ДОКУМЕНТ 5.2

TYPE TEST REPORT

NO. 1416.0077.3.036

CLIENT

Siemens Sanayi ve Tic. A. Ş.
Power Transmission and Distribution (PTD)
Yakacik Yolu No: 111
81430 Kartal-ISTANBUL (TURKEY)

MANUFACTURER

ALCE Elektrik Sanayi ve Ticaret A. Ş.

TEST OBJECT

Block-type current transformer

TYPE

4MA72

MANUFACTURING NO.

03/00815

RATED CHARACTERISTICS GIVEN BY THE CLIENT

Rated primary current	1250	A
Rated secondary current	5 - 5	A
Rated frequency	50 - 60	Hz
Rated output	15 - 15	VA
Accuracy class	0.5FS5 - 5P10	
Highest voltage for equipment	12	kV
Rated power-frequency withstand voltage	28	kV
Rated lightning impulse withstand voltage	75	kV
Rated short-time thermal current (I_{th}) 3 s	31.5	kA
Rated dynamic current (I_{dyn})	80	kA

NORMATIVE DOCUMENT

IEC 60044-1: 1996-12, mod. + am1: 2000-07
STL Guide to the interpretation of IEC 60044-1 1st Edition 1996-12

RANGE OF TESTS PERFORMED

- Impulse tests on the primary winding
- Determination of errors
- Short-time current test
- Temperature-rise test

DATE OF TEST

24 February to 7 March 2003

TEST RESULT

The test object has PASSED the above-mentioned type tests performed at 50 Hz.

На основание чл.36а ал.3 от ЗОП

Berlin, 15 August 2003

ВЯРНО С ОРИГИНАЛА

Contents

This test document consists of 30 sheets.

Distribution Copy No.: 1

Copies Nos. 1 and 2 in English: ALCE Elektrik Sanayi ve Ticaret A. Ş.

1. Present at the test

Mr.	Moritz	IPH test engineer in charge
Mrs.	Hauschild	IPH test engineer
Mr.	Vogler	IPH test engineer
Mr.	Wittwer	IPH test engineer
Mr.	Çiftçioğlu	ALCE Elektrik Sanayi ve Ticaret A. Ş.

2. Test performed

- Lightning impulse test on the primary winding
- Determination of errors
- Short-time current test
- Temperature-rise test

3. Identity of the test object

3.1 Technical data and characteristics

The technical data and characteristics of the test object are defined by the following parameters and specified by the client.

Test object:	Block-type current transformer
Type:	4MA72
Manufacturer:	ALCE Elektrik Sanayi ve Ticaret A. Ş.
Serial No.:	03/00815
Year of manufacture:	2003

Data:	Rated primary current (I_n)		1250	A
	Rated continuous thermal current (I_{cont})		1.2 x I_n	
	Rated secondary current	core 1	5	A
		core 2	5	A
	Rated frequency		50 - 60	Hz
	Rated output	core 1	15	VA
		core 2	15	VA
	Accuracy class	core 1	0.5FS5	
		core 2	5P10	
	Rated dynamic current (I_{dyn})		80	kA
	Rated short-time thermal current (I_{th})		31.5	kA
	Duration of short-circuit		3	s
	Rated insulation level			
	Highest voltage for equipment (U_m)		12	kV
	Rated power-frequency withstand voltage		28	kV
	Rated lightning impulse withstand voltage (list 2)		75	kV
	Insulating material class		E	
Characteristics:	Winding material	Primary winding	Cu	
		Secondary winding, core 1	Cu	
		Secondary winding, core 2	Cu	
	Cross-section of windings	Primary winding	660	mm^2
		Secondary winding, core 1	2.55	mm^2
		Secondary winding, core 2	2.54	mm^2

3.2 Identity documents

The manufacturer confirms that the test object has been manufactured in compliance with the drawings given in this document. IPH did not verify this compliance in detail.

The identity of the test object is fixed by the following drawings and data submitted by the client:

Name of drawing	Drawing No.	Date of drawing	Author	Notes
4MA72 BLOCK TYPE CURRENT TRANSFORMER	415	06.02.03	ALCE	Sheet 30

Entry of test object at IPH: 13 February 2003

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4. Impulse test on the primary winding

4.1 Test laboratory

High-voltage test laboratory, high-voltage hall 2

4.2 Normative document

IEC 60044-1: 1996-12, mod. + A1: 2000-07, Sub-clause 7.3.2

4.3 Required test parameters

Lightning impulse voltage 1.2/50 µs	75 kV	Peak value
Polarity		Positive and negative
Impulse sequence	1 impulse	Full wave at approx. 50 % of test voltage (reference impulse)
	15 impulses	Full wave at 100 % of test voltage
Atmospheric correction		Without

