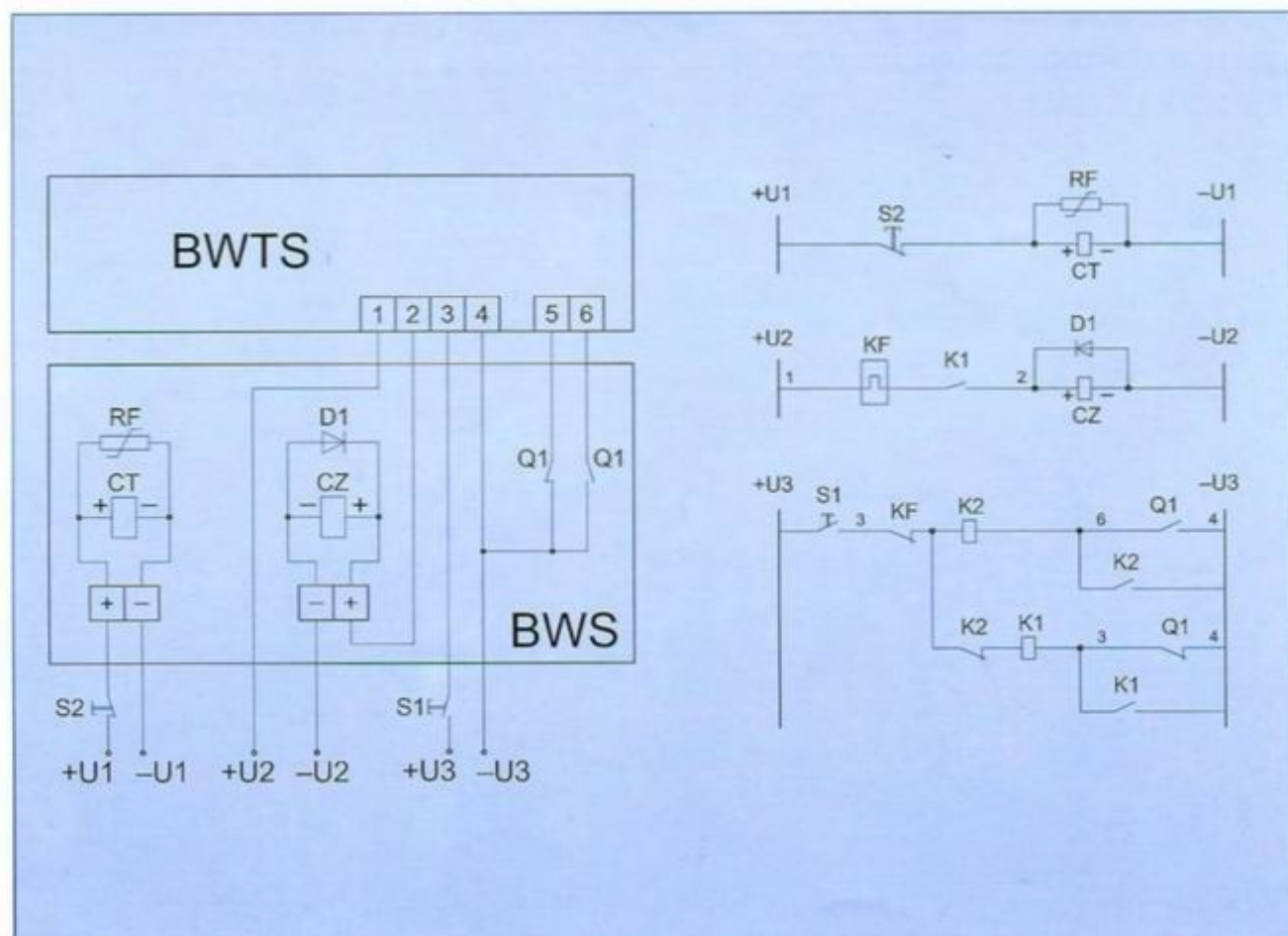
C – capacitor

D1 – diode

R – resistor

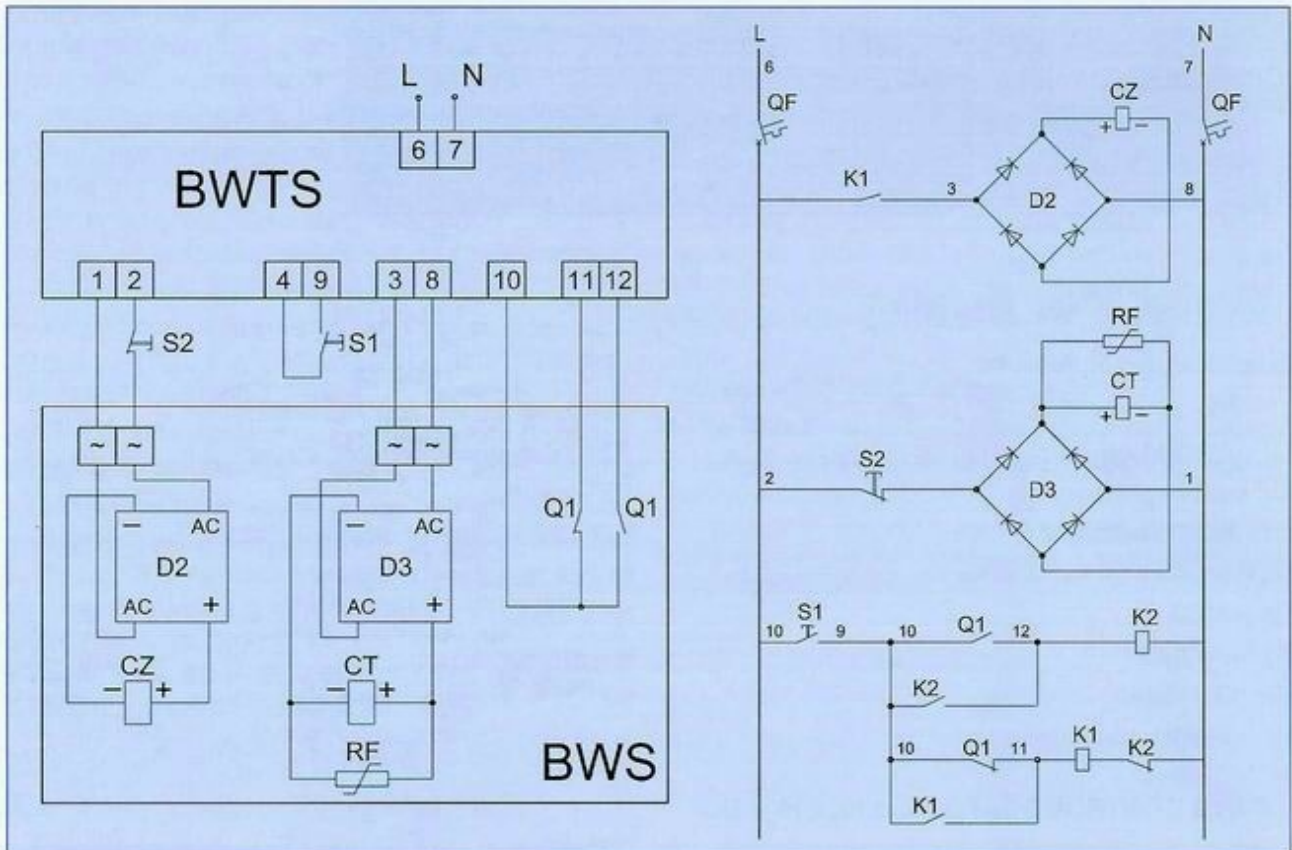
