Table 58. Event recorder DRPRDRE

Function		Value
Buffer capacity	Maximum number of events in disturbance report	150
	Maximum number of disturbance reports	100
Resolution		1 ms
Accuracy		Depending on time synchronizing

Table 59. Trip value recorder DRPRDRE

Function		Value
Buffer capacity	Maximum number of analog inputs	30
	Maximum number of disturbance reports	100

Table 60. Disturbance recorder DRPRDRE

Function		Value
Buffer capacity	Maximum number of analog inputs	40
	Maximum number of binary inputs	96
	Maximum number of disturbance reports	100
Maximum total recording time (3.4 s recording time and maximum number of channels, typical value)		340 seconds (100 recordings) at 50 Hz 280 seconds (80 recordings) at 60 Hz

Table 61. Station battery supervision SPVNZBAT

Function	Range or value	Accuracy
Lower limit for the battery terminal voltage	(60-140) % of Ubat	± 1.0% of set battery voltage
Reset ratio, lower limit	<105 %	-
Upper limit for the battery terminal voltage	(60-140) % of Ubat	± 1.0% of set battery voltage
Reset ratio, upper limit	>95 %	-
Timers	(0.000-60.000) s	± 0.5% ± 110 ms
Battery rated voltage	20-250V	-

Table 62. Insulation gas monitoring function SSIMG

Function	Range or value	Accuracy
Timers	(0.000-60.000) s	± 0.5% ± 110 ms

Table 63. Insulation liquid monitoring function SSIML

Function	Range or value	Accuracy
Timers	(0.000-60.000) s	± 0.5% ± 110 ms

Table 64. Circuit breaker condition monitoring SSCBR

Function	Range or value	Accuracy
Alarm levels for open and close travel time	(0-200) ms	± 0.5% ± 25 ms
Alarm levels for number of operations	(0 - 9999)	-
Setting of alarm for spring charging time	(0.00-60.00) s	± 0.5% ± 25 ms
Time delay for gas pressure alarm	(0.00-60.00) s	± 0.5% ± 25 ms
Time delay for gas pressure lockout	(0.00-60.00) s	± 0.5% ± 25 ms

Metering

Table 65. Pulse counter PCGGIO

Function	Setting range	Accuracy
Cycle time for report of counter value	(1-3600) s	-

Table 66. Function for energy calculation and demand handling ETPMMTR

Function	Range or value	Accuracy
Energy metering	MWh Export/Import, MVArh Export/Import	Input from MMXU. No extra error at steady load

Station communication

Table 67. Communication protocol

Function	Value
Protocol TCP/IP	Ethernet
Communication speed for the IEDs	100 Mbit/s
Protocol	IEC 61850–8–1
Communication speed for the IEDs	100BASE-FX
Protocol	DNP3.0/TCP
Communication speed for the IEDs	100BASE-FX
Protocol, serial	IEC 60870–5–103
Communication speed for the IEDs	9600 or 19200 Bd
Protocol, serial	DNP3.0
Communication speed for the IEDs	300–115200 Bd

Hardware

IED

Dimensions

Table 68. Dimensions of the IED - 3U full 19" rack

Description	Value
Width	442 mm (17.40 inches)
Height	132 mm (5.20 inches), 3U
Depth	249.5 mm (9.82 inches)
Weight box	10 kg (<22.04 lbs)

Inverse time characteristics

Table 69. ANSI inverse time characteristics

Function	Range or value	Accuracy
Operating characteristic: $t = \left(\frac{A}{(I^P - 1)} + B\right) \cdot k + tDef$	k = (0.05-999) in steps of 0.01	-
$I = I_{measured}/I_{set}$		
ANSI Extremely Inverse	A=28.2, B=0.1217, P=2.0	
ANSI Very Inverse	A=19.61, B=0.491, P=2.0	
ANSI Normal Inverse	A=0.0086, B=0.0185, P=0.02, tr=0.46	
ANSI Moderately Inverse	A=0.0515, B=0.1140, P=0.02	
ANSI Long Time Extremely Inverse	A=64.07, B=0.250, P=2.0	
ANSI Long Time Very Inverse	A=28.55, B=0.712, P=2.0	
ANSI Long Time Inverse	A=0.086, B=0.185, P=0.02	

Table 70. IEC inverse time characteristics

Function	Range or value	Accuracy
Operating characteristic: $t = \left(\frac{A}{(I^P - 1)}\right) \cdot k$	k = (0.05-999) in steps of 0.01	-
$I = I_{measured}/I_{set}$		
IEC Normal Inverse	A=0.14, P=0.02	
IEC Very Inverse	A=13.5, P=1.0	
IEC Inverse	A=0.14, P=0.02	
IEC Extremely Inverse	A=80.0, P=2.0	
IEC Short time inverse	A=0.05, P=0.04	
IEC Long time inverse	A=120, P=1.0	

The parameter setting *Characterist1 and 4/ Reserved* shall not be used, since this parameter setting is for future use and not implemented yet.

Table 71. RI and RD type inverse time characteristics

Function	Range or value	Accuracy
RI type inverse characteristic $t = \frac{1}{0.339 - \frac{0.236}{I}} \cdot k$ $I = I_{measured}/I_{set}$	k = (0.05-999) in steps of 0.01	
RD type logarithmic inverse characteristic $t = 5.8 - \left(1.35 \cdot ln\frac{I}{k}\right)$ $I = I_{measured}/I_{set}$	k = (0.05-999) in steps of 0.01	

Table 72. Inverse time characteristics for overvoltage protection

Function	Range or value	Accuracy
Type A curve: $t = \frac{k}{\left(\frac{U - U>}{U>}\right)}$ U> = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	±5% +60 ms
Type B curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{2.0}} - 0.035$	k = (0.05-1.10) in steps of 0.01	
Type C curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{3.0}} - 0.035$	k = (0.05-1.10) in steps of 0.01	

Table 73. Inverse time characteristics for undervoltage protection

Function	Range or value	Accuracy
Type A curve: $t = \frac{k}{\left(\frac{U< - U}{U<}\right)}$ U< = U_{set} U = $UV_{measured}$	k = (0.05-1.10) in steps of 0.01	±5% +60 ms
Type B curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U< - U}{U<} - 0.5\right)^{2.0}} + 0.055$ U< = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	

Table 74. Inverse time characteristics for residual overvoltage protection

Function	Range or value	Accuracy
Type A curve: $t = \frac{k}{\left(\frac{U - U>}{U>}\right)}$ U> = U_{set} U = $U_{measured}$	k = (0.05-1.10) in steps of 0.01	±5% +70 ms
Type B curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{2.0}} - 0.035$	k = (0.05-1.10) in steps of 0.01	
Type C curve: $t = \frac{k \cdot 480}{\left(32 \cdot \frac{U - U>}{U>} - 0.5\right)^{3.0}} - 0.035$	k = (0.05-1.10) in steps of 0.01	

20. Ordering for Customized IED

Guidelines

Carefully read and follow the set of rules to ensure order management. Be aware that certain functions can only be ordered in combination with other functions and that some functions require specific hardware selections.

Product specification

Basic IED 650 platform and common functions housed in 3U 1/1 sized 19" casing

RET650 Quantity: ☐ 1MRK 006 516-AD

Option:

Customer specific configuration On request

Connection type for Analog modules

Rule: One connection type must be selected

Compression terminals ☐ 1MRK 002 960-CA

Ring lug terminals ☐ 1MRK 002 960-DA

Connection type for Power supply, Input/Output and communication modules

Rule: One connection type must be selected

Compression terminals ☐ 1MRK 002 960-EA

Ring lug terminals ☐ 1MRK 002 960-FA

Power supply module

Rule: One Power supply module must be specified

Power supply module	PSM01	24–30V DC, 9BO	☐ 1KHL178029R0001
	PSM02	48–125V DC, 9BO	☐ 1KHL178073R0001
	PSM03	110–250V DC, 100–240V AC, 9BO	☐ 1KHL178082R0001

Communication and processing modules

Rule: One Communication and processing module must be selected
For redundant station communication PRP, COM03 must be selected.

Communication and processing module COM05, 12BI, IRIG-B, RS485, Ethernet LC optical, ST serial ☐ 1MRK 002 346-AA

Communication and processing module COM03, IRIG-B, RS485, 3 Ethernet LC optical, ST serial, ST PPS Slave ☐ 1MRK 002 346-BA
The 3rd Ethernet port and PPS Slave is not supported in this release.

Differential protection

Rule: One and only one of Transformer differential protection can be ordered

Transformer differential protection, two winding T2WPDIF Qty: ☐ 1MRK 004 904-AB

Transformer differential protection, three winding T3WPDIF Qty: ☐ 1MRK 004 904-BB

Logic

Rule: One Tripping logic must be ordered

Tripping logic, common 3-phase output SMPPTRC Qty: 1 2 3 ☐ ☐ ☐ 1MRK 004 922-AA

Optional functions

Differential protection

Restricted earth fault protection, low impedance REFPDIF Qty: 1 2 3 ☐ ☐ ☐ 1MRK 004 904-CA

1Ph High impedance differential protection HZPDIF Qty: 1 2 ☐ ☐ 1MRK 004 904-DA

Impedance protection

Power swing detection ZMRPSB Qty: ☐ 1MRK 004 906-GA

Underimpedance protection for generators and transformers ZGCPDIS Qty: ☐ 1MRK 004 906-SA

Load enchroachment LEPDIS Qty: ☐ 1MRK 004 906-NA

Current protection

Instantaneous phase overcurrent protection, 3-phase output PHPIOC Qty: 1 2 3 ☐ ☐ ☐ 1MRK 004 908-AA

Four step phase overcurrent protection, 3-phase output OC4PTOC Qty: 1 2 3 ☐ ☐ ☐ 1MRK 004 908-BC

Instantaneous residual overcurrent protection EFPIOC Qty: 1 2 3 ☐ ☐ ☐ 1MRK 004 908-CA

Four step residual overcurrent protection, zero/negative sequence direction EF4PTOC Qty: 1 2 3 ☐ ☐ ☐ 1MRK 004 908-FA

Thermal overload protection, two time constants TRPTTR Qty: 1 2 3 ☐ ☐ ☐ 1MRK 004 908-KB

Breaker failure protection, 3-phase activation and output CCRBRF Qty: 1 2 3 ☐ ☐ ☐ 1MRK 004 908-LA

Pole discordance protection CCRPLD Qty: 1 2 3 ☐ ☐ ☐ 1MRK 004 908-NA

Directional underpower protection GUPPDUP Qty: 1 2 ☐ ☐ 1MRK 004 908-RB

Directional overpower protection GOPPDOP Qty: 1 2 ☐ ☐ 1MRK 004 908-SB

Negative sequence based overcurrent function DNSPTOC Qty: 1 2 ☐ ☐ 1MRK 004 908-TB

Voltage protection

Two step undervoltage protection UV2PTUV	Qty:	1 2	1MRK 004 910-AB
Two step overvoltage protection OV2PTOV	Qty:	1 2	1MRK 004 910-BB
Two step residual overvoltage protection ROV2PTOV	Qty:	1 2	1MRK 004 910-CB
Overexcitation protection OEXPVPH	Qty:		1MRK 004 910-DC

Frequency protection

Underfrequency protection SAPTUF	Qty:	1 2 3 4	1MRK 004 912-AA
Overfrequency protection SAPTOF	Qty:	1 2 3 4	1MRK 004 912-BA
Rate-of-change frequency protection SAPFRC	Qty:	1 2 3 4	1MRK 004 912-CA

Control

Rule: Only one of the Circuit breakers or APC8 can be ordered

Apparatus control for single bay, max 8 app. 1CB incl. interlocking APC8	Qty:		1MRK 004 917-GA
Circuit breaker for 2 CB, CBC2	Qty:		1MRK 004 918-BA
Circuit breaker for 3 CB, CBC3	Qty:		1MRK 004 918-CA
Circuit breaker for 4 CB, CBC4	Qty:		1MRK 004 918-DA
Automatic voltage control for tapchanger, parallel control TR8ATCC	Qty:	1 2	1MRK 004 917-EB
Tap changer control and supervision, 6 binary inputs, TCMYLTC	Qty:	1 2	1MRK 004 917-FB

Logic

Configurable logic blocks Q/T			1MRK 002 917-MK

Monitoring

Station battery supervision SPVNZBAT	Qty:		1MRK 004 925-HB
Insulation gas monitoring function SSIMG	Qty:	1 2	1MRK 004 925-KA
Insulation liquid monitoring function SSIML	Qty:	1 2	1MRK 004 925-LA
Circuit breaker condition monitoring SSCBR	Qty:	1 2 3	1MRK 004 925-MA

First local HMI user dialogue language

HMI language, English IEC			Always included

Additional local HMI user dialogue language

HMI language, English US			1MRK 002 940-MA

Optional hardware

Human machine interface

Rule: One must be ordered.

Display type	Keypad symbol	Case size		
Local human machine interface LHMI01	IEC	3U 1/1 19"		1KHL160055R0001
Local human machine interface LHMI01	ANSI	3U 1/1 19"		1KHL160042R0001

Analog system

Rule: One Transformer input module must be ordered

Transformer module TRM01	6I+4U, 1/5A,100/220V	Qty:		1KHL178083R0001
Transformer module TRM01	8I+2U, 1/5A, 100/220V	Qty:		1KHL178083R0013
Transformer module TRM01	4I, 1/5A+1I, 0.1/0.5A+5U, 100/220V	Qty:		1KHL178083R0016
Transformer module TRM01	4I+6U, 1/5A, 100/220V	Qty:		1KHL178083R0003

Rule: Only one Analog input module can be ordered

Analog input module AIM01	6I+4U, 1/5A, 100/220V	Qty:		1KHL178083R5001
Analog input module AIM01	4I, 1/5A+1I, 0.1/0.5A+5U, 100/220V	Qty:		1KHL178083R5016

Binary input/output modules

Note: If analog input module AIM is ordered only 2 BIO modules can be ordered

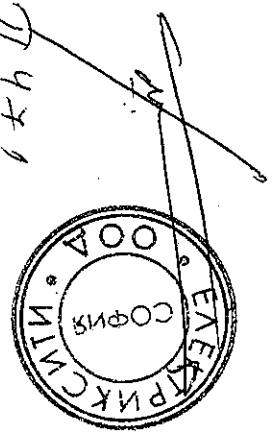
Binary input/output module BIO01	Qty:	1 2 3 4	1KHL178074R0001

Rack mounting kit

Rack mounting kit for 3U 1/1 x 19" case	Quantity:		1KHL400352R0001

Related documents

Documents related to RET650	Identity number
Application manual	1MRK 504 134-UEN
Technical manual	1MRK 504 135-UEN
Commissioning manual	1MRK 504 136-UEN
Product Guide, configured	1MRK 504 137-BEN
Type test certificate	1MRK 504 137-TEN
Application notes for Circuit Breaker Control	1MRG006806
650 series manuals	**Identity number**
Communication protocol manual, DNP 3.0	1MRK 511 280-UEN
Communication protocol manual, IEC 61850-8-1	1MRK 511 281-UEN
Communication protocol manual, IEC 60870-5-103	1MRK 511 282-UEN
Cyber Security deployment guidelines	1MRK 511 285-UEN
Point list manual, DNP 3.0	1MRK 511 283-UEN
Engineering manual	1MRK 511 284-UEN
Operation manual	1MRK 500 096-UEN
Installation manual	1MRK 514 016-UEN
Accessories, 650 series	1MRK 513 023-BEN
MICS	1MRG 010 656
PICS	1MRG 010 660
PIXT	1MRG 010 658



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Power and productivity
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Relion® 650 series

Accessories for 650 series IEDs
Product Guide

Power and productivity
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ABB

Contents

Disclaimer

1. Available accessories

Mounting kits
- Mounting kits for space-saving mounting in racks and cubicles and on walls

RHGS cases
- RHGS 6, RHGS 12 and RHGS 30 cases enable mounting of for example Combiflex modules

Test switch module
- Fail-safe testing of IEDs, using test switch RTXP 24
- Time saving while
  - all connections for test are made from the front
  - easy to move between IEDs of the same type

Combiflex modules
- Provide functionality such as lock-out, lock-out reset and external contact re-enforcement
- Supervision

Key switch for settings
- Possibility to lock settings with key switch

Connectors
- Flexible connection of analog and binary signals
  - Screw compression type
  - Terminal blocks suitable for ring-lugs

External resistor unit
- Used with the High impedance differential protection

Injection equipment hardware RXTTE4
- Used with the rotor earth fault protection to inject voltage and current signals to the generator or motor

ESD Field Kit
- Used to make work ESD safe

Power Supply
- Used to supply power to the IED

Configuration and monitoring tools
- Protection and control manager, PCM600, used to
  - configure the IED
  - set parameters
  - monitor the IED and the system
  - visualize and evaluate disturbance recordings

Cable and dust cover
- The cable is used to connect a PC to the RJ45 port on the local human machine interface
- The dust cover protects the RJ45 port

Labels
- Used to label the LEDs

2. Mounting kit for 3U

19" rack mounting for a single IED
Use the 19" rack mounting kit to mount the IED in a standard rack.

The 19" rack mounting kit for 3U housing consists of two mounting brackets with appropriate mounting details for fastening to the case.

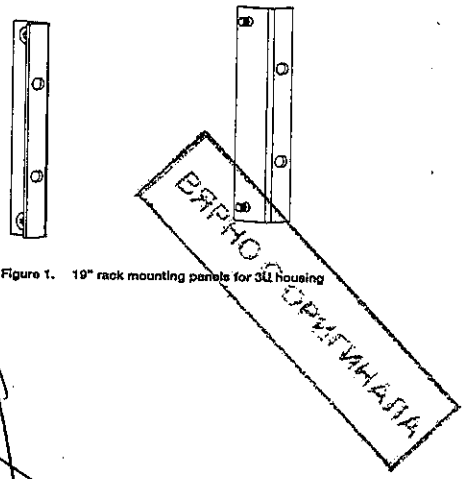


Figure 1. 19" rack mounting panels for 3U housing

3. Mounting kits for 6U

19" rack mounting for a single IED
Use the 19" rack mounting kit for 6U housing to mount the IED in a standard rack.

The 19" rack mounting kit consists of two mounting brackets with appropriate mounting details for fastening to the case.

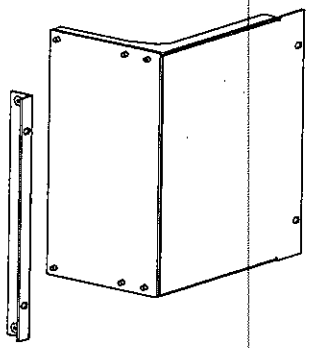


Figure 2. 19" rack mounting panels for 6U housing

Flush mounting
Use the flush mount kit for installation in a panel cut out.

The flush mounting kit for one 6U half 19" housing IED consists of a mounting frame and appropriate mounting details.

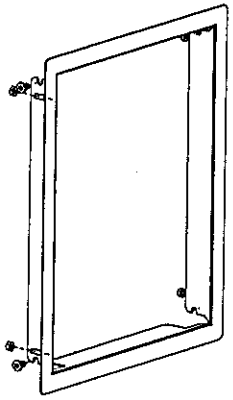


Figure 3. Flush mounting frame

Wall mounting
Use the wall mounting kit for one 6U half 19" housing IED to projection mount the IED on a wall.

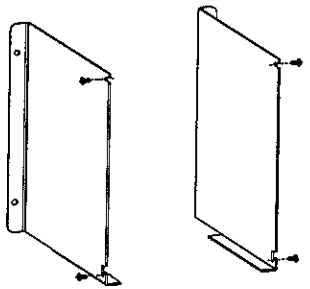


Figure 4. 6U wall mounting brackets

The wall mounting kit consists of an IED bracket pair. Screws and washers for fastening of the brackets to the IED are included, but not wall fasteners.

Wall mounting of IED with detached LHMI display
Use the wall mounting kit for one 6U half 19" housing IED to wall mount the main unit with detached display. An optional cable for connecting to the detached display is not included in the kit.

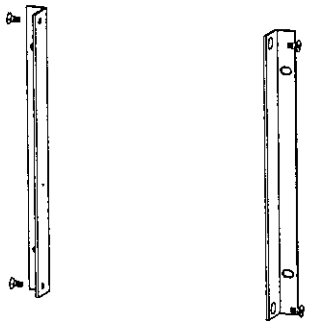


Figure 5. 6U main unit mounting brackets for IED with detached LHMI display

The wall mounting kit consists of an IED bracket pair. Screws and washers for fastening of the brackets to the IED are included, but not wall fasteners.

Rack mounting kit for two IEDs
Use the rack mounting kit to mount two IEDs next to each other.

The rack mounting kit for two 6U half 19" housing IEDs consists of upper mounting bracket, right mounting bracket, lower mounting bracket, left mounting bracket, middle mounting brackets and appropriate screws. The side-by-side mounted units are mounted in a rack or cubicle.

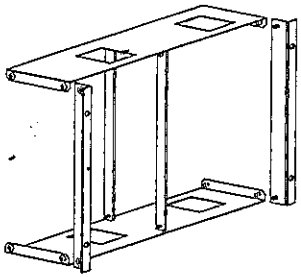


Figure 6. 19" rack mounting kit for two IEDs

Mounting kit for a RHGS 6 case next to an IED
Use the mounting kit to mount a RHGS 6 case next to one 6U half 19" housing IED.

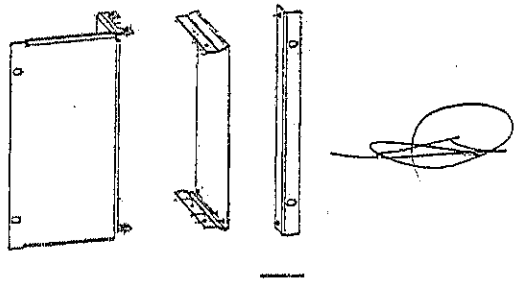


Figure 7. 6U 1/2 19" housing + RHGS 6 mounting brackets

The mounting kit for mounting a RHGS 6 case next to a 19" housing IED consists of right mounting bracket, middle mounting bracket and left mounting bracket. The side-by-side mounted units are mounted in a rack or cubicle. Screws and washers for fastening of the brackets to the IED are included, but not wall fasteners.

4. RHGS cases

RHGS Cases
Color matched (RAL7035) RHGS cases can be used to mount for example Combiflex modules together with 650 series.See section "Related documents" for reference to more detailed information about dimensions and mounting details for RHGS cases. Please observe that cases in referenced document has a different color.

5. Test switch module

General
The test switch module consists of a RHGS 6 case with a test switch, RTXP 24, and a two-seat Combiflex terminal base mounted. An optional DC-switch occupies one seat if selected.

All connections to the test switch module are made with Combiflex socket leads. Test contacts 1-24 of the test switch have 20 A Combiflex terminals. The signal contact of the test switch and the Combiflex terminal base have 10 A terminals.

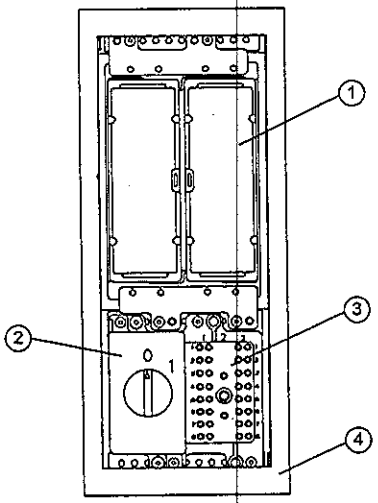
Two versions of the test switch module are available for use with:

- 3U IEDs
- 6U IEDs

The 3U version includes a test switch module and mounting details for 19" rack mounting over or under the IED.

The 6U version includes a test switch module and mounting details for 19" rack mounting of the test switch module side by side with a 6U 1/2 x 19" housing IED.

For more details about the Combitest system and Combiflex system see section "Related documents".



1 Test switch
2 DC switch
3 Spare seat, can be used for Key switch
4 RHGS 6 case

Figure 8. Example of a test switch module

Test switch
The test switch, RTXP 24, is used to make it possible to test an IED in a failsafe way. Inserting a test-plug handle into the test switch automatically makes all preparations for test in the proper sequence. Blocked trip circuits, shortcircuited CT's, opened voltage circuits makes the IED terminals available for secondary injection test.

DC-switch
The DC-switch is optional in the test switch module and are used to switch the DC-supply of the IED ON/OFF.

The DC-switch is of one seat Combiflex type and needs a Combiflex terminal base to be mounted.

6. Key switch for settings

The key switch for lock-out of settings via the local human machine interface is used to prevent unwanted changes of settings. The switch locks the settings via a binary input.

The key switch is of one seat Combiflex type. To install it, a case including a Combiflex terminal base is needed. One possibility is to install the key switch in the same case as the test switch.

7. Combiflex modules

Auxiliary relays

Auxiliary relays can be used together with the IED to provide functionality such as lock-out, lock-out reset or external contact re-enforcement

When the contact rating of the IED is insufficient, it is recommended to use RXME 1 as a contact re-enforcement. The RXME 1 is then activated from an IED contact which is set up to be activated together with the IED contacts tripping the breaker. The contact of the RXME 1 is connected in parallel, to take over the breaker trip coil current. This gives an efficient solution and means no time delay at tripping. See figure 9.

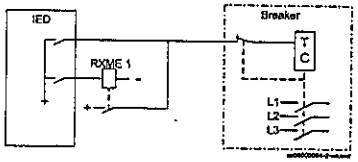


Figure 9. RXME 1 used as a trip contact re-enforcement

When single pole tripping is used one RXME 1 is required per phase and of course per subsystem in redundant systems.

Lock-out can be arranged with RXMD 1 remanence relay activated from binary outputs on IED and possible other protection relays required to activate lock-out, see figure 10. The contact of RXMD 1 is connected to open the closing circuit to the breaker closing coil. Another contact can also used to light-up a lamp push button to have indication of the lock-out and then reset with the push-button. It is recommended to avoid trip contact latching as this will mean problem for example with trip circuit supervision and further at failing breaker, mean that the trip coil is burnt and the trip coil DC supply is tripped. The most important is to prevent that the breaker is closed at persistent faults.

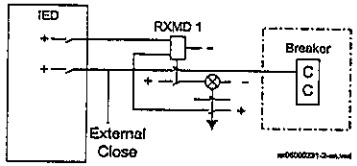


Figure 10. Lock-out using a RXMD 1 relay

For ordering codes see section "Related documents" for reference to more detailed information.

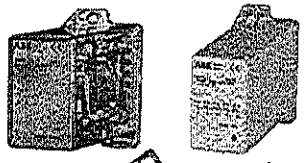


Figure 11. RMXE 1 and RXMD 1 relays

Push button and selector switch

The push button is available with or without pilot lamp and with one or two buttons. It is used to reset the lock-out relays when an external independent lock-out and lock-out indications is required. The push button unit can also be used as a local selector of Auto-Reclose operation when this is required to be done locally as well as through communication.

The selector switch is available with two or three fixed positions and with different contact combinations. Selector switch can e.g. be used as Local/Remote selector or as a local selector of Auto-Reclose operation. See section "Related documents" for reference to more detailed information.

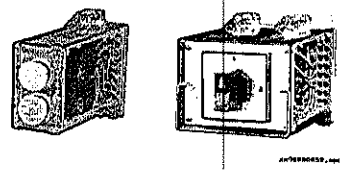


Figure 12. Push button and selector switch

Supervision relay

The relay RXEM1 can be used to detect for example loss of DC voltage supply or to detect open circuits. A typical application is continuous supervision of a circuit breaker trip circuit, including the breaker coil. See section "Related documents" for reference to more detailed information.

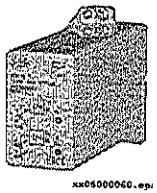


Figure 13. Supervision relay RXEM1

8. Connectors

The connectors are used for analog signals and binary in- and output signals.

Connectors for analog signals

The connectors have an automatic short-circuit mechanism for the current terminals. Therefore, detaching the connector from the unit will not open the secondary circuit of the CT which otherwise could cause dangerously high voltages.

Screw compression type

Each terminal for CTs/VTs is dimensioned for one 0.5... 6.0 mm² wire or for two wires of maximum 2.5 mm².

To help connecting the current and voltage inputs, the connector pair is marked with symbols. For a current input, the connector pair forms a circle. In the case of a voltage input, the connector pair forms two half-circles.

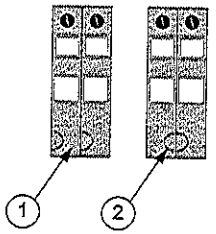


Figure 14. CT/VT connector symbols

1 VT symbol
2 CT symbol

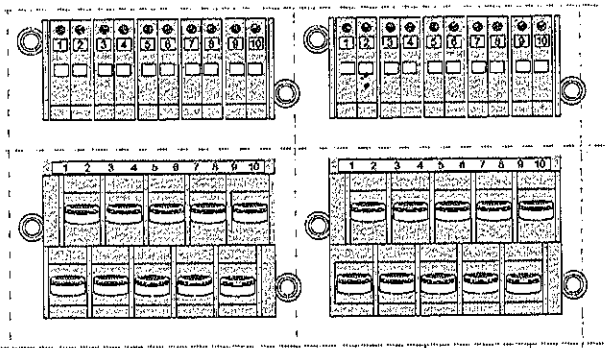
Ring-lug type

The maximum outside diameter for the M4 ring-lug type analog input terminals is 9 mm.

See the connection diagrams for information on the analog input module variant included in a particular configured IED.

Overview Analog input connectors

Table 1. Overview Analog input connectors — Transformer — AIM/TRM-variant



Terminal	1–2	3–4	5–6	7–8	9–10	1–2	3–4	5–6	7–8	9–10
Transformer	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10

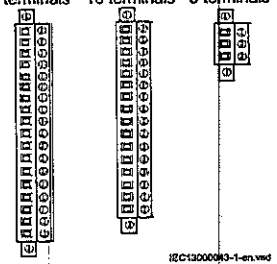
TRM/AIM Variant										
4I+1I / 5U	CT	CT	CT	CT	CTs	VT	VT	VT	VT	VT
Screw compression	1KHL380069R0001					1KHL380066R0001				
Ring-lug	1KHL380069R0002					1KHL380066R0002				
6I / 4U	CT	CT	CT	CT	CT	CT	VT	VT	VT	VT
Screw compression	1KHL380069R0001					1KHL380062R0001				
Ring-lug	1KHL380069R0002					1KHL380062R0002				
8I / 2U 1)	CT	CT	CT	CT	CT	CT	CT	CT	VT	VT
Screw compression	1KHL380069R0001					1KHL380063R0001				
Ring-lug	1KHL380069R0002					1KHL380063R0002				
4I / 6U 1)	CT	CT	CT	CT	VT	VT	VT	VT		
Screw compression	1KHL380064R0001					1KHL380066R0001				
Ring-lug	1KHL380064R0002					1KHL380066R0002				

CTs : Current Transducer (Sensitive) for 0,1 A / 0,5 A
1) TRM only

Connectors for binary signals
Screw compression type

Each signal connector terminal is connected with one 0.5...2.5 mm² wire or with two 0.5...1.0 mm² wires.

18 terminals 16 terminals 3 terminals

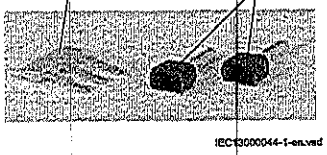


I2C13000083-1-en.vsd

Figure 15. Signal connectors, screw compression type

Use the ferrules to connect two wires to the same terminal point of a connector of screw compression type. Note that 1,5 mm² is the maximum dimension allowed on these wires. A special crimping tool from Phoenix is needed to apply the Phoenix ferrule to the wires. Use the bridge connector to jumper terminal points in a connector.

Bridge connector Ferrules



IEC13000044-1-en.vsd

Figure 16.

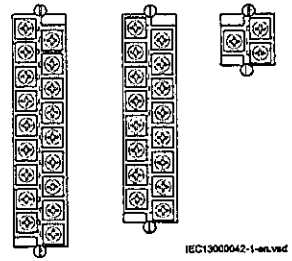
9. External resistor unit

External resistor unit
The high impedance resistor unit is used with the high impedance differential protection. It is available as one phase unit or three phase unit.

Ring-lug type
Use ring-lugs to connect the wire to terminal points of a connector of ring-lug type. Select ring-lugs suitable to wiring dimension and size of terminal point.

The maximum outside diameter for the M3 ring-lug type signal terminals is 8 mm.

18 terminals 16 terminals 3 terminals



IEC13000042-1-en.vsd

Figure 17. Signal connectors, ring-lug type

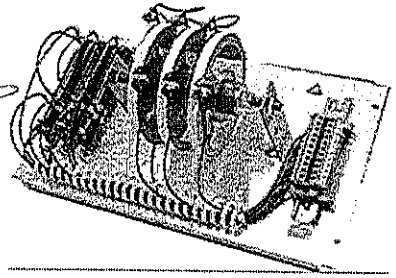


Figure 18. High impedance resistor unit, three phase

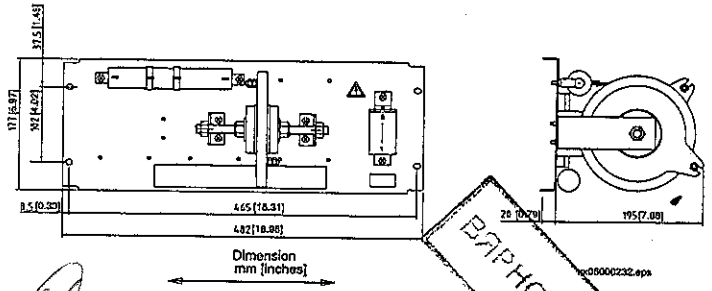


Figure 19. Dimension drawing of a one phase high impedance resistor unit

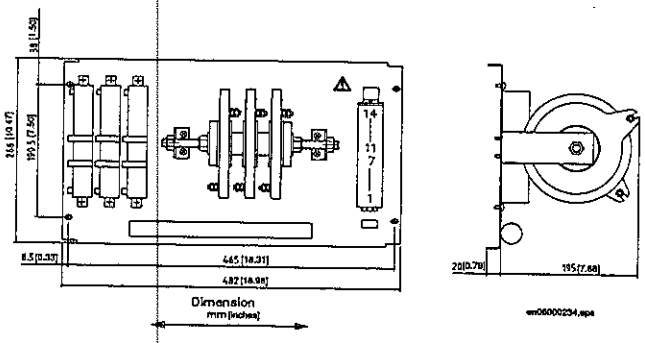


Figure 20. Dimension drawing of a three phase high impedance resistor unit

WARNING! USE EXTREME CAUTION!

Dangerously high voltages might be present on this equipment, especially on the plate with resistors. Do any maintenance ONLY if the primary object protected with this equipment is de-energized. If required by national law or standard, enclose the plate with resistors with a protective cover or install in a separate box.

10. Voltage injection unit RXTTE4

Voltage injection unit RXTTE4

The COMBIFLEX voltage injection unit RXTTE4 is used for rotor earth fault protection applications. The RXTTE 4 contains a voltage transformer with a primary winding for connection to 120 or 230 V, 50 or 60 Hz supply voltage. From the secondary winding of this internal voltage transformer approximately 40 V AC is injected via series capacitors and resistors into the rotor circuit. The injected voltage and current are fed to one voltage input and one current input on the IED.

In order to mount injection unit RXTTE4 some COMBIFLEX accessories are required; RX4 terminal base, 10A and 20A contact sockets and Crimping tool. See section "Related documents" for more detailed information.

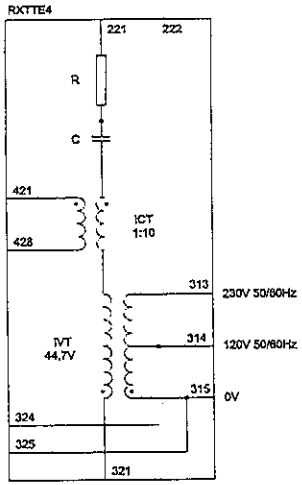


Figure 21. Voltage injection unit RXTTE4 with its main internal components

Rotor earth fault protection can be integrated in the IED among all other protection functions typically required for generator protection. How this is achieved by using COMBIFLEX injection unit RXTTE4 is described in Instruction 1MRG001910.

Table 2. Rotor earth fault protection based on Earth fault functions (SDEPSDE, EF5PTOC) and RXTTE4

Function	Range or value
For machines with:	
• rated field voltage up to	350 V DC
• static exciter with rated supply voltage up to	700 V 50/60 Hz
Supply voltage 120 or 230 V	50/60 Hz
Operate earth fault resistance value	Approx. 1–20 kΩ
Influence of harmonics in the DC field voltage	Negligible influence of 50 V, 150 Hz or 50 V, 300 Hz
Permitted leakage capacitance	(1–5) µF
Permitted shaft earthing resistance	Maximum 200 Ω
Protective resistor	220 Ω, 100 W, plate 135 x 160 mm

External resistor for RXTTE4

The external resistor is used when either there is a need to minimize physical exposure of the field circuit or when high harmonic content of the total injection current can cause overheating of the built-in RXTTE4 resistor. The external resistor is delivered mounted on an insulated plate with overall dimensions; Height = 160 mm, Width = 135 mm, suitable for wall mounting, see figure 22. It actually consists of two resistors (R1 and R2) which are on delivery connected in series. It is possible to order two different types of the external resistor. The first type (ordering number RK795102-AD) has exactly the same ohmic value of 220Ω as the internal RXTTE4 resistor. It shall be used in cases where only physical exposure of the field circuit shall be limited. The second type (ordering number RK795102-AB) has different ohmic value than internal RXTTE4 resistor. It shall be used in installations where current with high harmonic content is pushed back onto the RXTTE4 injection unit by the rotor circuit

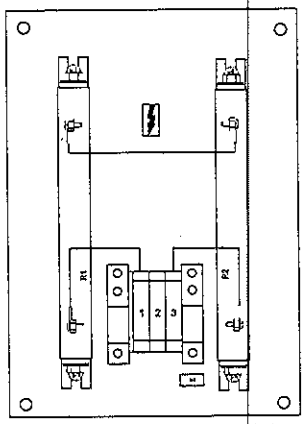
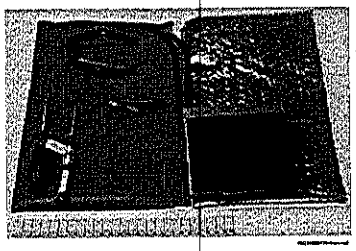


Figure 22. External resistor mounted on a plate

11. ESD Field Kit

Introduction

The ESD Field Kit provides a complete portable ESD safe workstation when working in the field.



12. Power Supply

Portable Power Supply

The portable Power Supply provides the IED with power. This can be used at education or demonstration of the IED.

Power Cable

For use with the portable Power Supply.

13. Configuration and monitoring tools

PCM600

Use PCM600 through all stages of a project, from engineering, configuring and parameter setting to testing, commissioning, documentation and maintenance. Use PCM600 to adjust the default configuration, or to make a new configuration. For more information about PCM600 visit www.abb.com/substationautomation.

14. Cable and dust cover

Front communication

The front connection cable is used to connect a PC to the RJ45 port on the local human machine interface. The cable is a standard crossed-over ethernet cable (RJ45 connectors).

Dust cover

The dust cover is used to protect the RJ45 connector on the local human machine interface.

15. Ordering

Mounting accessories

Name	For case size	Quantity	Article number
19" rack mounting kit for a single IED	3U		1KHL400352R0001
	6U		1KHL400239R0001
Wall mounting kit for one 6U half 19" housing IED	6U		1KHL400200R0001
Wall mounting kit for one 6U half 19" housing IED main unit with detached display	6U		1KHL400317R001
Flush mounting kit for one 6U half 19" housing IED	6U		1KHL400228R0001
Rack mounting kit for two 6U half 19" housing IEDs	6U		1KHL400240R0001
Mounting kit for a RHGS 6 next to one 6U half 19" housing IED	6U		1MRK002420-GA

Note: All kits are complete including screws for attaching the mounting details to the IED

Optional cables for detached display module (only for 6U versions)		Article number
LHMI cable (1m)	Quantity:	1KHL380031R0100
LHMI cable (2m)	Quantity:	1KHL380031R0200
LHMI cable (3m)	Quantity:	1KHL380031R0300
LHMI cable (4m)	Quantity:	1KHL380031R0400
LHMI cable (5m)	Quantity:	1KHL380031R0500

RHGS Cases

RHGS 6 with door, size 6Ux1/4, color RAL 7035	Quantity:	1MRK 000 315- AG
RHGS 12 with door, size 6Ux1/2, color RAL 7035	Quantity:	1MRK 000 315- BH
RHGS 30 with door, size 6Ux1/1, color RAL 7035	Quantity:	1MRK 000 315- BB

Test switch module

Selection of a RTXP test switch for each ordered test switch module is required. See Selection guide for recommendations. Please refer to section "Related documents".