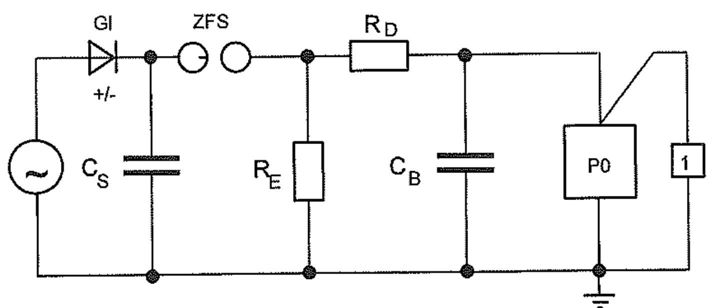
4.4 Test arrangement

The test voltage was applied between the connected terminals of primary winding and earth. The fastening screws, the core and the terminals of the secondary windings were earthed.

4.5 Test and measuring circuits

Technical data of test circuit

Impulse circuit:	Number of stages	n	=	2
	Impulse capacitance	C_S	=	70 nF
	Loading capacitance	C_B	=	1.5 nF
	Damping resistance	R_D	=	122 Ω
	Discharge resistance	R_E	=	1100 Ω



GI	Rectifier	R_D	Damping resistance
C_S	Impulse capacitance	C_B	Loading capacitance
ZFS	Spark gap	PO	Test object
R_E	Discharge resistance	1	Voltage measurement

Figure 1: Test and measuring circuit for the lightning impulse voltage withstand test

Technical data of measuring circuit

Measuring point	Measured quantity	Measuring sensor/device	Technical parameters
1	Test voltage	R divider of SMR 10/770 type (TURD) with digital measuring instrument of DMI 551 type (Haefely) and LC 574 AL digital oscilloscope type (LeCroy)	Ratio 472.4

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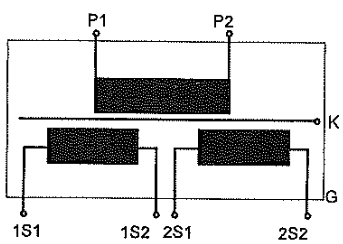
4.6 Test results

Front time of lightning impulse wave:	0.99 µs
Tail time of lightning impulse wave:	55.6 µs
Air temperature:	18.0 °C
Air pressure:	1001 mbar
Air humidity (relative):	50 %
Atmospheric correction of test voltage:	Without

Circuit diagram of the test object



Test No.:	Voltage applied to	Earthed	Test voltage kV	Impulse	Result No. of impulses/ disruptive discharges
1003 02129 to 1003 02144	P1 and P2	1S1-1S2, 2S1-2S2 K, G	+37.5 +75	50 % FW impulse 100 % FW impulse	1/0 [1)] 15/0 [1)]
1003 02145 to 1003 02160	P1 and P2	1S1-1S2, 2S1-2S2 K, G	-37.5 -75	50 % FW impulse 100 % FW impulse	1/0 [1)] 15/0 [1)]

Notes:

1) The Appendices include only the oscillograms of the reference impulse and of each first and last 100 % full wave (FW) impulse.

4.7 Routine tests after the lightning impulse test

The routine tests to Sub-clause 6.2 of the normative document are part of the type test – lightning impulse test – and serve to assess the latter.

Results

Test	Test parameters	Test results	
Power-frequency withstand test on the primary winding	Test voltage: 28 kV Test frequency: 50 Hz Duration of test: 60 s	No disruptive discharge	o.k.
Partial discharge measurement	Procedure A Prestress duration: 60 s Measuring voltage (points 1 to 3): $1.2 \times U_m = 14.4$ kV $U_m = 12.0$ kV $1.2 \times U_m/\sqrt{3} = 8.3$ kV Measuring time: 30 s	Partial discharge < 2 pC < 50 pC Partial discharge < 2 pC < 50 pC Partial discharge < 2 pC < 20 pC	o.k.
Power-frequency withstand test on the secondary windings	Test voltage: 3 kV Test frequency: 50 Hz Duration of test: 60 s	No disruptive discharge	o.k.
Interturn overvoltage test	Procedure A Test current (primary): 1250 A Test voltage (secondary 1): 373 V Test voltage (secondary 2): 1093 V Test frequency: 50 Hz Duration of test: 60 s	No disruptive discharge	o.k.

Notes:

The routine tests did not show anything that could have indicated a damage done to the test object during the previous lightning impulse test.