D2, D3 – bridge rectifiers

### BWTS CONTROL BOARD 55, 110, 220 V DC

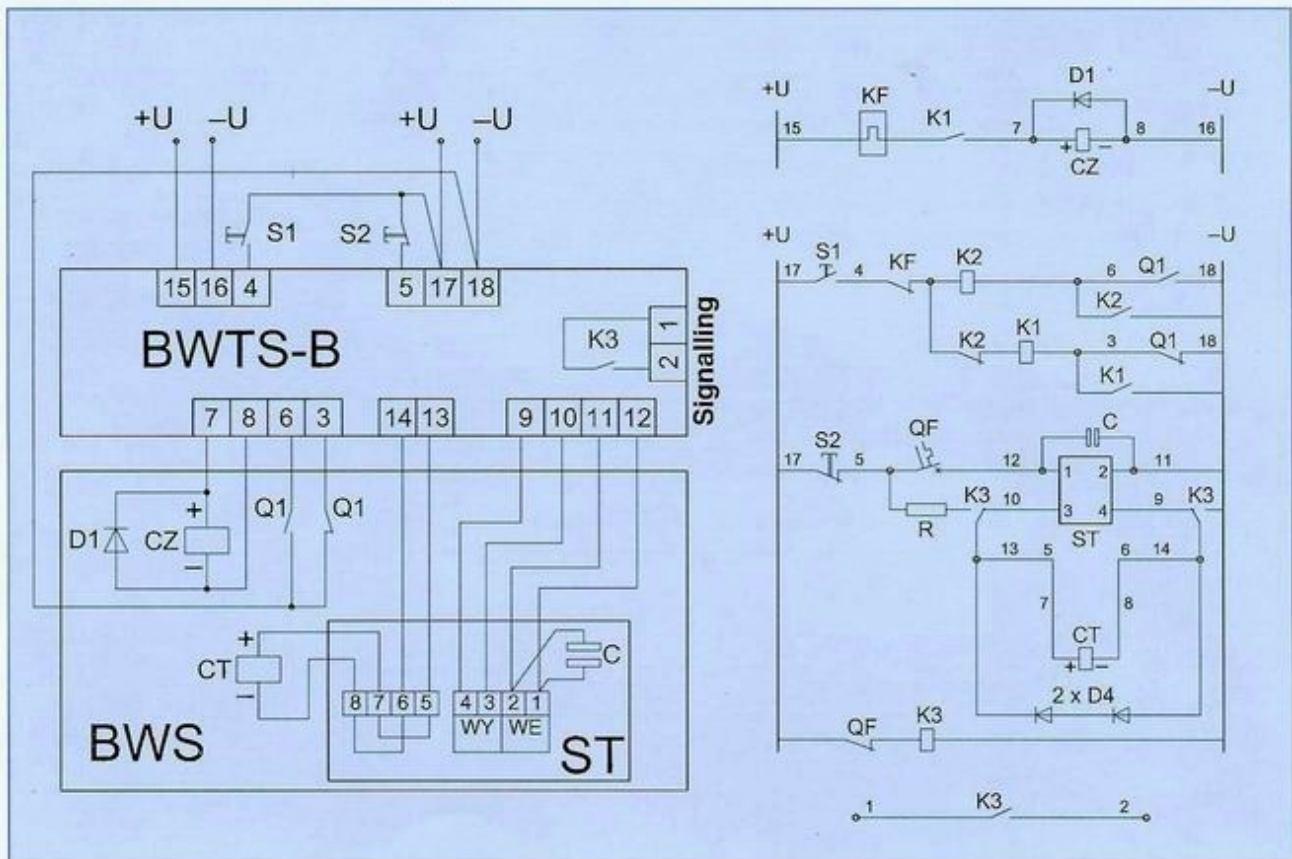