		Article number
Test switch module RTXP 24 for 3U	Quantity:	1MRK 000 371-HA
Test switch module RTXP 24 for 6U	Quantity:	1MRK 000 371-GA

Selection guide

Product	Product version	Variant	Analog configuration TRM	AIM	Type of earthing		Article number
REB 650	ALL	A03	6I + 4U	6I + 4U	Internal neutral	☐	RK 926 315-CA
REC 650	ALL	A01	5I + 5U	-	Internal neutral	☐	RK 926 315-AF
					External neutral	☐	RK 926 315-AY
	ALL	A02	5I + 5U	-	Internal neutral	☐	RK 926 315-AF
					External neutral	☐	RK 926 315-AY
	1.0 and 1.1	A07	6I + 4U	-	Internal neutral	☐	RK 926 315-CP
					External neutral	☐	RK 926 315-CD
	1.2 and 1.3	A07	4I + 6U	-	Internal neutral	☐	RK 926 315-BB
					External neutral	☐	RK 926 315-AW
REG 650	ALL	B01	5I + 5U	6I + 4U	Internal neutral	☐	RK 926 315-BX
	ALL	B05	5I + 5U	6I + 4U	External neutral	☐	RK 926 315-BX
REL 650	ALL	A01	5I + 5U	-	Internal neutral	☐	RK 926 315-AF
					External neutral	☐	RK 926 315-AY
	1.0 and 1.1	A05	5I + 5U	-	Internal neutral	☐	RK 926 315-AF
					External neutral	☐	RK 926 315-AY
	ALL	A11	5I + 5U	-	Internal neutral	☐	RK 926 315-AF
					External neutral	☐	RK 926 315-AY
	1.2 and 1.3	B01	5I + 5U	5I + 5U	Internal neutral	☐	RK 926 315-AM
					External neutral 1)	☐	RK 926 315-DB

Product	Product version	Variant	Analog configuration TRM	AIM	Type of earthing		Article number
REQ 650	ALL	A01	5I + 5U	-	Internal neutral	☐	RK 926 315-AF
					External neutral	☐	RK 926 315-AY
	ALL	A11	5I + 5U	-	Internal neutral	☐	RK 926 315-AF
					External neutral	☐	RK 926 315-AY
	ALL	B11	5I + 5U	-	Internal neutral	☐	RK 926 315-AF
					External neutral	☐	RK 926 315-AY
RET 650	ALL	A01	8I + 2U	-	Internal neutral	☐	RK 926 315-BD
	ALL	A05	6I + 4U	6I + 4U	Internal neutral	☐	RK 926 315-CZ
	ALL	A07	6I + 4U	-	Internal neutral	☐	RK 926 315-CP

1) Note: With this solution there are no test points on the test switch for trip commands. Separate test switch for just binary signals of type RK 926 315-AS can be added if required.

On/off switch for the DC-supply — Quantity: ☐ RK 795 017-AA

Labels with symbols for RTXP 24 — Quantity: ☐ 1MRK 000 132-53

Note: Leads with 20 A Combiflex socket on one end and insulation stripped on the other end must be used to connect the test switch to the terminal. To connect the signal contact of the test switch and the DC switch, leads with 10 A Combiflex socket on one end must be used.

Key switch for settings

Key switch for lock-out of settings via LCD-HMI — Quantity: ☐ 1MRK 000 611-A

Note: To connect the key switch, leads with 10 A Combiflex socket on one end must be used.

Combiflex modules

Auxiliary relays	See related documents
Push button and selector switch	See related documents
Supervision relay	See related documents

Connectors

Screw compression type

Analog input connector	1I+4U, 1 pc	Quantity: ☐	1KHL380062R0001
Analog input connector	3I+2U, 1 pc	Quantity: ☐	1KHL380063R0001
Analog input connector	4I+1U, 1 pc	Quantity: ☐	1KHL380064R0001
Analog input connector	5U, 1 pc	Quantity: ☐	1KHL380066R0001
Analog input connector	5I, 1 pc	Quantity: ☐	1KHL380069R0001
Signal connector	18 terminals, 1 pc	Quantity: ☐	1KHL380032R0001
Signal connector	18 terminals, 1 pc	Quantity: ☐	1KHL380083R0001
Signal connector	3 terminals, 1 pc	Quantity: ☐	1KHL380033R0001
Bridge connector	For 2 terminals, 1 pc	Quantity: ☐	1MKC 840 002-1
Bridge connector	For 3 terminals, 1 pc	Quantity: ☐	1MKC 840 002-2
Bridge connector	For 4 terminals, 1 pc	Quantity: ☐	1MKC 840 002-3
Ferrule	For 2 x 1.5 mm^2 conductors or screw compression terminal, 1 pc	Quantity: ☐	1MKC 840 003-4

Ring-lug type

Analog input connector	1I+4U, 1 pc	Quantity: ☐	1KHL380062R0002
Analog input connector	3I+2U, 1 pc	Quantity: ☐	1KHL380063R0002
Analog input connector	4I+1U, 1 pc	Quantity: ☐	1KHL380064R0002
Analog input connector	5U, 1 pc	Quantity: ☐	1KHL380066R0002
Analog input connector	5I, 1 pc	Quantity: ☐	1KHL380069R0002
Signal connector	18 terminals, 1 pc	Quantity: ☐	1KHL380051R0001
Signal connector	18 terminals, 1 pc	Quantity: ☐	1KHL380087R0001
Signal connector	3 terminals, 1 pc	Quantity: ☐	1KHL380055R0001

External resistor unit

High impedance resistor unit 1-ph with resistor and voltage dependent resistor for 20-100V operating voltage	Quantity: ☐	RK 795 101-MA
High impedance resistor unit 3-ph with resistor and voltage dependent resistor for 20-100V operating voltage	Quantity: ☐	RK 795 101-MB
High impedance resistor unit 1-ph with resistor and voltage dependent resistor for 100-400V operating voltage	Quantity: ☐	RK 795 101-CB
High impedance resistor unit 3-ph with resistor and voltage dependent resistor for 100-400V operating voltage	Quantity: ☐	RK 795 101-DC

External interface units for Rotor earth fault protection

Injection unit for Rotor earth fault protection (RXTTE 4)	Quantity: ☐	1MRK 002 108-BA
Protective resistor on plate. R1 = 100 Ω, R2 = 120 Ω	Quantity: ☐	RK 795 102-AD
Protective resistor on plate. R1 = 560 Ω, R2 = 560 Ω	Quantity: ☐	RK 795 102-AB

ESD Field kit

ESD Field kit	Quantity: ☐	1MRK 001 938-A

Power Supply

Power Supply Unit Input voltage: 90-264 V~, 47-63 Hz Output voltage: 48 V= Max. output current: 2,5 A Output power: 135 W max Switch frequency: 65 kHz	Quantity: ☐	1MRK 001 665-FA
Power Cable 2m	Quantity: ☐	1MRK 001 665-EA

Configuration and monitoring tools

PCM600	See related documents	

Labels

LED Label special paper A4, 1 pc	Quantity: ☐	1MRK 002 038-CA
LED Label special paper Letter, 1 pc	Quantity: ☐	1MRK 002 038-DA

Cable and dust cover

Front connection cable	Quantity: ☐	1MRK 001 665-CA
Dust cover LHMI (RJ45)	Quantity: ☐	1MKC 890 000-1

16. Related documents

Combiflex, connection and installation components	1MRK 513 003-BEN
Combitest	1MRK 512 001-BEN
Auxiliary, signalling and tripping relays	1MRK 508 015-BEN
Auxiliary relays	1MRK 508 006-BEN
Bistable relays	1MRK 508 017-BEN
Push button and selector switch	1MRK 513 016-BEN
Supervision relay	1MRK 508 024-BEN
PCM600	1MRS756448
REB650 Product guide	1MRK 505 290-BEN
REC650 Product guide	1MRK 511 289-BEN
REG650 Product guide	1MRK 502 050-BEN
REL650 Product guide	1MRK 506 337-BEN
RET650 Product guide	1MRK 504 137-BEN
REQ650 Product guide	1MRK 505 294-BEN
Rotor earth fault protection with injection unit RTTXE4	1MRG001910

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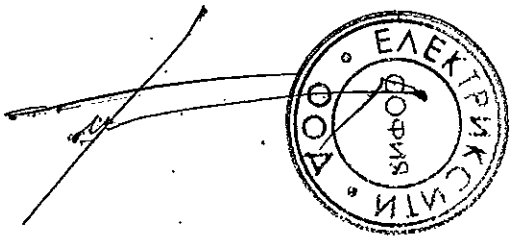
www.abb.com/substationautomation

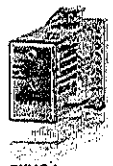
Приложение № 17 – Техническа документация (включително каталози), даваща пълно описание, технически данни и характеристики на предлаганото оборудване към Приложение № 8 - Общи изисквания за помощни и сигнални релета

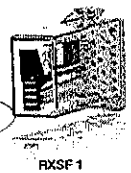


Сл. П. 485

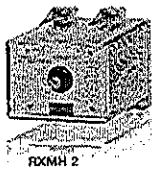
Auxiliary, signalling and tripping relays
RXMA1, RXMA 2, RXMM 1, RXMS 1, RXSF 1, RXME 1, RXME 18, RXMH 2 & RXMT 1

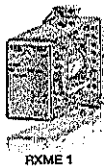

RXMA 1 (RXMA_1.eps)


RXMS 1 (RXMS_1.eps)


RXSF 1 (RXSF.eps)


RXMM 1 (RXMM_1.eps)


RXMH 2 (RXMH_2.eps)


RXME 1 (RXME_1.eps)

Features
- Suitable for tripping, blocking, interlocking, signalling etc. in protection, control and industrial systems
- Various ratings and contact configurations
- High voltage insulation
- Screen protected and dust-proof with a transparent plastic cover
- Low power consumption
- Heavy-, medium or light duty operation and long mechanical life
- Indication flags
- High resistance to shock and vibration
- Ultra high and high speed operation, down to 1,5 ms
- Up to 15 contacts in one relay

Application
The relays are intended for installations where high operating requirements exist, on operating time, contact rating (heavy breaking duty) or else where normal relays of industrial type are not suitable.

The relays are especially suitable in protection and control circuits. Models exist that are very suitable for high corrosive atmosphere or seismic areas. Tripping, interblocking and multiplying functions are easily achieved with single relays or combinations of relays.

Special requirements can be met by using different contact types, twin contacts, bridge contacts or dry-reed contacts.

Types RXMA 1, RXMA 2 and RXMM 1 are used as position repeat relays, as interposing relays in control equipment and as output relay in protection relays.

Type RXMM 1 is a space saving relay with two coils, each with 3 contacts for applications where few contacts are needed.

Type RXMS 1 is particularly suitable as tripping relay due to its extremely short operate time. A special variant, which is not influenced by capacitive discharges at earth fault and which also has improved insulation across open contact, is available for heavy applications where high disturbance immunity is required.

RXMS 1, in combination with heavy-duty relays, is used in high speed tripping assemblies as accessories to protection relays.

Type RXSF 1 is a signal flag relay intended for use as operation indicator. A zero voltage type is available and can be used to supervise dc supply voltages.

Types RXME 1 and RXME 18 are used where a low number of heavy duty contacts are required e.g. as trip relay. RXME 18 is a RXME 1 with an operating flag indicator.

Type RXMH 2 is used when many heavy duty contacts are required. It can be provided with an operating flag indicator, as an option.

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Functions which can be obtained with additional components

Auxiliary relays can be used in a number of ways with different accessories to obtain a variety of types of operation. A few typical circuits are shown below.

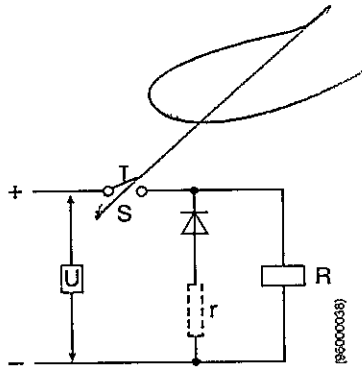
Plug-in units with e.g., diodes, resistors and capacitors are shown in other documents (see References on page 19). Connection blocks type RTXE for attachment to the pocket of the rear side of the terminal bases can be ordered from the same catalogue.

Drop-out time-lag with a diode
To obtain a dropout delay of a dc relay or to protect an electronic circuit against transients, a diode unit across the relay coil (R) can be used. Diode unit, type RXTDA 1, or terminal base mounted type RTXE can be selected.

If the dropout time (t) in the table is too long it can be reduced with a resistor (r) connected in series with the diode.

Type	Typical dropout time, t, with diode [2]
RXMA 1	100-125 ms
RXMA 2	20 ms
RXMM 1	40 ms
RXMS 1 [1]	10 ms
RXME 1	
RXME 18	35 ms
RXMH 2	60 ms

[1] The diode is to be connected to terminals 21-23.
[2] The deviation in dropout time from the values in the table can be considerable, due to numbers of contacts, inductance in the coil, depending on operating voltage etc.



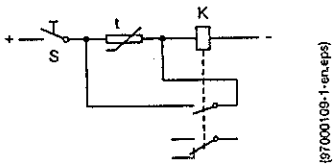
Drop-out delay can be achieved by connecting a parallel diode across the relay coil as shown. Please observe the polarities of the dc voltage and the diode.

When S makes the relay picks up instantaneously. When S breaks the relay drops out with a time lag caused by the diode.

Inductive transient protection
The diode also provides transient protection of the relay and also for the parallel connected devices by reducing the induced overvoltages (many kV's) caused by the inductance of the auxiliary relay upon disconnection from the dc supply when the energizing contact opens.

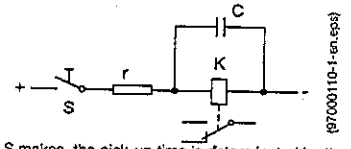
Transient protection (and shorter drop-out delays) may also be achieved by using a parallel connected resistor, thermistor or varistor across the relay instead of the diode. These components are available for mounting directly in the rear pocket of the terminal base using type RTXE component blocks.

Pick-up time-lag using a thermistor



When S makes, the current heats the thermistor t and its resistance drops as its temperature increases. When the current through K reaches the pick-up value, the relay picks up and the thermistor is short-circuited by a make contact on the relay.

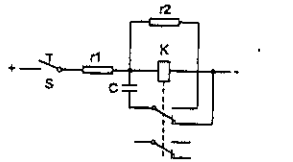
Pick-up and drop-out time-lag using a capacitor



(97000110-1-en.eps)

When S makes, the pick-up time is determinated by the values r, K and C. The relay picks up when C is sufficiently charged and the time lag upon drop-out is caused by C discharging through K after S breaks.

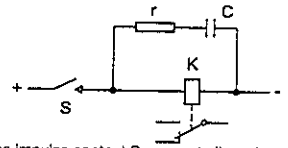
Pick-up time-lag using a capacitor (normal drop-out)



(97000111-1-en.eps)

The pick-up time is determined by the values of r1, K and C. When the relay has picked up C is discharged across r2 and normal drop-out is obtained.

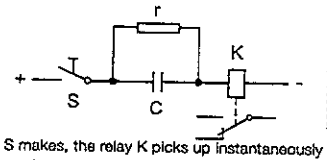
Impulse storing circuit (impulse lengthening)



(97000113-1-en.eps)

When the impulse contact S momentarily makes, the relay picks up and remains picked up for a period the length of which is determined by r, K and C.

Impulse shortening circuit



(97000114-1-en.eps)

When S makes, the relay K picks up instantaneously and remain a picked up until C is sufficiently charged. The relay then drops out, since the current through r and K falls below the relay drop-out value. (S remains closed all the time).

RTXV Control unit

High-speed auxiliary relays can at earth-fault in unearthed DC voltage systems give unwanted operation.

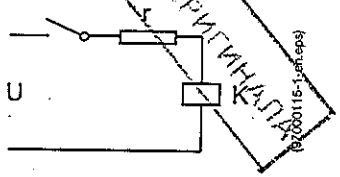
To avoid the risk that the voltage caused by the earth-fault causes unwanted operation on auxiliary relays, we have designed a control unit, type designated RTXV, to be connected in series with the terminal of the relay coil.

The control unit connects applied voltage to the relay only if the voltage is larger than 60-80% of the rated voltage of the unit. The voltage drop in the control unit is about 2 V.

The control unit is mounted in a component box, which in its turn can be mounted on the rear of the terminal base of COMBIFLEXrelays.

For more information, see References on page 19.

Shorter pick-up times with separate, seriesconnected resistor



(97000115-1-en.eps)

The operating time can be reduced for auxiliary relays by connecting a separate resistor – r in the diagram – in series with the relay coil K.

The connection reduces the L/R ratio, i.e. the time constant of the drawn relay coil operating current.

The pick-up time and characteristics of the series resistor for a number of types of relays are listed in the table 1.

The dispersion of the pick-up time is about ±20% at rated voltages and up to ±50% if considering voltage range variations.

The drop-out time of the relay will be approximately the same as for a relay without the series resistor.

Table 1: Dimensioning the series resistor for obtaining shorter pick-up times

D.c. supplied auxiliary relays with supply voltage U = 110, 125, 220 and 250 V.

(The table contains information also for some non-standard voltages for relays available on request.)

Relay type	operating value group	Pick-up time 1) Break contact ms	Make contact ms	U = 110 V Relay with rated voltage V	Series resistance, r Ω	Wattage of r W	Wattage of r + R W	U = 125 V Relay with rated voltage V	Series resistance, r Ω	Wattage of r W	Wattage of r + R W	Max. permitted connection time
RXME 1		10	20	24	630	9	13	24	750	11	15	5 min.
		7	15	12	400	21	25	12	450	25	30	5 min.
RXMH 2		10	25	24	500	14	19	24	600	17	21	Cont.
		6	15	12	160	48	60	12	200	54	65	5 min.
RXMA 1	1-3	5	10	12	2000	5	6	12	2250	6	7	Cont.
RXMA 2	6	8	13	12	330	25	30	12	400	28	33	Cont.
Relay type	**operating value group**	**Pick-up time 1) Break contact ms**	**Make contact ms**	**U = 220 V Relay with rated voltage V**	**Series resistance, r Ω**	**Wattage of r W**	**Wattage of r + R W**	**U = 250 V Relay with rated voltage V**	**Series resistance, r Ω**	**Wattage of r W**	**Wattage of r + R W**	**Max. permitted connection time**
RXME 1		10	20	48-55	2500	9	13	48-55	3000	11	15	5 min.
		7	15	24	1600	21	25	24	1800	26	30	5 min.
RXMH 2		10	25	48	2000	15	19	48	2300	18	22	Cont.
		6	15	24	630	50	62	24	750	57	69	5 min.
RXMA 1	1-3	5	10	24	8000	5	6	24	9000	6	7	Cont.
RXMA 2	6	8	13	24	1600	22	26	24	1800	28	30	Cont.

1) The dispersion of the pick-up time is about ±20%, ±50% if considering voltage range variations

Table 2: Coil resistance, relays with twin contacts

(The table contains information also for some non-standard voltages for relays available on request.)

Rated voltage V	Relays with twin contacts RXMA 1	RXMA 2, dc	RXMM 1	RXMS 1, dc			RXMS 1, dc		
	dc op. v. gr.[1] 1–3	op. v. gr.[1] 6	dc	Variant A, E			Variant B		
	Coil resistance Ω			Coil resistance Ω	Series resistance Ω	Total resistance Ω	Coil resistance Ω	Series resistance Ω	Total resistance Ω
12	110	70	140	6,3	18	23,3	21	27	48
24	480	270	480	21	72	93	82	110	192
30-36	625	375	735	-	-	-	-	-	-
36	-	-	-	40	156	196	210	240	450
48	-	-	-	108	320	428	360	410	770
48-55	2020	1070	2050	-	-	-	-	-	-
55	-	-	-	108	360	468	485	570	1035
110	-	-	-	380	1430	1810	1920	2070	3990
110-125	9680	6120	10800	-	-	-	-	-	-
125	-	-	-	610	2000	2610	2450	2900	5370
220	-	-	-	1520	5700	7220	6090	8420	14510
220-250	39200	19300	40000	-	-	-	-	-	-
250	-	-	-	1920	8000	9920	8670	10700	19370

1) op. v. gr. = Operating value group

Table 3: Coil resistance, relays with bridge contacts

Rated voltage	Relays with bridge contacts		
	RXME 1 RXME 18	RXMH 2	
	dc	dc	ac 50 and 60 Hz
	Coil resistance Ω		
12	78	39	-
24	301	155	39
48	-	564	-
48-55	1130	-	-
55	-	700	194
110	-	2930	700
110-125	5780	-	-
125	-	3610	-
127	-	-	890
220	-	10600	2930
220-250	23300	-	-
250	-	13500	-
380	-	-	6520

Table 4: Coil resistance, relays with single contacts

Rated voltage V	Relays with single contacts, RXMT 1					
	Symbol No.110		Symbol No. 111		Symbol No. 112	
	Terminal marks of coils					
	11-12	21-22	11-12	21-22	11-12	21-22
	Coil resistance Ω					
12-15	670	670	670	670	670	670
24	2600	2600	2600	2600	2600	2600
48-60	6600	6600	6600	6600	6600	6600
110-125	16800	16800	16800	16800	16800	16800

Design

The auxiliary relays in the COMBIFLEX system permit interchanging between various types of relays chiefly because the coil terminals are always connected to the same terminal on the plug-in base of the relay. Relays having the same contact symbol can be interchanged without alteration of the connection.

The contact elements are made of silver, however, gold elements on the contacts can sometimes be necessary, for example in sulfuric atmospheres or when the voltage in the contact circuit is lower than 10 V and the current lower than 10 mA.

Each relay has a dust-tight cover, except the RXMS variants A and E, and is intended to be mounted on a terminal base. Terminal bases are available in four sizes. The relays are fixed to the terminal bases with two or four Phillips No. 2 cross-head screws. Each relay cover has a hole covered by a removable plastic plug with the exception of RXME 18, RXSF 1 and RXMT 1. Through the hole the armature of the relay can be activated. Relays with indicating flags have a resetting knob accessed from the outside of the cover.

The relays are marked with the type designation, Ordering No., rated voltage, and where applicable, the symbol of the relay is also shown.

All dc supplied relays, with the exception of RXMS 1 and RXMT 1, can be supplied with full-wave or half-wave rectified ac.

For supply with full-wave rectified ac, select relays with a rated voltage equivalent to the supply voltage.

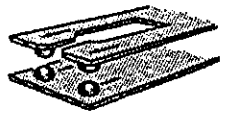
For supply with half-wave rectified ac, a diode in addition to the series diode is to be connected in parallel across the coil and the rated voltage of the relay is to be equivalent to half the supply voltage. If transients are expected in the supply voltage, these determine the choice of matching diodes.

Smoothing capacitors are unnecessary in both cases.

The auxiliary relays will operate within a range of 80-110% of the rated voltage. If the rated voltage is given as a voltage range, e.g. 110-125 V, the relays will operate within a range of 80-110 % of each rated voltage between 110 and 125 V. Permissible temperature range is given in the data table.

Relays with twin contacts

Auxiliary relays used in automatic equipment for control and regulation must have a very high degree of contact reliability even at lower voltages. Auxiliary relays with twin contacts fulfil this requirement. A twin contact has two contact elements on each contact member and each of these makes independent and simultaneous contact with the corresponding element on the other contact member. This gives two parallel current paths and greatly reduces the risk of contact failures. The contact sets have contact levellers of wear-resistant material with a low coefficient of expansion. This means that the correct contact force is always obtained even in contact units containing numerous contact springs. Type RXMA, RXMM, RXMS and RXSF contain twin contacts.



(960000039)

Figure 1: Twin contact

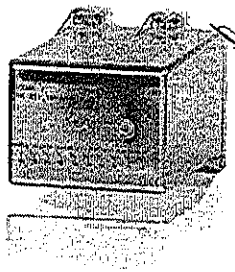
RXMA 1
This relay is designed for dc supply. The outstanding features of this relay are its low power consumption and long mechanical life.

A few variants of RXMA 1 is ac operated with a valid frequency between 50-60 Hz and rated voltage of 115 or 230 V. A half-wave rectifier is built in, connected in parallel across the coil.

RXMA 2
This relay is a variant of RXMA 1, with a larger terminal plug-in plate, and a greater number of contacts.

The relay occupies two seats.

RXMA 1 and RXMA 2 have one, two or three sets of contact stacks. The system voltage across one stack of contacts must not exceed 300 V dc or 250 V ac. The corresponding voltage between contact stacks must not exceed 600 V dc or 500 V ac.


(RXMA_2.eps)

RXMM 1
The relay is designed for dc supply. Two smaller type relays are included in RXMM 1. These relays can each have up to 3 contacts (6 contact springs). Relay RXMM 1 with different rated voltages for the two relays is also available as an option.

RXSF 1
The unit contains one or two smaller relays with three contacts and red indicating flags. The flags are reset manually with an external knob or automatically when the dc is switched off.

The RXSF 1 is also available as loss-of-voltage relay. The indicating flag is always automatically reset in this variant.

There are DC voltage and DC current operated versions of the RXSF 1 relay. See the selection tables on p. 16. The current operated relay may e.g. be used to indicate that breaker trip coil current has flown, i.e. as a series trip current flag (target).

SCADA Interposing Relay type RXSF 1
Interposing relays for SCADA equipment must not misoperate due to induced AC overvoltages that may occur as a result of a relatively long distance between the RTU and the remote control panel. Such a misoperation may lead to maloperation of breaker or isolator open / close commands.

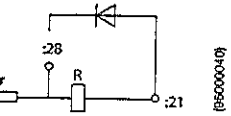
There is a variant of the well proven relay RXSF 1 that may be used to reduce the risk of such a misoperation. The RXSF 1 is designed to reject induced AC voltages. The SCADA interposing version of RXSF 1 is in addition designed to provide a higher operating current in order to even further increase security against maloperation due to induced AC voltage interference.

RXMS 1
This relay is designed for dc supply. It has a very short pick-up time, down to 4 ms for a make contact (variant A, 7 W). Variant B is a low power variant (3 W) with 1.5 ms longer pick-up time.

Variant E (7 W) is safe for capacitive discharge through the coil at dc earth faults. It has also a larger contact gap, which can withstand 2 kV test voltage.

Because of the high power consumption in variants A and E, these variants should not be continuously energized.

The relay has an additional terminal (28) brought out between the coil and the series resistor. This terminal is intended for dropout delay by connecting a diode across the coil.



(9500040)

Figure 2: RXMS 1

Relays with bridge contacts
Auxiliary relays which are to be used as tripping relays or as operating relays should have a high breaking capacity, good contact reliability and be free from risk of contact welding. These qualities are possessed by relays with bridge contacts.

The contacts have two fixed contact members and a moving bridge-shaped member. This design with two breaking points in series gives high breaking capacity.

The moving contact member is designed so that a considerable sliding motion is obtained between the contact elements during closing; this increases contact reliability and reduces the risk of welding.

Design

Types RXME 1, RXME 18 and RXMH 2 contain bridge contacts.

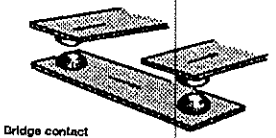
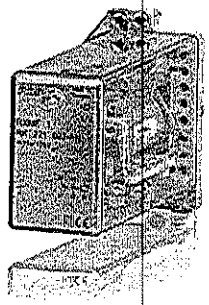
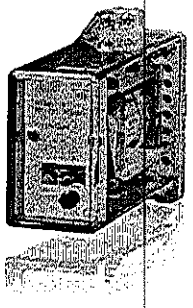

(9500041)

Figure 3: Bridge contact

RXME 1
This relay is designed for dc supply. It has two or four contacts.


(RXME_1.eps)

RXME 18
The relay consists of an RXME 1 relay fitted with a red indicating flag. The flag becomes visible when the armature picks-up and remains visible after drop-out. The flag is manually reset by means of a resetting knob in the cover. The relay has two contacts.


(RXME_18.eps)

RXMH 2
This relay has eight heavy duty contacts and can be fitted with an indicating flag which becomes visible when the armature picks-up and remains visible after drop-out. The flag is manually reset by means of a resetting knob in the cover. For checking the operation the relay has a push-button which is accessible through a hole in the cover. The relay occupies two seats.

Relays with single contacts (dry-reed relays)
In certain cases auxiliary relays are used in a highly corrosive atmosphere or under other conditions where special contacts are required, e.g. for low voltages and currents such as in automatic control circuits with static components. For such applications, auxiliary relays with built-in special contacts, e.g. dry-reed elements should be used. A dry-reed element has one fixed and one moving contact of magnetic material. If the coil, which encircles a dry-reed element with a make contact, is energized, magnetic flux flows through the contact which then closes. When the coil is de-energized the contact opens.

In dry-reed relays with break contacts the coil also encircles a permanent magnet of which the flux holds the contact closed. When the coil is energized the flux of the permanent magnet is counter-balanced and the contact opens. When the coil is de-energized the contact is reclosed by the permanent magnet. This implies that dry-reed relays with break contacts are dependent on polarity, and the coil must be connected in accordance with the symbols in the ordering table.


(9500042)

Figure 4: Single contact

RXMT 1

RXMT 1 has 2 dc-supplied dry-reed relays, each with one make or break contact (dryreed element). The relay is very fast and has a pick-up time of < 1,5 ms.

RXMT 1 should not be positioned alongside relays which have powerful magnets as they may cause RXMT 1 to remain in the pickedup position.

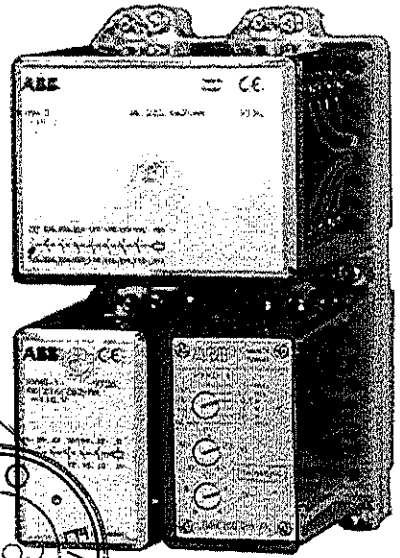
(RXMT_1.eps)

Tripping assemblies

Single auxiliary or flag relays of any model may be used in tripping circuits, depending on requirements. Specially designed combinations of relays mounted on terminal bases and apparatus bars are available. These tripping units combine an ultra-high speed relay, type RXMS1 and a heavy duty relay for carrying and breaking high currents. Combinations with latching relays or time relays for prolonged trip pulse and delayed resetting are available.

Trip and indication module

An auxiliary trip module for tripping from transformer protection device, e.g. Buchholz, temperature, etc., is available. It contains up to 10 inputs and the inputs are safe for capacitive discharge. A timer provides the required pulse length.



(SE970673)

Technical data

Rated voltage Ur	see ordering table
Duty range in % of Ur	
RXMA 1	80-125%
other types	80-110% [1]

Operate values and times

Relay type	Pick-up value % of Ur	Drop-out value % of Ur	Pick-up time, typical values, make/break contact ms	Drop-out time, typical values, make/break contact ms
RXMA 1	< 50	> 12	40/30	15/20
RXMA 1, variant 37 and 52 dc	< 40	> 10	25/15	15/20
RXMA 1, variant 37 and 52 ac	< 70	> 30	50/35	80/80
RXMA 2	< 80	> 25	30/20	5/10
RXME 1	< 80	> 10	35/25	5/15
RXMH 2 dc	< 80	> 20	60/35	25/35
RXMH 2 ac	< 80	> 20	60/35	60/60
RXMM 1	< 80	> 5	30/20	5/10
RXMS 1 var. A	< 80	> 5	4/3,5	2,5/5
RXMS 1 var. B	< 80	> 5	5,5/5	2,5/5
RXMS 1 var. E	55-80	> 10	8/6	3/5
RXMT 1	< 80	> 10	1,5/1,5	1,5/1,5
RXSF 1	< 80	> 5	30/20	5/10

Salient features of SCADA interposing relay type RXSF 1

- Immune to AC induced voltages across coil up to 150 V AC
- Higher burden than its counterparts
  - Minimum pickup current >25mA
  - Drop-off current >15mA
- Pickup voltage is 30% - 50% of Un
- Maximum permitted energizing time is 10 seconds every 2 minutes
- Drop-out voltage is more than 60% of Pickup voltage
- Self reset flag indicator
- 2 NO + 1 NC contacts

Technical data for current relay RXSF 1 is identical as for voltage relay except for following:	
Operating time (closing contact)	
2 x I_r	< 14 ms
4 x I_r	< 10 ms
Minimum pulse time for the flag	50 ms
Operate value, % of I_r	80-100
Thermal capacity, % of I_r	250
Continuous with both relays energized	250%
Power consumption at $I = I_r$	0,1 W

Power consumption at $U = U_r$	
RXMA 1 dc	1,1-1,3 W
RXMA 1 ac	appr 2 VA
RXMA 2	2,0-2,5 W
RXMM	1,1-1,3 W
RXSF	1,1-1,3 W
RXMS var. A [1]	6-7 W
RXMS var. B	2,6-3,3 W
RXMS var. E [1]	6-7 W
RXME	1,9-2,1 W
RXMH dc	3,7-4,6 W
RXMH ac	appr. 8 VA
RXMT	0,2-0,7 W

[1] The RXMS variants A and E can be energized for max five minutes per interval of ten minutes

Contact data

Relay type	Max. system voltage dc/ac within a contact set V	Current-carrying capacity (for already closed contact) 200 ms/1 s/cont. A	Making and conducting capacity L/R > 10 ms, 200 ms/1 s, two contacts in parallel [2] A	Breaking capacity dc, cont. < 0,1 A, max. 250 V	Breaking capacity dc L/R < 40 ms 24/48/110/220 V A
RXMA 1	300/250 (600/500[3])	90/50/5	30/10/15	10	4/1,5/0,4/0,2
RXMA 2	300/250 (600/500[3])	90/50/5	30/10/15	10	4/1,5/0,4/0,2
RXME 1	450/400	55/30/6	30/20/30	20[1]	20/18/3/1 [2]
RXMH 2	600/500	135/75/10	30/20/30	20	20/20/6/1,2
RXMM 1	300/250	90/50/5	30/10/15	10	4/1,5/0,4/0,2
RXMS 1					
var. A, B	300/250	35/20/4	30/10/15	10	2,3/1,2/0,3/0,15
var. E	300/250	35/20/4	30/10/15	10	2,7/1,4/0,35/0,17
RXMT 1	250/250	3/2,5/2	2/2/-	0,6	1/0,5/0,2/0,1
RXSF 1	300/250	90/50/5	30/10/15	10	4/1.5/0,4/0,2

[1] 10 A for RXME 1 with four contacts

[2] 15/6/0,9/0,3 A for RXME 1 with four contacts

[3] between sets of contacts

Permitted ambient temperature			-25°C – +55°C
Dimensions	RXMA 1, RXME 1, RXMM 1, RXMS 1, RXMT 1, RXSF 1		2U 6C
	RXMA 2, RXMH 2		2U 12C
Weight	RXMA 2		0,5 kg
	RXMH 2		0,7 kg
	Other types		0,4 kg
Insulation tests:	Dielectric test, 50 Hz, 1 min		
		RXME, RXMH	2,5 kV
		Other types	2,0 kV
	Impulse voltage test		
		1,2/50 µs, 0,5 J	5,0 kV

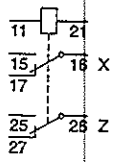
Diagrams and ordering

Specify:
- Type
- Quantity
- Ordering No.
  - consists of a number and letters for the rated voltage, example RK 211 052-AN, see tables below.
- Ordering No. for flag and reset knob when applicable

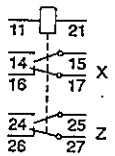
Ordering number selection table RXMA 1

RK 211 025-..

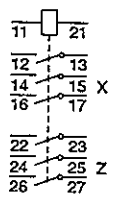
RK 211 037-..



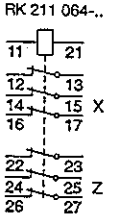
RK 211 052-..



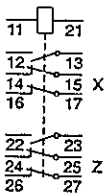
RK 211 063-..



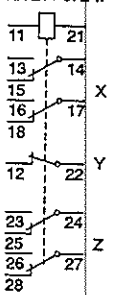
RK 211 064-..



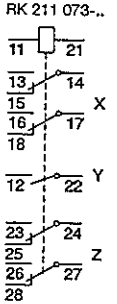
RK 211 066-..



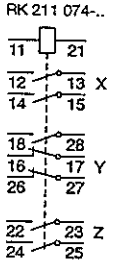
RK 211 072-..



RK 211 073-..

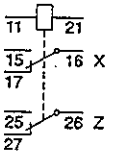


RK 211 074-..

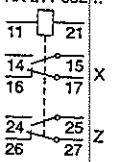


Letter selection table, DC rated voltage V			
24	48-55	110-125	220-250
AD	AH	AN	AS

RK 211 037-..



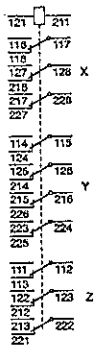
RK 211 052-..



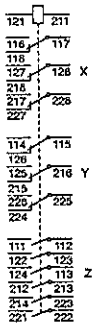
Letter selection table, AC rated voltage V, 50-60 Hz	
115	230
BN	BS

Ordering number selection table RXMA 2

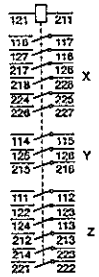
RK 211 185-..



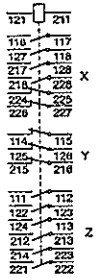
RK 211 186-..



RK 211 188-..



RK 211 189-..



Letter selection table, DC rated voltage V			
24	48-55	110-125	220-250
AD	AH	AN	AS

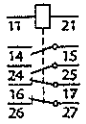
Ordering number selection table RXME 1

RK 221 025-..

RK 221 026-..

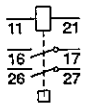
RK 221 027-..

RK 221 052-..

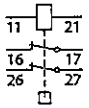


Ordering number selection table RXME 18

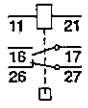
RK 221 825-..



RK 221 826-..



RK 221 827-..

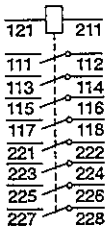


Letter selection table, DC rated voltage V			
24	48-55	110	220-250
AD	AH	AN	AS

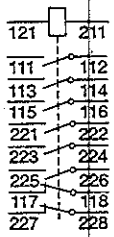
Diagrams and ordering

Ordering number selection table RXMH 2

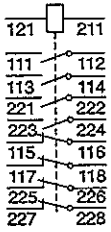
RK 223 067-..



RK 223 068-..



RK 223 069-..

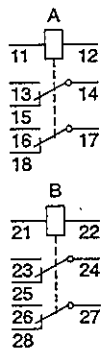


Letter selection table, rated voltage V								
	24	48	110	120	125	127	220	250
DC	AD	AH	AN	-	AP	-	AS	AT
AC	-	-	EN	EC	-	EP	ES	-
15-60 Hz								

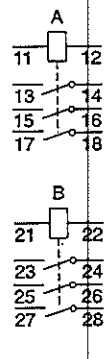
RXMH 2 with red flag and resetting knob
Ordering No. for desired relay according to the table above
+ RK 223 900-XA

No. selection table RXMM 1

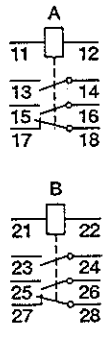
RK 214 002-..



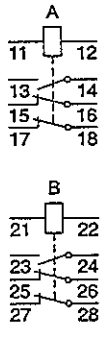
RK 214 003-..



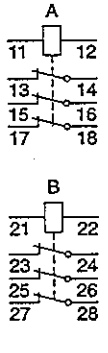
RK 214 004-..



RK 214 005-..



RK 214 006-..

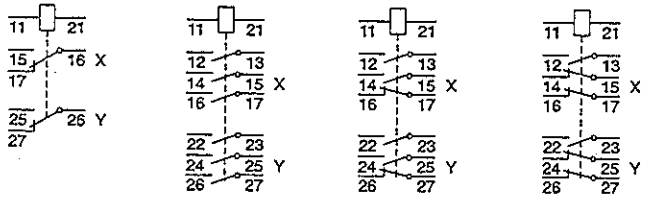


Letter selection table, DC rated voltage V			
24	48-55	110-125	220-250
AD	AH	AN	AS

Diagrams and ordering

Ordering number selection table RXMS 1

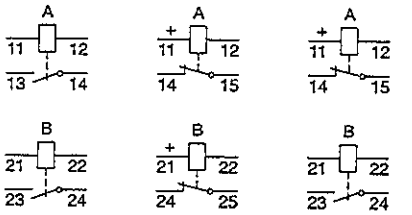
Variant A:	RK 216 237-..	RK 216 263-..	RK 216 265-..	RK 216 266-..
Variant B:	RK 216 037-..	RK 216 063-..	RK 216 065-..	RK 216 066-..
Variant E:		RK 216 463-..	RK 216 465-..	RK 216 466-..



Letter selection table, DC rated voltage V					
24	48	110	125	220	250
AD	AH	AN	AP	AS	AT

Ordering number selection table RXMT 1

RK 241 110-.. RK 241 111-.. RK 241 112-..

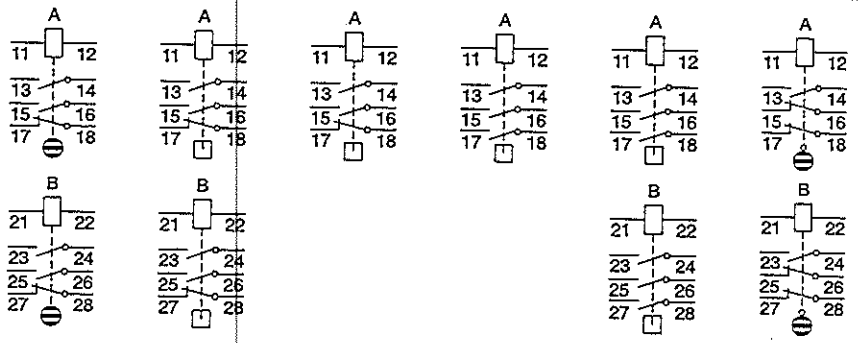


Letter selection table, DC rated voltage V		
24	48-60	110-125
AD	AH	AN [1]

[1] This relay for 110-125 V can also be used at 220-250 V when it is connected via a resistor block type RTXE, RK 741 225-EF 18 kohm, 2W

Ordering number selection table RXSF 1

RK 271 006-.. RK 271 007-.. RK 271 016-.. RK 271 017-.. RK 271 018-.. RK 271 019-..