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5. Determination of errors

5.1 Test laboratory

Low-voltage test laboratory, test room 3

5.2 Normative document

IEC 60044-1: 1996-12, mod. + A1: 2000-07, Sub-clauses 11.4 and 12.4

5.3 Required test parameters

Protective current transformer: The current errors shall be determined at 100 % of rated current and 100 % of rated burden.

Measuring current transformer: The current errors shall be determined at 5 %, 20 %, 100 % and 120 % of rated current and 25 % and 100 % of rated burden.

For a burden less than 5 VA a power factor of cos β = 1 shall be used, otherwise a power factor of cos β = 0.8 shall be applied.

The test frequency shall equal the rated frequency and be 50 Hz.

Maximum permissible error limits of current transformers for measuring and protecting purposes:

Accuracy class	Current error at percentage of rated current				Phase displacement at percentage of rated current			
	%				Minutes			
	5	20	100	120	5	20	100	120
0.5	1.5	0.75	0.5	0.5	90	45	30	30
5P	1				60			

5.4 Test arrangement

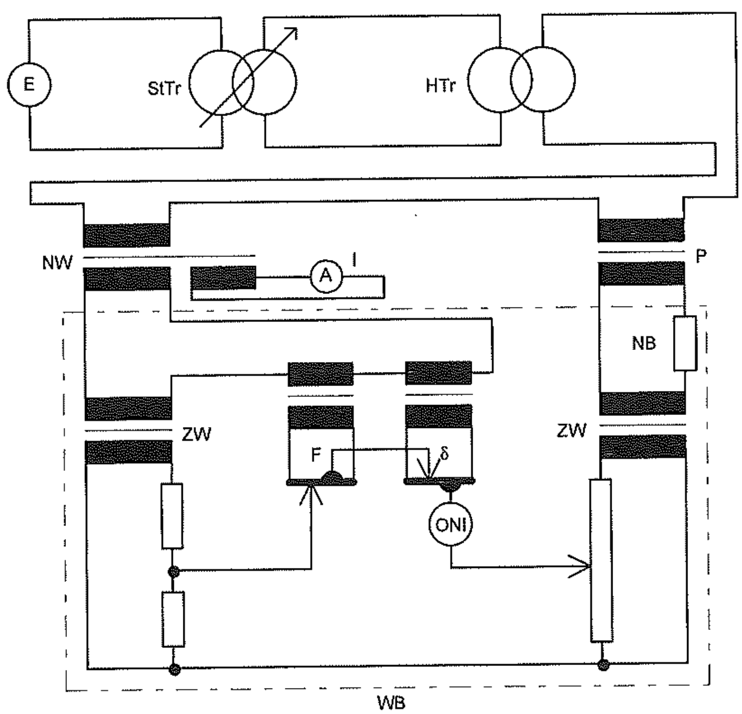
To IEC 60044-1: 1996, mod. + A1: 2000, Sub-clauses 11.4 and 12.4

After it had been demagnetised, the test object was connected via a matching transformer to an instrument transformer measuring device including a measurement standard transformer. An oscillographic null detector was used for the visual check of the comparison. The test object was subjected to the prescribed test conditions by connection of a standard burden.

5.5 Test and measuring circuits

Technical data of test and measuring circuits

Device	Type	Technical data
Standard current transformer NW	ITN 0.5a (TuR Dresden)	Ratio 5 A .. 3 kA / 5 and 5 A, resp. Class 0.1, 15 VA
Standard burden of current transformer NB	(AEG)	50 Hz, 1.25 .. 90 VA ß = 0.8/1, 1..2A
Instrument transformer measuring bridge I	Hohle type (AEG)	16 $^{2}/_{3}$, 50 and 60 Hz
Matching transformer to the bridge ZW	Hohle type (AEG)	Matching transformer for 1, 2, 5, 10 A
Null detector ONI	OIK (MWB)	20 mm/µV



E Power supply
StTr Adjusting transformer
HTr High-current transformer

Figure 2: Test and measuring circuit for the determination of errors

5.6 Test results

Rated current: 1250 A
Transformation ratio: 1250 A/5 A Burden: 15 VA, cos β = 0.8

At percentage of rated current	Errors		Permissible error for accuracy class 0.5	
	Current error	Phase displacement	Current error	Phase displacement
	%	Minutes	%	Minutes
120 %	-0.10	5.1	± 0.5	± 30
100 %	-0.08	2.9	± 0.5	± 30
20 %	-0.48	6.1	± 0.75	± 45
5 %	-1.28	19.1	± 1.5	± 90

Rated current: 1250 A
Transformation ratio: 1250 A/5 A Burden: 3.75 VA, cos β = 1