### BWTS CONTROL BOARD 220 V AC

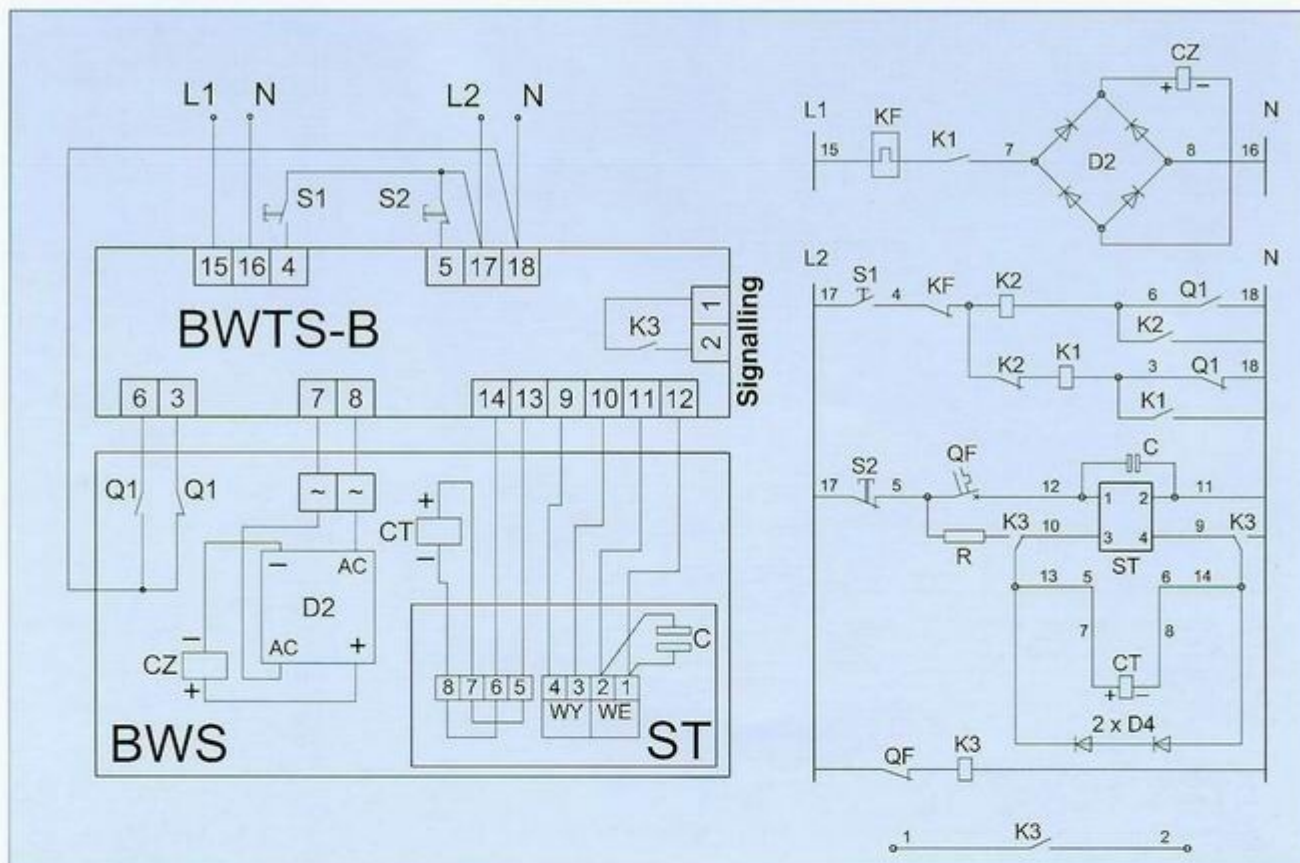


### BWTS-B CONTROL BOARD 110, 220 V DC

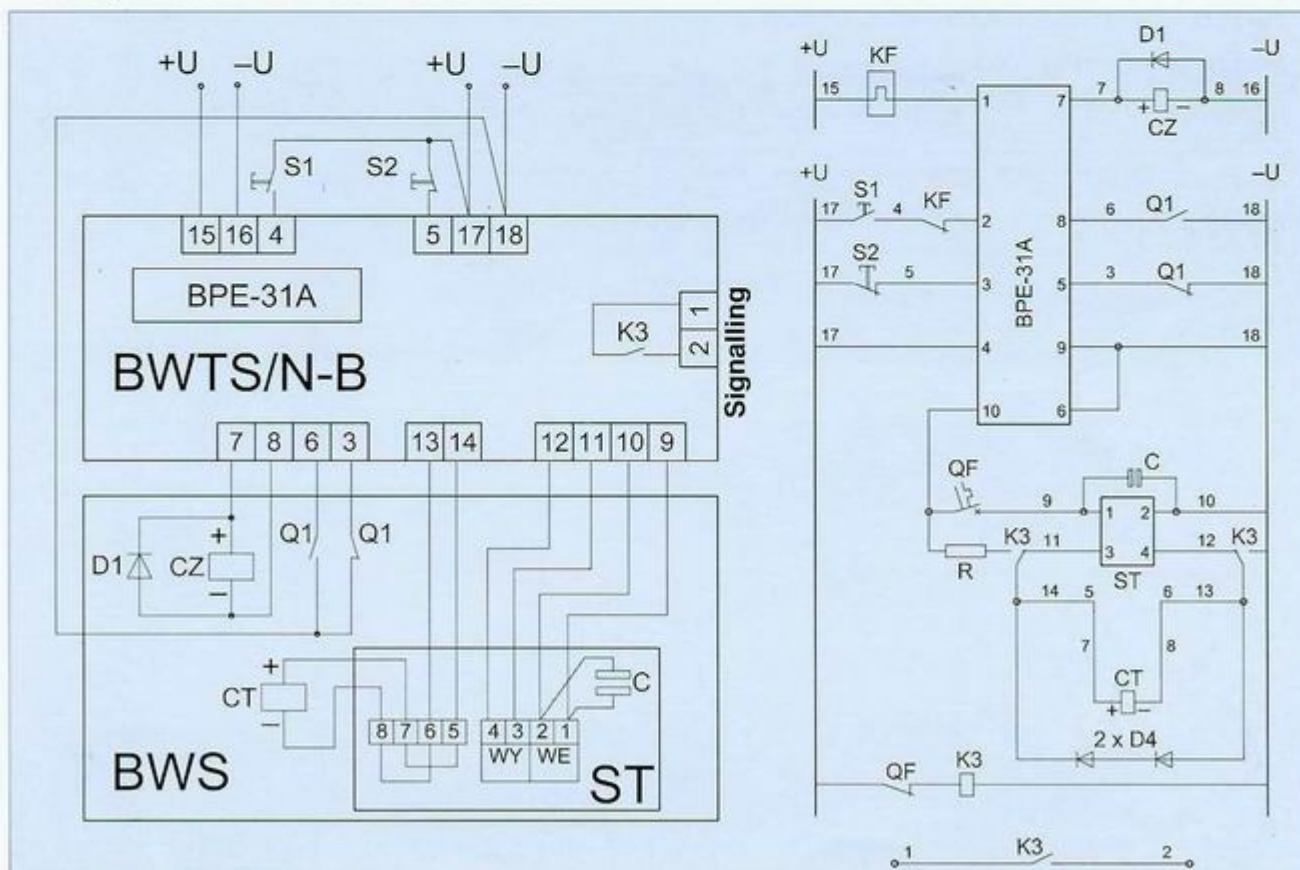