Flag is automatically reset when deenergizing the coil

Flag is to be reset

Loss of voltage relay

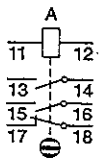
(2x3000096)

Voltage operated relay Letter selection table, DC rated voltage V			
24	48-55	110-125	220-250
AD	AH	AN	AS

Current operated relay Letter selection table, DC rated Current A		
0,2	1,0	2,0
HB	HF	HG

Other current operated variants on request

Scada interposing relay RXSF 1
Ordering Number: 1MRK 001 799-AP

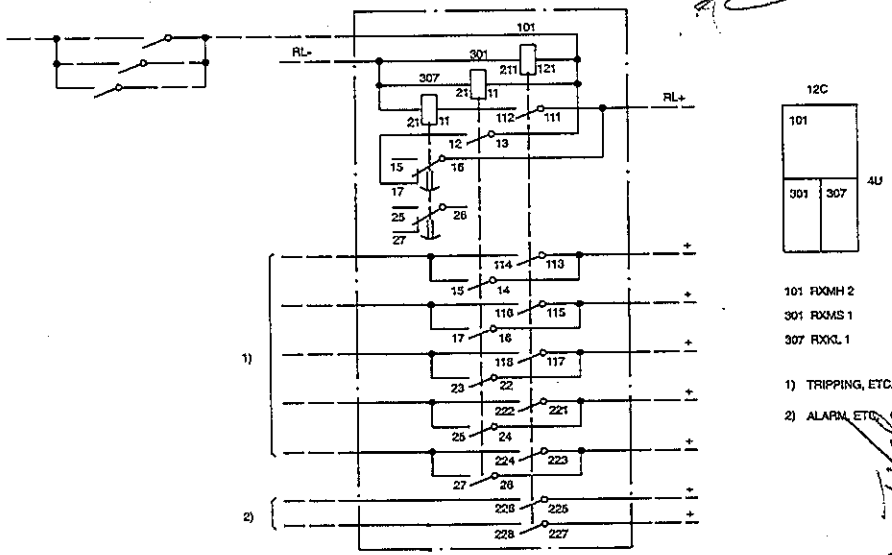


Rated voltage 125 V DC.

Diagrams and ordering

High-speed trip units

Specify:
- Ordering No.
- Auxiliary DC voltage



101 RXMH 2
301 RXMS 1
307 RXKL 1

1) TRIPPING, ETC.
2) ALARM, ETC.

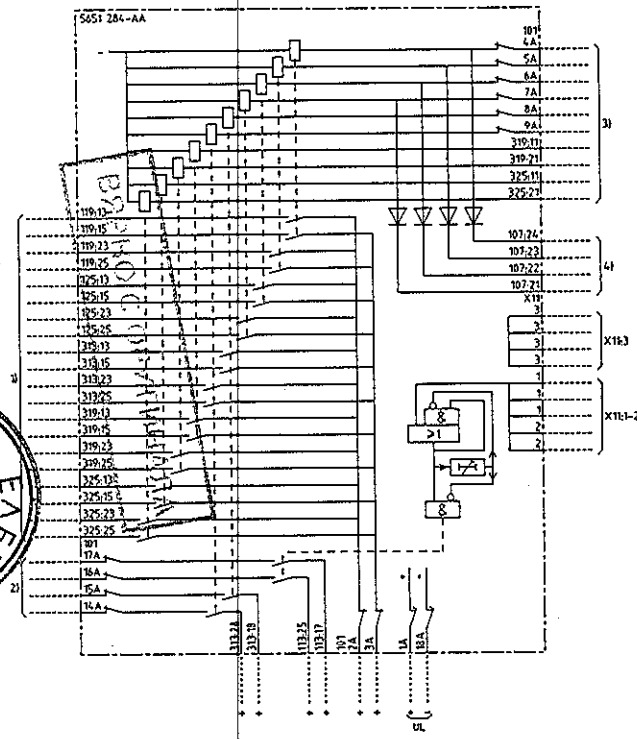
Figure 5: High-speed tripping assembly, RK 651 231-AB, Diagram No. 5651 109-AB

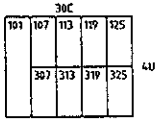
RXMS 1	RXME 1	RXMH 2	RXMVB 2	RXKL 1	Ordering No.	Diagram No.
1	1				5651 273-C	5651 273-CA
1		1			5651 260-F	5651 260-AA
1			1		5651 261-D	5651 261-AA
1		1		1	RK 651 231-AB	5651 109-AB
2		2			5651 260-G	5651 260-AA
2			2		5651 261-E	5651 261-AA

Auxiliary trip unit for transformer protection device

Specify:
- Ordering No.
- No. of inputs
- Auxiliary DC voltage

Function	Ordering No.	Diagrams
6 inputs (+ 4 alarm inputs)	RK 891 031-AA	5651 284-AA/ -AAA
4 inputs	RK 891 031-BA	5651 284-BA/ -BAA





101	RTXP 18
107	RXTDA 1
307	RXKL 1
113	RXMS 1
119,125,313,319,325	RXSF 1
X11	RTXC 3

1) ALARM ETC.
2) TRIP ETC.
3) GUARDS
4) FOR TRIP CONNECT TO X11:1-2
FOR SIGNAL ONLY CONNECT TO X11:3

Figure 6: Auxiliary trip unit, RK 891 031-AA, Diagram No. 5651 284-AAA

References

COMBIFLEX	
Connection and installation components	1MRK 513 003-BEN
Relay mounting systems	1MRK 514 001-BEN
RTXE Component blocks	1MRK 513 019-BEN
RXT Plug-in component unit	1MRK 513 017-BEN
Time relay RXKL 1	1MRK 508 002-BEN
Voltage control unit RTXV	1MRK 513 007-BEN
Auxiliary relays, Self-reset and bistable	1MRK 508 015-UEN
Auxiliary relays RXMB 1 and RXMB 2	1MRK 508 006-BEN
Bistable relay RXMD 1 and RXMD 2	1MRK 508 017-BEN

Contact us

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Phone: +91 80 2294 9632
Facsimile: + 91 80 2294 9188

1MRK 508 015-BEN Revision: D

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 № 9 – Технически параметри за комбинирани измервателни трансформатори 110 kV;

ЕЛЕКТРИК СИН ООД

Со. П. 496

ABB

Data Schedule : Inductive Combined Transformer

Date :	2016-01-08	Name :	bozena.trajer@pl.abb.com
Our ref :	KU 16/16	Revision :	A
Project :	CEZ project		

General data

Quantity	3
Type	PVA 123
Standards	IEC 61869-4
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

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

ВЯРНО С ОРИГИНАЛА

Voltage ratings

Rated primary voltage U_{pr}	110000 /√3
Rated voltage factor F_V / Rated time	1.2/continuous & 1.5/30s

Accuracy ratings

Winding No.	Rated sec. voltage U_{sr}	Rated output S_r	Class	Total simult. output	Thermal limiting output	No. of terminal box	Cover for sealing
I (1a - 1n)	100 : √3 V	0-10 VA	0,2*	30 VA	1000 VA		-
II (2a - 2n)	100 : √3 V	0-10 VA	0,5*	30 VA	1000 VA		-
III (3a - 3n)	100 : √3 V	0-10 VA	0,5/3P	30 VA	1000 VA		-
IV (da - dn)	100 V	0-10 VA	3P	40 VA	450 VA		-

*) 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		2GKK614616A0016;rev.A
Rating plate language		Bulgarian
Insulator type / colour		Porcelain / brown
Minimum creepage distance	mm	4495
Minimum arcing distance	mm	1190
Primary terminal type		Al flat pad 100x120 T=20 mm; 4xD=14/50x50mm 4xø14/50x50mm
Earthing terminals type		
Voltage secondary terminals type		Phoenix rail terminal blocks; spring, type ST 10
Current secondary terminals type		Phoenix rail terminal blocks; spring, type ST 10
Cable glands – terminal box No. 1		Polyamide; 2xM40 + 2xM32 M32 (cable diam. 11-21 mm), with strain relief; 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	640
Weight of oil	kg	170
Insulating oil type		Nynas Nytro 10XN – inhibited mineral insulating oil acc. to IEC 60296
Packing		Horizontal - wooden base
Shipping weight	kg/units	772
Shipping volume	m3/units	3

ЕЛЕКТРИК СИН ООД София

ВЯРНО С ОРИГИНАЛА

ABB

Комбиниран измервателен трансформатор

Изолационно ниво	123/230/550 kV	Стандарт	IEC 61869-4	Тип	PVA 123
Тип на маслото	Nytro 10XN	Тегло / Тегло на маслото	640 / 170 kg	Честота	50 Hz
Сериен №	S/N	Напреженов фактор	1,5Un/30s	Темп. диапазон	-40°C → +40°C
					0,2 mV/kA

Токова Част

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		
Class	0,2S	0,5	5P	5P		
FS/ALF	10	10	30	30		
Ext.%						

Напреженова Част

A-N 110:√3 kV

	1a-1n	2a-2n	3a-3n	4a-4n	da-dn
V	100:√3	100:√3	100:√3		100
VA	0-10	0-10	0-10		0-10
Class	0,2	0,5	0,5/3P		3P
VA_{sth}	1000	1000	1000		450

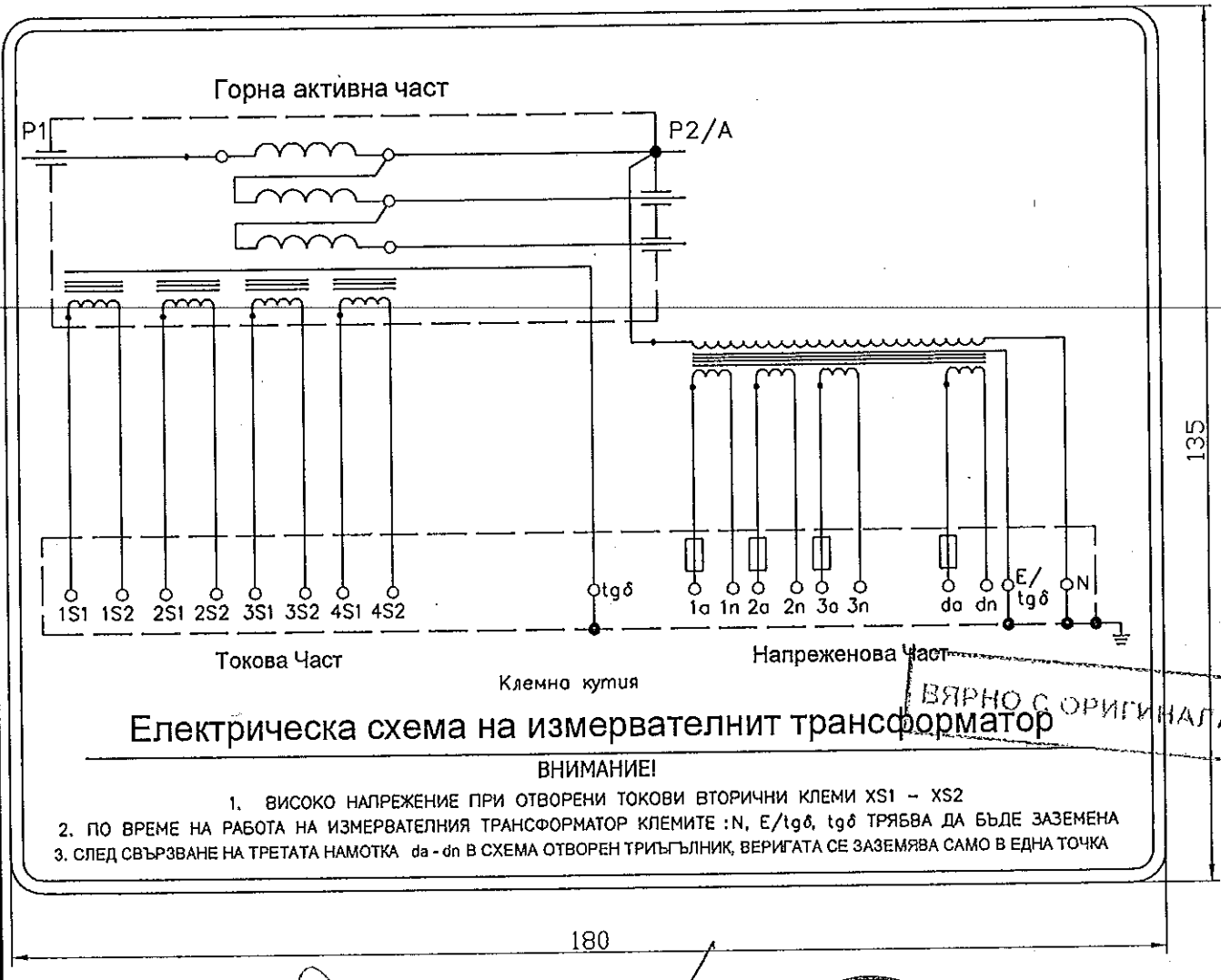
Транспортиране Вертикално / Хоризонтално

135

180

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 thickness/ 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.: ------	Application:/Zastosowanie: ------	Page size: A4
Checked by: Sprawdził:	--------	Date: / Data: --.--.----	Name of item:/Grupa mat.:	Title:/Tytuł: Name plate/ Tabliczka znamionowa	
Approved by: Zatwierdził:	--------	Date: / Data: --.--.----	Mass:/Masa:		Language EN/PL
Revision:/Rewizja: A	Responsible department:/ Dział odpowiedzialny: PPHV	Take over department: /Dział przejmujący:	Scale:/Skala: 1:1	Document no.:/Dokument nr: 2GKK614003/ KU16/16	Sheet no. 1
ABB	ABB Sp z o.o. Power Products				No. Shts. 1



ВЯРНО С ОРИГИНАЛА

Електрическа схема на измервателнит трансформатор

ВНИМАНИЕ!

1. ВИСОКО НАПРЕЖЕНИЕ ПРИ ОТВОРЕНИ ТОКОВИ ВТОРИЧНИ КЛЕМИ XS1 – XS2
2. ПО ВРЕМЕ НА РАБОТА НА ИЗМЕРВАТЕЛНИЯ ТРАНСФОРМАТОР КЛЕМИТЕ :N, E/tgδ, tgδ ТРЯБВА ДА БЪДЕ ЗАЗЕМЕНА
3. СЛЕД СВЪРЗВАНЕ НА ТРЕТАТА НАМОТКА da - dn В СХЕМА ОТВОРЕН ТРИЪГЪЛНИК, ВЕРИГАТА СЕ ЗАЗЕМЯВА САМО В ЕДНА ТОЧКА

Cat II 500

ЕЛЕКТРИКСИМ АД София

Aluminium sheet/ Blocho aluminiowo: EN AW-5754(AlMg3) Materiol standard/ Standard materiotu: EN 485-1/EN 573-3			Anodizing/ Anodowanie ISO 7599 Layer thisckness/ Grubość warstwy 20µm		Black/ Czarny
Materiol: /Materiał:			Cooting: /Pwołoko:		Colour: / Kolor:
Prepored by: Przygotowol:	Ł.Lubieniecki	Date: / Data: 13.01.2016	Replocement of:/Zastępuje rys. nr.: — — — — —	Applicotion:/Zastosowonie: — — — — —	Page size: A4
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ABB ABB Sp z o.o. Power Products					No. Shts. 1

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AC 117

CERTIFICATE OF CONFORMITY

No. 109/2015

Issue No. 01 of 2015.12.29 r.

Name and address of the Certificate Holder:	ABB Sp. z o.o. 1 Żegańska Str. 04-713 Warsaw, Poland
Name of the product:	Combined transformer
Type:	PVA 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 Combined transformer assigned for power systems of rated voltages 110 kV
The product meets requirements of the:	IEC 61869-4 ed. 1.0 (2013) and IEC 61869-1 ed. 1.0 (2007)
According to the report made by:	Instytut Energetyki
Number of the evaluation report:	DZC/158c/E/2015
Period of validity:	from 29th of December 2015 until 29th of December 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 Ia (PN-EN ISO/IEC 17067:2014-01)
(product parameters confirmed by type test)

pp of the DIRECTOR OF
INSTYTUT ENERGETYKI

dr hab. inż. Jerzy Przybysz prof. IEn

Warsaw, 2015.12.29

AC 117

APPENDIX TO THE CERTIFICATE OF CONFORMITY
No. 109/2015
Issue No. 01 of 2015.12.29

LIST OF EVIDENCED PARAMETERS

Intrument transformer type	**PVA 123**
Highest voltage for the equipment 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	 3640 mm 3800 mm
Load class Static withstand load	II 3600 N
Degree of protection of the secondary terminals enclosure	IP55
Degree of protection against external mechanical impacts provided by enclosure	IK7 1)
Current part	
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

ЕЛЕКТРИКОСТИН ООД София

Сд.5.02

Certificate

Standard: **ISO 9001:2008, ISO 14001:2004, PN-N-18001:2004**

Certificate Registr. No. 0198 150 01525

TÜV Rheinland Polska Sp. z o.o. certifies:

Certificate Holder: **ABB Sp. z o.o.**
ul. Żegańska 1
PL - 04-713 Warszawa
including the locations according to annex

Scope:

Research and development as well as design, programming, manufacturing, sale, process and final testing, services and turnkey execution:

- distribution and power transformers, insulation kits as well as painting and welding works; dry transformers including also components for dry transformers, components for traction transformers
- low, medium and high voltage electrical apparatus and power systems;
- automation products including control and measurement equipment, motors, interlocks
- and protection, informative as well as automation systems for power facilities and industry;
- gas compressor and metering stations, gas compressor units and equipment, underground gas storages, gas pipelines and similar services for gas industry petroleum refineries and petrochemical industry;
- robots and industrial robotics stations;
- supercharging of diesel and gas engines;
- main host;
- production of low voltage motors;
- production of power electronics and medium voltage drives;
- Computer software production and implementation.

Technical training in scope of automatics, robotics and electrical power equipment and systems.

An audit was performed, Report No. 0 01525. Proof has been furnished that the requirements according to ISO 9001:2008, ISO 14001:2004, PN-N-18001:2004 are fulfilled.

Validity: The certificate is valid from 2013-11-29 until 2016-11-28.

Warsaw, 2013-11-29

TÜV Rheinland Polska Sp. z o.o.
ul. 17 Stycznia 56 02-146 Warszawa

www.tuv.com

AC 129
QMS, EMS
BHP

Znak IAF dotyczy tylko systemów QMS i EMS

TÜVRheinland®
Precisely Right.

Annex to certificate

Certificate Registr. No. 0198 150 01525

Standard **ISO 9001:2008, ISO 14001:2004, PN-N-18001:2004**

Location:	**ABB Sp. z o.o. Oddział w Łodzi** ul. Aleksandrowska 67/93 PL - 91-205 Łódź
Location:	**ABB Sp. z o.o. Oddział w Aleksandrowie Łódzkim** ul. Placydowska 27 PL - 95-070 Aleksandrów Łódzki
Location:	**ABB Sp. z o.o. Oddział w Oddział w Krakowie** ul. Wadowicka 12 PL - 30-415 Kraków
Location:	**ABB Sp. z o.o. Oddział w Oddział w Krakowie** ul. Starowiślna 13A PL - 31-038 Kraków
Location:	**ABB Sp. z o.o. Oddział w Elblągu** ul. Królewiecka 11 PL - 82-300 Elbląg
Location:	**ABB Sp. z o.o. Oddział w Przasnyszu** ul. Leszno 59 PL - 06-300 Przasnysz
Location:	**ABB Sp. z o.o. Oddział we Wrocławiu** ul. Graniczna 8B PL - 54-610 Wrocław
Location:	**ABB Sp. z o.o. Oddział we Wrocławiu** ul. Bacciarellego 54 PL - 51-649 Wrocław

ВЯРНО С ОРИГИНАЛА

Warsaw, 2013-11-29

Grzegorz Grabka
TÜV Rheinland Polska Sp.z o.o.
ul. 17 Stycznia 56 02-146 Warszawa

ЕЛЕКТРИК ООД София

High Voltage Products

Combined instrument transformer PVA 123
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 specially 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). This standard describes on-site non-voltage conditions while maintaining the transformer.

If you have any questions regarding the information contained in this manual, our organization will provide the necessary information.

Power and productivity
for a better world™

ABB

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 therein.

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 in this manual are marked according to their meaning.

For the purposes of this manual, failure to follow the instructions concerning the dangers could result in death or serious injury.

ВЯРНО С ОРИГИНАЛА

ООД ЕЛЕКТРИКСИТИ София

Table of contents

ЕЛЕКТРИКСИТИ АД София

ВЯРНО С ОРИГИНАЛА

Combined instrument transformer PVA 123

1. Introduction

The overhead combined instrument transformer type PVA 123 is the subject of the manual. Those instrument transformers are used for feeding measurement and protection systems in power networks of 123 kV highest system voltage or lower (the greatest effective value of line-to-line 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. Delivery of transformer

Immediately after delivery check whether the combined instrument 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 damages 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.
Any found damage or other error should be immediately notified to the carrier and manufacturer. Sending photos of damages will be helpful in their assessment.

3. Transportation, unpacking, shifting

Transformers may be transported in either vertical or horizontal position.
In the case of horizontal transportation, transformers should be transported on a crate bed in accordance with transportation instruction No 2GKK614135. 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. This manual contains all the information regarding unpacking and shifting the transformer after delivery.
In vertical transportation, due to the high position of the centre of gravity, the transformer should be transported in wooden boxes. Those elements shall be removed before setting the transformer on the support structure (in the working location/at the installation site). Transformers should be shifted with a crane of min. 1,000 kg load capacity using four slings of the same length (min. 3 m) of load capacity of min. 200 kg each. Hooks should be placed in adapted holders in the bottom tank cover and slings tied with each other additionally at the transformer head height.

4. Storage

Transformers should be stored in the vertical position 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.
Under unfavourable weather conditions, during storage in a horizontal position, water can condense inside the terminal box, causing corrosion. In such case take the appropriate action.

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 point 3 while shifting the transformer. It should be fastened to the structure with screw elements of 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 energizing.

5.1. Earthing terminals

Two earthing terminals are diagonally located in the bottom tank. The contact surface 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/A, are placed on the opposite sides of the head. In the case of reconnectable transformer, up to 3 P2/A terminals can be found on the primary side, marked with respective values of the rated primary current. The P2 terminal of the current module corresponding to the highest current range is common with the A terminal of the voltage module. Reconnection of the primary winding to the required current range is performed by placing a movable terminal (bolt or flat) in the location marked by the respective current value. Movable terminals should be fastened to the transformer with four supplied M12 bolts, cleaning contact surfaces 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. To such prepared terminals the line cable terminals should be tightened with M12 bolts (stainless bolts are recommended). 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 minimize 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 tank of the transformer. 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. Secondary winding terminals of both transformer modules and terminals for earthing during normal operation (screen (E) and primary winding terminal (N) of the voltage coil) are connected to two-way connectors. These are typically Phoenix ST spring connectors with terminals adapted to connection of cables of cross-section up to 10 mm^2 or up to 6 mm^2 and up to 4 mm^2 in the case of pressure signalling device connectors.

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 (tgδ 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 for the current module and two M32 glands with the choking range of Φ11 mm – Φ21 mm for the voltage module.

An example of a terminal box for secondary windings of the transformer is shown in Fig. 1.

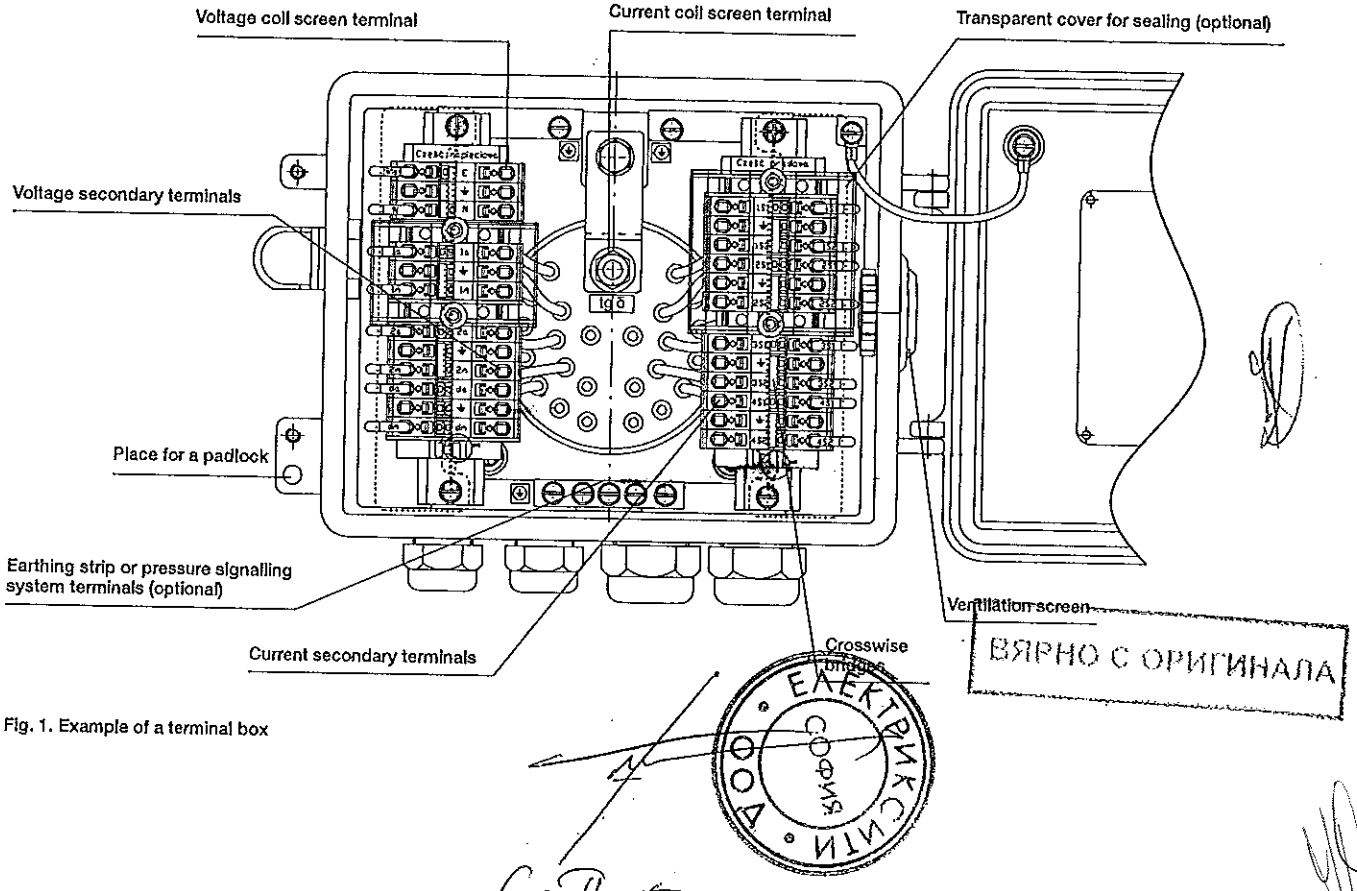

Fig. 1. Example of a terminal box

5.3.1. Current module terminals

Connect external circuits to secondary terminals of the current module of the transformer pursuant to the wiring shown on the schematic diagram plate and in accordance with design documentation,

The current coil screen terminal (tgδ) 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 of the current module 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 current module 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.

5.3.2. Voltage module terminals

Connect external circuits to secondary terminals of the voltage module of the transformer pursuant to the wiring shown on the schematic diagram plate and in accordance with design documentation.

The screen terminal (E) and the primary winding (N) terminal of the voltage coil shall be earthed with crosswise bridges with the neighbouring earthing connector 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. The unused winding of the voltage part shall remain open and its "end" marked as "..n" should be earthed with a crosswise bridge.

In all the windings there are chokes constructed of copper wire Cu-ETP of the diameter of 1.2 mm and length of 50 mm. The chokes are installed in the conductors running out of the resin bushing downstream the terminal block located in the transformer box.

The chokes protect the transformer against damage in case of shorting of the transformer secondary terminals. This type of protection is sufficient to protect the transformer at a short section to the nearest point in which proper protections are installed. Additional fuses in the transformer terminal box are not necessary. If a short circuit has occurred and this type of protection has been activated, the choke must be replaced.

Note:
Secondary terminals of the voltage module of the transformer shall never be shorted.
Residual voltage windings marked as "da-dn", used to connect three transformers in an open delta, should be grounded in one point only (in one of three transformers). Earthing of so connected "da-dn" windings in more than one point will cause shorting and may lead to explosion of the transformer.

5.3.3. Pressure signalling device circuit (optional)

Optionally, the transformer may be equipped with an oil pressure signalling device in the form of a sensor or contact manometer. Each is equipped with two NO contacts, reacting in two steps to oil pressure increase inside the device. The first, "ALARM", step is activated when oil pressure exceeds the value of 0.6 bar. The second, "SWITCH OFF", step reacts to pressure increase above 0.8 bar.

Sensor contacts rating:
AC voltage – 15 A 125/250/480 V, resistive circuit
DC voltage – according to the table below

V_{DC} [V]	8	14	30	48	125	220
I [A]	8	5	1	0.75	0.03	0.02

Ratings of a contact manometer contacts: max. 0.7 A/60 – 250 V (10 W DC, 18 VA AC).

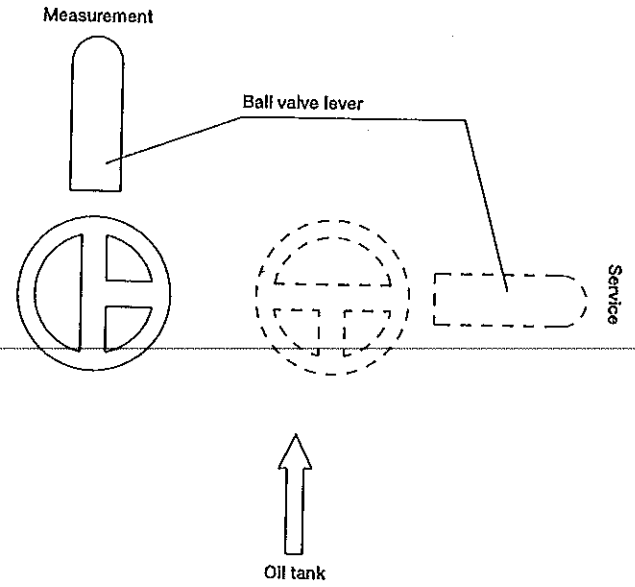

Fig. 2. Positions of the three-way valve

The plate placed on the transformer valve reflects the position on the ball inside the three-way valve (Fig. 2.). Setting of the valve lever in the MEASUREMENT position allows control (measurement) of oil pressure.

Placing the valve lever in the SERVICE position causes cutting off of the signalling device system from the transformer interior. In such a position it is possible, for example, to replace the metering element in the case of incorrect operation or failure. The factory setting of the transformer valve is the MEASUREMENT position.

Note: In a transformer equipped with a contact manometer, in order to enable pressure measurement, the metering structure should be unlocked by turning the interlock as shown in Fig. 3.

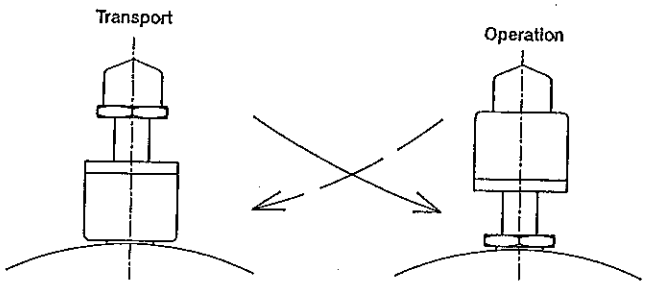

Fig. 3. Unlocking the manometer metering structure

5.4. Ferroresonance phenomenon

The PVA 123 transformers are resistant to Ferroresonance in a wide range of capacitance to earth and of control capacitors used in circuit breakers. However, in the case of networks for which these phenomena occurred before or network configurations being particularly sensitive to such phenomena (e.g. with long cable lines), it is recommended to use an additional damping resistor with a value of 50-60 ohms and power of 200 W, connected in the open delta circuit of three da-dn transformer windings.

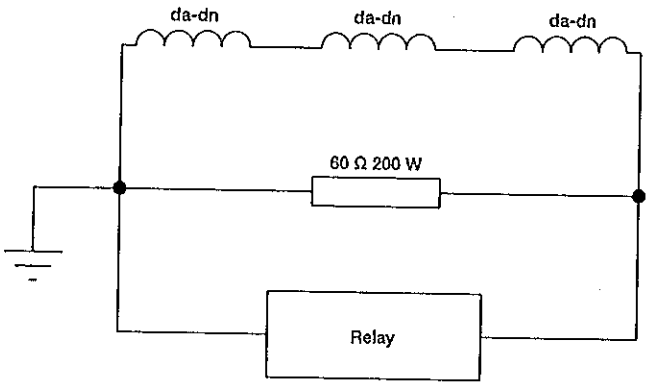

Fig. 4. Schematic diagram of a resistor in the open delta circuit

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. Servicing

Transformers do not require special servicing. Visual inspection is usually sufficient. The check-list is placed at the end of this manual.

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 damages 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 Fig. 5.

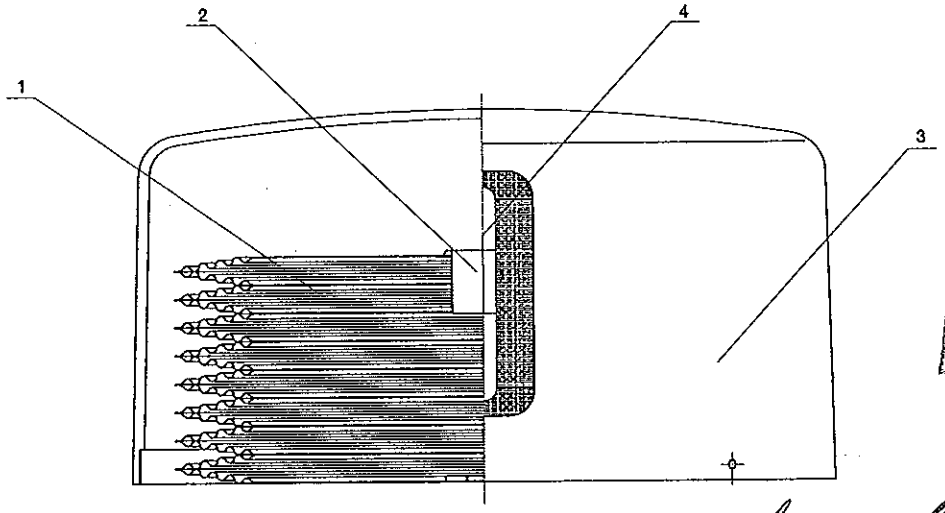

Fig. 5. Construction of the compensation system

Position of the oil level indicator	Interpretation
Indicator on the green field	Correct transformer operation
	Too high oil pressure
	Overheating of the transformer
Indicator on the upper red field	Oil gasification (damage of insulation)
	Further inspection necessary
	Immediately contact the manufacturer
	Too low oil level
Indicator on the lower red field	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 tgδ:
It is recommended to perform such measurement separately for each module: voltage and current. In each of these modules respective terminals are marked with the symbols: tgδ and E and they are used only for connecting the measuring bridge. One should remember to earth them after performing the measurement. Usually the test voltage should equal 10 kV RMS and it should be applied across primary terminals and earth.

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 PN-EN 60296 (IEC 60296). It is recommended to check the oil after 15-20 years of operation or after a non-conformity state, if there are a suspicions as to transformer efficiency. Contact the manufacturer in order to obtain necessary instructions concerning oil sampling. If oil samples are taken during the warranty 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.

ЕЛЕКТРИКСИТИ АДСО

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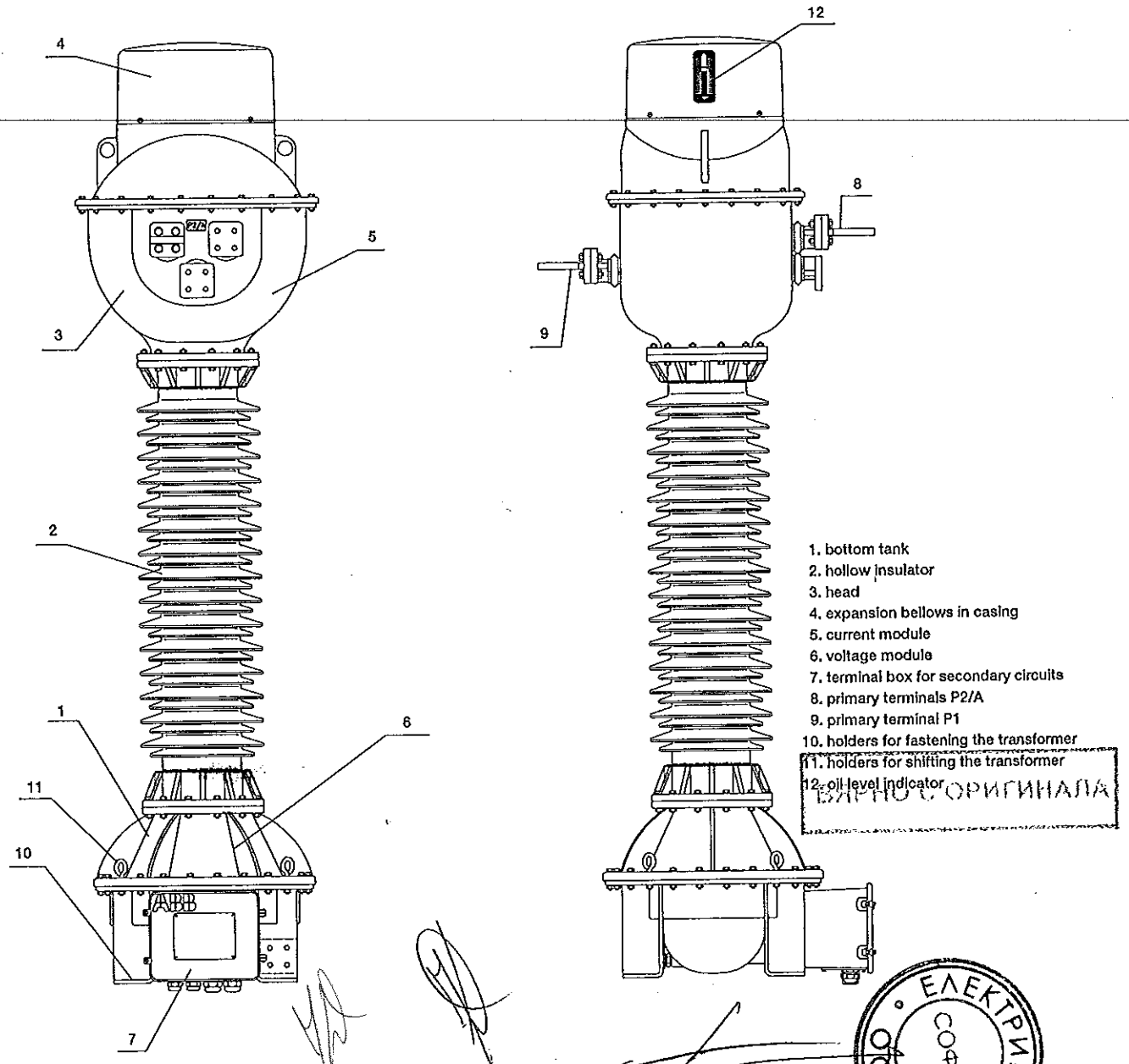
8. Transformer construction

The PVA 123 combined instrument transformer comprises current and voltage modules encapsulated in a common air tight housing filled with transformer oil.

Seals in the transformer of the o-ring type are made of NBR oil-resistant rubber.

If calibration of measuring windings has been performed, respective marking (designations) have been placed on the transformer and the rating plate (where required).



1. bottom tank
2. hollow insulator
3. head
4. expansion bellows in casing
5. current module
6. voltage module
7. terminal box for secondary circuits
8. primary terminals P2/A
9. primary terminal P1
10. holders for fastening the transformer
11. holders for shifting the transformer
12. oil level indicator

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Fig. 6. Construction of combined instrument transformer PVA 123

9. Disposal

During correct operation and when no mechanical damages occur, 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)	30
2	Aluminium alloy AC-Al Si10Mg (Cu)	130
3	Steel	55
4	Transformer plate	50 – 150
5	Permalloy (iron-nickel alloy)	10
6	Mineral transformer oil	170
7	Electrical grade paper	45
8	Solid insulation materials (epoxy resin, bakelite paper)	10
9	Porcelain	110
10	Composite insulator	40

Item 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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10. Check list

10.1. Before first energizing

What to check:	When	Check if (there are)
1. External packing appearance	A	No signs of careless handling
2. Transformer tightness	A, B, C	No visible oil leaks or greasy stains (even if the packing is intact)
3. Transformer housing	B, C	Insulator, terminals and housing of the transformer show no signs of mechanical damage.
4. Oil level	B, C	Oil level indicator is in the proper position
5. Quality and correctness of performed connections	C	Performed connections are reliable and in accordance with the project

10.2. After first energizing

What to check:	When	Check if (there are)
6. Transformer tightness	D, E	No visible oil leaks or greasy stains
7. Transformer housing	D, E	Insulator, terminals and housing of the transformer show no signs of mechanical damage.
8. Oil level	D, E	Oil level indicator is in the proper position
9. Secondary winding insulation test (measurement method depends on local practices)	E	Values dependent on age, voltage level, measurement method and temperature
10. Dielectric loss factor tgδ (measurement method depends on local practices)	E	Values dependent on age, voltage level, measurement method and temperature. It is recommended to perform a separate measurement for the current and voltage module. Respective terminals are marked as: "tgδ" and "E"
11. Oil sampling: gas analysis (DGA), tgδ, water content	E	Measurements did not indicate exceeding of permissible limits

When

A	After arrival of the transformer to the final location
B	After unpacking
C	Directly before applying voltage
D	During routine inspection in accordance with the schedule determined for the station
E	After 15-20 years or inspection of efficiency after the non-conformity state if there are suspicions as to transformer efficiency

11. End

For additional information concerning the operation and maintenance of PVA 123 transformers, please contact the transformer manufacturer.