At percentage of rated current	Errors		Permissible errors for accuracy class 0.5	
	Current error	Phase displacement	Current error	Phase displacement
	%	Minutes	%	Minutes
120 %	0.29	5.6	± 0.5	± 30
100 %	0.27	6.0	± 0.5	± 30
20 %	0.09	14.9	± 0.75	± 45
5 %	-0.22	30.2	± 1.5	± 90

Rated current: 1250 A
Transformation ratio: 1250 A/5 A Burden: 15 VA, cos β = 0.8

At percentage of rated current	Errors		Permissible error for accuracy class 5P	
	Current error	Phase displacement	Current error	Phase displacement
	%	Minutes	%	Minutes
100 %	-0.1	1.5	± 1	± 60

The measured current error and phase displacement values are within the limits permissible for accuracy class 0.5 for measuring current transformers and class 5P for protective current transformers.

6. Short-time current tests

6.1 Dynamic test and thermal short-time current test

6.1.1 Test laboratory

High-power test laboratory, high current test bay

6.1.2 Normative document

IEC 60044-1: 1996-12, mod. + am1: 2000-07, Sub-clause 7.1

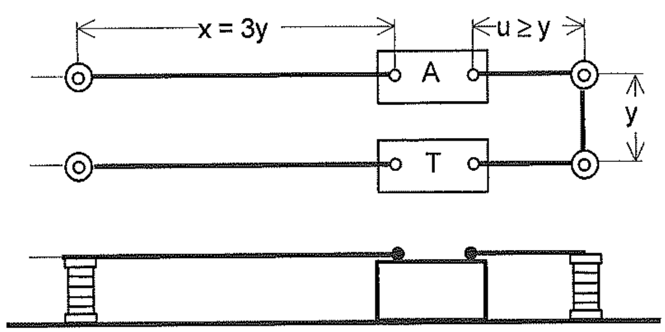
6.1.3 Required test parameters

Short-circuit current	31.5	kA
Peak current	80	kA
Duration of short-circuit	3	s
Joule integral	2977×10^6	A^2s

6.1.4 Test arrangement

The test was carried out single-phase in accordance with the STL guide to the interpretation of IEC 60044-1. A second current transformer of the same type was set up in the return conductor. The pole centres distance was to the manufacturer's instructions.
The distance x was 540 mm, the distances u and y were 180 mm.
The test object was connected by copper bars of 80 mm x 10 mm.
The secondary windings were short-circuited by flexible copper conductors of 10-mm² cross-section.

See Figures 9 and 10, Sheet 24.



A Auxiliary current transformer
T Test object
y Minimum pole centre distance declared by the client

Figure 3: Test arrangement for the short-time current tests

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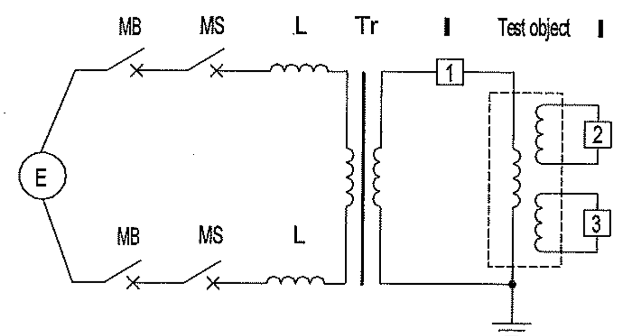
6.1.5 Test and measuring circuits

Technical data of the test circuit

Test requirement		Short-time current tests
Test No.		103 0788 and 103 0789
Number of phases (Test circuit)		1
Number of poles/phases (Test object)		1
Power frequency Hz		50
Power factor cos φ		< 0.15
Earthing conditions	Grid	Not earthed
	Short-circuit transformer	Not earthed
	Short-circuit point	Earthed
Short-circuit power of the test circuit		150 MVA
Current measurement		Rogowski measuring device



E	Power supply	Tr	Short-circuit transformer
MB	Master breaker	I	Current measurement
MS	Making switch	1 - 3	Measuring points
L	Current limiting reactor		

Figure 4: Test circuit

Technical data of the measuring circuits

Test No.	Measuring point	Symbol in oscillograms	Measuring quantity	Measuring sensor/device
103 0788 and 103 0789	1	i	Short-circuit current primary winding	Rogowski measuring device
	2	i1 sek	Short-circuit current secondary winding 1	Rogowski measuring device
	3	i2 sek	Short-circuit current secondary winding 2	Rogowski measuring device
Recording instrument: BE256 transient recorder				

6.1.6 Test results

Test object:	Current transformer, Serial No. 03/00815
Condition of test object before test:	Prestressed
Connection of test object:	See Sheet 13
Short-circuit point:	Secondary windings
Ambient temperature:	15 °C