### BWTS-B CONTROL BOARD 220 V AC

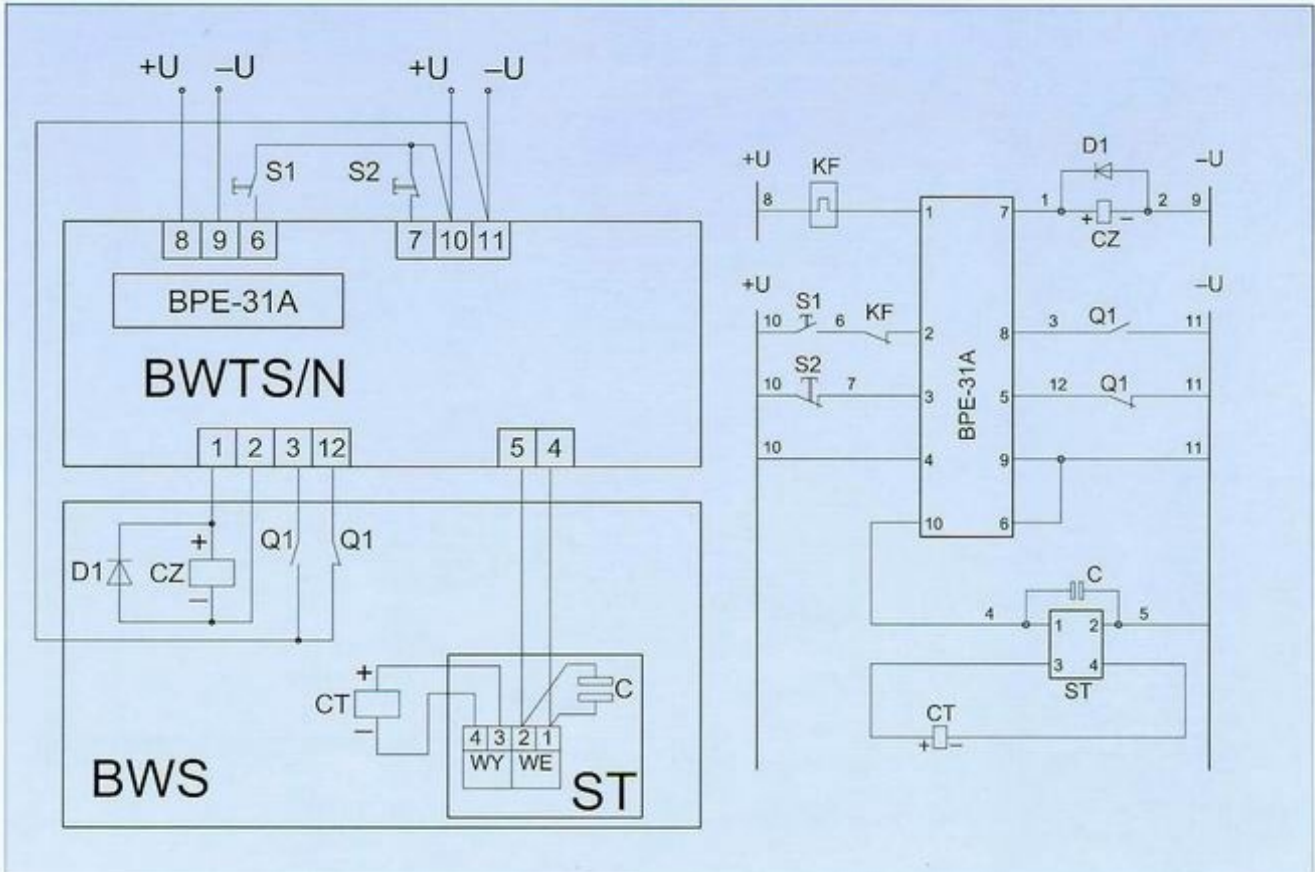


### BWTS/N-B CONTROL BOARD 220 