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ АД София

For more information, please contact:

ABB Sp. z o.o.
Branch Office in Przasnysz
ul. Leszno 59 06-300 Przasnysz
Phone: +48 22 22 38 931, +48 22 22 39 255
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www.abb.pl

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LABORATORIUM WYSOKICH NAPIĘĆ

INSTYTUTU ENERGETYKI

LABORATORY ACCREDITED
BY THE POLISH CENTRE FOR ACCREDITATION

Accreditation Certificate of Testing Laboratory
No AB 272

AB 272

TEST REPORT

No. EWN/70/E/11-1

Type test, special tests and additional tests

of Combined transformer type PVA 123

manufactured by ABB sp. z o.o.

ВЯРНО С ОРИГИНАЛА

Warsaw, December 2011

TESTS REPORTS No EWN/70/E/11-1

TEST OBJECT:	**Combined transformers type PVA 123** **Serial No: 2GKP011K1084500** **and No: 2GKP011K1084502**
TEST ORDERED BY:	**ABB Sp. z o.o.** **04-713 Warszawa, ul. Żegańska 1**
~~ORDER NO:~~	**4500339007 – 31.05.2011**
SCOPE OF TEST:	**Type test, special tests and additional tests**
PROCEDURA OF TESTS:	**in accordance with standards:** **PN-EN 60044-1:2000 (EN 60044-1:1999)** **PN-EN 60044-2:2001 (EN 60044-2:1999)** **PN-EN 60044-3:2006 (EN 60044-3:2003)**
RECEIVING OBJECT DATE:	**June 2011**
DATE OF TESTS:	**June 2011 – August 2011 and December 2011**
TESTS RESULTS:	**are presented in following parts of report** Test results are concern to tested object only.

Tests was performed in witness of representatives of ABB sp. z o.o. :

Marcin TARNOWSKI M.Sc.E.E.
Paweł DĘBSKI M.Sc.E.E.
Jarosław DUZDOWSKI M.Sc.E.E.
Zbigniew WESOŁOWSKI M.Sc.E.E.

TEST PERFORMERS: **Jerzy MIKOŁAJCZYK M.Sc.E.E.**

ВЯРНО С ОРИГИНАЛА
SIGNATURE

HEAD OF HIGH VOLTAGE DEPARTMENT: **January L. MIKULSKI, Ass. Prof., Dr. hab. E. E.**

SIGNATURE

Warsaw, December 2011

CONTENTS

The Report contain:

39 numbered pages

In Report are presented:

5 drawing
1 numbered table
6 appendixes
and non numbered diagrams and tables

1. COMPETENCE OF THE LABORATORY

The High Voltage Laboratory of Institute of Power Engineering (IEn) in Warsaw is in possession of accreditation issued by the Polish Centre for Accreditation (Accreditation Certificate of Testing Laboratory No AB 272) concerning following tests:

Insulators and insulator strings	–	lightning and switching impulse tests
	–	power-frequency voltage 50 Hz tests
	–	radio interference measurements
Distribution substations	–	lightning and switching impulse tests
	–	power-frequency voltage 50 Hz tests
	–	radio interference measurements
Circuit breakers, disconnectors	–	lightning and switching impulse tests
	–	power-frequency voltage 50 Hz tests
	–	radio interference measurements
Insulators	–	lightning and switching impulse tests
	–	power-frequency voltage 50 Hz tests
	–	radio interference measurements
Current and voltage transformers	–	**lightning and switching impulse tests**
	–	**power-frequency voltage 50 Hz tests**
Power transformers	–	lightning and switching impulse tests
	–	power-frequency voltage 50 Hz tests
Lightning arresters and limiters	–	lightning and switching impulse tests
	–	power-frequency voltage 50 Hz tests
Cables and cable fittings	–	lightning and switching impulse tests

Note! Tests described in sub-clauses 4.6.2, 4.6.3, 4.9, 4.12, hereby Report are not comply the scope of Laboratory accreditation.

Hereby Report concerning test results obtained in other competent laboratories - (see Appendixes 2,3,4) :

2. Distribution Equipment Laboratory of Institute of Power Engineering in Warsaw having Accreditation Certificate PCA Nr AB 324
3. High Current Laboratory of Institute of Power Engineering in Warsaw having Accreditation Certificate PCA Nr AB 323
4. Factory Laboratory of ABB sp. z o.o. in Przasnysz - Regional Verification Office in Warsaw - determination of errors and test in range of type tests at supervision of representative of High Voltage Laboratory of Institute of Power Engineering in Warsaw.

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД София

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2. DESCRIPTION OF TEST OBJECT

The tested object was two combined transformers type PVA 123 manufactured by ABB sp. z o.o. 04-713 Warszawa, ul. Żegańska 1, had following parameters:

Combined transformer A
Serial number 2GKP011K1084500 (84500/11)

Rated primary voltage	$110/\sqrt{3}$ kV
Rated primary current	50 – 100 – 200 A
Rated frequency	50 Hz
Rated insulation level	LI 550kV/ AC 230kV
Rated short-time thermal current	10 – 20 – 40 kA
Rated dynamic current	25 – 50 – 100 kA
Minimum creepage distance	3640 mm (porceline insolator)

Combined transformer B
Serial number 2GKP011K1084502 (84502/11)

Rated primary voltage	$110/\sqrt{3}$ kV
Rated primary current	3000 A
Rated frequency	50 Hz
Rated insulation level	LI 550kV/ AC 230kV
Rated short-time thermal current	63 kA
Rated dynamic current	158 kA
Minimum creepage distance	3800 mm (composite insulator)

View of rated nameplates of tested transformers show figure 1.

A B

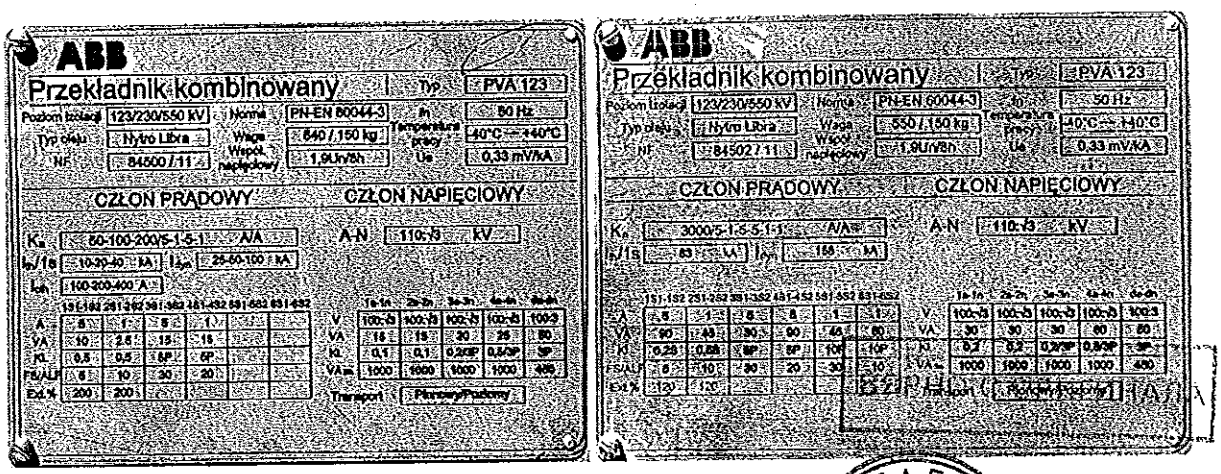

Fig. 1 Rated nameplates of tested transformers

Identification of tested object was done at following documents attached to hereby Report (Appendix 1):

- Manufacturer Conformity Declaration No. 1/2011 (28.09.2011),
- Dimension drawing No. 2GKK610211/ (12.07.2011),
- Dimension drawing No. 2GKK610212/ (12.07.2011),
- Assembly drawing No. 2GKK314001M (26.05.2011),
- Electric diagram of combined transformer 50-100-200 A (25.07.2011),
- Electric diagram of combined transformer 3000 A (25.07.2011).

3. AGREED SCOPE OF TESTS

According to ordered tests the type test and selected special test were done comply following standards:

- PN-EN 60044-1:2000 + A1:2003 +A2:2004 „Przekładniki. Część 1: Przekładniki prądowe" (EN-60044-1:1999 + A1:2000 + A2:2003 „Instrument transformers. Part 1: Current transformers"),
- PN-EN 60044-2:2001 + A1:2003 +A2:2004 „Przekładniki. Część 2: Przekładniki napięciowe indukcyjne" (EN-60044-2:1999 + A1:2000 + A2:2003 „Instrument transformers. Part 2: Inductiv voltage transformers"),
- PN-EN 60044-3:2006 „Przekładniki. Część 3: Przekładniki kombinowane" (EN-60044-3:2003 „Instrument transformers. Part 1: Combined transformers").

On request of ordering party the additional special test were performed. The performed test results are contained in Table 1.

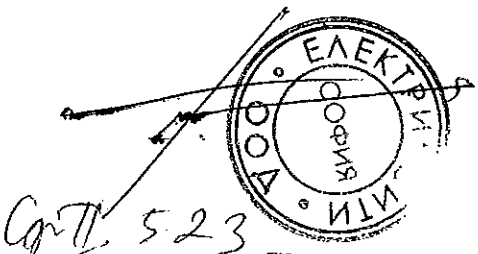

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Table 1. List of performed tests

Item	Performed tests	Requirement
TYPE TESTS		
1	Short-time current test	PN EN 60044-1, p.7.1
2	Temperature-rise test	PN EN 60044-1, p.7.2 PN EN 60044-2, p.8.1, 13.6.1 PN EN 60044-3, p.7.2
3	Lighting impulse test	PN EN 60044-1, p.7.3 PN EN 60044-2, p.8.3 PN EN 60044-3, p.7.3
4	Wet test for outdoor transformers	PN EN 60044-1, p.7.4 PN EN 60044-2, p.8.4
5	Short-circuit withstand capability test of secondary windings	PN EN 60044-2, p.8.2,
6	Determination of errors and mutual influence test	PN EN 60044-1, p. 11.4, 11.6, 12.4, 12.5 PN EN 60044-2, p. 12.3, 13.6.2, PN EN 60044-3, p. 11
7	Measurement of the radio interference voltage (RIV)	PN EN 60044-1/A1, p. 7.5 PN EN 60044-2/A1, p. 8.5
SPECIAL TESTS		
8	Chopped impulse test on the primary winding	PN EN 60044-1, p. 9.1 PN EN 60044-2, p. 10.1 PN EN 60044-3, p. 7.3
9	Measurement of capacitance and dielectric dissipation factor	PN EN 60044-1, p. 9.2 PN EN 60044-2, p. 10.2 PN EN 60044-3, p. 9.2
10	Mechanical test	PN EN 60044-1, p. 9.3 PN EN 60044-2, p. 10.3
11	Transmitted overvoltage measurement	PN EN 60044-1/A2, p. 9.3 PN EN 60044-2/A2, p. 10.3 PN EN 60044-3, p. 9.3
ADDITIONAL TESTS		
12	Discharge capacitor test	C=6μF, U=1,1·√2·110/√3 kV No breakdown and temperature. rise over 65 K.

9.11.529

During mentioned above tests at Factory Laboratory of ABB sp. z o.o. in Przasnysz Leszno 59 Street, were performed determination of errors of transformer to prove positive results of consecutive tests. The complete tests were performed according to mentioned above standards. The tests were supervised by representatives of High Voltage Laboratory of Institute of Power Engineering in Warsaw in purpose to prove results of tests. The tests stands are under authority of Regional Verification Office in Warsaw (No. stand S08/OUM1-5/01 XVI i S08/OUM1-5/01 XVII).

4. PERFORMED TESTS

4.0 Routine test and determination of errors in current and voltage parts before tests in IEn and after tests finishing.

Before delivery the transformer to IEn Laboratory and after type test and special test completed in ABB Factory Laboratory in Przasnysz were performed determination of errors measurement under supervision of representative of IEn. During test were checked:

- verification of terminals marking,
- power-frequency withstand test on the primary winding 50 Hz, Utest = 230 kV, t = 60 s,
- partial discharge measurement for voltage transformers q<10pC (U_m) q < 5pC ($1{,}2 \cdot U_m / \sqrt{3}$),
- power-frequency withstand test on secondary windings 50 Hz, Utest = 3 kV, t = 60 s,
- power-frequency withstand test between sections 50 Hz, Utest = 4,5 kV, t = 60 s,
- determination of errors.

The test results are presented in reports attached to hereby Report (Appendix 2):

- Tests before type test and special test (Measurements before type test and special tests) - Report No. 2GKP011K1084500 – 27.07.2011,
- Tests after type test and special tests completed (Measurements after type test and special test completed) - Report No. 2GKP011K1084500 – 11.08.2011.
- Tests before type test and special test (Measurements before type test and special tests) - Report No. 2GKP011K1084502 – 20.06.2011,
- Tests after type test and special tests completed (Measurements after type test and special test completed) - Report No. 2GKP011K1084502 – 1.08.2011.

It were proved that all tests required in routine test gave positive results. It were proved that all metrological properties of transformer are comply accurate classes for all winding.

These tests results are base for later determination of errors for purpose of verification result of tests described below,

4.1 Short-time current test

Short-time current test was performed in Distribution Equipment Laboratory of Institute of Power Engineering in Warsaw. To the current path of transformer was applied short-circuit current – thermal and dynamic (two tests).

Test results:

Combined transformer A

Tested current range 50 A, I_{th} = 10 kA, I_{dyn} = 25 kA, t = 1 s

Tested current range 100 A, I_{th} = 20 kA, I_{dyn} = 50 kA, t = 1 s

Tested current range 200 A, I_{th} = 40 kA, I_{dyn} = 100 kA, t = 1 s

Combined transformer b

Tested current range 3000 A, I_{th} = 63 kA, I_{dyn} = 158 kA, t = 1 s

During test the transformers was behaved properly. There were stated any fault or oil leakage.

The test result - positive.

Detailed information about test arrangement and performed tests, tests results and recorded oscillograms diagrams are present in Reports No. EUR/33/E/11-1E of 25.07.2011 and No. EUR/33/E/11-2E of 10.08.2011– (Appendix 3)

After short-time current test were done determination of error measurement. This measurements were performed Factory Laboratory of ABB sp. z o.o. in Przasnysz 59 Leszno 59 Street under supervision of representative of IEn. Test result of these measurement are present in Reports No: 2GKP011K1084500 – 11.08.2011 and No: 2GKP011K1084502 – 1.08.2011 (Appendix No. 2 of hereby Report).

It was found that metrological properties of transformers are comply to assigned accurate classes of transformer windings and measured values are practically identically to measured values before short-time test (clause 3.0 of hereby Report). This prove positive result of short-time test.

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4.2 Temperature-rise test

This test was performed in High Current Laboratory of Institute of Power Engineering in Warsaw. The test was performed by simultaneously heating current part of transformer and voltage part of transformer.

Combined transformer A

This test was performed on the identical transformer No 2GKP011K1084501 in three stages:

Stage 1 – Heating current 400 A (200 ext. 200%) at voltage $1,2 \cdot 110/\sqrt{3}$ kV, and rated burden of voltage part. Time of test up to stabilizing of temperature.

Stage 2 – Heating current 400 A (200 ext. 200%) at voltage $1,9 \cdot 110/\sqrt{3}$ kV, and rated burden of winding for measurement and residual voltage winding of voltage part.
Time of test – 8 hour.

Stage 3 – Heating current 400 A (200 ext. 200%) at voltage $110/\sqrt{3}$ kV, and burdened winding for measurement by rated thermal limiting output. Time of test up to stabilizing of temperature.

Combined transformer B

This test was performed in three stages:

Stage 1 – Heating current 3000 A at voltage $1,2 \cdot 110/\sqrt{3}$ kV, and rated burden of voltage part. Time of test up to stabilizing of temperature.

Stage 2 – Heating current 3000 A at voltage $1,9 \cdot 110/\sqrt{3}$ kV, and rated burden of winding for measurement and residual voltage winding of voltage part.
Time of test – 8 hour.

Stage 3 – Heating current 3000 A at voltage $110/\sqrt{3}$ kV, and burdened winding for measurement by rated thermal limiting output. Time of test up to stabilizing of temperature.

Rise of temperature in steady state not exceeding permissible value of 65 K + 10 K = 75 K (according to 5.4 of PN-EN 60044-2 and 4.2 of PN-EN 60044-3).

Test result - positive.

Detailed information about test arrangement and performed tests, tests results are present in separate Reports No. EWP/38/E/2011-2e of 9.09.2011 and No. EWP/69/E/2011-e of 28.12.2011 (Appendix 4)

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4.3 Lightning impulse test

Test was done in test arrangement of surge generator type Haefely 5 MV, 375 kJ. Equivalent circuit diagram is shows on Figure 2. The test was performed on standardized lightning impulse 1,2/50μs. The purpose of test was checking internal insulation of transformer. The influence of atmospheric condition on test voltage value was not taken into consideration.

The Lightning impulse test was performed jointly with chopped impulse test on the primary winding (clause 3.8 of hereby Report).

Combined transformer A and combined transformer B

Test condition:

- Full impulse test voltage U = 550 kV,
- Chocked impulse test voltage 1,15 · 550 kV = 632,5 kV,
- Sequence of impulses:
  positive polarity – 15 full impulses,
  negative polarity – 1 full impulse, 2 chocked impulses, 14 full impulses,
- During test was recorded test voltage, current flowed through along HV winding of voltage part of the transformer and voltage on the LV winding 1a-1n of voltage part of transformer.

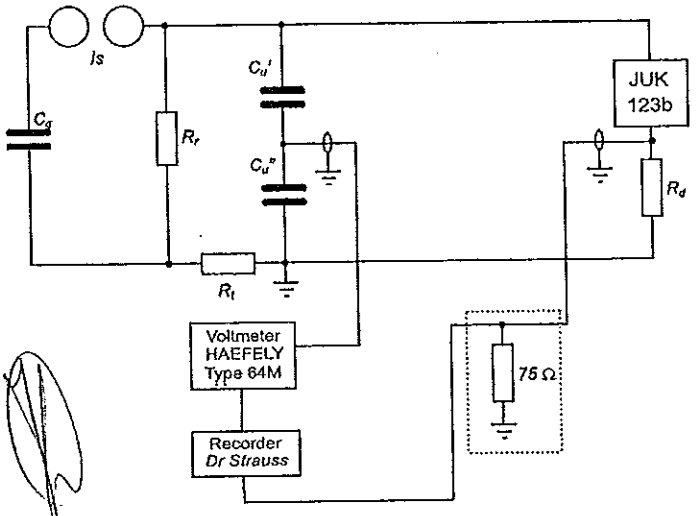

Fig. 2 Equivalent circuit diagram of test arrangement for lightning impulses:
$C_g = 0{,}125$ μF, $C_u = 1{,}2$ nF, $R_t = 175$ Ω, $R_r = 600$ Ω, $R_d = 8{,}95$ Ω.
Measurement uncertainty - 1,5 %

For combined transformers A and B recorded oscillograms not shows failures of transformer insulation.

Result of test - positive.

Recorded oscillograms of all applied impulses are shown in Appendix No. 5 of hereby Report.

4.4 Wet test for outdoor transformers

The test was performed in arrangement of test transformer type TuR 700kV, 0,5A. Equivalent circuit diagram is presented on Figure 3.

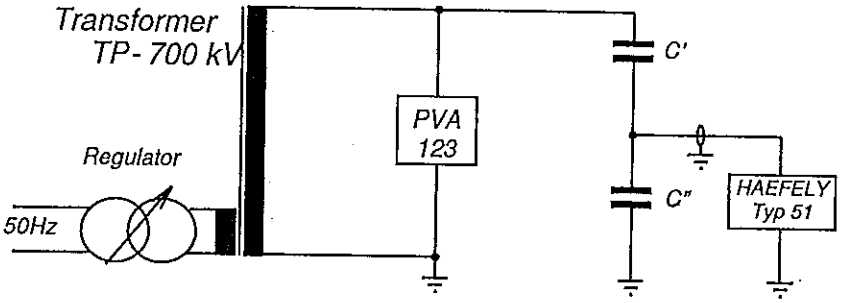

Fig. 3 Equivalent circuit diagram for power frequency voltage 50 Hz:
C = 200 pF (C' in series with C")
Measurement uncertainty - 1,5 %

Combined transformer A and combined transformer B

The test was performed on transformers model with disassembled winding (Figure 3). All external elements of transformers, which can influenced on test results were identical to the complete transformer. The purpose of test was to check withstanding of porceline housing (transformer A) and composite housing (transformer B), which are hazard on weather conditions.

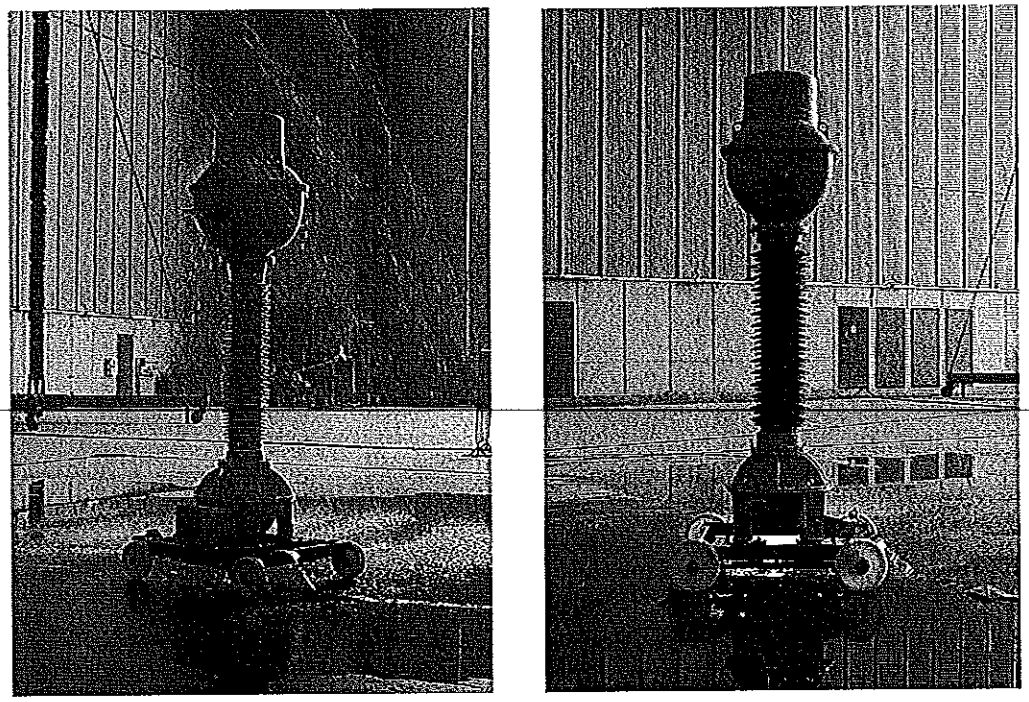

Fig. 4 Wet test of combined transformers type PVA 123 at power frequency voltage 50 Hz

Because electric strength of inner insulation is not depend from atmospheric conditions and this property was tested during routine test at ABB's Factory Laboratory (Raports No. 2GKP011K1084500 – 27.07.2011 and No. 2GKP011K1084502 – 20.06.2011 of Factory Laboratory ABB sp. z o.o. Przasnysz Division).

In each cases the test voltage was U=230 kV was applied during 1 minute.

During wet test for outdoor transformers the transformer was wetting by artificial rain at parameters:

- vertical component of precipitation H_v = 1,4 mm/min
- horizontal component of precipitation H_h = 1,5 mm/min
- water electrical resistivity ρ= 103 Ωm

The test voltage was corrected according to density of air.

During test were not observed any flashover or failure of insulation.

Test result - positive.

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- Tests before type test and special test (Measurements before type test and special tests) - Report No. 2GKP011K1084500 – 27.07.2011,
- Tests after type test and special tests completed (Measurements after type test and special test completed) - Report No. 2GKP011K1084500 – 11.08.2011.
- Tests before type test and special test (Measurements before type test and special tests) - Report No. 2GKP011K1084502 – 20.06.2011,
- Tests after type test and special tests completed (Measurements after type test and special test completed) - Report No. 2GKP011K1084502 – 1.08.2011.

Detailed information about tests results consists Appendix No. 2 of hereby Report.

Combined transformer A

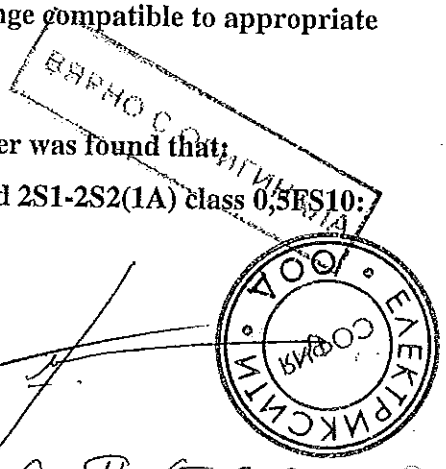
Analyzing test results for voltage part of combined transformer was found that:

- **For measurement windings 1a-1n and 2a-2n class 0,1:**
  - for voltages $0,8U_n$, $1U_n$ i $1,2U_n$ voltage error $\Delta U(\%) < 0,1\%$ and phase displacement $\delta_u(min) < 5$ min.
- **For winding for protection 3a-3n class 0,2% and 3P:**
  - for voltages $0,8U_n$, $1U_n$ i $1,2U_n$ voltage error $\Delta U(\%) < 0,2\%$ and phase displacement $\delta_u(min) < 10$ min.
  - for voltages $0,02U_n$, $0,05U_n$ i $1,9U_n$ voltage error $\Delta U(\%) < 3\%$ and phase displacement $\delta_u(min) < 120$ min.
- **For winding for protection 4a-4n class 0,5% and 3P:**
  - for voltages $0,8U_n$, $1U_n$ i $1,2U_n$ voltage error $\Delta U(\%) < 0,5\%$ and phase displacement $\delta_u(min) < 20$ min.
  - for voltages $0,02U_n$, $0,05U_n$ i $1,9U_n$ voltage error $\Delta U(\%) < 3\%$ and phase displacement $\delta_u(min) < 120$ min.
- **For residual voltage winding da-dn class 3P:**
  - for voltages $0,02U_n$, $0,05U_n$ $1,0U_n$ i $1,9U_n$ voltage error $\Delta U(\%) < 3\%$ and phase displacement $\delta_u(min) < 120$ min.

For each of voltage windings values of error are contain in range compatible to appropriate class of accuracy.

Analyzing test results for current part of combined transformer was found that:

- **For measurement windings 1S1-1S2(5A) class 0,5SFS5 and 2S1-2S2(1A) class 0,5FS10:**
  - for currents 0,05 I_n current error $\Delta I(\%) < 1,5\%$ and phase displacement $\delta_u(min) < 90$ min.
  - for currents 0,20 I_n current error $\Delta I(\%) < 0,75\%$ and phase displacement $\delta_u(min) < 45$ min.
  - for currents 1,0 I_n i 1,2 I_n current error $\Delta I(\%) < 0,5\%$ and phase displacement $\delta_u(min) < 30$ min.



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- For protective windings 3S1-3S2(5A) class 5P30 and 4S1-2S2(1A) class 5P20:
  - for currents 1,0 I_n current error $\Delta I(\%) < 1\%$
    and phase displacement $\delta_u(\min) < 60$ min.

For each of current windings values of error are contain in range compatible to appropriate class of accuracy.

Combined transformer B

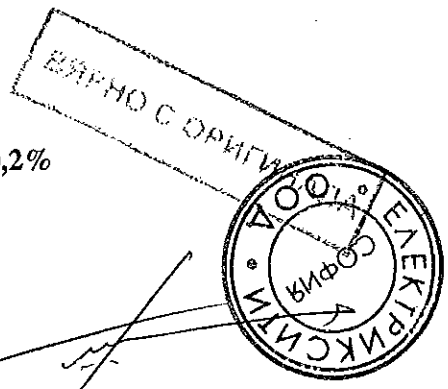
Analyzing test results for voltage part of combined transformer was found that:

- For measurement windings 1a-1n and 2a-2n class 0,2:
  - ~~for voltages $0{,}8U_n$, $1U_n$ i $1{,}2U_n$ voltage error $\Delta U(\%) < 0{,}2\%$~~
    and phase displacement $\delta_u(\min) < 10$ min.
- For winding for protection 3a-3n class 0,2% and 3P:
  - for voltages $0{,}8U_n$, $1U_n$ i $1{,}2U_n$ voltage error $\Delta U(\%) < 0{,}2\%$
    and phase displacement $\delta_u(\min) < 10$ min.
  - for voltages $0{,}02U_n$, $0{,}05U_n$ i $1{,}9U_n$ voltage error $\Delta U(\%) < 3\%$
    and phase displacement $\delta_u(\min) < 120$ min.
- For winding for protection 4a-4n class 0,5% and 3P:
  - for voltages $0{,}8U_n$, $1U_n$ i $1{,}2U_n$ voltage error $\Delta U(\%) < 0{,}5\%$
    and phase displacement $\delta_u(\min) < 20$ min.
  - for voltages $0{,}02U_n$, $0{,}05U_n$ i $1{,}9U_n$ voltage error $\Delta U(\%) < 3\%$ and phase displacement $\delta_u(\min) < 120$ min.
- For residual voltage winding da-dn class 3P:
  - for voltages $0{,}02U_n$, $0{,}05U_n$ $1{,}0U_n$ i $1{,}9U_n$ voltage error $\Delta U(\%) < 3\%$
    and phase displacement $\delta_u(\min) < 120$ min.

For each of voltage windings values of error are contain in range compatible to appropriate class of accuracy.

Analyzing test results for current part of combined transformer was found that:

- For measurement winding 1S1-1S2(5A) class 0,2SFS5:
  - for currents 0,01 I_n current error $\Delta I(\%) < 0{,}75\%$
    and phase displacement $\delta_u(\min) < 30$ min.
  - for currents 0,05 I_n current error $\Delta I(\%) < 0{,}35\%$
    and phase displacement $\delta_u(\min) < 15$ min.
  - for currents 0,2 I_n , 1,0 I_n i 1,2 I_n current error $\Delta I(\%) < 0{,}2\%$
    and phase displacement $\delta_u(\min) < 10$ min.
- For measurement winding 2S1-2S2(1A) class 0,5SFS5:
  - for currents 0,01 I_n current error $\Delta I(\%) < 1{,}5\%$
    and phase displacement $\delta_u(\min) < 90$ min.
  - for currents 0,05 I_n current error $\Delta I(\%) < 0{,}75\%$
    and phase displacement $\delta_u(\min) < 45$ min.
  - for currents 0,2 I_n , 1,0 I_n i 1,2 I_n current error $\Delta I(\%) < 0{,}5\%$
    and phase displacement $\delta_u(\min) < 30$ min.



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- **For protective windings 3S1-3S2(5A) class 5P30 and 4S1-2S2(5A) class 5P20:**
  - for currents 1,0 I_n current error $\Delta I(\%) < 1\%$
  and phase displacement $\delta_n(min) < 60$ min.
- **For protective windings 5S1-5S2(1A) class 10P30 and 6S1-6S2(1A) class 10P10:**
  - for currents 1,0 I_n current error $\Delta I(\%) < 3\%$

For each of current windings values of error are contain in range compatible to appropriate class of accuracy.

4.6.2 Verification of instrument security factor FS of current part measurement windings of instrument transformer

Combined transformer A

The tested combined transformer has two measurement windings:

1S1-1S2 → I_n= 5 A, S_n=10VA, class 0,5 FS5;

2S1-2S2 → I_n= 1 A, S_n=2,5VA, class 0,5 FS10.

The results of determination of core magnetization characteristics and veryfication of limiting e.m.f (check of instrument security factor (FS)) are present in Report No. 2GKP011K1084500 – 27.07.2011– (Appendix No. 2 of hereby Report).

Combined transformer B

The tested combined transformer has two measurement windings:

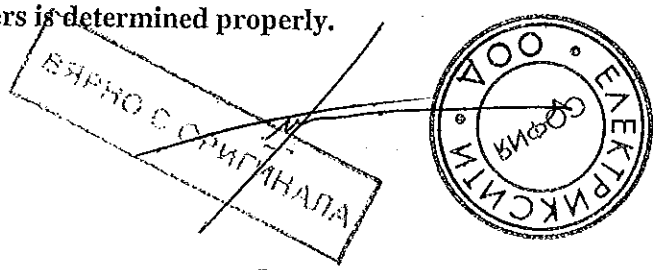
1S1-1S2 → I_n= 5 A, S_n=90VA, class 0,2S FS5;

2S1-2S2 → I_n= 1 A, S_n=45VA, class 0,5S FS10.

The results of determination of core magnetization characteristics and veryfication of limiting e.m.f (check of instrument security factor (FS)) are present in Report No. 2GKP011K1084502 – 20.06.2011– (Appendix No. 2 of hereby Report).

It was found that instrument security factor FS is equal to 5 and 10 for measurement windings of combined transformers is determined properly.

Test result - positive.



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4.6.3 Verification of Limits of error ALF for protective winding of current part of instrument transformer

Combined transformer A

3S1-3S2 → I_n= 5 A, S_n=15VA, class 5P30;

4S1-4S2 → I_n= 1 A, S_n=15VA, class 5P20.

The results of determination of core magnetization characteristics and veryfication of limiting e.m.f (check of accuracy limit factor (ALF)) are present in Report No. 2GKP011K1084500 – – 27.07.2011– (Appendix No. 2 of hereby Report).

Combined transformer B

The tested combined transformer has for windings for protection purposes:

3S1-3S2 → I_n= 5 A, S_n=30VA, class 5P30;

4S1-4S2 → I_n= 5 A, S_n=90VA, class 5P20;

5S1-5S2 → I_n= 1 A, S_n=45VA, class 10P30;

6S1-6S2 → I_n= 1 A, S_n=60VA, class 10P10.

The results of determination of core magnetization characteristics and veryfication of limiting e.m.f (check of accuracy limit factor (ALF)) are present in Report No. 2GKP011K1084502 – 20.06.2011– (Appendix No. 2 of hereby Report).

It was found that limit of error ALF equal 30, 20, 30 and 10 for windings for protection of combined transformers is determined properly.

Test result - positive.

4.6.4 Checking influence of the current transformer on the voltage transformer

Combined transformer A

The measurements was performed by excited in primary winding current with range I_n = 200 A of current part of combined transformer 50 Hz current at value:

$$2 \cdot I_n = 400 \text{ A}$$

Current path of supply line in shape of horizontal rectangular loop with dimensions circa 3500 x 1100 mm. Secondary windings of current part of transformer and primary winding of voltage part of transformer was short-circuited. On all windings of voltage part of combined transformer which

are burdened by 15 VA were measured in turn interference voltage using instrument KEITHLEY type 2001.

Reasults:

Winding	1a-1n	2a-2n	3a-3n	4a-4n	da-dn
Burden [VA]	15	15	15	15	15
U [mV]	0,07	0,07	0,07	0,08	0,08

The following parameters were calculated:

- change of voltage error (at 80% voltage of secondary winding for measurement 1a-1n)

  $\Delta\varepsilon_V < (U_V \cdot 100)/(0{,}8\ U_n) = (70\ \mu V \cdot 100)/(0{,}8 \cdot 100V/\sqrt{3}) \cong 0{,}00015\%$

- change of phase displacement (in min.) for measurement winding: 1a-1n

  $\Delta\delta_V = \Delta\varepsilon_V \cdot 34{,}4 \cong 0{,}0052$ min.

- change of voltage error (at 2% voltage of secondary winding for protection 4a-4n)

  $\Delta\varepsilon_V < (U_V \cdot 100)/(0{,}02\ U_n) = (80\ \mu V \cdot 100)/(0{,}02 \cdot 100V/\sqrt{3}) \cong 0{,}007\%$

- change of phase displacement (in min.) for winding for protection 4a-4n

  $\Delta\delta_V = \Delta\varepsilon_V \cdot 34{,}4 \cong 0{,}238$ min.

- change of voltage error (at 2% voltage of residual voltage winding da-dn)

  $\Delta\varepsilon_V < (U_V \cdot 100)/(0{,}02\ U_n) = (80\ \mu V \cdot 100)/(0{,}02 \cdot 100V/3) \cong 0{,}012\%$

- change of phase displacement (in min.) for windings for protection

  $\Delta\delta_V = \Delta\varepsilon_V \cdot 34{,}4 \cong 0{,}413$ min.

- factor of proportionality between induced voltage (interfere) and current flow in current transformer (in mV/kA)

  $p < U_V/(2 \cdot I_N) = 0{,}080$ mV / 0,400 kA $\cong$ **0,2 mV/kA**

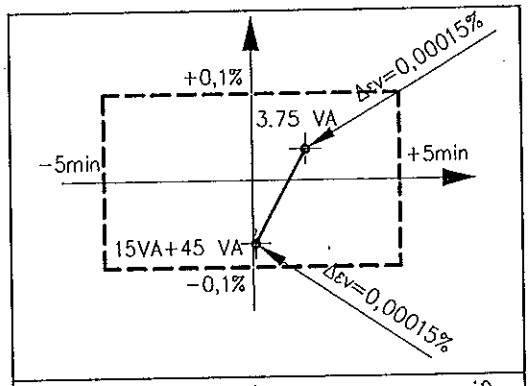
The maximal error of voltage transformer was valuated by summarize mentioned above errors originated from influence of current path on voltage path together with extreme values of errors measured during routine test at $U = 0{,}8 \cdot U_n \div 1{,}2 \cdot U_n$ (Report No. 2GKP011K1084500 – 27.07.2011, Appendix No. 2 of hereby Report).

Below are presented chosen results of calculation in analytic and graphic form (for maximal errors).

Maximal possibly voltage error of measurement winding 1a-1n ($U = 0{,}8 \cdot U_n \div 1{,}2 \cdot U_n$)

$\pm\varepsilon_v' = |\varepsilon_v| + |\Delta\varepsilon_v| = 0{,}036\% + 0{,}00015\% = 0{,}0362\ \%$

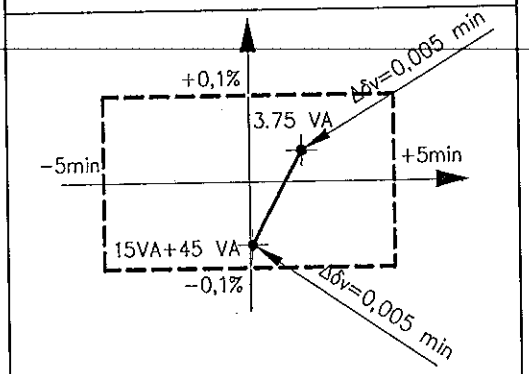
$\pm\varepsilon_v' = |\varepsilon_v| + |\Delta\varepsilon_v| = -0{,}073\% - 0{,}00015\% = -0{,}0732\ \%$



Maximal possibly phase displacement of measurement winding 1a-1n ($U = 0{,}8 \cdot U_n \div 1{,}2 \cdot U_n$)

$\pm\delta_v' = |\delta_v| + |\Delta\delta_v| = 1{,}8\ \text{min} + 0{,}005\ \text{min} = 1{,}805\ \text{min}$

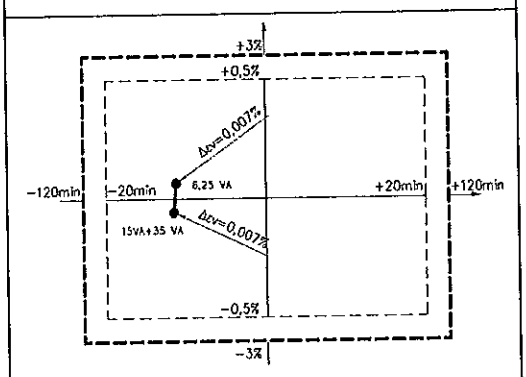
$\pm\delta_v' = |\delta_v| + |\Delta\delta_v| = 0{,}1\ \text{min} + 0{,}005\ \text{min} = 0{,}105\ \text{min}$



Maximal possibly voltage error of winding for protection 4a-4n ($U=0{,}02 \cdot U_n$)

$\pm\varepsilon_v' = |\varepsilon_v| + |\Delta\varepsilon_v| = 0{,}064\% + 0{,}007\% = 0{,}071\ \%$

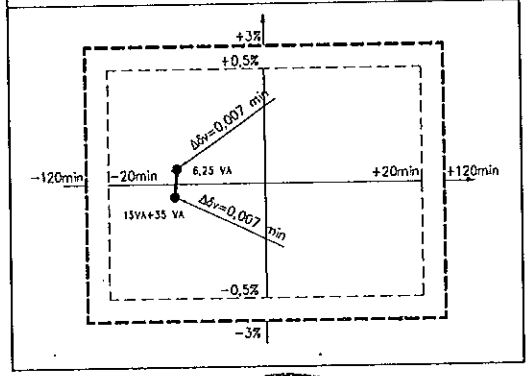
$\pm\varepsilon_v' = |\varepsilon_v| + |\Delta\varepsilon_v| = -0{,}057\% - 0{,}007\% = -0{,}064\ \%$



Maximal possibly phase displacement of winding for protection 4a-4n ($U=0{,}02 \cdot U_n$)

$\pm\delta_v' = |\delta_v| + |\Delta\delta_v| = -11{,}3\ \text{min} - 0{,}238\ \text{min} = -11{,}54\ \text{min}$

$\pm\delta_v' = |\delta_v| + |\Delta\delta_v| = -11{,}6\ \text{min} - 0{,}238\text{min} = -11{,}84\ \text{min}$



Combined transformer B

The measurements was performed by excited in primary winding current with range $I_n = 3000$ A of current part of combined transformer 50 Hz current at value:

$$1{,}2 \cdot I_n = 3600 \text{ A}$$

Current path of supply line in shape of horizontal rectangular loop with dimensions circa 3500 x 1100 mm. Secondary windings of current part of transformer and primary winding of voltage part of transformer was short-circuited. On all windings of voltage part of combined transformer which are burdened by 15 VA were measured in turn interference voltage using instrument KEITHLEY type 2001.

Reasults:

Winding	1a-1n	2a-2n	3a-3n	4a-4n	da-dn
Burden [VA]	15	15	15	15	15
U [mV]	0,072	0,0216	0,018	0,018	0,9

The following parameters were calculated:

- change of voltage error (at 80% voltage of secondary winding for measurement 1a-1n)
  $\Delta\varepsilon_V < (U_V \cdot 100)/(0{,}8\ U_n) = (72\ \mu V \cdot 100)/(0{,}8 \cdot 100V/\sqrt{3}) \cong 0{,}00016\%$
- change of phase displacement (in min.) for measurement winding: 1a-1n
  $\Delta\delta_V = \Delta\varepsilon_V \cdot 34{,}4 \cong 0{,}0055$ min
- change of voltage error (at 2% voltage of secondary winding for protection 4a-4n)
  $\Delta\varepsilon_V < (U_V \cdot 100)/(0{,}02\ U_n) = (18\ \mu V \cdot 100)/(0{,}02 \cdot 100V/\sqrt{3}) \cong 0{,}0016\%$
- change of phase displacement (in min.) for winding for protection 4a-4n
  $\Delta\delta_V = \Delta\varepsilon_V \cdot 34{,}4 \cong 0{,}054$ min.
- change of voltage error (at 2% voltage of residual voltage winding da-dn)
  $\Delta\varepsilon_V < (U_V \cdot 100)/(0{,}02\ U_n) = (900\ \mu V \cdot 100)/(0{,}02 \cdot 100V/3) \cong 0{,}135\%$
- change of phase displacement (in min.) for windings for protection
  $\Delta\delta_V = \Delta\varepsilon_V \cdot 34{,}4 \cong 4{,}644$ min.
- factor of proportionality between induced voltage (interfere) and current flow in current transformer (in mV/kA)
  $p < U_V/(1{,}2 \cdot I_N) =$ **0,072mV / 3,6 kA ≅ 0.02 mV/kA**

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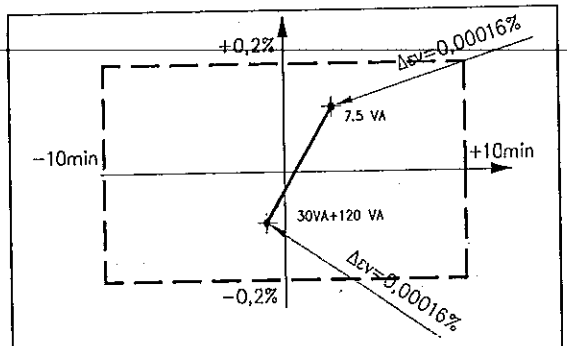
The maximal error of voltage transformer was valuated by summarize mentioned above errors originated from influence of current path on voltage path together with extreme values of errors measured during routine test at $U = 0{,}8 \cdot U_n \div 1{,}2 \cdot U_n$ (Report No. 2GKP011K1084502 – 20.06.2011, Appendix No. 2 of hereby Report)

Below are presented chosen results of calculation in analytic and graphic form (for maximal errors).

Maximal possibly voltage error of measurement winding
1a-1n $(U = 0{,}8 \cdot U_n \div 1{,}2 \cdot U_n)$

$\pm\varepsilon_v' = |\varepsilon_v| + |\Delta\varepsilon_v| = 0{,}120\% + 0{,}00016\% = 0{,}120\ \%$

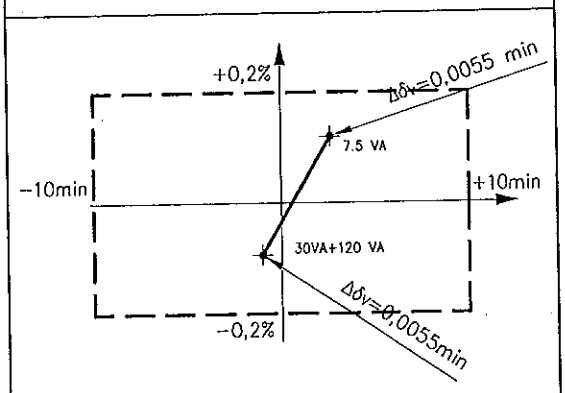
$\pm\varepsilon_v' = |\varepsilon_v| + |\Delta\varepsilon_v| = -0{,}094\% - 0{,}00016\% = -0{,}094\ \%$



Maximal possibly phase displacement of measurement winding 1a-1n $(U = 0{,}8 \cdot U_n \div 1{,}2 \cdot U_n)$

$\pm\delta_v' = |\delta_v| + |\Delta\delta_v| = 2{,}6\ \text{min} + 0{,}0055\ \text{min} = 2{,}606\ \text{min}$

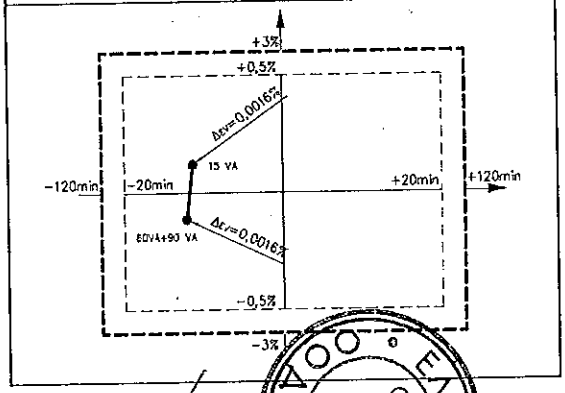
$\pm\delta_v' = |\delta_v| + |\Delta\delta_v| = -1{,}0\ \text{min} - 0{,}0055\ \text{min} = 1{,}006\ \text{min}$



Maximal possibly voltage error of winding for protection 4a-4n $(U = 0{,}02 \cdot U_n)$

$\pm\varepsilon_v' = |\varepsilon_v| + |\Delta\varepsilon_v| = 0{,}120\% + 0{,}0016\% = 0{,}122\ \%$

$\pm\varepsilon_v' = |\varepsilon_v| + |\Delta\varepsilon_v| = -0{,}114\% - 0{,}0016\% = -0{,}116\ \%$



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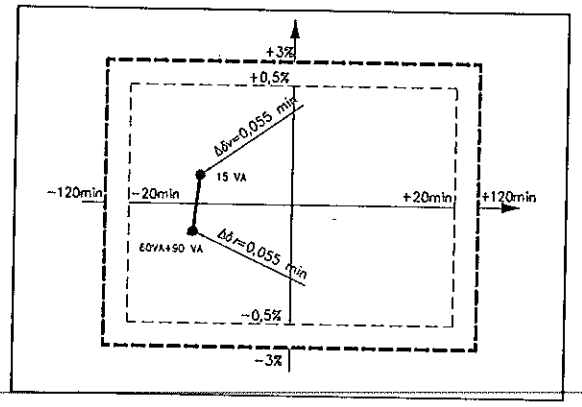
Maximal possibly phase displacement of winding for protection 4a-4n (U=0,02· U_n)

$\pm\delta_v' = |\delta_v| + |\Delta\delta_v| = -11{,}3$ min $-0{,}055$ min $= -11{,}36$ min

$\pm\delta_v' = |\delta_v| + |\Delta\delta_v| = -12{,}1$ min $-0{,}055$ min $= -12{,}16$ min



It was found that errors origin from influence of current path on voltage path of combined transformers PVA 123 not cause loss of metrological properties (loss of class) for all secondary voltage windings .
Test result - positive.

4.6.5 Checking influence of the voltage transformer on the current transformer

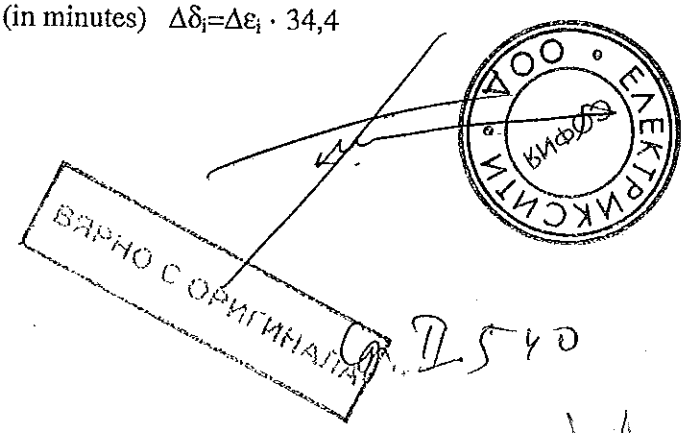
The test was performed by applying two value of voltage of power frequency 50 Hz to the voltage transformer primary winding of combined transformer:

$U = 1{,}9 \cdot 110/\sqrt{3}$ kV = 121 kV and $U = 1{,}2 \cdot 110/\sqrt{3}$ kV = 76 kV

On all secondary windings of current transformer were measured interfere voltages U_i. Winding with rated current In = 5 A were burdened by resistor R = 4 Ω and winding with rated current In = 1 A were burdened by resistor R = 100 Ω.. The sensitiveness of instrument KEITHLEY type 2001 was 1 μV.

For each of windings were done two measurements of interfere voltage U_i, with earthed input terminal or input terminal. The calculation were performed:

- value of interfere current $I=U_i/R$
- change of measured current error (at 5% of rated current) $\Delta\varepsilon_i=(U_i \cdot 100)/(R \cdot 0{,}05\ I_n)$
- change of phase displacement (in minutes) $\Delta\delta_i=\Delta\varepsilon_i \cdot 34{,}4$



Combined transformer A

Test results and calculated values are present in tables below.

Tested winding 1s1-1s2 **earthed 1s1**

x U_N	U_i (R=4 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	1,83	0,458	0,183	6,30
1,2	1,17	0,293	0,117	4,02

Tested winding 1s1-1s2 **earthed 1s2**

x U_N	U_i (R=4 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	1,77	0,443	0,177	6,09
1,2	1,13	0,283	0,113	3,89

Tested winding 2s1-2s2 **earthed 2s1**

x U_N	U_i (R=100 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	8,30	0,083	0,166	5,71
1,2	5,27	0,053	0,105	3,63

Tested winding 2s1-2s2 **earthed 2s2**

x U_N	U_i (R=100 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	8,25	0,083	0,165	5,68
1,2	4,8	0,048	0,096	3,30

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Tested winding 3s1-3s2 **earthed 3s1**

x U_N	U_i (R=4 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,56	0,140	0,056	1,93
1,2	0,32	0,080	0,032	1,10

Tested winding 3s1-3s2 **earthed 3s2**

x U_N	U_i (R=4 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,62	0,155	0,062	2,13
1,2	0,38	0,095	0,038	1,31

Tested winding 4s1-4s2 **earthed 4s1**

x U_N	U_i (R=100 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	2,14	0,021	0,043	1,47
1,2	1,3	0,013	0,026	0,89

Tested winding 4s1-4s2 **earthed 4s2**

x U_N	U_i (R=100 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	1,89	0,019	0,038	1,30
1,2	1,00	0,010	0,020	0,69

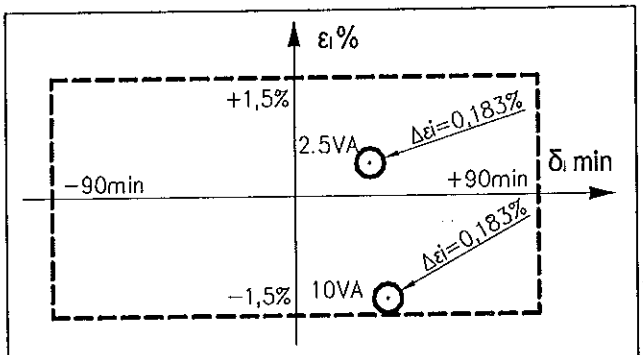
Current transformer maximal error of combined transformer was valuated by summarize mentioned above errors originated from influence voltage path on current path together with extreme values of errors measured during routine test at $I = 0,05 \cdot I_n \div 2 \cdot I_n$ (Report No. 2GKP011K1084500 – 27.07.2011, Appendix No. 2 of hereby Report).

Below are presented chosen results of calculation in analytic and graphic form (for maximal errors).

Maximal possibly current error of winding for measurement ($I = 0{,}05 \cdot I_n \div 2 \cdot I_n$)

$\pm\varepsilon_i' = |\varepsilon_i| + |\Delta\varepsilon_i| = 0{,}419\% + 0{,}183\% = 0{,}602\ \%$

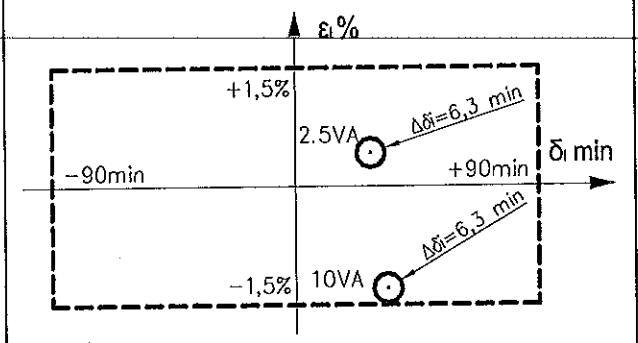
$\pm\varepsilon_i' = |\varepsilon_i| + |\Delta\varepsilon_i| = -1{,}291\% - 0{,}183\% = -1{,}474\ \%$



Maximal possibly phase displacement of for measurement ($I = 0{,}05 \cdot I_n \div 2 \cdot I_n$)

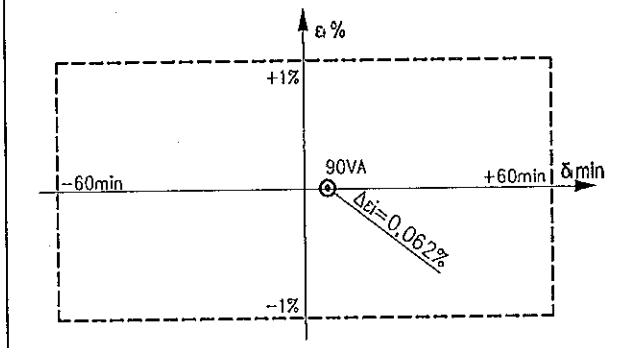
$\pm\delta_i' = |\delta_i| + |\Delta\delta_i| = 27{,}7$ min$+7{,}08$ min $= 34{,}78$ min

$\pm\delta_i' = |\delta_i| + |\Delta\delta_i| = 34{,}0$ min$+7{,}08$min $= 41{,}08$ min



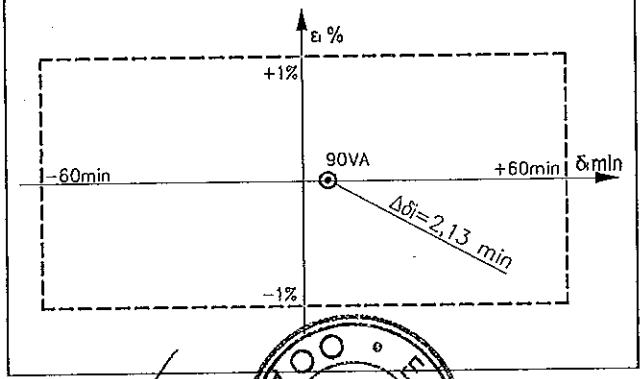
Maximal possibly current error of winding for protection ($I = 0{,}05 \cdot I_n \div 2 \cdot I_n$)

$\pm\varepsilon_i' = |\varepsilon_i| + |\Delta\varepsilon_i| = 0{,}007\% + 0{,}062\% = 0{,}069\ \%$



Maximal possibly phase displacement of winding for protection ($I = 0{,}05 \cdot I_n \div 2 \cdot I_n$)

$\pm\delta_i' = |\delta_i| + |\Delta\delta_i| = 5{,}5$ min $+2{,}13$ min $= 7{,}63$ min



ВЯРНО С ОРИГИНАЛА

ООД "ЕЛЕКТРОКСИМ" СОФИЯ

Q.D. 543

Combined transformer B

Test results and calculated values are present in tables below.

Tested winding 1s1-1s2 **earthed 1s1**

x U_N	U_i (R=4 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,88	0,2200	0,088	3,03
1,2	0,55	0,1370	0,055	1,89

Tested winding 1s1-1s2 **earthed 1s2**

x U_N	U_i (R=4 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,16	0,0400	0,016	0,55
1,2	0,1	0,0250	0,010	0,34

Tested winding 2s1-2s2 **earthed 2s1**

x U_N	U_i (R=100 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,89	0,0089	0,018	0,61
1,2	0,56	0,0056	0,011	0,39

Tested winding 2s1-2s2 **earthed 2s2**

x U_N	U_i (R=100 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,22	0,0022	0,004	0,15
1,2	0,14	0,0014	0,003	0,10

ООО "ЕЛЕКТРИКСИЛА" КОПИЯ

ВЕРНО С ОРИГИНАЛА

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Tested winding 3s1-3s2 **earthed 3s1**

x U_N	U_i (R=4 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,19	0,0475	0,019	0,65
1,2	0,12	0,0300	0,012	0,41

Tested winding 3s1-3s2 **earthed 3s2**

x U_N	U_i (R=4 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,05	0,0125	0,005	0,17
1,2	0,03	0,0075	0,003	0,10

Tested winding 4s1-4s2 **earthed 4s1**

x U_N	U_i (R=100 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,18	0,0450	0,018	0,62
1,2	0,11	0,0275	0,011	0,38

Tested winding 4s1-4s2 **earthed 4s2**

x U_N	U_i (R=100 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,14	0,0350	0,014	0,48
1,2	0,09	0,0225	0,009	0,31

ООО ЕЛЕКТРИКСИМ ВИФОС

ВЯРНО С ОРИГИНАЛА

Tested winding 5s1-5s2 **earthed 5s1**

x U_N	U_i (R=4 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,17	0,0017	0,003	0,12
1,2	0,11	0,0011	0,002	0,08

Tested winding 5s1-5s2 **earthed 5s2**

x U_N	U_i (R=4 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,25	0,0025	0,005	0,17
1,2	0,16	0,0016	0,003	0,11

Tested winding 6s1-6s2 **earthed 6s1**

x U_N	U_i (R=100 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,06	0,0006	0,001	0,04
1,2	0,04	0,0004	0,001	0,03

Tested winding 6s1-6s2 **earthed 6s2**

x U_N	U_i (R=100 Ω)	$I=U_i/R$	$\Delta\varepsilon_i$	$\Delta\delta_i$
[-]	[mV]	[mA]	[%]	[min]
1,9	0,24	0,0024	0,005	0,17
1,2	0,15	0,0015	0,003	0,10

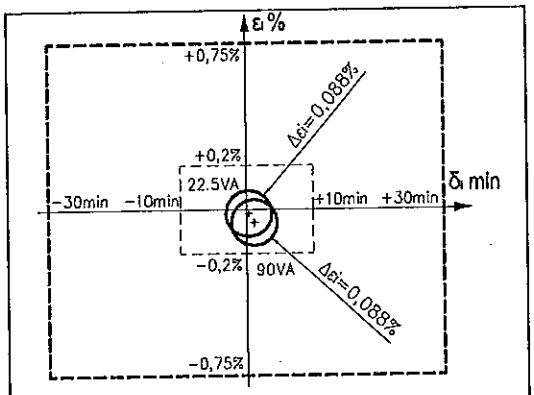
Current transformer maximal error of combined transformer was valuated by summarize mentioned above errors originated from influence voltage path on current path together with extreme values of errors measured during routine test at $I = 0{,}05 \cdot I_n \div 2 \cdot I_n$ (Report No. 2GKP011K1084502 – 20.06.2011, Appendix No. 2 of hereby Report).

Below are presented chosen results of calculation in analytic and graphic form (for maximal errors).

Maximal possibly current error of winding for measurement ($I = 0{,}05 \cdot I_n \div 2 \cdot I_n$)

$\pm\varepsilon_i' = |\varepsilon_i| + |\Delta\varepsilon_i| = -0{,}018\,\% + 0{,}088\,\% = 0{,}07\,\%$

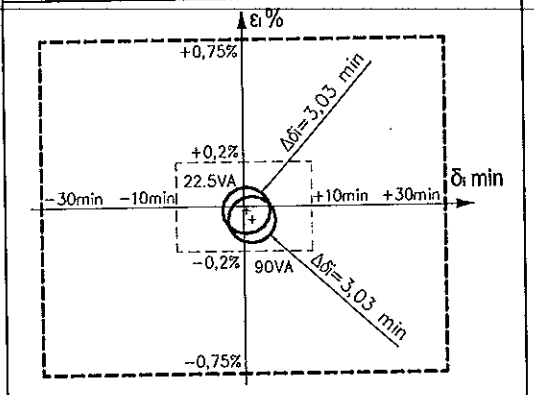
$\pm\varepsilon_i' = |\varepsilon_i| + |\Delta\varepsilon_i| = -0{,}059\,\% - 0{,}088\,\% = -0{,}147\,\%$



Maximal possibly phase displacement of for measurement ($I = 0{,}05 \cdot I_n \div 2 \cdot I_n$)

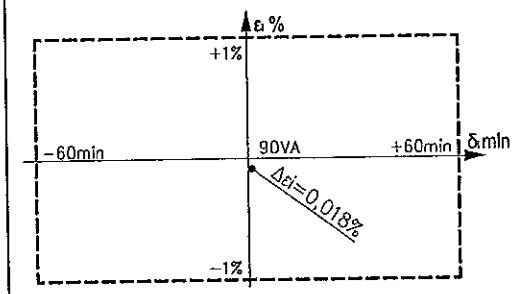
$\pm\delta_i' = |\delta_i| + |\Delta\delta_i| = 0{,}3\text{ min} - 3{,}03\text{ min} = -2{,}73\text{ min}$

$\pm\delta_i' = |\delta_i| + |\Delta\delta_i| = 1{,}0\text{ min} + 3{,}03\text{ min} = 4{,}03\text{ min}$



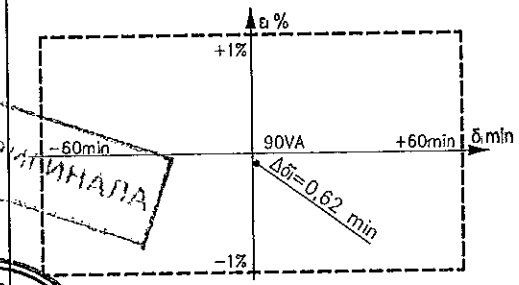
Maximal possibly current error of winding for protection ($I = 0{,}05 \cdot I_n \div 2 \cdot I_n$)

$\pm\varepsilon_i' = |\varepsilon_i| + |\Delta\varepsilon_i| = -0{,}085\,\% - 0{,}018\,\% = -0{,}103\,\%$



Maximal possibly phase displacement of winding for protection ($I = 0{,}05 \cdot I_n \div 2 \cdot I_n$)

$\pm\delta_i' = |\delta_i| + |\Delta\delta_i| = 1{,}0\text{ min} + 0{,}62\text{ min} = 1{,}62\text{ min}$



It was found that errors origin from influence of voltage path on current path of combined transformers PVA 123 not cause loss of metrological properties (loss of class) for all secondary voltage windings .

Test result - positive.

4.7 Radio interference voltage measurement

Following to requirement of IEC/CISPR 18-2 the measurements was performed in testing arrangement as is show on Figure 5. The interference voltage was measured on resistance 300Ω at frequency 0,5 MHz. To determinate coefficient of correction +23 dB before measurement the instrument was calibrated by stabile signal generator . To measurement of interference voltage the instrument LMZ-5 was used. The level of background was checked for range of test voltages 0 - 150 kV. Interference voltages originated form testing arrangement, radio broadcasts etc., were below 5μV (14 dB).

According to PN EN 60044-1/A1 and PN EN 60044-2/A1 interference voltage at voltage $Up=1.1\cdot U_m/\sqrt{3}=78$ kV has not to exceed the value $RIV_{dop} = 2500\mu V$.

The instrument had logarithmic scale: $RIV_{dop} = 2500\mu V \rightarrow 68$ dB (0 dB = 1 μV).

The measurements were done at test voltages in range $0,3\div1,1\cdot U_m/\sqrt{3}$.

Test voltage was decreased step by step with value 0,1xUp since $Up=1,1\cdot U_m/\sqrt{3}$ up to value $Up=0,3\cdot U_m/\sqrt{3}$. Next, voltage was increased by this same values and finally deceased again.. For each of test voltage the measurement of radio interference voltage were performed and registered level in last series of decreasing voltage was drawn in function of test voltage Utest.

Combined transformer B

(Combined transformer A was identical construction.)

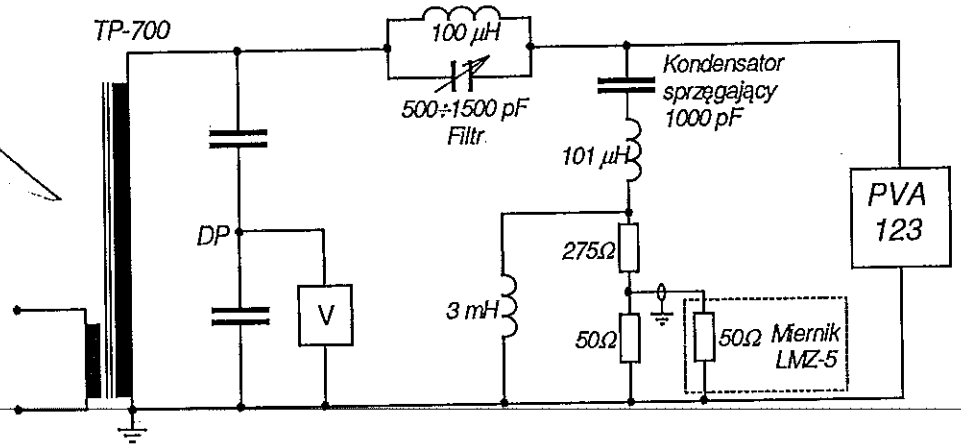
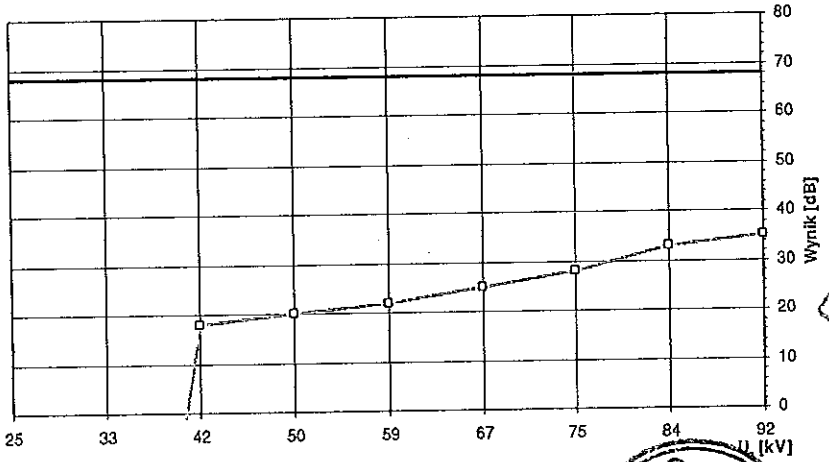


Fig. 5 Test arrangement for Radio interference voltage measurement

The results of measurements are present in Table and diagram below.

U_p [kV]	92	84	75	67	59	50	42	33	25
x Un/√3	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3
⇒	12	11	6	1	-1	-3	-5		
[dB] ⇐	12	11	6	2	-1	-4	-5		
⇒	12	10	5	2	-1	-3	-5		
Wynik: [dB]	35	33	28	25	22	20	18	-	-
[µV]	56	45	25	18	13	10	8	-	-



Measured Radio Interference Voltage RIV = 56 µV (35dB) is much less than permissible level RIV_{perm} = 2500 µV (68dB).

Test result - positive.

4.8 Chopped impulse test on the primary winding

Chopped Impulse Test was supplemented to Lightning Impulse test 1,2/50μs and was described in clause 3.3 of hereby Report.

Recorded oscillograms not show of failure of insulation of combined transformers. Test result - positive.

Oscillograms of all applied impulses are present in Appendix No. 4 of hereby Report.

4.9 Measurement of capacitance and dielectric dissipation factor

The measurement was performed by Schering bridge of TETTEX Type 2801 with standard capacitor TETTEX type 3370/100/330kV.

Condition of measurements:

Up = 10 kV; $110/\sqrt{3}$ kV = 63,5 kV; $123/\sqrt{3}$ kV = 71 kV

Ambient temperature during measurement was 18°C.

Combined transformer A

Test results are present in table below:

Up [kV]	C_x [pF]	tgδ [%]
10	1183	0.23
63,5	1183	0,24
71	1183	0,24

The standard specifications for capacitance and dissipation factor for instrument transformers not provide criterion for these parameters. The Standard PN-EN 60044-2:2001 (EN 60044-2:1999) only contain note that value of dissipation factor is usually less than 0,5%.

ЗАВЕРЕНО С ОРИГИНАЛА

4.10 Mechanical tests

Combined transformer A and combined transformer B

The mechanical tests were performed in Distribution Equipment Laboratory of Institute of Power Engineering in Warsaw. The test consist in applying to the current path of transformers A and B mechanical load – static and dynamic, in three direction in turn. Static load was 20% higher than standard requirement for II class of load. The test conditions were as follow:

$F_R = 3600$ N, $t = 60$ s

It was assumed that dynamic load is 1,4 times higher than static load.

During the tests behaving of combined transformer was correct. After test not stated any damages or oil leakage.

Test result - positive.

Detailed information about test arrangement, performed tests and tests results are present in Reports No. EUR/33/E/11-1E of 25.07.2011 and No. EUR/33/E/11-2E of 10.08.2011 – (Appendix 3)

4.11 Transmitted overvoltage measurement

Combined transformer B

During the test to the HV terminal of transformer were applied impulse voltage. It were recorded maximal value of overvoltages which came in each secondary windings - both current and voltage. According to requirement of Standard for impulse 0,5/50 μs and value $U_{test}=1{,}6 \cdot \sqrt{3} \times U_m/\sqrt{3} \cong 160$ kV the values of transmitted overvoltages can not exceed 1,6 kV. During all measurements to the transformer were applied lightning impulses at value ten times less, that is $U_1 = 16$ kV. Concerning linear of phenomenon, registered overvoltages should have values less than 160 V (peak-to- peak value).

Registration was don by digital oscilloscope of KIKUSUI COR 5502U with input impedance 50 Ω and transmission band 100 MHz.

Results of test are present in table below.

Winding	Overvoltage value $U_{pp}/2$ [V]	Percent of permissible overvoltage [%]
1a-1n	72,5	90,6
2a-2n	69,5	86,9
3a-3n	54,5	68,1
4a-4n	51,0	63,8
da-dn	62,5	81,3
1S1-1S2	70	87,5
2S1-2S2	52,5	38,5
3S1-3S2	75,5	94,4
4S1-4S2	73,0	91,3
5S1-5S2	64,5	80,6
6S1-6S2	64,0	80,0

It was found that for each of secondary winding of transformer transmitted overvoltages not exceed value of 800 V that is maximum 91,3 % permissible value.

Test result - positive.

The oscillograms of all applied and registered impulses are present in Appendix No. 6 of hereby Report.

4.12 Discharge capacitor test

Combined transformer B

(Voltage part of combined transformer A was identical construction.)

Discharge capacitor test consists of ten time discharged capacitor with capacitance C = 6 μV charged through combined transformer to voltage of value $U=1{,}1\cdot\sqrt{2}\cdot 110/\sqrt{3}\,\text{kV}\approx 100$ kV. Before tests and before each discharge the resistance of winding was measured and temperature rise were calculated.. The discharges was performed after 3 minutes, that is short as possibly time because charging capacitor and performing measurements. Additionally in purpose of checking transformer cooling the measurements of resistance of winding were performed and measurement value were used to calculation decrease of temperature during 15 minutes. Ambient temperature (initial temperature of transformer) was $T_0 = 23^0$C.

Rise of temperature was calculated according to formula:

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$$\Delta T = \frac{\Delta R}{Ro \cdot \alpha}$$

where: ΔR – increase of resistance of winding;

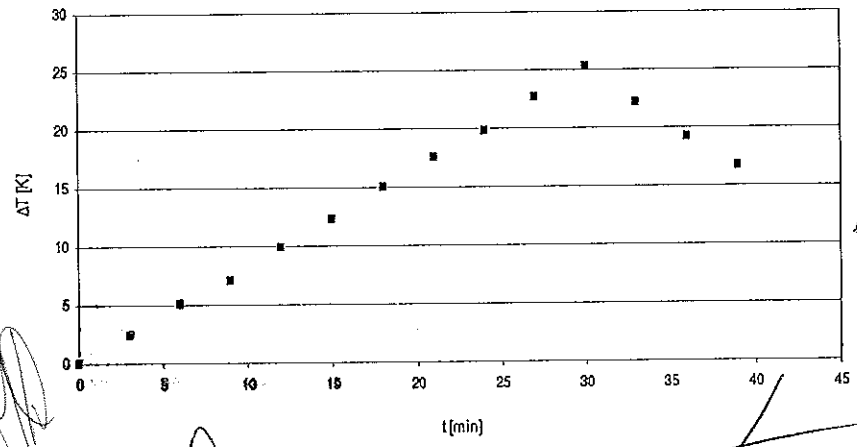
R_0 – resistance of winding before test;

α – temperature coefficient of resistance for copper (assumed α = 0,004)

Results of performed test are presented in table and on diagram, below.

t [min]	R [Ω]	ΔR [Ω]	ΔT [K]
0	20420	0	0.00
3	20610	190	2.33
6	20830	410	5.02
9	20990	570	6.98
12	21230	810	9.92
15	21420	1000	12.24
18	21650	1230	15.06
21	21850	1430	17.51
24	22030	1610	19.71
27	22270	1850	22.65
30	22480	2060	25.22
33	22230	1810	22.16
36	21990	1570	19.22
39	21780	1360	16.65

Rise of temperature of transformer PVA 123
during discharging capacitor test C=6uF



The measured rise of temperature circa 25 K is not danger for insulation of combined transformer. Maximal, permissible rise of temperature in temperature-rise test is 65 K. This criterion cab be use to capacitor discharge test too. The behave of combined transformer during test was proper. After test there not found any damages or oil leakage. Test result - positive.

After discharge capacitor test in Factory Laboratory of ABB sp. z o.o. in Przasnysz, under supervision of representative of IEn, was performed routine test (together with partial discharge measurement) and determination of error. He test results are presented Report No. 2GKP011K1084502 – 1.08.2011 – (Appendix No. 2).

It was found that metrological properties of combined transformer are comply assigned accuracy classes for separate windings and measured values after tests are practically identically to values measured before tests (clause 3.0 of hereby Report). This prove positive result of Discharge Capacitor Test.

5. SUMMARY

- The tests of combined transformers type PVA 123 manufactured by ABB sp. z o.o. 04-713 Warszawa, ul. Żegańska 1, with parameters described in clause 2 of hereby Report and identified on base provided documents (as presented in Appendix No. 1) was performed.
- The combined transformers type PVA 123 **passed positively** type test according to requirement of standard:
  - PN-EN 60044-1:2000 + A1:2003 +A2:2004 „Przekładniki. Część 1: Przekładniki prądowe" (EN-60044-1:1999 + A1:2000 + A2:2003 „Instrument transformers. Part 1: Current transformers"),
  - PN-EN 60044-2:2001 + A1:2003 +A2:2004 „Przekładniki. Część 2: Przekładniki napięciowe indukcyjne" (EN-60044-2:1999 + A1:2000 + A2:2003 „Instrument transformers. Part 2: Inductiv voltage transformers"),
  - PN-EN 60044-3:2006 „Przekładniki. Część 3: Przekładniki kombinowane" (EN-60044-3:2003 „Instrument transformers. Part 1: Combined transformers"),

  and program described in Table 1, clause 3 of hereby Report.

ПО С ОРИГИНАЛА

ООО ЭЛЕКТРИКСНТИ

- The combined transformers type PVA 123 **passed positively** special tests according requirement mentioned above standards and program described in Table 1, clause 3 of hereby Report.
- The combined transformers type PVA 123 **passed positively** additional test according to program described in Table 1, clause 3 of hereby Report what prove operation property of connection to long overhead lines or long cable lines.

6. LIST OF APPENDIXES

Appendix No. 1

Documents provided by ABB Sp. z o.o. used as base of identification of test object:

- Manufacturer Conformity Declaration No. 1/2011 (28.09.2011),
- Dimension drawing No. 2GKK610211/ (12.07.2011),
- Dimension drawing No. 2GKK610212/ (12.07.2011),
- Assembly drawing No. 2GKK314001M (26.05.2011),
- Electric diagram of combined transformer 50-100-200 A (25.07.2011),
- Electric diagram of combined transformer 3000 A (25.07.2011).

Appendix No. 2

Reports of routine test and determination of errors of combined transformer type PVA 123 performed in Factory Laboratory of ABB sp. z o.o.

- Tests before type test and special test (Measurements before type test and special tests) - Report No. 2GKP011K1084500 – 27.07.2011,
- Tests after type test and special tests completed (Measurements after type test and special test completed) - Report No. 2GKP011K1084500 – 11.08.2011.
- Tests before type test and special test (Measurements before type test and special tests) - Report No. 2GKP011K1084502 – 20.06.2011,
- Tests after type test and special tests completed (Measurements after type test and special test completed) - Report No. 2GKP011K1084502 – 1.08.2011.

ВЯРНО С ОРИГИНАЛА

Appendix No. 3

Report of performed tests in Distribution Equipment Laboratory of Institute of Power Engineering in Warsaw.

- Test Report No. EUR/33/E/11-1E of 25.07.2011
- Test Report No. EUR/33/E/11-2E of 10.08.2011 (Short-time current tests, short-circuit withstand capability test and mechanical tests.)

ООД ЕЛЕКТРИКСИТИ СОФИЯ

Стр. II. 555

Appendix No. 4

Report of performed tests in High Current Laboratory of Institute of Power Engineering in Warsaw.

- Test Report No. EWP/38/E/2011-2e of 9.09.2011
- Test Report No. EWP/69/E/2011e of 28.12.2011 (Temperature-rise tests)

Appendix No. 5

Lightning impulse test. Impulse 1,2/50 μs, full and chopped:

- Oscillograms of test voltages and detection currents.

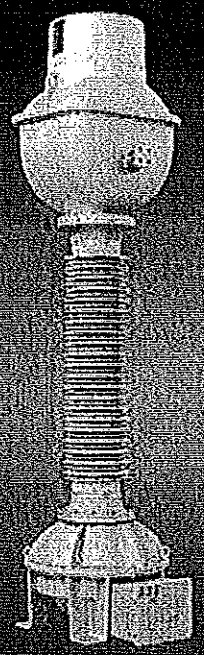
Appendix No. 6

Transmitted overvoltage measurement:

- Oscillograms of measured transmitted to secondary windings overvoltages.

ВЯРНО С ОРИГИНАЛА

Стр. II 556



High Voltage Products

Combined instrument transformer PVA 123

Power and productivity
for a better world™

ABB

General information

The PVA 123 combined instrument transformers are used for feeding measurement and protection systems in electric power grids with highest system voltage of up to 123 kV and frequency of 50 Hz.
They are designed to operate in grids with effectively earthed or insulated neutral points as well as in resonant (compensated) earthed systems. The PVA123 combined instrument transformers are suitable to operate in outdoor conditions with ambient temperature from 233 K (– 40°C) to 313 K (40°C) and at relative humidity of up to 100% at 303 K (30°C) and at the altitude not exceeding 1000 m above sea level.

The PVA 123 combined instrument transformer is top core construction; it comprises current and voltage modules encapsulated in common hermetically sealed housing filled with PCB free transformer oil. The current module is located in transformer's head and voltage module is in the bottom tank.
The transformer's stainless steel expansion bellows is fixed to the head and shielded with an aluminium cover. The expansion bellows compensates for thermal changes in oil volume.
The location of both CT and VT modules in one housing benefits the environment and offers reductions in the total cost of ownership of a substation due to:
- Reduced Station footprint:
  - lower number of transformers in a bay,
  - lower number of supporting structures,
  - lower number of connections,
  - lower cost of civil works,
  - lower transportation costs,
  - lower installation costs.

Top core construction
Top core construction makes it possible to achieve high values of thermal and dynamic short-circuit currents as well as a broad range of rated primary currents and outputs of secondary windings.

Primary and secondary windings and accuracy classes
The primary and secondary windings are made of highest quality electrical copper, enabling us to deliver to customers requiring high accuracy (classes 0.2S and 0.5S) with low values of rated primary current. We guarantee very high transformation accuracy in special classes ["S"], from 1% to 120%, 150% and even to 200% of the value of selected rated primary currents for both secondary currents of 1A and 5 A.
The voltage module of PVA 123 has accuracy from 0.1 for measuring windings. High transformation accuracy for protection windings is guaranteed from 2% to 120% typically and even up to 190% of rated primary voltage.