V DC





## BWTS/N CONTROL BOARD 220 V DC

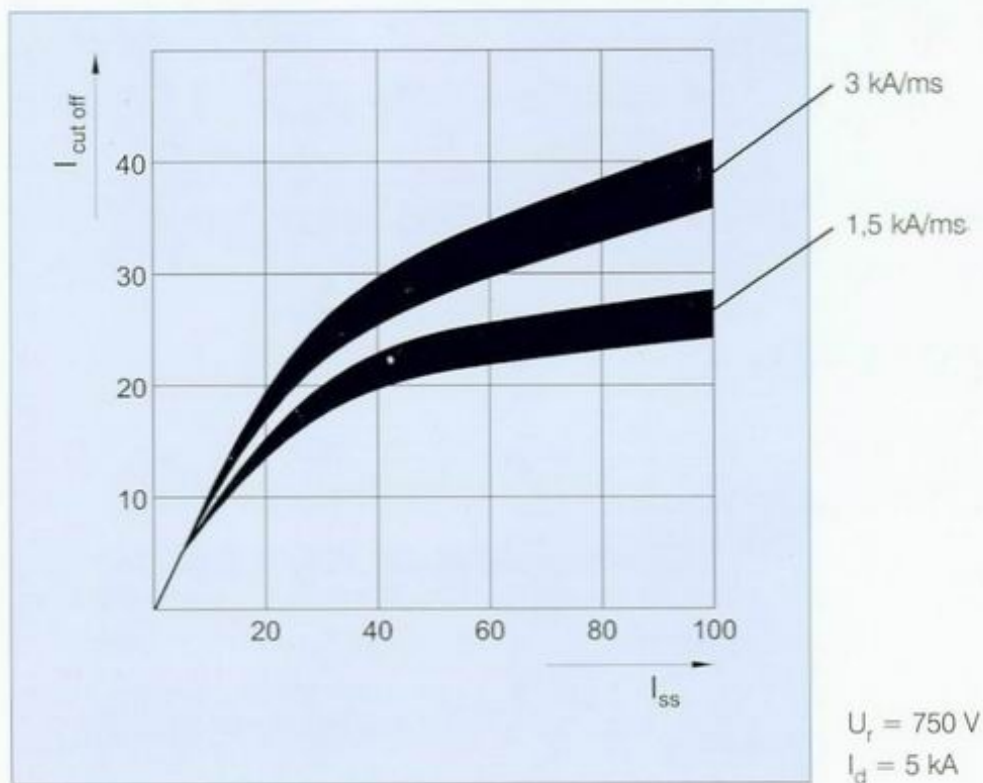
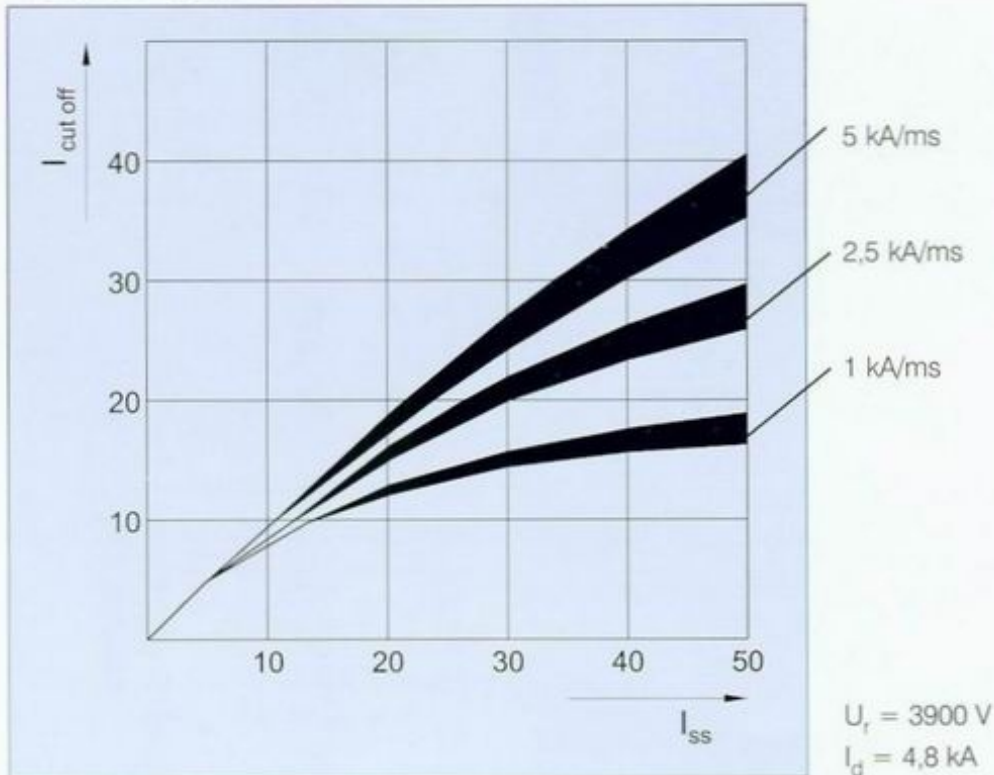