Main insulation
The main insulation is made of insulation paper impregnated with transformer oil. We utilise a high quality oil conforming to IEC 60296 Standard requirements. This oil does not contain PCB's or any other toxic substances and has low environmental impact.

Hollow insulator
The standard insulator is made of brown porcelain with creepage distance of 25 mm/kV. A grey composite insulator with creepage distance of 31 mm/kV is available upon request. All materials used in the production of our insulators conform to relevant IEC Standards.

Housing
All external parts are robust and made from corrosion resistant materials.
The PVA 123 combined instrument transformer is leak proof due to o-ring sealing system in the housing that is made of high quality aluminium alloy. The expansion bellows is equipped with large oil level indicator that enables observations of thermal changes in oil volume even from a distance. Each completely assembled unit is subject to stringent leakage checks during routine testing.

Primary terminals
The standard primary terminals are flat, made of aluminium, 100 mm or 200 mm width. Upon request we can offer pin type primary terminals, made of copper or aluminium, with a diameter of 30 mm or 40 mm.

Secondary terminal box
The secondary terminal box is IP55, constructed of aluminium. The terminal box is fixed to the transformer's bottom tank. Secondary terminals are available for connection of up to 10 mm² conductors. Sealing of current and voltage measurement secondary terminals is also possible upon request. The secondary terminal box has two M32 cable glands (for cables from Ø 11 mm to Ø 21 mm) and two M40 cable glands (for cables from Ø 19 mm to Ø 28 mm). We offer secondary terminal boxes with higher number of cable glands upon request.
On all secondary windings of voltage part of the transformer the breaking points made of copper Cu-ETP 1.2 mm dia 50 mm were applied. Breaking points protect the voltage part of the transformer from damage in case of secondary terminal short circuit. This protection is sufficient to protect the transformer for a short distance to the nearest point where adequate protections are installed. Additional fuses in terminal box of the transformer are not needed.

Technical data

General information

Parameter	Value
Type	PVA 123
Compliance with the standards	IEC 60044-3; PN-EN 60044-3
Rated primary voltage	110: √3 kV
Highest system voltage	123 kV
Rated power – frequency withstand voltage at 50 Hz	230 kV
Rated lighting – impulse withstand voltage 1.2/50 µs	550 kV
Minimum creepage distence	16; 20; 25; 31 mm/kV
Rated frequency	50 Hz
Total weight	650; 580* kg

*composite insulator

Current module

Rated current [A]	Rated 1s thermal current [kA]	Rated dynamic current [kA]
50–3000	10–63	25–157

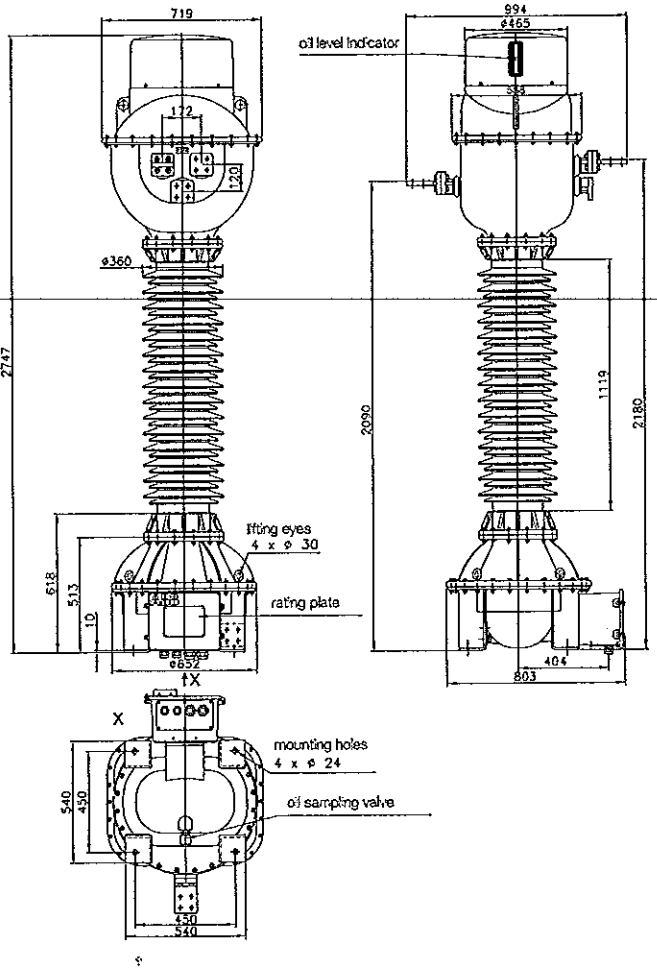
reconnectable 1:2 or 1:2:4

Parameter	Value
Rated secondary current	1 A; 5 A
Rated continuom thermal current	120%; 150%; 200%
Number of cores:	1–6
Measuring cores parameters:	
– total rated output	2.5–90 VA
– accuracy clases	from 0.2S
Protection cores parameters	
– total rated output	2.5–90 VA
– accuracy classes	5P, 10P, 5PR, 10PR, TPX, TPY, TPZ, PX, PXR

Voltage module

Voltage factor and time	1.2 continuous and 1.5/30 s; 1.9/30 s; 1.9/8 h		
Number of windings:	1–5		
Measuring/protection windings:			
– rated secondary voltage	100: √3 V; 110: √3 V		
– total rated output	up to 75 VA	up to 150 VA	up to 400 VA
– accuracy clases	0.1; 0.1/3P	0.2; 0.2/3P	0.5; 0.5/3P
Residual winding:			
– rated secondary voltage	100 V; 110 V; 100:3 V; 110:3 V		
– rated output	up to 400 VA		
– accuracy classes	1; 3; 3P; 6P		

Dimensional drawing



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ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИК СИТИ ООД София

Power and productivity
for a better world™

Приложение № 17 – Техническа документация (включително каталози), даваща пълно описание, технически данни и характеристики на предлаганото оборудване към Приложение № 10 - Технически данни на елегазов прекъсвач 110kV за въводно поле и силов трансформатор в ПС „Орион“

ЕООД • ЕЛЕКТРИКСИТИ • СОФИЯ

Сф. II - 561

CIRCUIT DIAGRAM SHOWS OPERATING MECHANISM WHEN CIRCUIT BREAKER IS OPEN, WITHOUT PRESSURE, CLOSING SPRING NOT CHARGED AND HANDCRANK ADAPTED.
SCHEMAT VISAR MANÖVERDONET DÅ HÖGSPÄNNINGSBRYTAREN ÄR I FRÅNSLAGET LÄGE, EJ TRYCKSATT SAMT MED MANÖVERDONETS TILLSLAGSFJÄDER OSPÄND OCH HANDVEVEN APTERAD.

CLOSE CIRCUIT
TILLKRETS

CIRCUIT BREAKER
BRYTARE

+S1
I
O

+S4
REMOTE FJÄRR
LOCAL LOKAL
DISCONN. AVST.

CLOSE 1 +, REMOTE
TILL 1 +, FJÄRR

CLOSE 1 +, LOCAL
TILL1 +, LOKAL

+

(-)

CLOSE
TILL 1

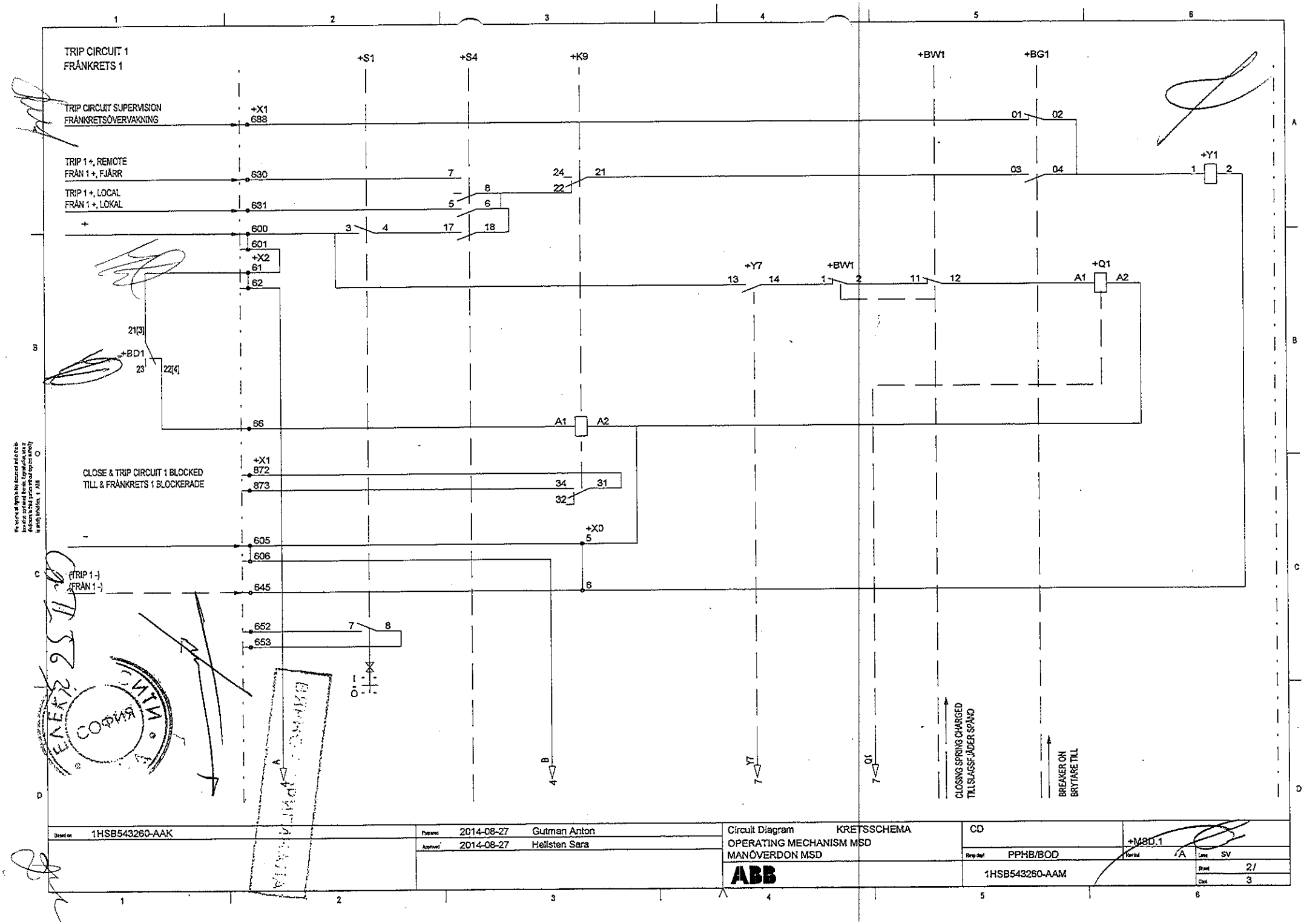
+X1
610
611
602
607
626
625

+K9
+K3
+BW1
+BG1
+XC3
+Y3
+BN
+K3
+XC4
A1
A2

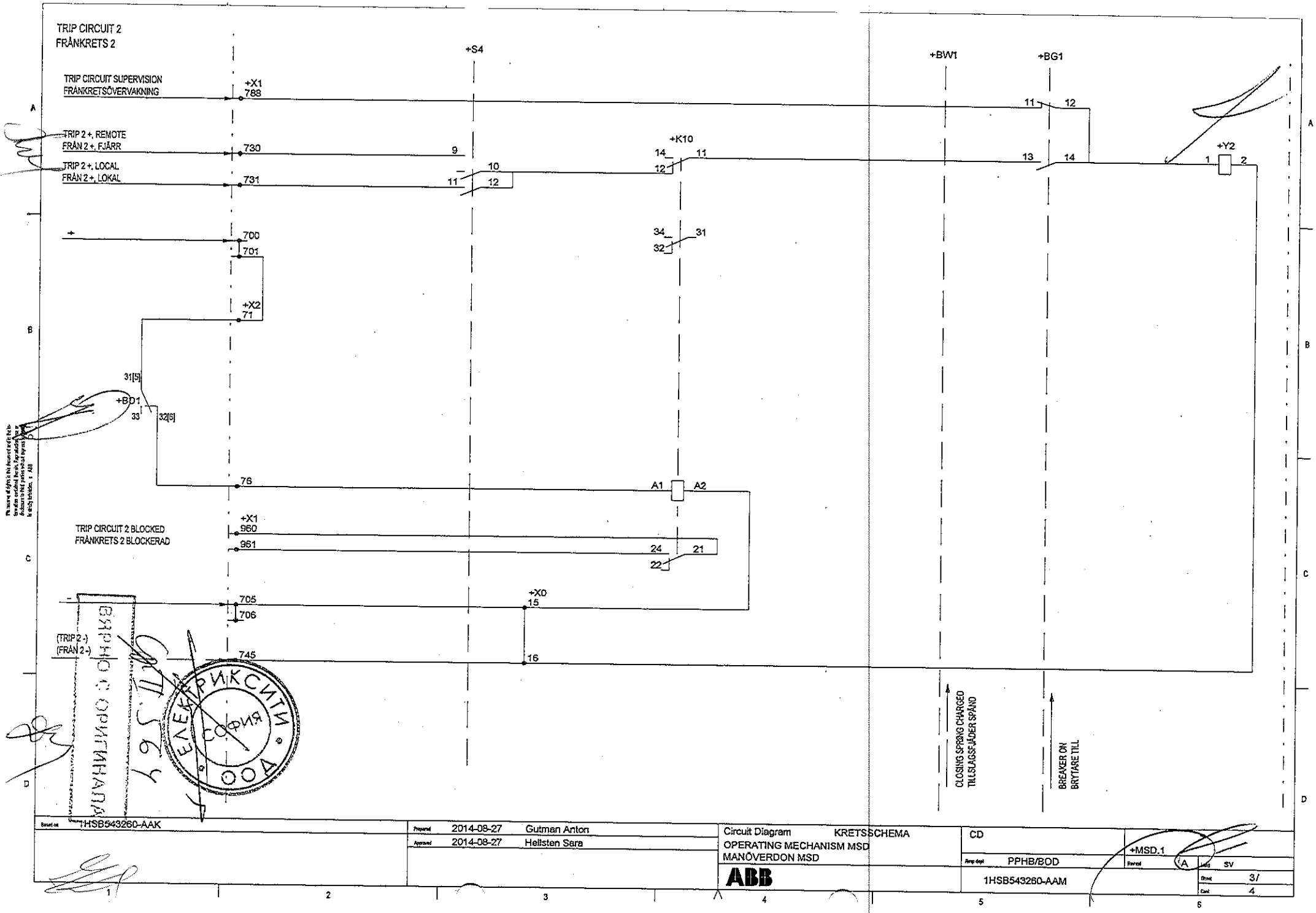
CLOSING SPRING CHARGED
TILLSLAGSFJÄDER SPÄND

BREAKER ON
BRYTARE TILL

1HSB543260-AAK	Prepared	2014-08-27	Gutman Anton	Circuit Diagram KRETSSCHEMA OPERATING MECHANISM MSD MANÖVERDON MSD	CD
	Approved	2014-08-27	Hellsten Sara	ABB	Resp dept PPHB/BOD
					1HSB543260-AAM
					+MSD.1
					Revind A
					Lang SV
					Sheet 1/10
					Cont 2



Based on 1HSB543260-AAK	Prepared 2014-08-27 Gutman Anton	Circuit Diagram KRETSSCHEMA OPERATING MECHANISM MSD MANÖVERDON MSD	CD
	Approved 2014-08-27 Hellsten Sara	ABB	Resp dept PPHB/BOD 1HSB543260-AAM
			+M8D.1 Terminal A Lang SV Sheet 2/ Cont 3


TRIP CIRCUIT 2
FRÅNKRETS 2
TRIP CIRCUIT SUPERVISION
FRÅNKRETSÖVERVAKNING
+X1
788
+S4
+BW1
+BG1
11
12
TRIP 2 +, REMOTE
FRÅN 2 +, FJÄRR
730
9
+K10
14
11
TRIP 2 +, LOCAL
FRÅN 2 +, LOKAL
731
10
11
12
13
14
+Y2
1
2
+
700
701
34
31
32
+X2
71
31[5]
+BD1
33
32[6]
76
A1
A2
TRIP CIRCUIT 2 BLOCKED
FRÅNKRETS 2 BLOCKERAD
+X1
960
961
24
21
22
-
705
706
+X0
15
(TRIP 2 -)
(FRÅN 2 -)
745
16
CLOSING SPRING CHARGED
TILLSLAGSFJÄDER SPÄND
BREAKER ON
BRYTARE TILL
1HSB543260-AAK
2014-08-27
Gutman Anton
2014-08-27
Hellsten Sara
Circuit Diagram
KRETSSCHEMA
OPERATING MECHANISM MSD
MANÖVERDON MSD
ABB
CD
PPHB/BOD
1HSB543260-AAM
+MSD.1
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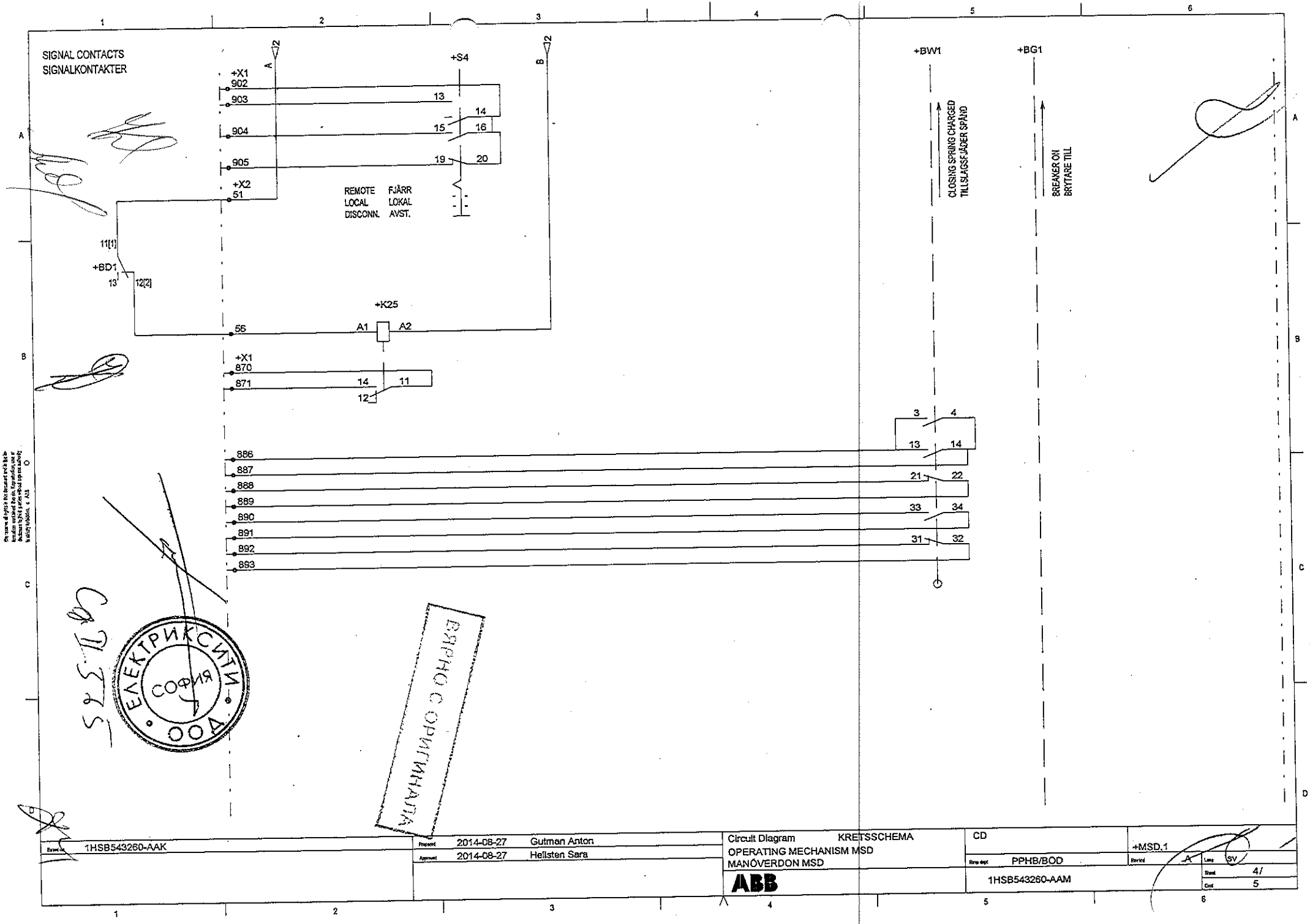
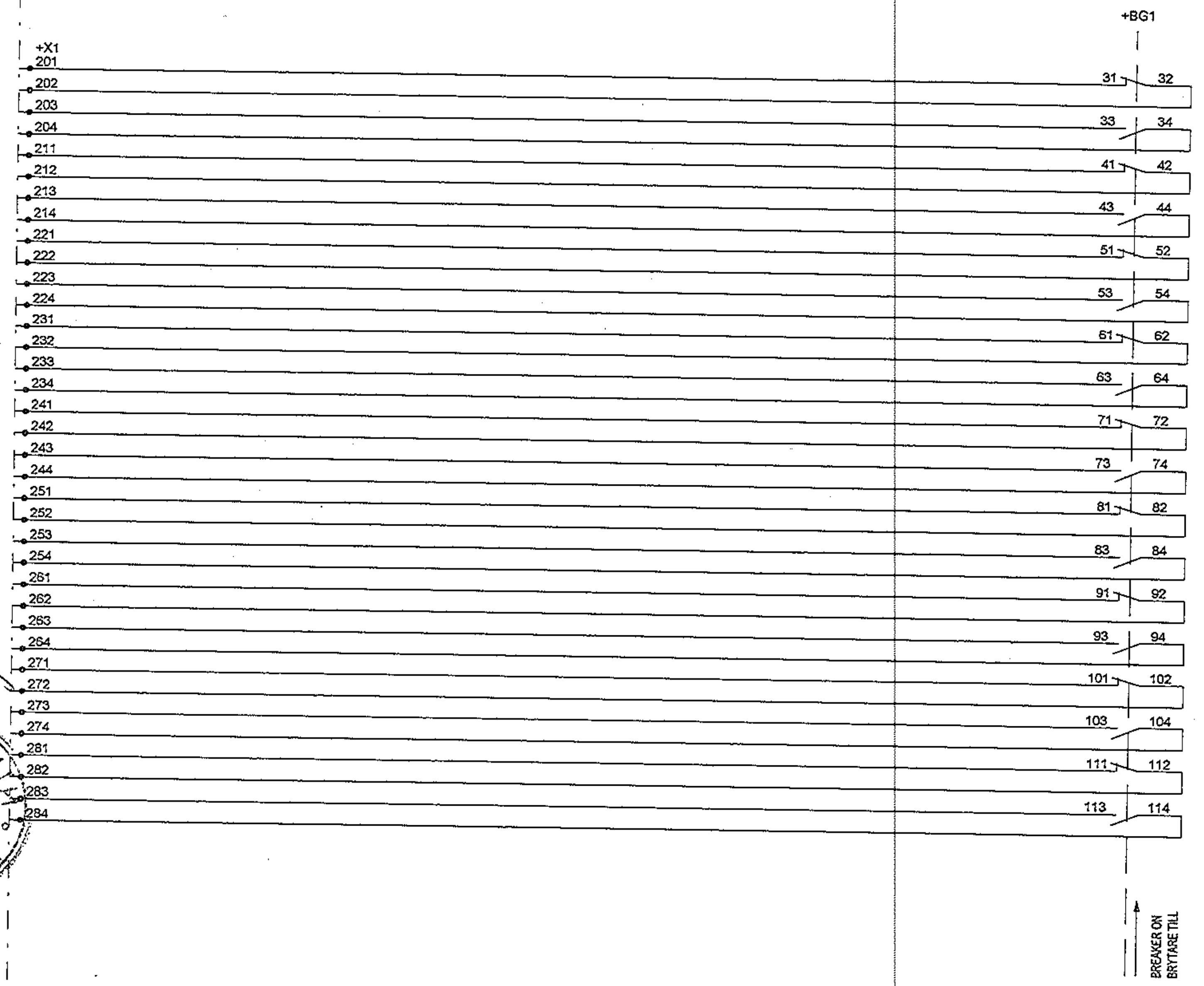
SV
3/
4



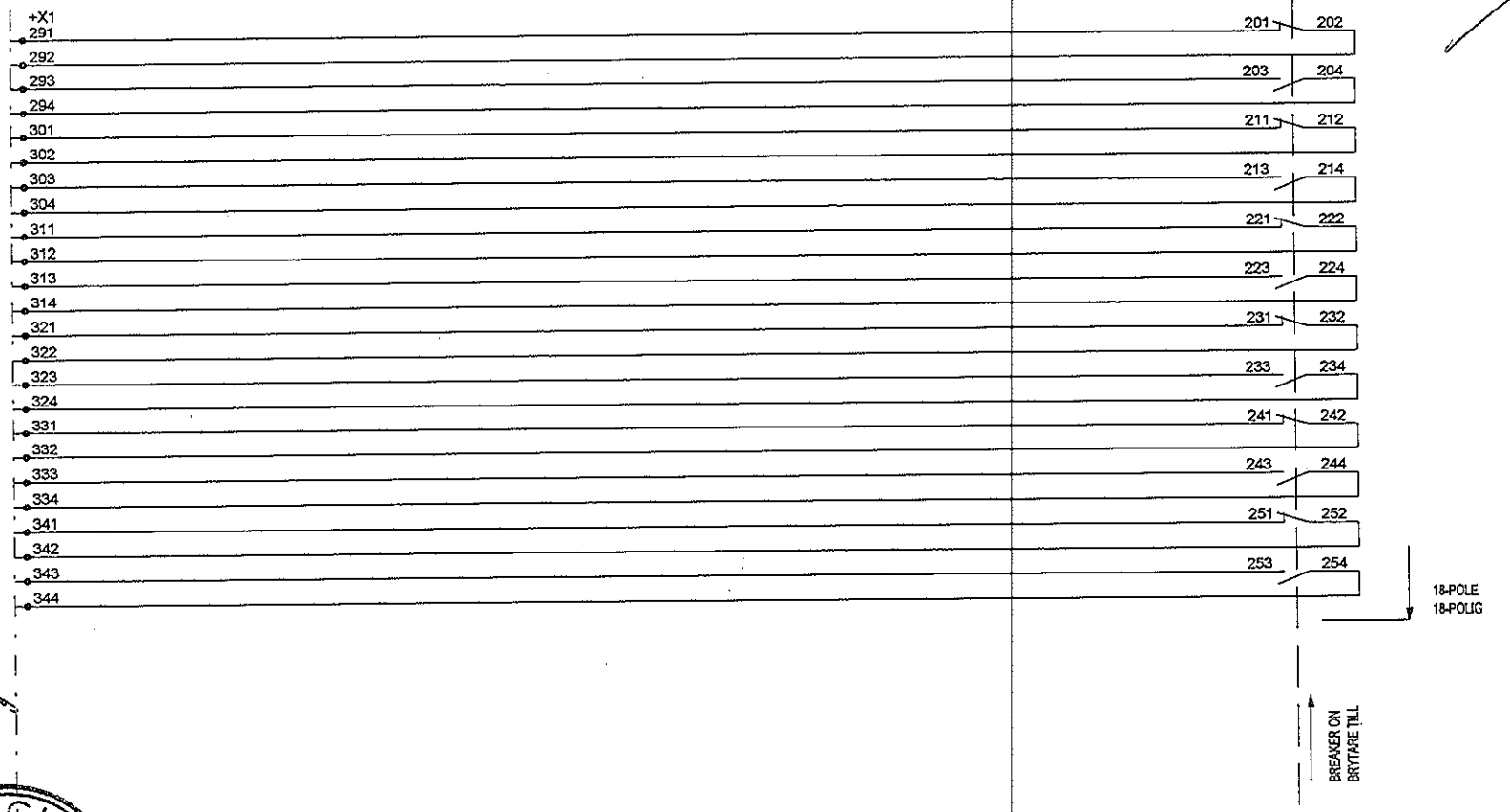
Based on	1HSB543260-AAK		Circuit Diagram KRETSSCHEMA OPERATING MECHANISM MSD MANÖVERDON MSD	CD	+MSD.1
Prepared	2014-08-27	Gutman Anton		Resp dept PPHB/BOD	Revised A Lang SV
Approved	2014-08-27	Hellsten Sara	ABB	1HSB543260-AAM	Sheet 4/ Cnt 5

AUXILIARY CONTACTS
HJÄLPKONTAKTER



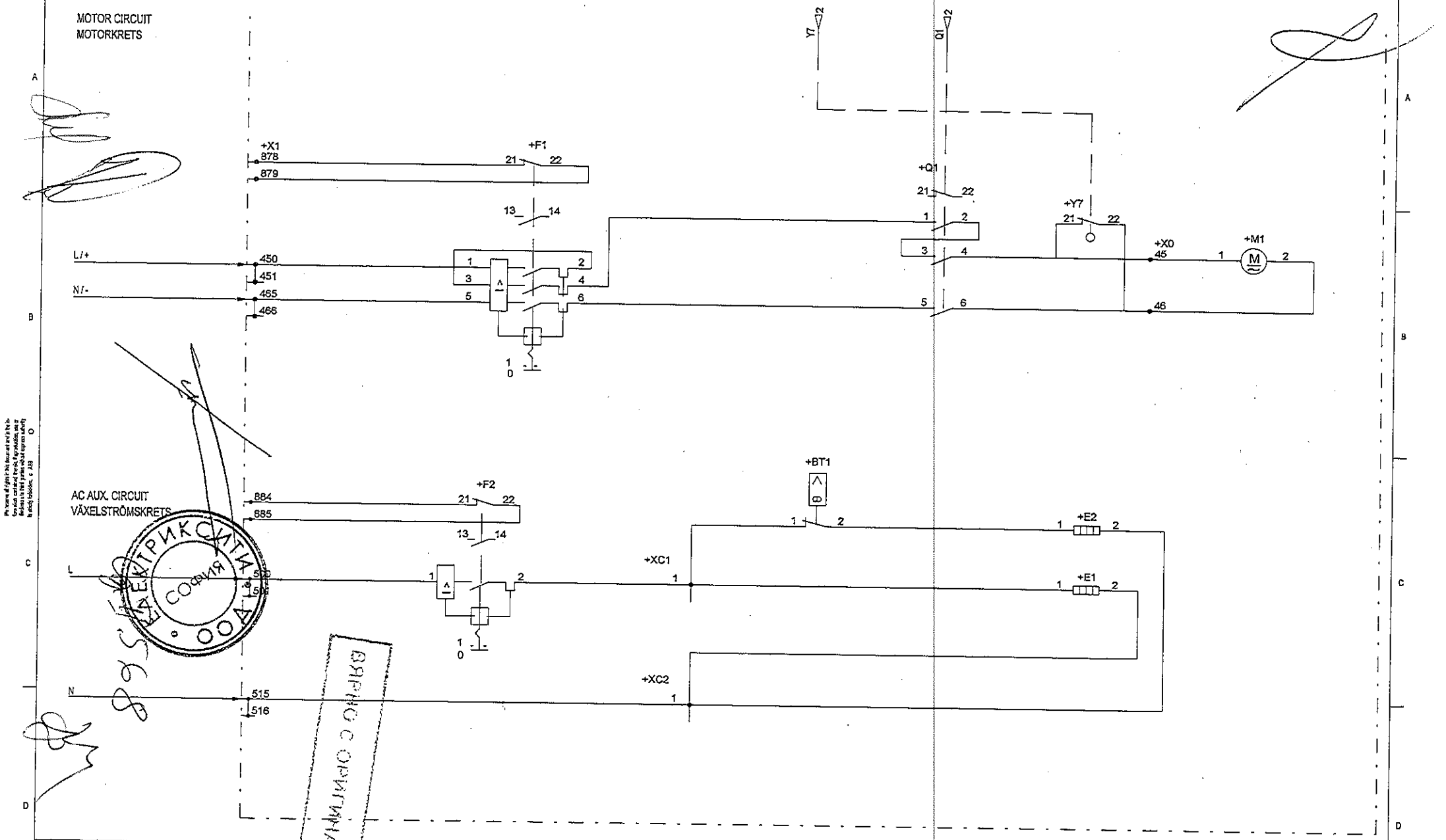
Based on 1HSB543260-AAK	Prepared 2014-08-27 Gutman Anton	Circuit Diagram KRETSSCHEMA	CD	+MSD.1
	Approved 2014-08-27 Hollsten Sara	OPERATING MECHANISM MSD MANÖVERDON MSD	Resp dept PPHB/BOD	Rev A, Lang SV
		ABB	1HSB543260-AAM	Sheet 5/, Cont 6

AUXILIARY CONTACTS
HJÄLPKONTAKTER



Based on 1HSB543260-AAK	Prepared 2014-08-27 Gutman Anton Approved 2014-08-27 Helisten Sara	Circuit Diagram KRETSSCHEMA OPERATING MECHANISM MSD MANÖVERDON MSD	CD Revised PPHB/BOD 1HSB543260-AAM
		ABB	+MSD1 Revision A Lang SV Sheet 6/10 Cont 7

MOTOR CIRCUIT
MOTORKRETS



AC AUX. CIRCUIT
VÄXELSTRÖMSKRETS

Based on	1HSB543260-AAK						
		Prepared	2014-08-27	Gutman Anton	Circuit Diagram KRETSSCHEMA OPERATING MECHANISM MSD MANÖVERDON MSD	CD	+MSD.1
		Approved	2014-08-27	Hellsten Sara	ABB	Resp dept PPHB/BOD	Revised A
						1HSB543260-AAM	Lang SV
							Sheet 7/
							Cont 8

CIRCUIT DIAGRAM SHOWS OPERATING MECHANISM WHEN CIRCUIT BREAKER IS OPEN, WITHOUT PRESSURE, CLOSING SPRING NOT CHARGED AND HANDCRANK ADAPTED.
SCHEMAT VISAR MANÖVERDONET DÅ HÖGSPÄNNINGSBRYTAREN ÄR I FRÅNSLAGET LÄGE, EJ TRYCKSATT SAMT MED MANÖVERDONETS TILLSLAGSFJÄDER OSPÄND OCH HANDVEVEN APTERAD.

ITEM POS.	DESIGNATION BENÄMNING
BD1	DENSITY SWITCH 2) DENSITETSVAKT 2)
BG1-2	AUXILIARY CONTACT HJÄLPKONTAKT
BN	COUNTER RÄKNEVERK
BT1	THERMOSTAT TERMOSTAT
BW1	LIMIT SWITCH GRÄNSSTÄLLARE
E1	HEATER (CONTINUOUS CONNECTED) VÄRMEELEMENT (KONTINUERLIGT INKOPPLAD)
E2	HEATER (THERMOSTAT CONTROLLED) VÄRMEELEMENT (TERMOSTATSTYRD)
F1	DIRECT-ON-LINE MOTORSTARTER MOTORSKYDDSBRYTARE
F2	MINIATURE CIRCUIT BREAKER (AC-CIRCUIT) DVÄRGBRYTARE (VÄXELSTRÖMSKRETS)
K3	ANTIPUMPING RELAY ANTIPUMPRELÄ
K9	INTERLOCKING RELAY (GAS SUPERVISION) (CLOSE / TRIP 1) FÖRREGLINGSRELÄ (GASÖVERVAKNING) (TILL/FRÅN 1)
K10	INTERLOCKING RELAY (GAS SUPERVISION) (TRIP 2) FÖRREGLINGSRELÄ (GASÖVERVAKNING) (FRÅN 2)
K25	AUXILIARY RELAY (GAS SUPERVISION) (ALARM) HJÄLPRELÄ (GASÖVERVAKNING) (LARM)
M1	MOTOR MOTOR
Q1	CONTACTOR KONTAKTOR

ITEM POS.	DESIGNATION BENÄMNING
S1	CONTROL SWITCH (TRIP/CLOSE) MANÖVERSTÄLLARE (FRÅN/TILL)
S4	SELECTOR SWITCH (OPERATION) OMKOPPLARE (MANÖVER)
X0	TERMINAL BLOCK (INTERNAL) KOPPLINGSPLINT (INTERN)
X1	TERMINAL BLOCK (EXTERNAL) KOPPLINGSPLINT (EXTERN)
X2	TERMINAL BLOCK (INTERNAL) (GAS SUPERVISION) 2) KOPPLINGSPLINT (INTERN) (GASÖVERVAKNING) 2)
XC1-4	TERMINAL BLOCK (INTERNAL) KOPPLINGSPLINT (INTERN)
Y1	SHUNT TRIP COIL 1 FRÅNSLAGSMAGNET 1
Y2	SHUNT TRIP COIL 2 FRÅNSLAGSMAGNET 2
Y3	CLOSING COIL 1 TILLSLAGSMAGNET 1
Y7	BLOCKING CONTACT (HANDCRANK ADAPTED) BLOCKERINGSKONTAKT (VEV APTERAD)

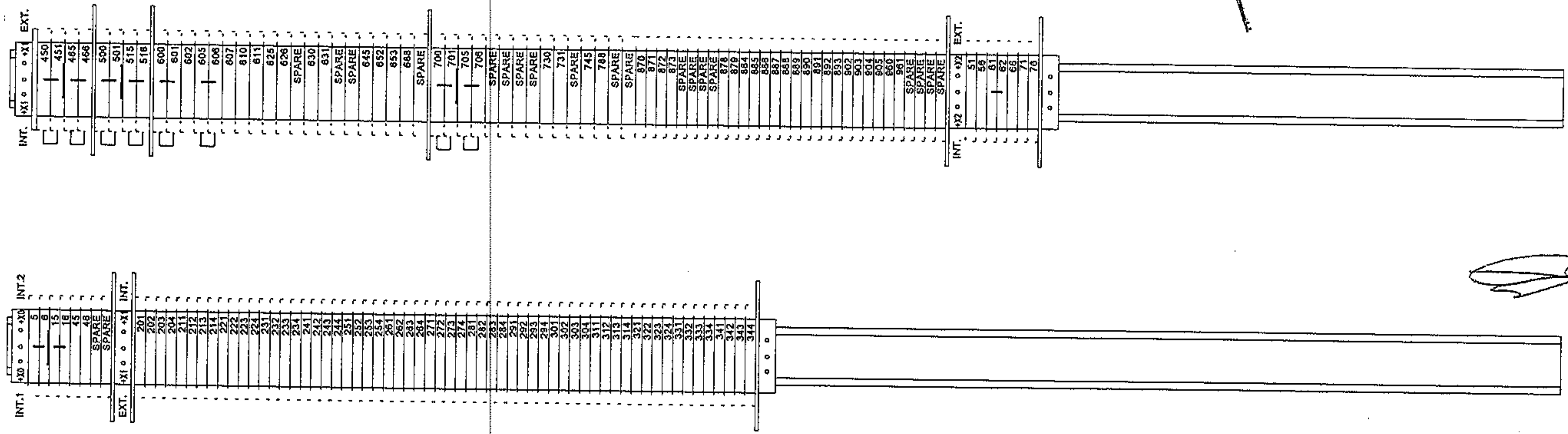
2) TO BE CONNECTED ON SITE WHEN INSTALLING.
2) ANSLUTES PÅ MONTAGEPLATSEN I SAMBAND MED INSTALLERING.

Based on	1HSB543260-AAK	Prepared	2014-08-27	Gutman Anton	Circuit Diagram KRETSSCHEMA OPERATING MECHANISM MSD MANÖVERDON MSD
		Approved	2014-08-27	Hellsten Sara	

ABB

CD		+MSD.1	
Resp dept	PPHB/BOD	Revind	A
1HSB543260-AAM		Lang	SV
		Sheet	8/
		Cont	9

TERMINAL ARRANGEMENT (VERTICAL MOUNT.)
PLINTARRANGEMANG (LODRÄT MONT.)



Based on	1HSB543260-AAK		
Prepared	2014-08-27	Gutman Anton	
Approved	2014-08-27	Hellsten Sara	
Circuit Diagram	KRETSSCHEMA	CD	
OPERATING MECHANISM MSD		+MSD.1	
MANÖVERDON MSD		Resp dept PPHB/BOD	Revind A
ABB		1HSB543260-AAM	Lang SV; Sheet 9/; Cont R1

List of Revisions

Rev Index	Revision text	Date	Prepared	Approved
A	First edition.	2014-08-27	Gutman Anton	Hellsten Sara

Based on 1HSB543260-AAK	Prepared 2014-08-27 Gutman Anton Approved 2014-08-27 Hellsten Sara	Circuit Diagram KRETSSCHEMA OPERATING MECHANISM MSD MANÖVERDON MSD ABB	CD Resp dept PPHB/BOD 1HSB543260-AAM Revised A Date SV Sheet R1/ Cont

ABB

Data schedule: SF_6 Circuit Breaker

Tender: 16Q2863109 , Item: 10

General data		
Type		LTB 123D1/B
Type of operation		3 Pole Operation
Number of poles		3
Min temperature	°C	-35
Max temperature	°C	40
Max altitude	m	1000

Ratings and guaranteed performance in accordance with IEC 62271-100

Rated voltage	kV	123
Rated insulation levels		
Rated lightning impulse withstand voltage		
to earth	kV_{peak}	550
across the open circuit breaker	kV_{peak}	650
Rated switching impulse withstand voltage		
to earth	kV_{peak}	-
across the open circuit breaker	kV_{peak}	-
Rated power frequency withstand voltage		
to earth	kV	230
across the open circuit breaker	kV	275
Rated frequency	Hz	50
Rated normal current	A	2500
Rated short-circuit breaking current	kA	31.5
DC component	%	41
First pole-to-clear factor		1.5
Rated transient recovery voltage for terminal faults	kV_{peak}	211
Rated characteristics for short line fault		
Peak factor		1.6
RRRV factor	kV/µs/kA	0.2
Surge impedance	Ohm	450
Rated peak making current	kA_{peak}	78.8
Rated duration of short-circuit current	s	3
Rated out of phase characteristics		
Out of phase making and breaking current	kA	7.9
Voltage factor		2.5
Rated line charging breaking current	A	31.5
Rated cable charging breaking current	A	140
Rated operating sequence		O-0.3s-CO-3min-CO
Mechanical endurance class		M2
Operating times		
Opening time	ms	30-36
Break time	ms	50
Closing time	ms	<56

Constructional features

Number of breaks per pole		1
Gas mixture		0.7 MPa SF6
Total mass of gas	kg	7
Volume of gas	liter	3 x 50
Max. working pressure	MPa (gauge)	0.80
Filling pressure at +20°C	MPa (abs)	0.70
Alarm pressure	MPa (abs)	0.62
Blocking pressure	MPa (abs)	0.60
Bursting disc		No
HV terminal		IEC(40) 9-hole + NEMA(44.5) 4-hole

Heater in packing boxes		Yes
Dimension print		1HSBDG00003-710
Rating plate		1HSBRG00003-519
Seismic/Reinforced		0.5g IEC 62271-300
Insulators		
Type of insulators and colour		Brown porcelain
Min nominal creepage distance phase-to-earth	mm	4015
Min nominal creepage distance across open breaker	mm	3800
Operating mechanism		
Number of drives		1
Motor charged spring operating mechanism		MSD1
Whether fixed trip or trip-free (IEC Publ.60050(441))		Trip-free
Operating voltage	VDC	220
Heater voltage	VAC	230
Motor voltage	VDC	220
Power required at rated supply voltage by		
Closing coil	W	230
Opening coil	W	230
Motor	kW	0.6
Heating element, continuously	W	75
Heating elements, connected by thermostat	W	155
Number of available auxiliary contacts making and breaking		15NO+15NC
Manual trip		Yes, internal
Type of terminals supply		Entrelec M6/8
Type of terminals signals		Entrelec M4/6
TCS resistor drive		YES without resistor
Circuit diagram drive		1HSB543260-AAM

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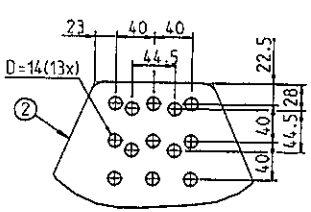
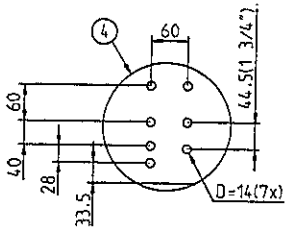
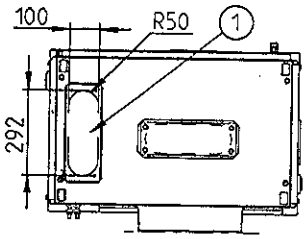
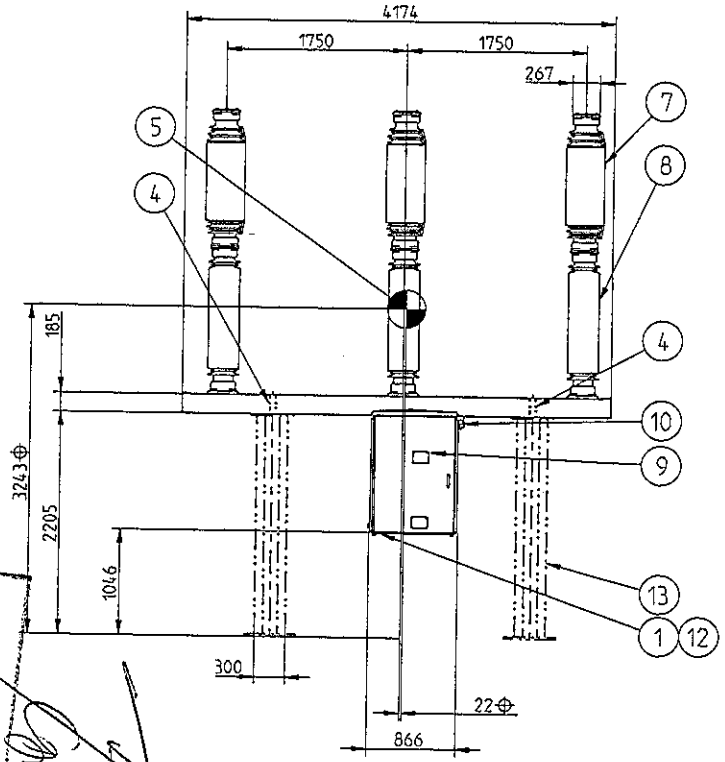
Сл.Д.573

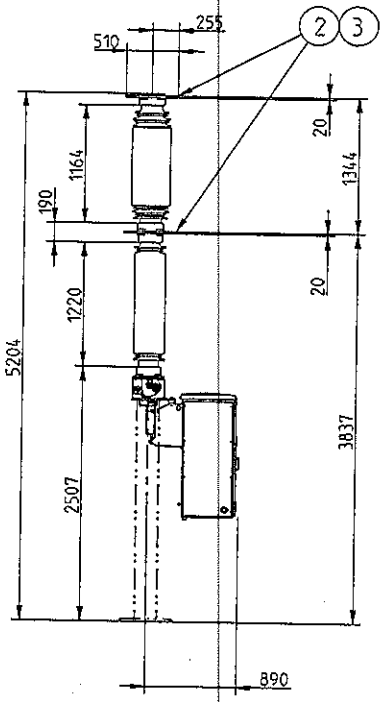
ВЕРНО С ОРИГИНАЛА



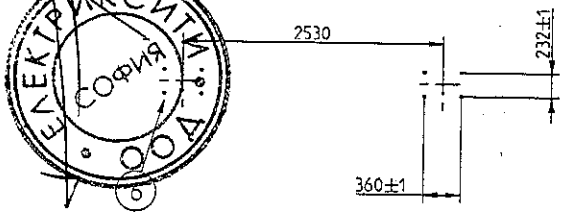








1. Cable inlet see fig.
2. Terminal of aluminium.
3. Terminal of aluminium.
4. Holes for earthing clamp
5. Centre of gravity
6. Hole D=25 for bolt M20 (8x)
7. Break chamber insulator Porcelain insulator
8. Post insulator Porcelain insulator
9. Open/closed indicator.
10. Density switch
11. -
12. Cubicle
13. The frame is only shown as a reference. The delivery will be without frame.



SF6 BREAKER LTB 123D1/B WITH OPERATING MECHANISM TYPE MSD1

Comments			Order	Scale / Units mm	Format A3
Prepared 2016-01-12	M Sellen	Based on			
Reviewed 2016-01-12	M Sellen	Responsible department PPHB/BDD	SF6 CIRCUIT BREAKER LTB 123D1/B		Language en
Approved 2016-01-12	P Stengård	Document kind Drawing			Page 1 of 2
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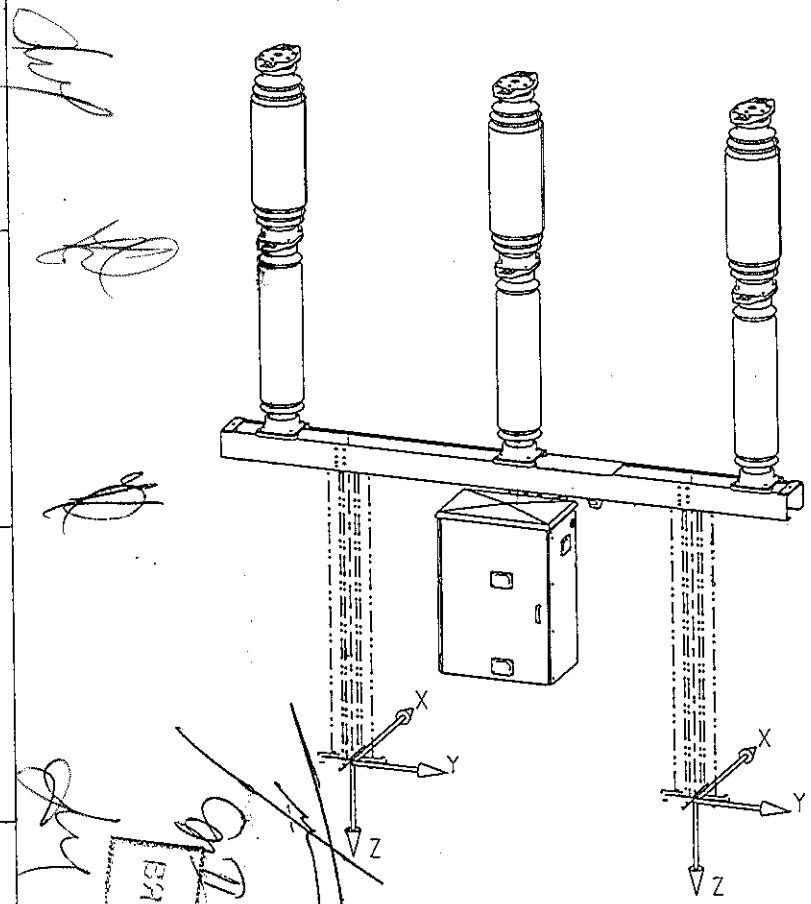
Mass in kg			
Breaker	Frame/polebeam	Operating mechanism	Total mass (gas excluded)
3x266	138	230	1165



Loads on foundation and foundation bolts

Load definition			Foundation					Foundation bolt
			Horizontal forces		Bending moments		Vertical force	Vertical force
			Fx [kN]	Fy [kN]	Mx [kNm]	My [kNm]	Fz [kN]	Fbz [kN]
Weight			---	---	---	---	5.9	1.4
Static terminal load			1.9	1.1	5.8	10.1	1.5	13
Short circuit	31.5	kA	---	0.8	0.6	---	---	0.8
Wind	34	m/s	1.6	1.2	4	4.9	---	6.1
Operation	Upwards		---	---	---	---	12.1	3.9
	Downwards		---	---			8.3	4.4

SF6 BREAKER LTB 123D1/B WITH OPERATING MECHANISM TYPE MSD1

Comments			Order	Scale / Units mm	Format A3
Prepared 2016-01-12	M Sellen	Based on			
Reviewed 2016-01-12	M Sellen	Responsible department PPHB/BDD	SF6 CIRCUIT BREAKER LTB 123D1/B		Language en
Approved 2016-01-12	P Stengård	Document kind Drawing			Page 2 of 2
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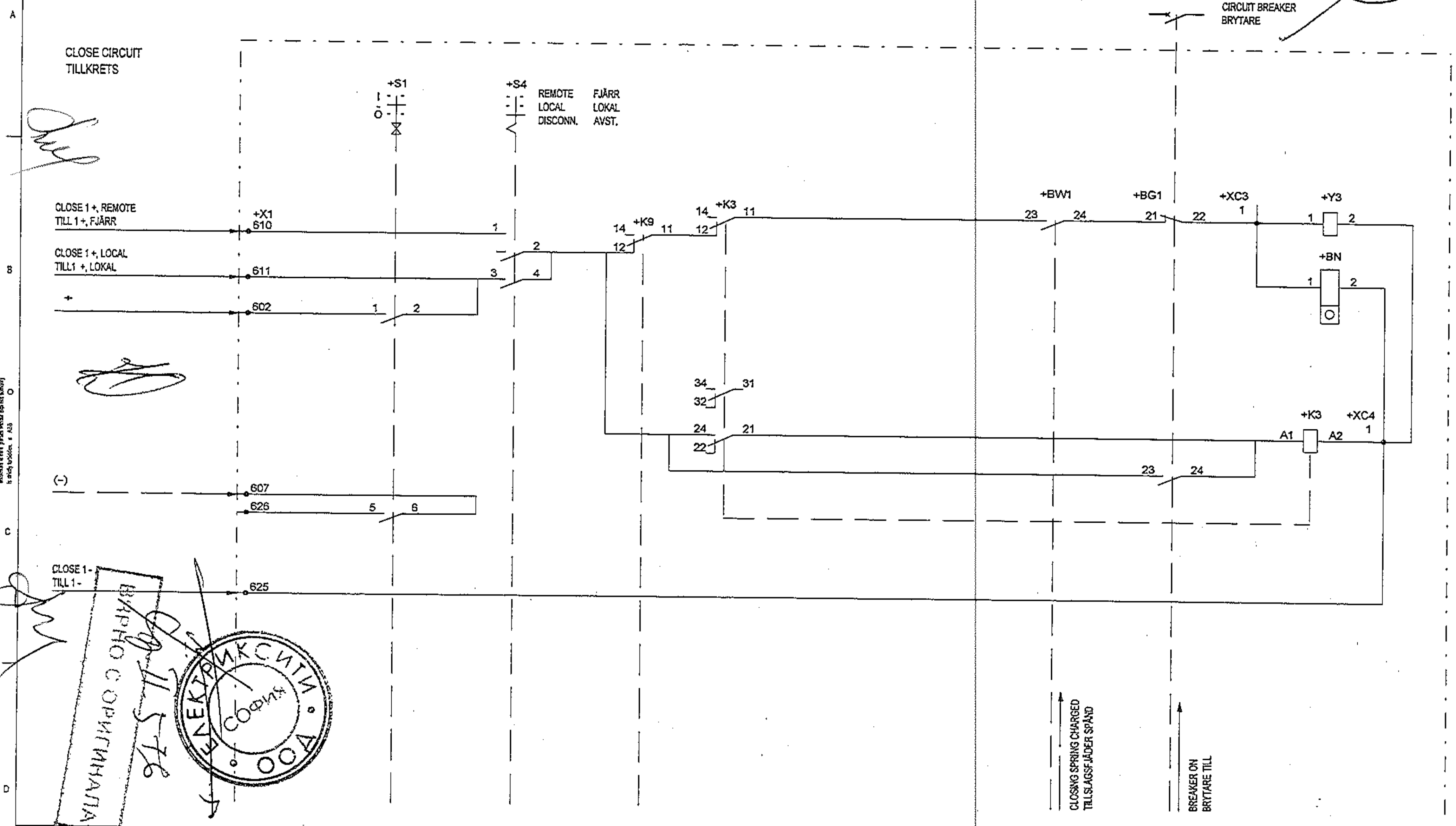
CIRCUIT DIAGRAM SHOWS OPERATING MECHANISM WHEN CIRCUIT BREAKER IS OPEN, WITHOUT PRESSURE, CLOSING SPRING NOT CHARGED AND HANDCRANK ADAPTED.
SCHEMAT VISAR MANÖVERDONET DÅ HÖGSPÄNNINGSBRYTAREN ÄR I FRÅNSLAGET LÄGE, EJ TRYCKSATT SAMT MED MANÖVERDONETS TILLSLAGSFJÄDER OSPÄND OCH HANDVEVEN APTERAD.



Based on	1HSB543260-AAK	
Prepared	2014-08-27	Gutman Anton
Approved	2014-08-27	Hellsten Sara

Circuit Diagram KRETSSCHEMA
OPERATING MECHANISM MSD
MANÖVERDON MSD

ABB

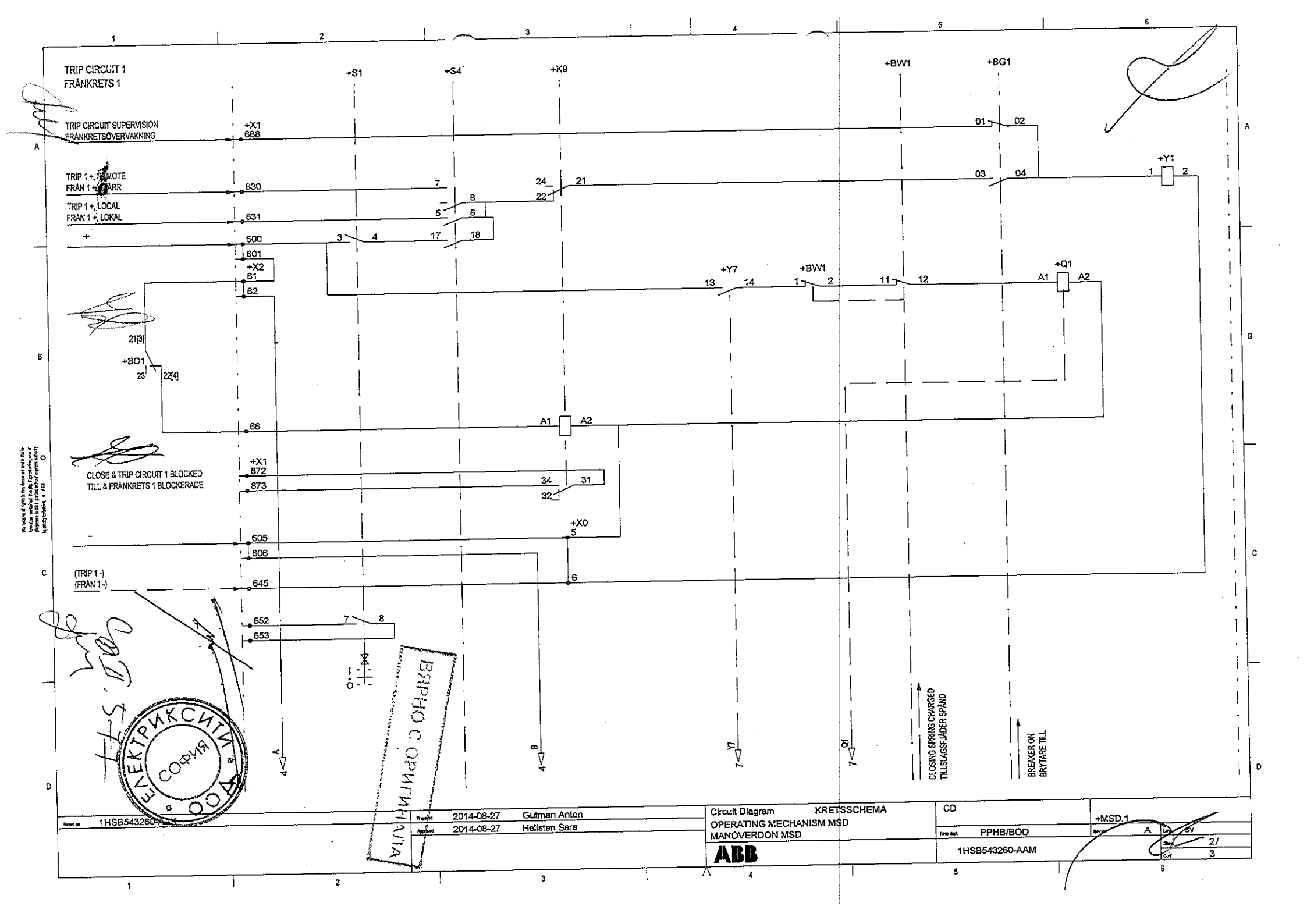
CD

+MSD.1

Resp dept PPHB/BOD

1HSB543260-AAM

Revind A | Lang SV | Sheet 1/10 | Cont 2


TRIP CIRCUIT 1
FRÅNKRETS 1
TRIP CIRCUIT SUPERVISION
FRÅNKRETSÖVERVAKNING
TRIP 1 +, REMOTE
FRÅN 1 +, FJÄRR
TRIP 1 +, LOCAL
FRÅN 1 +, LOKAL
+
-
(TRIP 1 -)
(FRÅN 1 -)
CLOSE & TRIP CIRCUIT 1 BLOCKED
TILL & FRÅNKRETS 1 BLOCKERADE
+X1
+X2
+X0
+S1
+S4
+K9
+BW1
+BG1
+Y1
+Y7
+Q1
+BD1
688
630
631
600
601
61
62
872
873
605
606
645
652
653
66
CLOSING SPRING CHARGED
TILLSLAGSFJÄDER SPÄND
BREAKER ON
BRYTARE TILL
Circuit Diagram KRETSSCHEMA
OPERATING MECHANISM MSD
MANÖVERDON MSD
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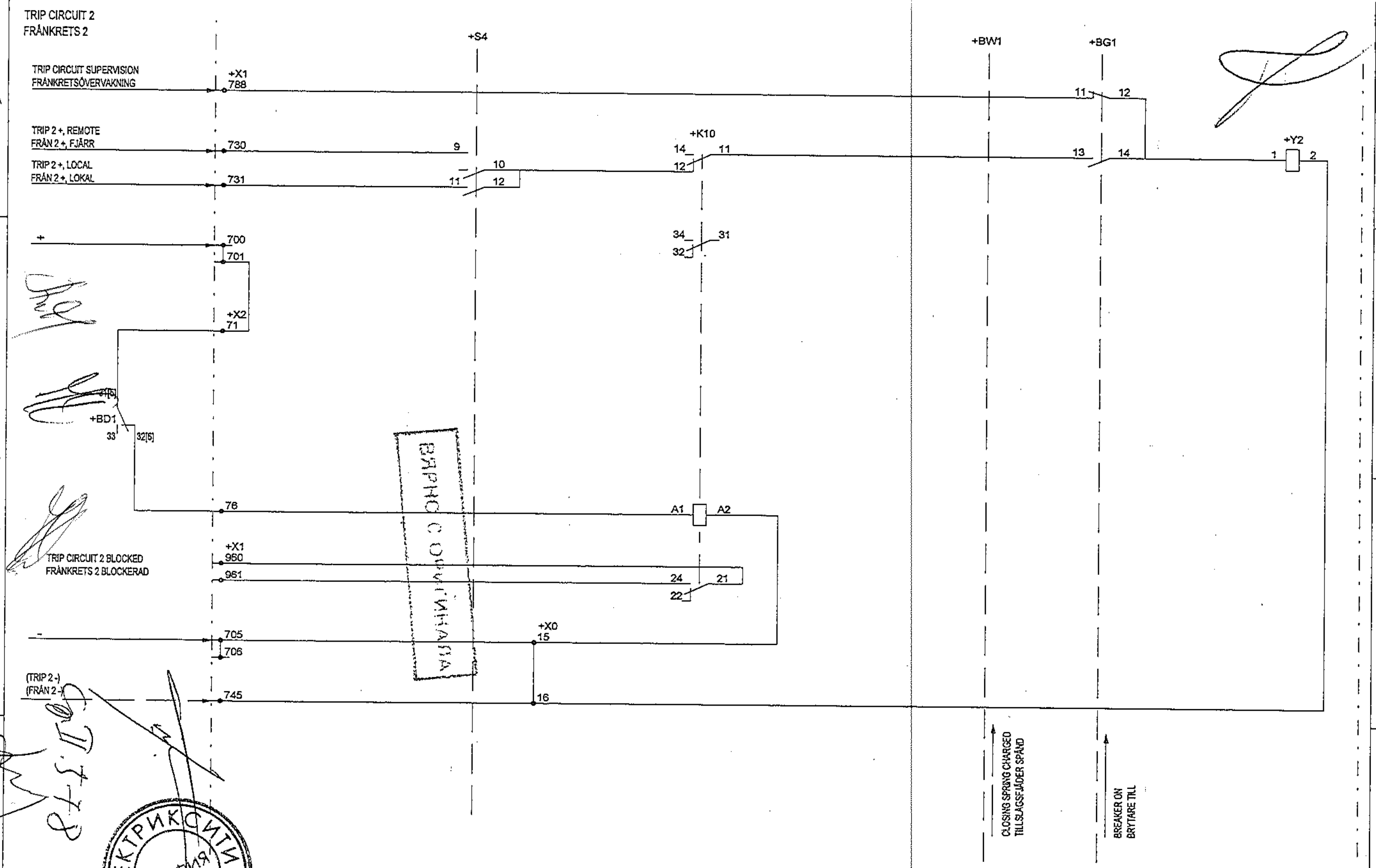
+MSD.1
Rev A
Lang SV
Sheet 2/
Cont 3
Prepared 2014-08-27 Gutman Anton
Approved 2014-08-27 Hellsten Sara
Based on 1HSB543260-AAK



Based on	1HSB543260-AAK	Prepared	2014-08-27 Gutman Anton
		Approved	2014-08-27 Hellsten Sara

Circuit Diagram KRETSSCHEMA
OPERATING MECHANISM MSD
MANÖVERDON MSD

ABB

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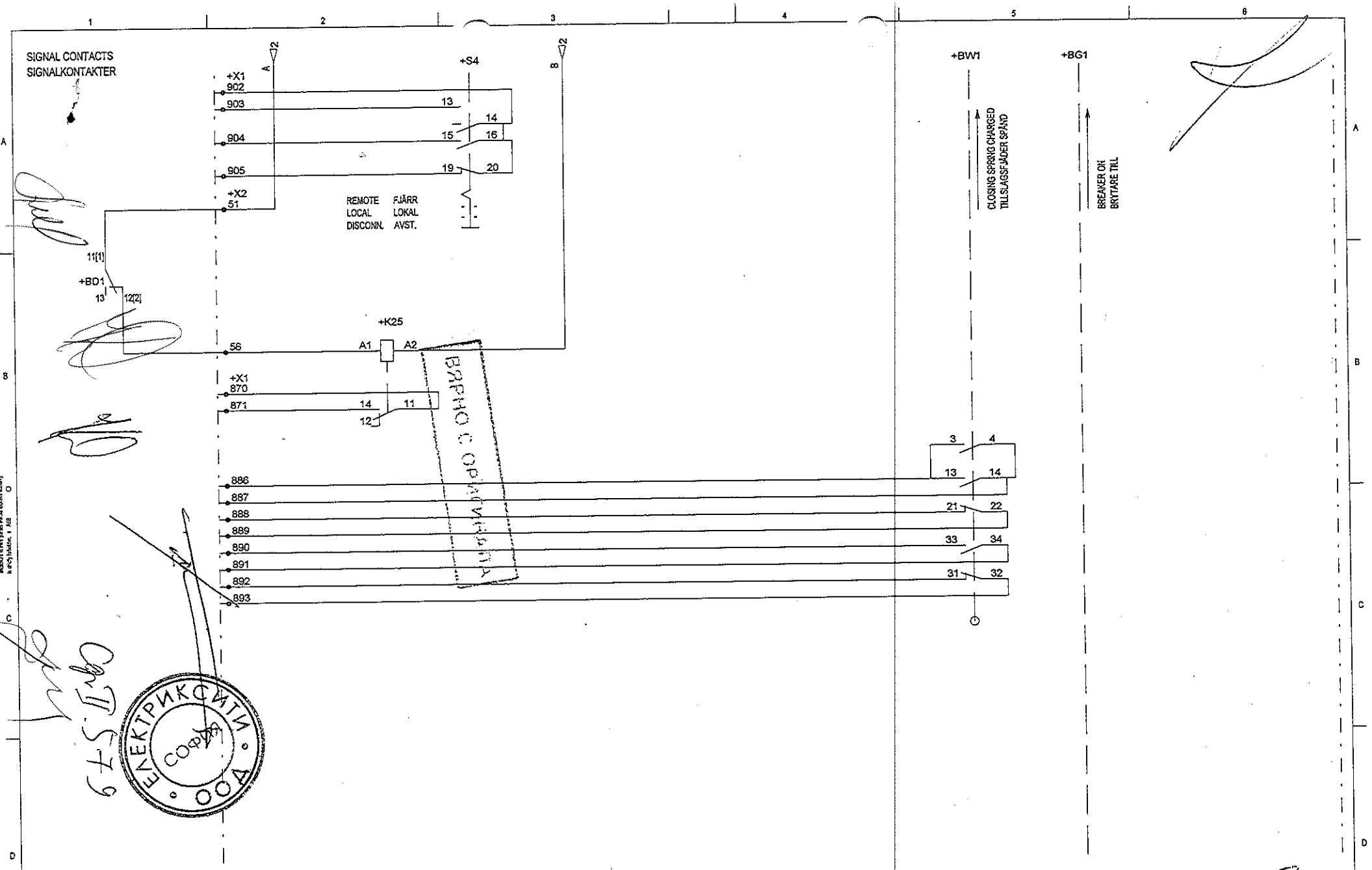
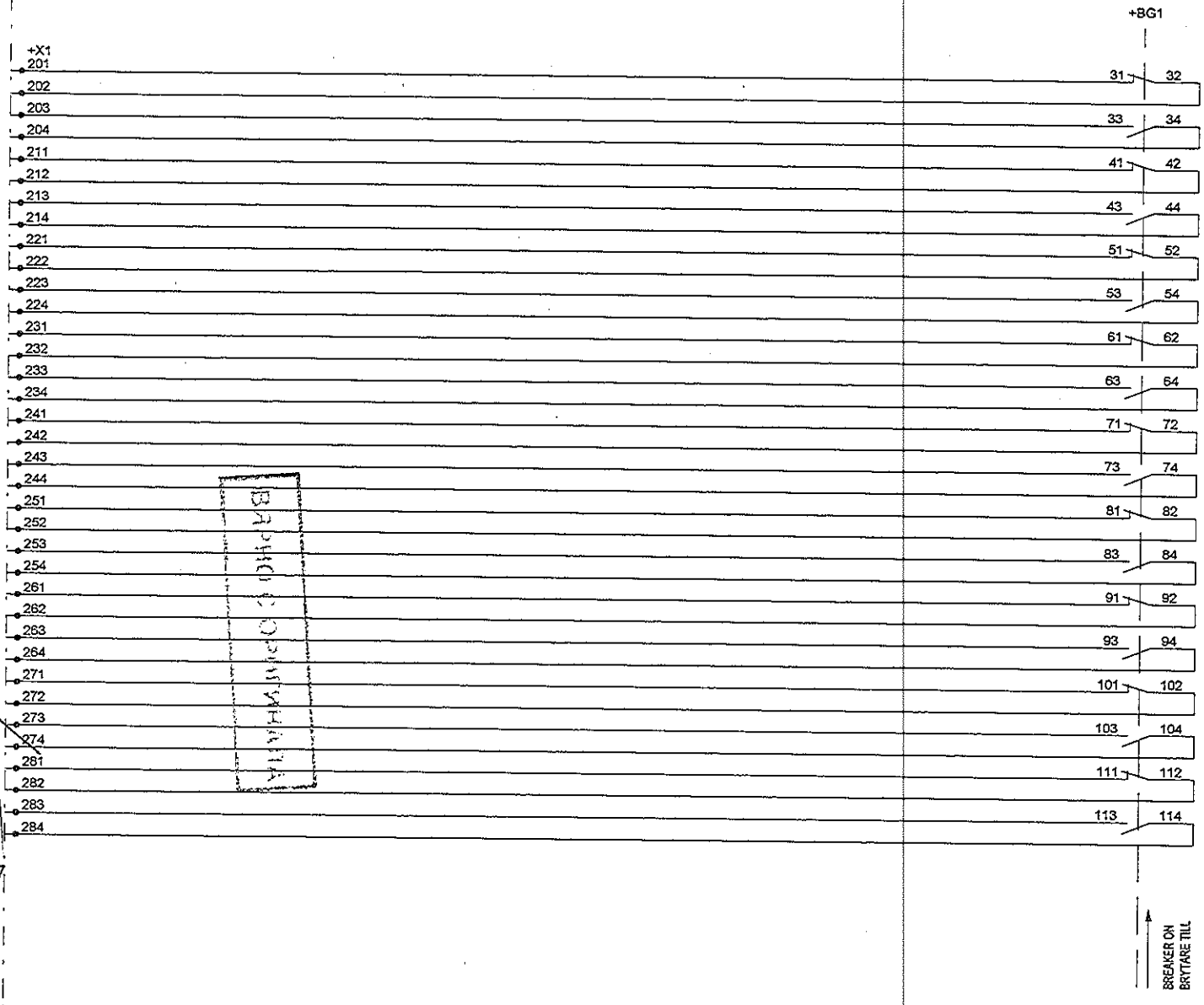
		Cont	4



Based on 1HSB543260-AAK	Prepared 2014-08-27 Gutman Anton Approved 2014-08-27 Hellsten Sara	Circuit Diagram KRETSSCHEMA OPERATING MECHANISM MSD MANÖVERDON MSD	CD Resp dept PPHB/BOD 1HSB543260-AAM	+MSD.1 Revised A Lang SV Sheet 4/ Cont 5

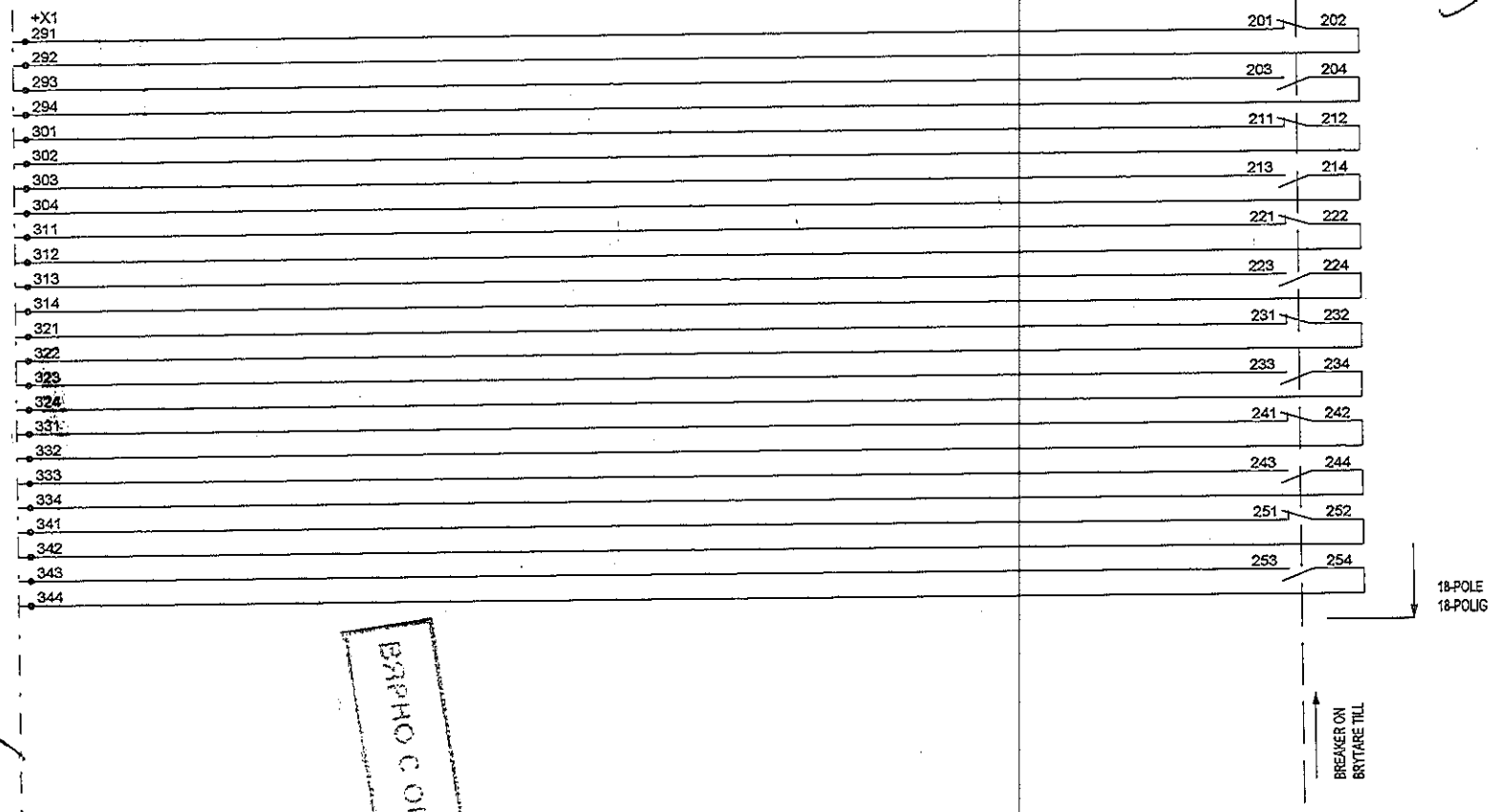
ABB

AUXILIARY CONTACTS
HJÄLPKONTAKTER



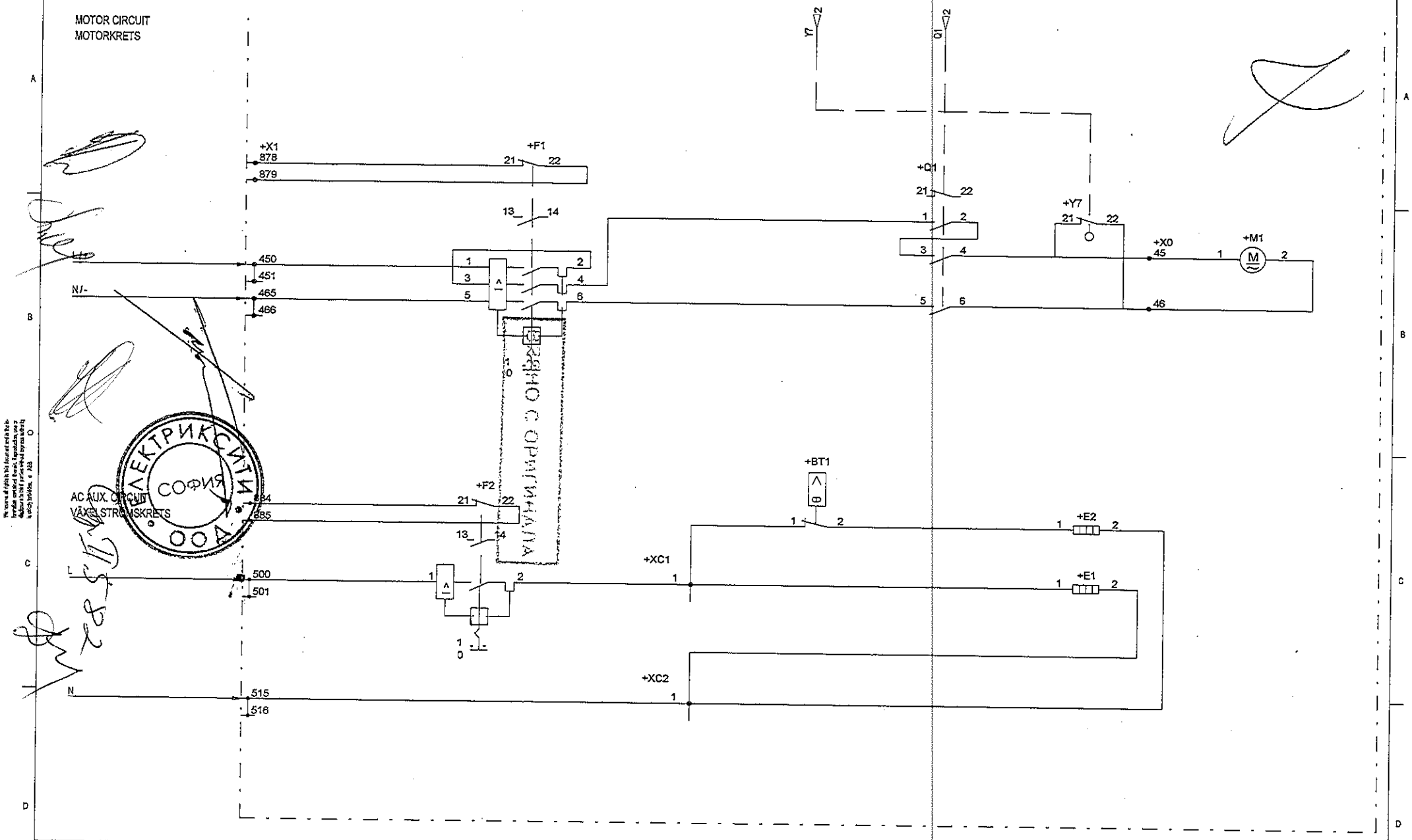
Based on 1HSB543260-AAK	Prepared 2014-08-27 Gutman Anton Approved 2014-08-27 Hellsten Sara	Circuit Diagram KRETSSCHEMA OPERATING MECHANISM MSD MANÖVERDON MSD	CD	+MSD 1	
		ABB	Prep dept PPHB/BOD 1HSB543260-AAM	Project A	Lang SV Sheet 5/ Cont 6

AUXILIARY CONTACTS
HJÄLPKONTAKTER



Issued on 1HSB543260-AAK	Prepared 2014-08-27 Gutman Anton	Circuit Diagram KRETSSCHEMA	CD
	Approved 2014-08-27 Helisten Sara	OPERATING MECHANISM MSD	+MSB.1
		MANÖVERDON MSD	Rev dept PPHB/BOD
		ABB	1HSB543260-AAM
			Revind A Lang SV
			Sheet 6/10
			Cont 7

MOTOR CIRCUIT
MOTORKRETS



Based on 1HSB543260-AAK	Prepared 2014-08-27 Gutman Anton	Circuit Diagram KRETSSCHEMA	CD		
	Approved 2014-08-27 Hellsten Sara	OPERATING MECHANISM MSD		+MSD,1	
		MANÖVERDON MSD	Rmp-dwg PPHB/BOD	Revind A	Lang SV
		ABB	1HSB543260-AAM		Sheet 7/
					Cast 8

CIRCUIT DIAGRAM SHOWS OPERATING MECHANISM WHEN CIRCUIT BREAKER IS OPEN, WITHOUT PRESSURE, CLOSING SPRING NOT CHARGED AND HANDCRANK ADAPTED.
SCHEMAT VISAR MANÖVERDONET PÅ HÖGSPÄNNINGSBRYTAREN ÄR I FRÅNSLAGET LÄGE, EJ TRYCKSATT SAMT MED MANÖVERDONETS TILLSLAGSFJÄDER OSPÄND OCH HANDVEVEN APTERAD.