### RATED VOLTAGE OF CONTROL BOARDS

Control board	Rated voltage			
	55 VDC	110 VDC	220 VDC	220 VAC
BWTS	55 VDC	110 VDC	220 VDC	220 VAC
BWTS/N	220 VDC			
BWTS - B	110 VDC	220 VDC	220 VAC	
BWTS/N - B	220 VDC			



## CUT-OFF CURRENT CHARACTERISTICS



$I_{\text{ss}}$  – prospective short circuit current;  
 $I_d$  – over-current release setting;  
 $I_{\text{cut off}}$  – cut-off current;  
 $U_r$  – recovery voltage

## EXAMPLE TEST CYCLE OSCILLOGRAM OF BWS CIRCUIT BREAKER WITH KBD-3/50b ARC CHUTE

Test parameters:

BWS 2500 A with KBD-3/50b built-in APENA switchboard

- test cycle: O - 15 s - CO - 15 s - CO - 60 s - CO

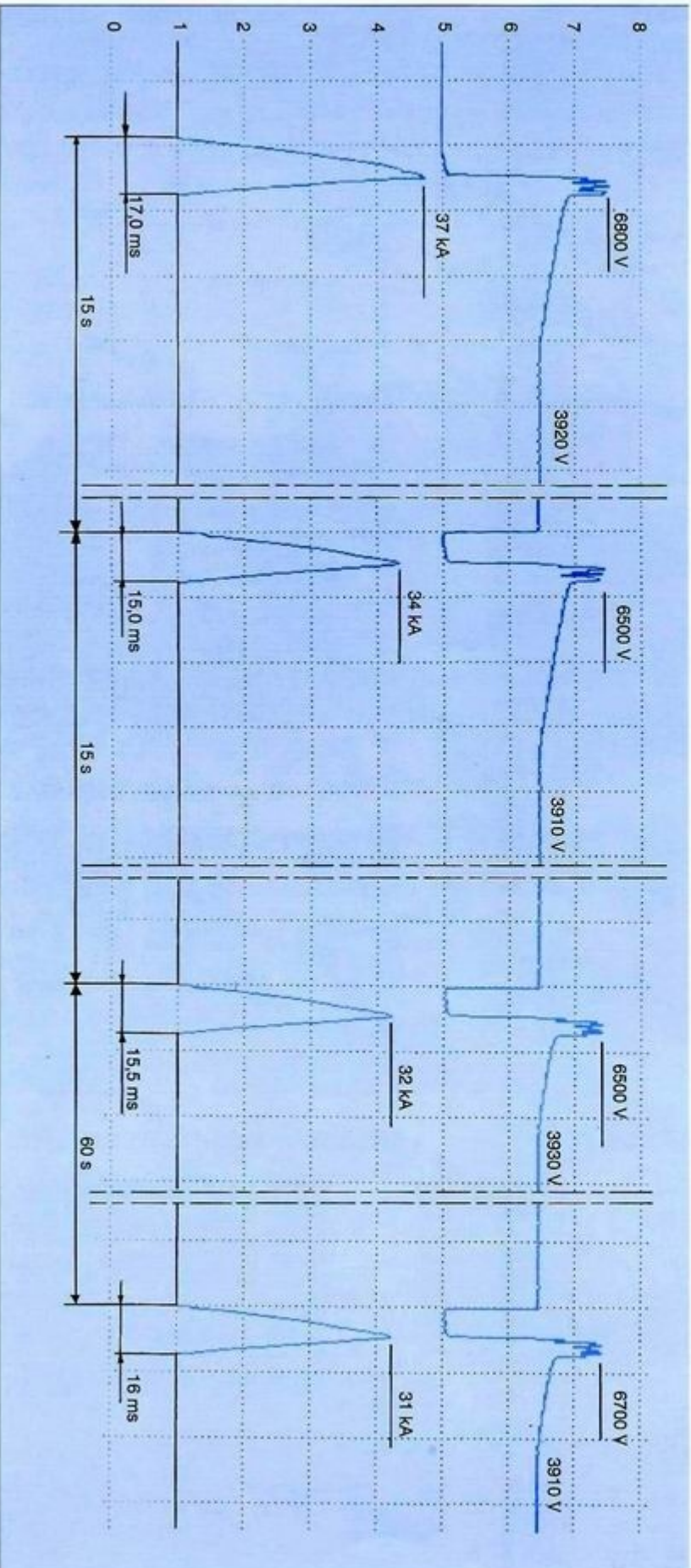
-  $U_r = 3900$  V

-  $I_{ss} = 44$  kA

-  $T = 7.2$  ms

-  $I_D = 4800$  A

$I_D$  = over-current release setting current





## 2xBWS CIRCUIT-BREAKER

The 2xBWS circuit-breaker is a factory made set of two parallel connected BWS circuit-breakers mounted on a common frame equipped with wheels. The over-current releases of the circuit breakers are connected parallel with the help of an additional equalising bus-bar. It provides, that the flow of current through the releases is independent of the resistance differences in the current circuits of both circuit-breakers.