ITEM POS.	DESIGNATION BENÄMNING
BD1	DENSITY SWITCH 2) DENSITETSVAKT 2)
BG1-2	AUXILIARY CONTACT HJÄLPKONTAKT
BN	COUNTER RÄKNEVERK
BT1	THERMOSTAT TERMOSTAT
BW1	LIMIT SWITCH GRÄNSSTÄLLARE
E1	HEATER (CONTINUOUS CONNECTED) VÄRMEELEMENT (KONTINUERLIGT INKOPPLAD)
E2	HEATER (THERMOSTAT CONTROLLED) VÄRMEELEMENT (TERMOSTATSTYRD)
F1	DIRECT-ON-LINE MOTORSTARTER MOTORSKYDDSBRYTARE
F2	MINIATURE CIRCUIT BREAKER (AC-CIRCUIT) DVÄRGBRYTARE (VÄXELSTRÖMSKRETS)
K3	ANTIPUMPING RELAY ANTIPUMPRELÄ
K9	INTERLOCKING RELAY (GAS SUPERVISION) (CLOSE / TRIP 1) FÖRREGLINGSRELÄ (GASÖVERVAKNING) (TILL/FRÅN 1)
K10	INTERLOCKING RELAY (GAS SUPERVISION) (TRIP 2) FÖRREGLINGSRELÄ (GASÖVERVAKNING) (FRÅN 2)
K25	AUXILIARY RELAY (GAS SUPERVISION) (ALARM) HJÄLPRELÄ (GASÖVERVAKNING) (LARM)
M1	MOTOR MOTOR
Q1	CONTACTOR KONTAKTOR

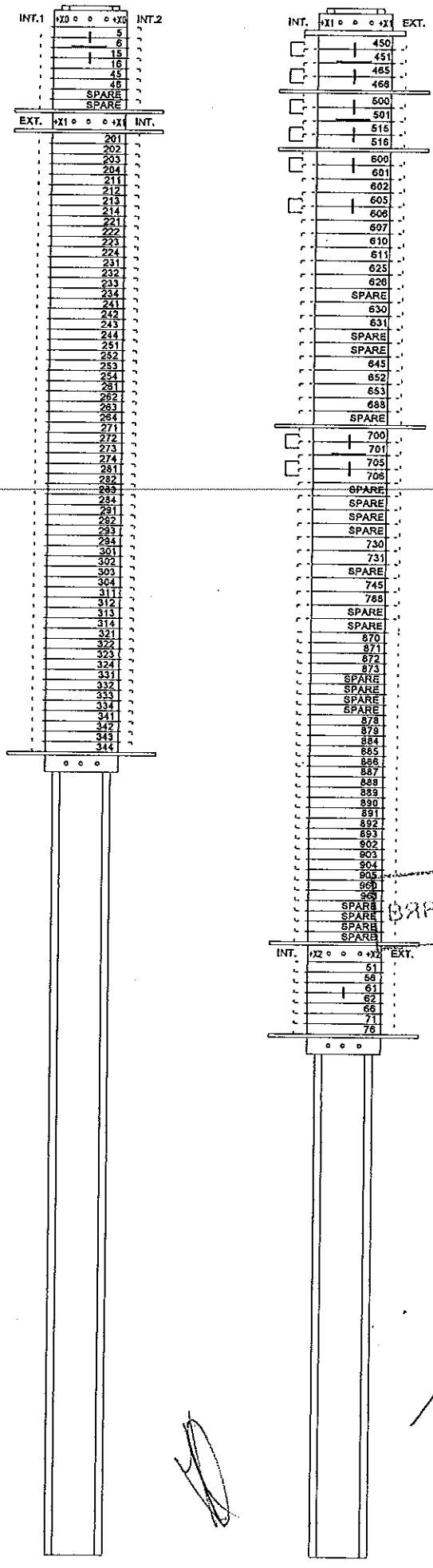
ITEM POS.	DESIGNATION BENÄMNING
S1	CONTROL SWITCH (TRIP/CLOSE) MANÖVERSTÄLLARE (FRÅN/TILL)
S4	SELECTOR SWITCH (OPERATION) OMKOPPLARE (MANÖVER)
X0	TERMINAL BLOCK (INTERNAL) KOPPLINGSPLINT (INTERN)
X1	TERMINAL BLOCK (EXTERNAL) KOPPLINGSPLINT (EXTERN)
X2	TERMINAL BLOCK (INTERNAL) (GAS SUPERVISION) 2) KOPPLINGSPLINT (INTERN) (GASÖVERVAKNING) 2)
XC1-4	TERMINAL BLOCK (INTERNAL) KOPPLINGSPLINT (INTERN)
Y1	SHUNT TRIP COIL 1 FRÅNSLAGSMAGNET 1
Y2	SHUNT TRIP COIL 2 FRÅNSLAGSMAGNET 2
Y3	CLOSING COIL 1 TILLSLAGSMAGNET 1
Y7	BLOCKING CONTACT (HANDCRANK ADAPTED) BLOCKERINGSKONTAKT (VEV APTERAD)

2) TO BE CONNECTED ON SITE WHEN INSTALLING.
2) ANSLUTES PÅ MONTAGEPLATSEN I SAMBAND MED INSTALLERING.

Based on	1HSB543260-AAK	Prepared 2014-08-27 Gutman Anton Approved 2014-08-27 Hellsten Sara	Circuit Diagram KRETSSCHEMA OPERATING MECHANISM MSD MANÖVERDON MSD
			CD +MSD1
			Resp dept PPHB/BOD Revised A
			1HSB543260-AAM
			Lang SV Sheet 8/ Cont 9

ABB

TERMINAL ARRANGEMENT (VERTICAL MOUNT.)
PLINTARRANGEMANG (LODRÄT MONT.)



ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ • ДОО • БИФОО

Drawing	1HSB543260-AAK		
Prepared	2014-09-27	Gutman Anton	
Approved	2014-09-27	Hellsten Sara	
Circuit Diagram	KRETSSCHEMA		
OPERATING MECHANISM MSD	MANÖVERDON MSD		
Project def.	PPHB/BOD		CD
Revised	A		+MSD.1
Lng	SV	Sheet	9 /
			R1

1HSB543260-AAM

List of Revisions

Rev Index	Revision text	Date	Prepared	Approved
A	First edition.	2014-08-27	Gutman Anton	Hellsten Sara

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД София

1HSB543260-AAK	Prepared 2014-08-27 Gutman Anton Approved 2014-08-27 Hellsten Sara	Circuit Diagram KRETSSCHEMA OPERATING MECHANISM MSD MANÖVERDON MSD	CD Resp dept PPHB/BOD	Revised A Dwg SV
		ABB	1HSB543260-AAM	Sheet R1/

Routine test description

DESCRIPTION

ROUTINE TESTS ON CIRCUIT-BREAKERS TYPE HPL, ED and LTB

The routine tests are performed for the purpose of revealing faults in material or construction and are made on each apparatus manufactured. In general, these tests are performed according to IEC 62271-100 or ANSI/IEEE 37.09.

The routine tests are part of the production flow and are always performed using the test procedures outlined below, irrespective whether the tests are witnessed by the client's representative or not.

If, during testing, questions will arise from the client's representative with respect to test procedures, test data or documentation, please contact the ABB order representative. The routine test is a critical part of the production flow and must not be interrupted in the middle of the process.

After each routine test, a test review meeting is held together with the inspector in order to summarize the tests, documentation and for solving any questions which may have arisen during tests.

Routine tests on circuit-breakers consisting of one single interrupter per phase are performed on completely assembled poles.

When the circuit-breaker consists of more than one interrupter per phase, i.e. V-, or T-shaped breaking units, the routine tests are performed on the circuit-breaker assembled as transport units. The transport units (post insulators and breaking units) are in this case mounted on special frames to enable connection to the operating mechanism.

The tests on transport units have been verified with respect to operating values and contact travel measurement and compared with full scale testing. Hence, the technical provisions include operating values on both full scale testing and the corresponding tests on transport units.

ВЯРНО С ОРИГИНАЛА

ROUTINE TEST SEQUENCE

The complete routine test has been described below, in order of appearance and with reference to the sub-clause of the relevant international standard.

Tests 1-4 in the table below are, if otherwise not agreed, performed prior to the client's arrival. The routine test witnessed by the client starts with test 5.

Tests	Reference (IEC)	Reference (ANSI/IEEE)
1. - Design check. - Visual check. - Nameplate check.	IEC 62271-100, Cl. 7.5	ANSI/IEEE C37.09, Cl. 5.6
2. Resistance measurement of components included in auxiliary and control circuits. - Operating coils 1) - Relays1) - Contactors1) - Heaters. Measurements are made before the test object is installed into the test bay. Test values are stored in the computer. 1) Not applicable for Motor-Drive	IEC 62271-100, Cl. 7.101	ANSI/IEEE C37.09, Cl. 5.9
3. The test object is assembled in the test bay and adjusted to correct test position. The gas hose is connected to the gas valve(s) on the mechanism housing. Control and earthing cables are connected in the test equipment.	-	-
4. Overpressure test at 1.15 MPa (abs) for 5 minutes. After the test, the pressure is reduced to rated filling pressure.	Not specified	ANSI/IEEE C37.09, Cl. 5.4.4.
5. - Circuits of test equipment are checked. - Function check of the limit switch during first motor charging operation.	-	-

6. The circuit-breaker is operated and adjusted acc. to relevant technical provision.		ANSI/IEEE C37.09, Cl. 5.11
7. Function check of relays and auxiliary equipment (if applicable). - Wiring (in accordance with circuit-diagram) - Interlocking relays - Undervoltage relays - Current relays - Signalling devices - Time relays - Anti-pumping device (relay) - Contactors1) - Heaters	IEC 62271-100, Cl. 7.101	ANSI/IEEE C37.09, Cl. 5.10 and Cl. 5.14.2
- Counter - Auxiliary contacts - Thermostat settings - Local/Remote operation - Check of min. operating voltage for the release of latches - Logical functions (only applicable for Motor-Drive) -Check of discharge function (only applicable for Motor-Drive). 1) Not applicable for Motor-Drive		

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКОНТИ ООД София

Сл.Д.589

8. Mechanical operating test (timing test run by semi-automatic test program). At minimum supply voltage: - Five closing operations - Five opening operations At maximum supply voltage: - Five closing operations - Five opening operations At rated supply voltage: - Five closing operations - Five opening operations - Five close-open operations - Four open-300ms-close operations - One open-300ms-close-open operation Measurement of pre-insertion resistance and timing test on pre-insertion resistors (if applicable).	IEC 62271-100, Cl. 7.101	ANSI/IEEE C37.09, Cl. 5.12 and Cl. 5.13
9. - Check of damping device - Measurement of time and current for spring charging		
10. Resistance measurement of the main circuit. - Check of quality control marks (paint- marking, etc.)	IEC 62271-100, Cl. 7.3	ANSI/IEEE C37.09, Cl. 5.15
11. Dielectric test on auxiliary and control circuits. 1) Test voltage 2 kV for 1s. 2) Motors are tested at 900 V for 1 min (only ANSI/IEEE). 1) Motors are disconnected during dielectric tests, as they already have been tested by the sub-supplier. 2) Test requirement acc. to IEC is 1 kV for 1 s and acc. to ANSI/IEEE 1.8 kV for 1 s.	IEC 62271-100, Cl. 7.2	ANSI/IEEE C37.09, Cl. 5.17

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД София

Sp. D. 589

12. The test object are transferred to the high voltage test bay (only for circuit-breakers of type HPL and LTB-E).	-	-
13. Dielectric tests on the main circuit at minimum functional pressure. Please refer to section for dielectric tests below, for detailed information - Overpressure test at 1.15 MPa (abs) for 10 minutes.	IEC 62271-100, Cl. 7.1	ANSI/IEEE C37.09, Cl. 5.16
14. Tightness test (leakage test). ~~A tightness test is performed at~~ transport pressure, by sniffing sealed joints on insulators and housings.	IEC 62271-100, Cl. 7.4	ANSI/IEEE C37.09, Cl. 5.7
15. Identification of material and articles. -Serial numbers of insulators are registered - Charge numbers of pressurized metal parts are registered.	Not specified	Not specified

After completion of the routine tests, the test object is removed from the high voltage test bay and prepared for packing.

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСЕЛТИ • ООД • СОФИЯ

Dielectric tests

The power frequency voltage tests on the main circuit are performed on complete poles (in case of single-unit circuit-breakers) or transport units (in case of multi-unit circuit-breakers). The power frequency voltage tests are performed with the circuit-breaker in open position only. This is valid for both single- and multi-unit circuit-breakers. For application of the voltage, please refer to Fig. 1 for single-unit circuit-breakers and Fig. 2 for multi-unit circuit-breakers.

When the circuit-breaker is in open position, the internal flash-over distance phase-to-earth is at its minimum. Hence, the test phase-to-earth with the circuit-breaker in closed position is deemed to be covered.

At routine tests of support insulators, when the voltage requirement is higher than the maximum available test voltage, the test voltage is split in two parts, see Fig. 3.

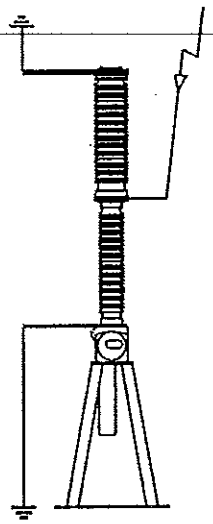


Figure 1: Dielectric tests on single-unit circuit-breaker

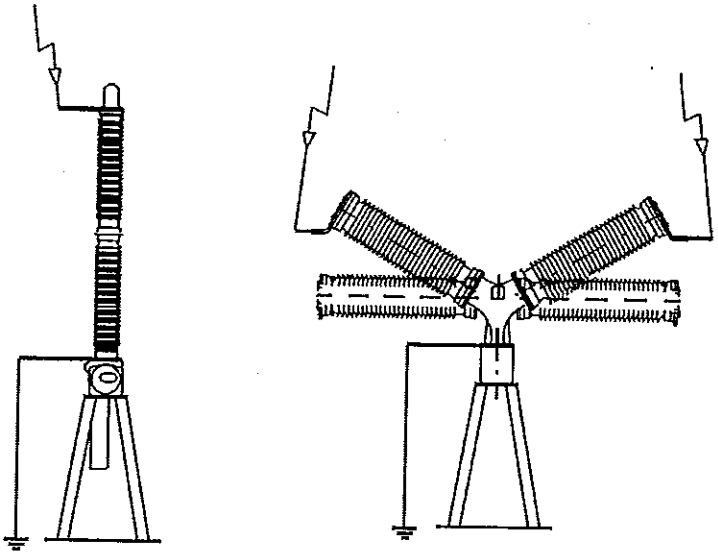


Figure 2: Dielectric tests on multi-unit circuit-breaker

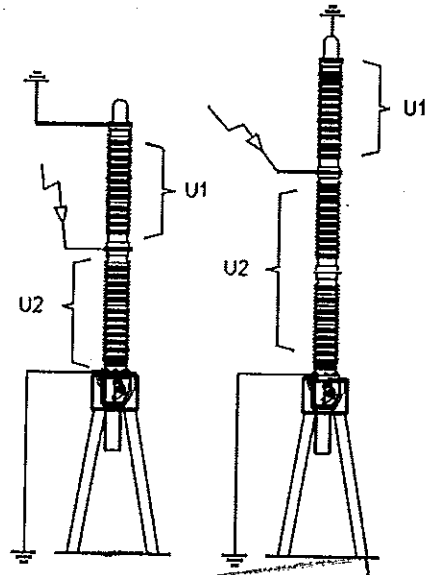


Figure 3: Split voltage tests on support insulators

REVISION

Rev. ind.	Page (P) Chapt. (C)	Description	Date Dept./Init.
A	P 7, C.3.1	Standard reference IEC 60694 is replaced by IEC 62271-1.	2009-04-28
B	P1-10	Editorial changes.	2015-01-08
C	P 2, 4-5	Editorial changes.	2015-03-24
D	P4	Number of mechanical operations corrected	2015-04-17

ВЯРНО С ОРИГИНАЛА

ЕЛЕКТРИКСИТИ ООД София

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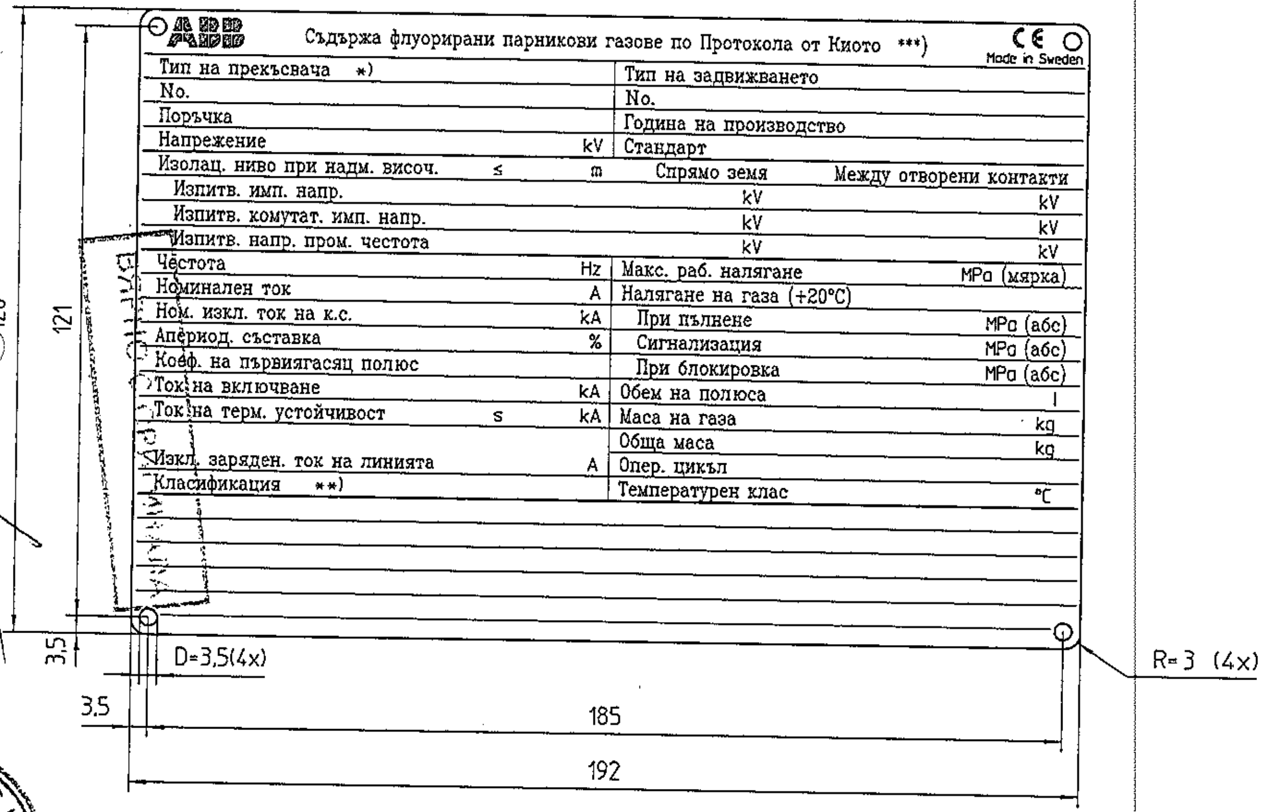

*) To be marked "Тип на прекъсвача", "Прекъсвач с разединител" or "Прекъсвач на количка".
Märkes Brytare typ. Frånskiljande brytare typ eller Utdragbar brytare typ.

**) Only if different from C1 and M1.
Endast om annat än C1 och M1.

***) This text should be removed for breakers with CO2-gas.
Denna text skall tas bort för brytare med CO2-gas.

1) Stainless steel. Engraved with laser. Language: Bulgarian.
Rostfritt stål. Graveras med laser. Språk: Bulgariska.

Article No: 2940 1637-10	Material,type,etc: 1)	Dimensions: 192x128, t=0.70	Name of item: Rating plate / Märkskylt
Prepared: Ruthstrom, Joakim 2013-07-05	Responsible department: PPHB/BOD	Title: RATING PLATE / MÄRKSKYLT	
Approved: P.Andersson 2013-08-08	Take over department		Language: 82
Revision: A Note added		Document no.: 1HSB492950-22	Sheet: 1 / Cont: -

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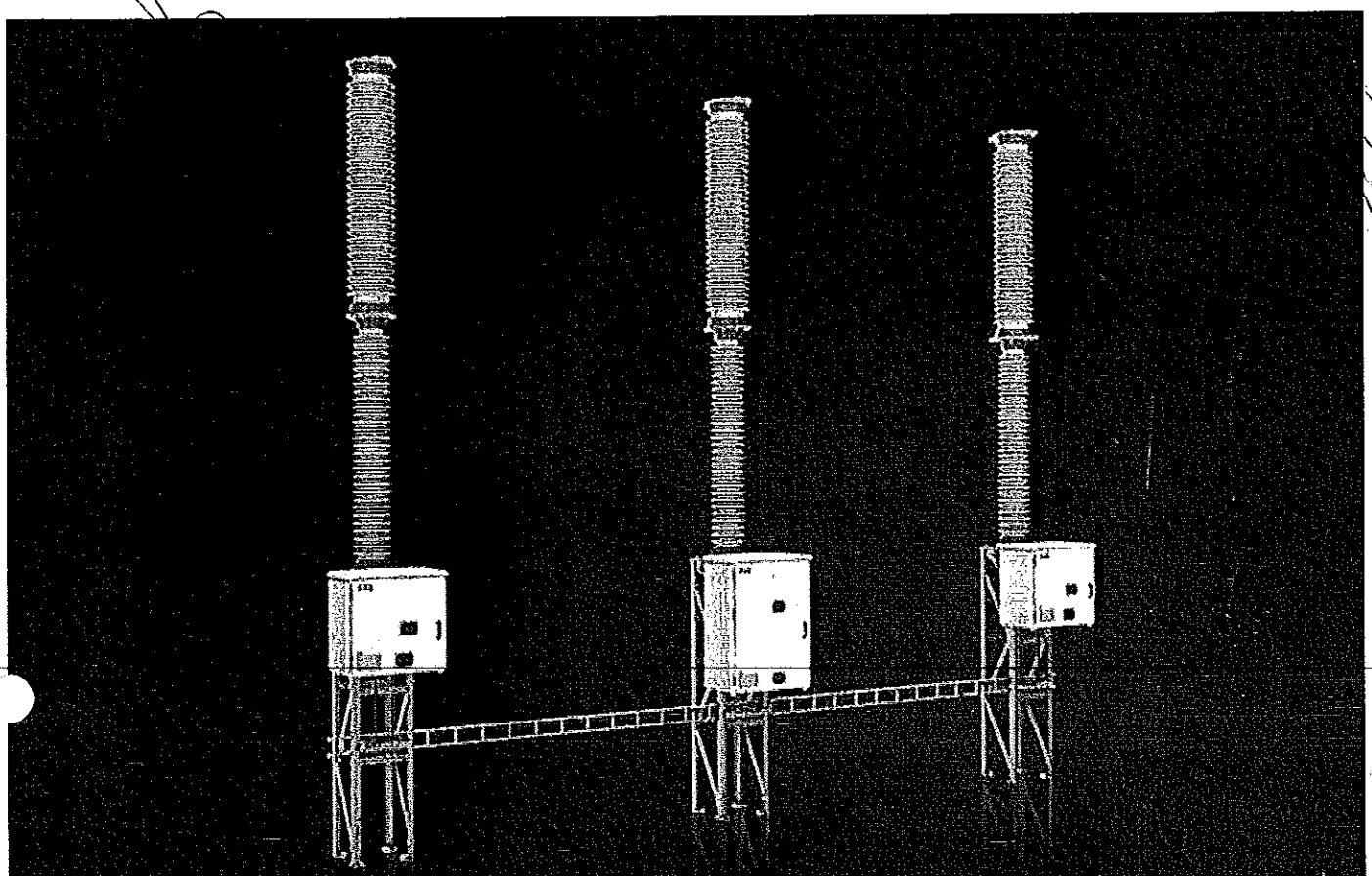
СОФИЯ ЕЛЕКТРИКС ООД



Live Tank Circuit Breakers
Buyer's Guide

Power and productivity
for a better world™

ABB

Table of contents

ABB is the supplier of cutting edge technology

Our task is to help our customers to a more reliable power grid and sustainable society at large. This is why we always strive for the leading position in research and development. ABB has all the experience necessary for successful development of power transmission technology.

This Buyer's Guide concerns one of our true specialty areas – high voltage circuit breakers – an area in which we are constantly striving to improve product performance that delivers real customer value. What has pushed development forward has been the capability to increase availability at our customers' installations by supplying reliable high voltage equipment.

Development is a team effort

Our development team consists of highly qualified and experienced technicians with expert knowledge in, for example, plasma physics, materials physics, gas dynamics, mechanics and high voltage technology. We also collaborate with others with expert knowledge and skills, both at ABB and externally.

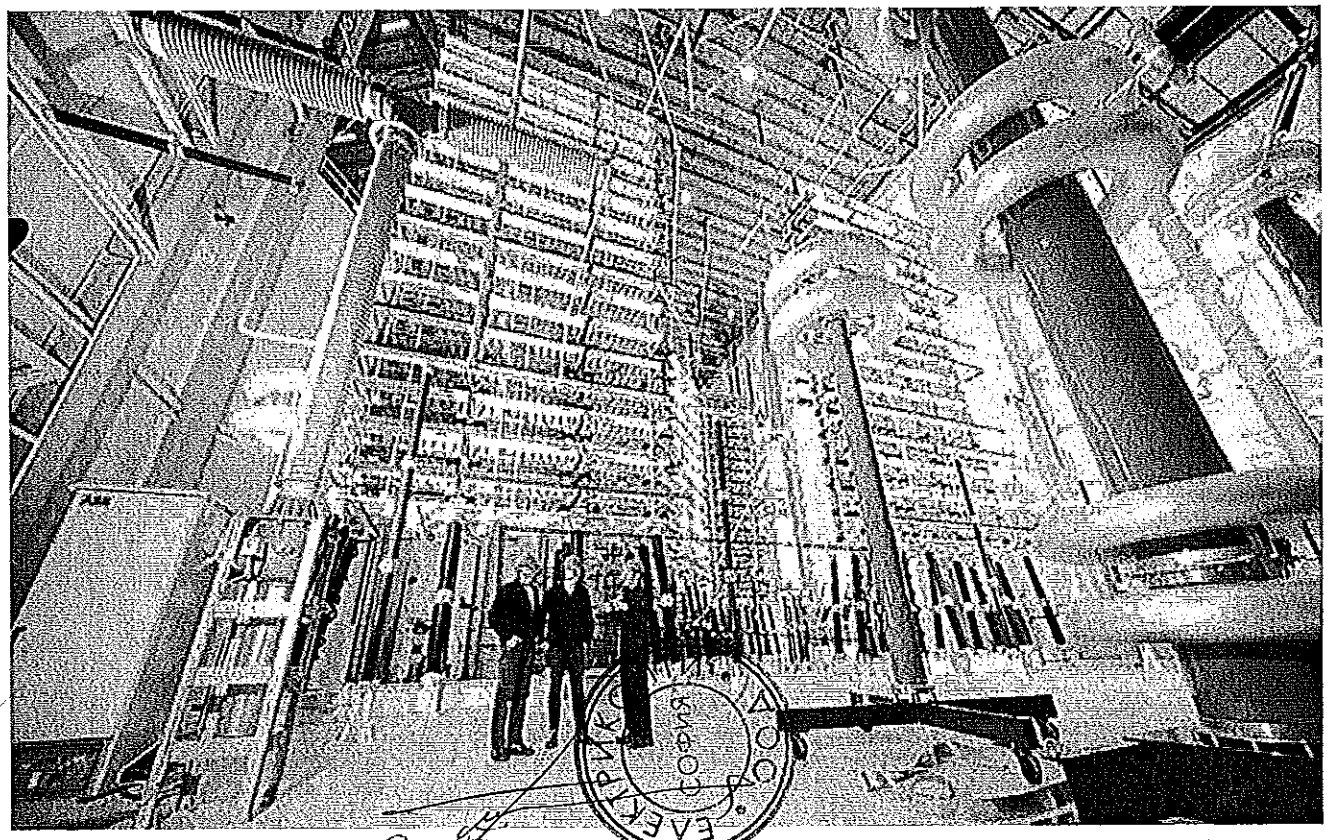
An important aspect of development work is our close dialog with customers, which enables us to find out about their experiences. Customers who demand more of our products give us the best platforms to realize new innovations.

Thought leadership

Our design work with constant improvements and simplification of our products have resulted in; 550 kV circuit breakers without grading capacitors; the Motor Drive with a servo motor system that accurately controls and monitors the contact operation and the LTB D1 and E1 circuit breakers with MSD operating mechanism that provide fast and simple installation at site.

Other mile stones:

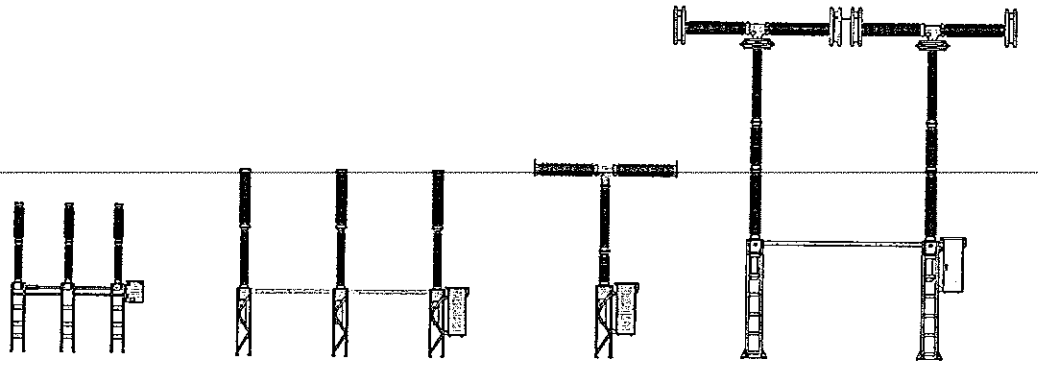
- 80 kA with only two breaking chambers per pole
- The DCB concept that enables smarter, safer and greener substations
- Excellent earthquake performance suitable for seismic regions
- The eco-efficient CO_2 circuit breaker LTA



New technology requires careful testing.
ABB's high power laboratory is among the world's most modern and best equipped labs for switchgear technology, with facilities for testing circuit breakers with rated voltages of up to 1200 kV and breaking currents of up to 80 kA.

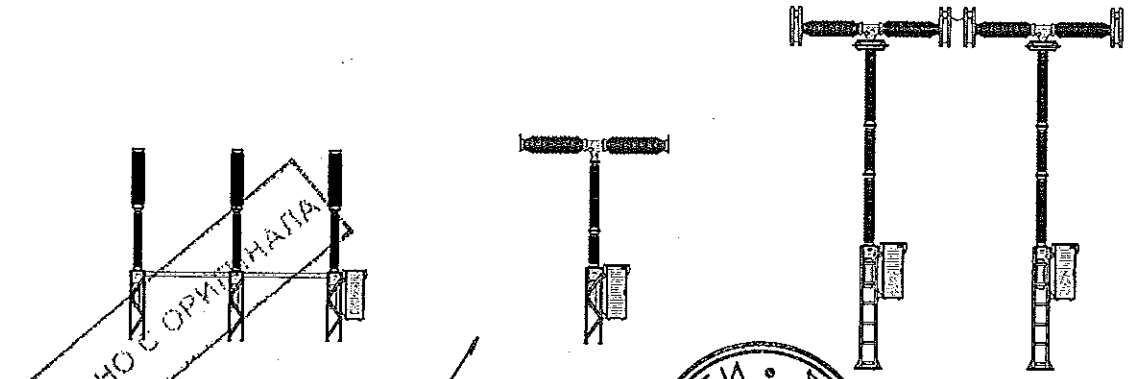
Product portfolio
Live Tank Circuit Breakers

ABB has a complete portfolio and well proven technology for high voltage circuit breakers used in a number of applications.



	LTB D1 72.5 – 170	LTB E1 72.5 – 245	LTB E2 362 – 550	LTB E4 800
Standards	IEC, IEEE	IEC, IEEE	IEC, IEEE	IEC, IEEE
Rated voltage	72.5 – 170 kV	72.5 – 245 kV	362 – 550 kV	800 kV
Rated current	up to 3150 A	up to 4000 A	up to 4000 A	up to 4000 A
Circuit-breaking capacity	up to 40 kA	up to 50 kA	up to 50 kA	up to 50 kA
Ambient temperature	-30 – +40 °C	-30 – +40 °C	-30 – +40 °C	-30 – +40 °C

The circuit breakers can also be supplied for ambient temperatures down to -60 or up to +70 °C.

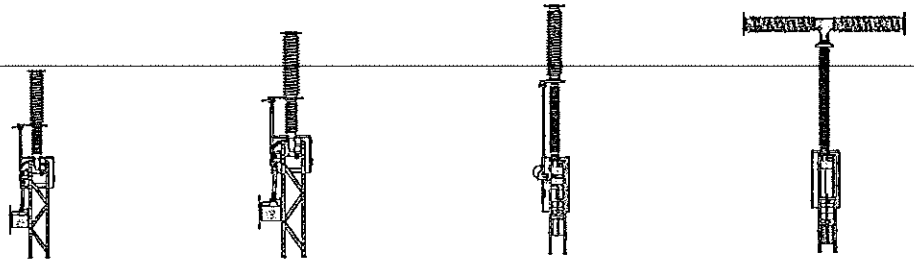


	HPL 72.5 – 300	HPL 362 – 550	HPL 800
Standards	IEC, IEEE	IEC, IEEE	IEC, IEEE
Rated voltage	72.5 – 300 kV	362 – 550 kV	800 kV *)
Rated current	up to 4000 A	up to 4000 A	up to 4000 A
Circuit-breaking capacity	up to 80 kA	up to 80 kA	up to 80 kA
Ambient temperature	-30 – +40 °C	-30 – +40 °C	-30 – +40 °C

*) Up to 1200 kV on request
The circuit breakers can also be supplied for ambient temperatures down to -60 or up to +70 °C.

Product portfolio
Disconnecting Circuit Breakers

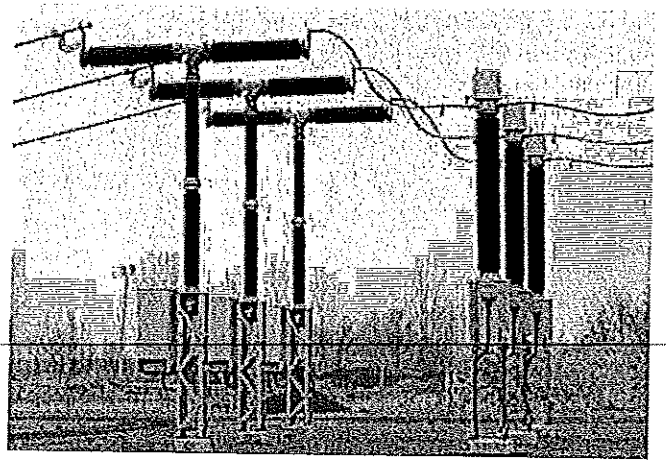
As a complement to the basic versions of our circuit breakers, which are primarily designed for conventional substation solutions, there is a disconnecting circuit breaker configuration with the disconnecting function integrated into the breaking chamber. A safe interlocking system, composite insulators and a motor-driven grounding switch provide personal safety.



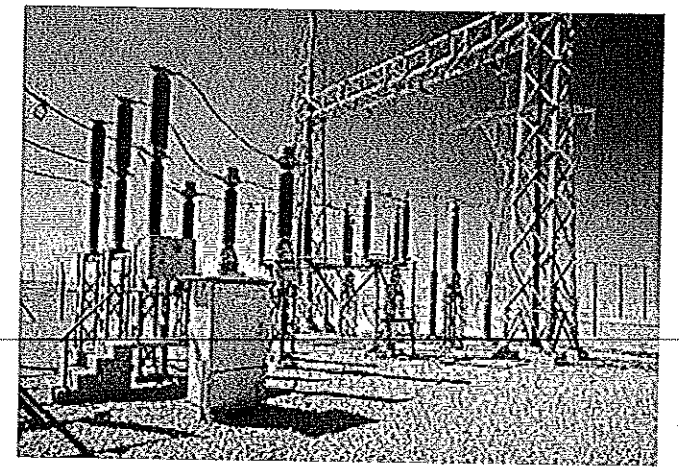
	DCB LTB 72.5	DCB LTB 145	DCB HPL 170-300	DCB 362-550
Standards	IEC	IEC	IEC	IEC
Rated voltage	72.5 kV	145 kV	170 - 300 kV	362 - 550 kV
Rated current	up to 3150 A	up to 3150 A	up to 4000 A	up to 4000 A
Circuit-breaking capacity	up to 40 kA	up to 40 kA	up to 50 kA	up to 63 kA
Ambient temperature	-30 – +40 °C	-30 – +40 °C	-30 – +40 °C	-30 – +40 °C

The disconnecting circuit breakers can also be supplied for other data on request.
For more information about DCBs, please see Application Guide 1HSM 9543 23-03en

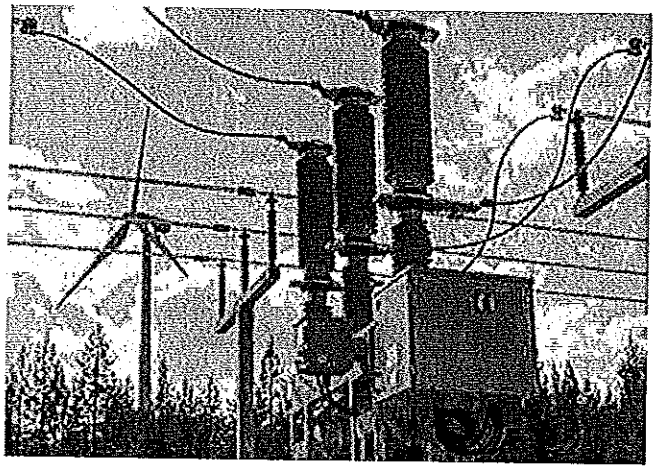
Installations with ABB Live Tank Circuit Breakers



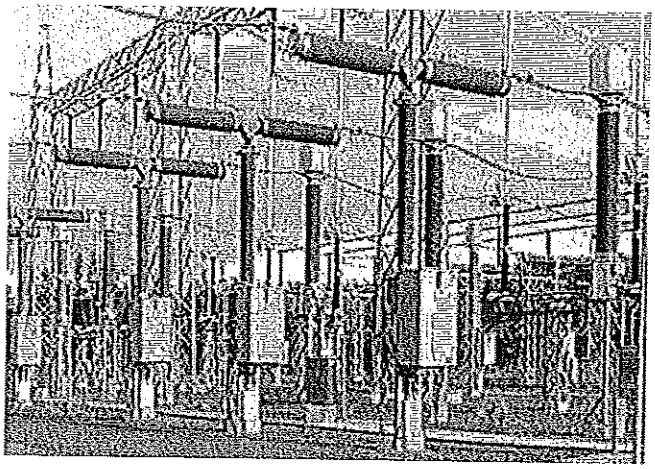
LTB 420 E2 with current transformer IMB. Installation in Denmark.



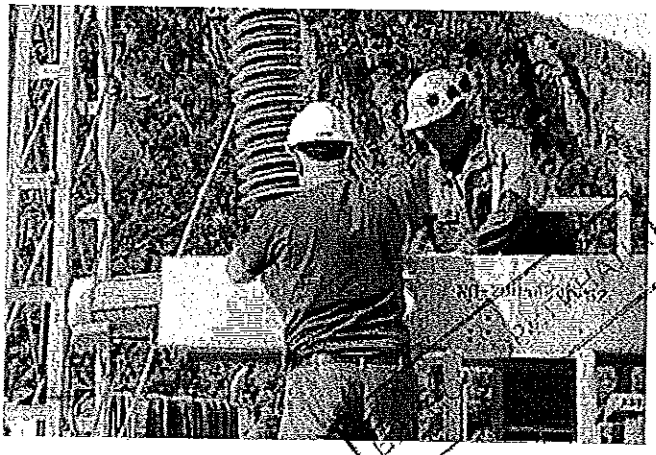
Substation in Oman with dessert climate. ABB equipment with LTB 145.



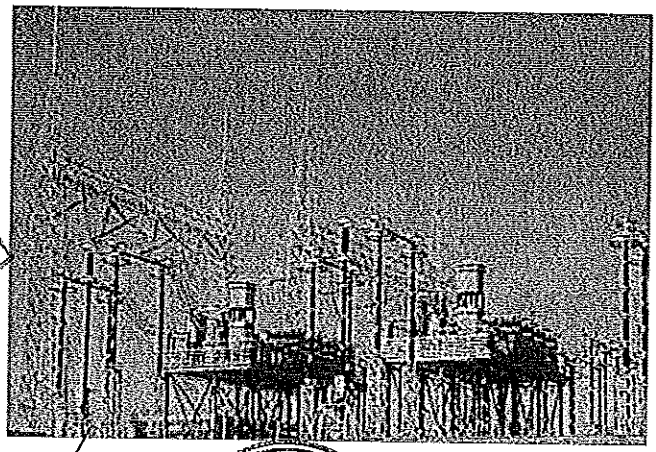
Disconnecting circuit breaker LTB DCB for 72.5 kV installed at a windfarm in Sweden.



Disconnecting circuit breaker HPL DCB for 420 kV installed in a switching station in Sweden.



Disconnecting circuit breaker LTB DCB for 145 kV with the operating mechanism Motor Drive installed at refurbishment in Norway.



1100 kV by-pass switch in series compensation installation in China.