### TECHNICAL DATA

1	Circuit breaker type	-	2xBWS
2	Rated voltage $U_{Ne}$	V	600, 825, 1500 DC
3	Rated insulation voltage	Main circuit	4000
		Auxiliary circuits	800
4	Dielectric strength of main circuit insulation	50 Hz, 1 min	15
		1,2 / 50 $\mu$ s	35
5	Rated service current $I_{Ne}$	A	4000; 5000; 6000
6	Electrical life at $U_e=1,25 U_{Ne}$ , $I_e=I_{Ne}$	-	1 000 operating cycles
7	Mechanical endurance	-	50 000 cycles
8	Making capacity for overload currents	-	$\leq 70$ % of release current setting
9	Rated short-circuit breaking capacity	-	see table page 7
10	Opening time ( $di/dt \geq 0,5$ kA/ms)	ms	$\leq 5$
11	Voltage of holding coil	with holding current stabilizer	110, 220 DC; 220 AC
		without holding current stabilizer	110, 220 DC; 220 AC
12	Voltage range of holding coil	-	0,8 ÷ 1,1
13	Power consumption of holding coil	with holding current stabilizer	2 x 45
		without holding current stabilizer	2 x 100
14	Voltage of closing coil	V	110, 220 DC; 220 AC
15	Voltage range of closing coil	-	0,8 ÷ 1,1
16	Power consumption of closing coil	W	2 x 1600
17	Number of switches	-	2 x (6a + 6b)

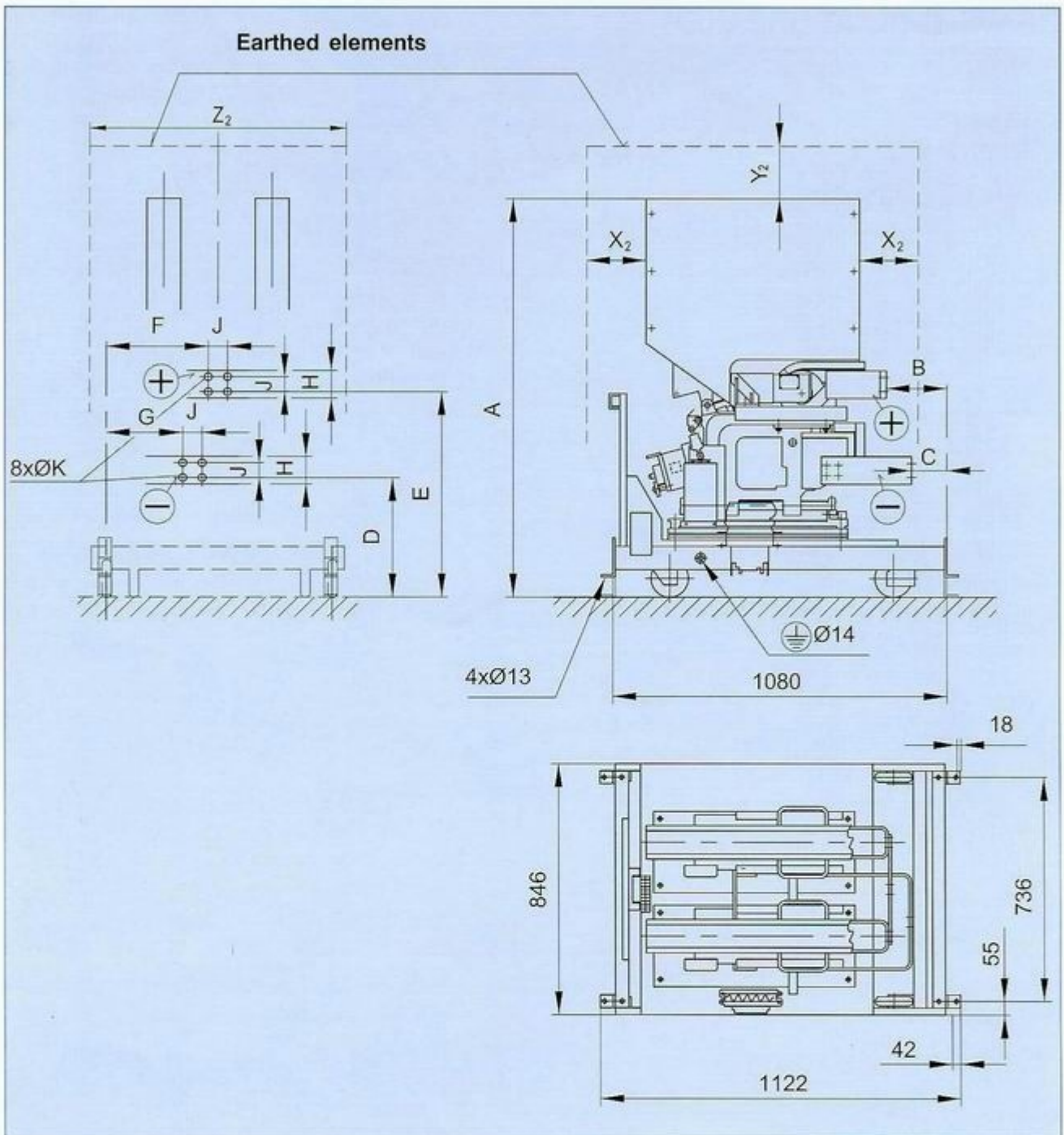
### OVERALL DIMENSIONS

#### DIMENSIONS OF CIRCUIT BREAKERS WITH ARC CHUTES AND ARC ZONES

Arc chute	Rated voltage	A mm	X2 mm	Y2 mm	Z2 mm
KBS - 0,6	600 V	1016	200	500	1000
KBS - 0,8	825 V	1016	200	500	1000
KBD - 1,5	1500 V	1096	600	800	1300

#### VARIABLE TERMINAL DIMENSIONS

Rated current	B	C	D	E	F	G	H	J	K
4000 A	170	95	455	680	365	228	50	26	11
5000 A	191	70	417	660	343	208	100	50	17
6000 A	191	70	417	660	343	208	100	50	17



### RELEASE SETTING RANGES

Circuit breaker rated current	Current setting range		
4000 A	2400 - 4800 A	3000 - 6000 A	3600 - 7200 A
5000 A	3200 - 6400 A	4000 - 8000 A	4800 - 9600 A
6000 A	4000 - 8000 A	5000 - 10000 A	6000 - 12000 A



# ORDER FORMS

## BWS CIRCUIT BREAKER ORDER FORM

Orderer:

Order number:

Quantity

Rated voltage:

3000 V     
  1500 V     
  825 V     
  600 V

Arc shute:

KBD-3/50b     KBDk-3/50b  
 KBDd-3/50b    KBDp-3/50b

KBD-1,5     
  KBS-0,8     
  KBS-0,6

Circuit breaker without arc shute

Sets of elements for adapting WSe WSp to operation to arc shutes:

KBD-3/50b     KBDk-3/50b     KBD-1,5     KBS-0,6  
 KBDd-3/50b    KBDp-3/50b     KBS-0,8

Number of auxiliary switches:

6a + 6b  
 7a + 7b

Rated current of circuit breaker:

630 A     1000 A     1600 A     2000 A     2500 A     3150 A

Release current ranges:

360-720 A     600-1200 A     960-1920 A     1200-2400 A     1800-4000 A     3000-6000 A  
 480-960 A     800-1600 A     1200-2400 A     1500-4000 A     2400-4800 A     4000-8500 A  
 600-1200 A     1000-2000 A     1600-3200 A     1600-3200 A     2000-4000 A  
 675-1350 A     2000-4000 A     2000-5000 A

Other 1)  -  A

Holding coil voltage:

Without holding current stabilizer:

55 V DC     110 V DC     220 V DC     220 V AC

With holding current stabilizer:

110 V DC     220 V DC     220 V AC

Type and voltage of closing mechanism:

electromagnetic

55 V DC     110 V DC     220 V DC  
 600 V DC     220 V AC

electropneumatic 0,5 MPa <sup>2)</sup>

24 V DC     48 V DC     55 V DC  
 110 V DC     220 V DC

Type and voltage of control board: <sup>3)</sup>

BWTS <sup>4)</sup>

55 V DC     110 V DC  
 220 V DC     220 V AC

BWTS/N <sup>5)</sup>

220 V DC

No board

BWTS-B <sup>6)</sup>

110 V DC     220 V DC  
 220 V AC

BWTS/N-B <sup>7)</sup>

220 V DC



## 2xBWS CIRCUIT BREAKER ORDER FORM

Orderer:

Order number:

Quantity:

Rated voltage:

1500 V

825 V

600 V

Arc shute:

KBD-1,5

KBS-0,8

KBS-0,6

Holding coil voltage:

110 V DC  220 V DC

220 V AC  stabilizer

Rated current:

4000 A

5000 A

6000 A

Closing coil voltage:

110 V DC  220 V DC

220 V AC

Release current ranges:

2400-4800 A

3200-6400 A

4000-8000 A

3000-6000 A

4000-8000 A

5000-10000 A

3600-7200 A

4800-9600 A

6000-12000 A

Other <sup>1)</sup>

-  A

## ORDER FORM FOR SPARE PARTS

Orderer:

Order number:

Quantity:

Arc shute:

KBD-3/50b

KBDk-3/50b

KBDd-3/50b

KBDp-3/50b

KBD-1,5

KBS-0,8

KBS-0,6

Main contacts:

Rated voltage of circuit breaker: 600, 825, 3000 V

630 - 2000 A

2500 A

3150 A

Rated voltage of circuit breaker: 1500 V

630 - 2000 A

2500 A

3150 A

## NOTES TO ORDER FORMS

- 1) Release range as agreed
- 2) Version with no control board
- 3) Relationship between control voltages and holding coil voltages are given in the section 'Control Boards'
- 4) Board with electromechanical relays without a by-pass circuit
- 5) Board with electronic relays without a by-pass circuit
- 6) Board with electromechanical relays with a by-pass circuit for holding coil with stabilizer
- 7) Board with electronic relays with a by-pass circuit for holding coil with stabilizer



**FAE „APENA” SA offers  
also the following products:**

- DC Switchboards - type RPS for tramway, railway and underground substations;
- STB/BWS test unit for testing the release of the BWS circuit-breaker;
- Measuring unit for measuring the resistance of the short-circuit loop of traction feeders

## OUR PRODUCT RANGE

- High speed circuit breakers
- LV HRC fusegear
- Pole mounted fuse switches
- Fuse disconnecter switches
- DC contactors
- High current disconnectors
- LV switchboards
- DC switchboards for railway, tram, etc substations
- LV pole mounted switchboards
- Work time counters
- Temperature regulators
- Inverters
- Brushless servo-drives
- Drive units for machine tools
- Thyristor controller for batterie fed trucks



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CERTIFICATES  
**ISO 9001**  
**ISO 14001**  
GERMANISCHER LLOYD  
POLSKI REJESTR STATKÓW