Test values:

Test No.		103 ...	0788	0789
Peak current primary winding		kA	80.6	48.3
Short-circuit current, primary winding	r.m.s. value	kA	30.0	31.5
Short-circuit current, secondary winding 1	r.m.s. value	A	197	221
Short-circuit current, secondary winding 2	r.m.s. value	A	60.9	75.4
Short-circuit duration		ms	205	3005
Joule integral 10^6		A^2s	-	2982
Short-circuit current 3 s		kA	-	31.5
Note			1)	2)

Notes:

1) Test with dynamic current
2) Test with short-time thermal current

Condition of test object after test:

The current transformer did not show any visible damage. See Figure 10, Sheet 24.

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6.2 Determination of errors after the short-time current test

Rated current: 1250 A
Transformation ratio: 1250 A/5 A
Burden: 15 VA, cos β = 0.8

At percentage of rated current	Difference between the errors measured before and after the short-time current test		Permissible errors for accuracy class 0.5	
	Current error	Phase displacement	Current error	Phase displacement
	%	Minutes	%	Minutes
120 %	0.04	-0.9	± 0.25	± 15
100 %	0.03	-1.1	± 0.25	± 15
20 %	0.02	0.1	± 0.375	± 22.5
5 %	-0.09	11.1	± 0.75	± 45

Rated current: 1250 A
Transformation ratio: 1250 A/5 A
Burden: 3.75 VA, cos β = 1

At percentage of rated current	Difference between the errors measured before and after the short-time current test		Permissible errors for accuracy class 0.5	
	Current error	Phase displacement	Current error	Phase displacement
	%	Minutes	%	Minutes
120 %	0.02	-0.4	± 0.25	± 15
100 %	0.02	-0.3	± 0.25	± 15
20 %	0.04	-0.8	± 0.375	± 22.5
5 %	0.04	-0.5	± 0.75	± 45

The measured differences of current error and phase displacement are within the limits permissible for accuracy class 0.5. The test object is able to comply with the requirements of accuracy class 0.5 after the short-time current test.

Determination of errors after the short-time current test (continued)

Rated current: 1250 A
Transformation ratio: 1250 A/5 A Burden: 15 VA, cos β = 0.8

At percentage of rated current	Difference between the errors measured before and after the short-time current test		Permissible error for accuracy class 5P	
	Current error	Phase displacement	Current error	Phase displacement
	%	Minutes	%	Minutes
100 %	0.0	-0.1	± 0.5	± 30

The measured differences of current error and phase displacement are within the limits permissible for accuracy class 5P. The test object is able to comply with the requirements of accuracy class 5P after the short-time current test.

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6.3 Routine test after the short-time current test

The dielectric routine tests to Sub-clause 6.2 of the normative document are part of the type test – short-time current test – and serve to assess the latter.

Results

Test	**Test parameters**	**Test results**	
Power-frequency withstand test on the primary winding	Test voltage: 25.3 kV Test frequency: 50 Hz Duration of test: 60 s	No disruptive discharge	o.k.
Partial discharge measurement	Procedure A Prestress duration: 60 s Measuring voltage (points 1 to 3): $1.2 \times U_m = 14.4$ kV $U_m = 12.0$ kV $1.2 \times U_m/\sqrt{3} = 8.3$ kV Measuring time: 30 s	 Partial discharge < 3 pC < 50 pC Partial discharge < 2 pC < 50 pC Partial discharge < 2 pC < 20 pC	o.k.
Power-frequency withstand test on the secondary windings	Test voltage: 2.7 kV Test frequency: 50 Hz Duration of test: 60 s	No disruptive discharge	o.k.
Interturn overvoltage test	Procedure A Test current (primary): 1250 A Test voltage (secondary 1): 373 V Test voltage (secondary 2): 1093 V Test frequency: 50 Hz Duration of test: 60 s	No disruptive discharge	o.k.

Notes:

The routine tests did not show anything that could have indicated a damage done to the test object during the previous short-time current test.

7. Temperature rise test

7.1 Test laboratory

Low-voltage test laboratory, test room 3

7.2 Normative document

IEC 60044-1: 1996-12, mod. + A1: 2000-07, Sub-clause 7.2

7.3 Required test parameters

Test current	1500 A
Test frequency	50 Hz

7.4 Test arrangement

To IEC 60044-1: 1996, mod. + A1: 2000, Sub-clause 7.2

The current transformer was tested in a single-phase outdoor current circuit. Both cores were subjected to their rated burden with a power factor cos β = 1.

7.5 Test and measuring circuits

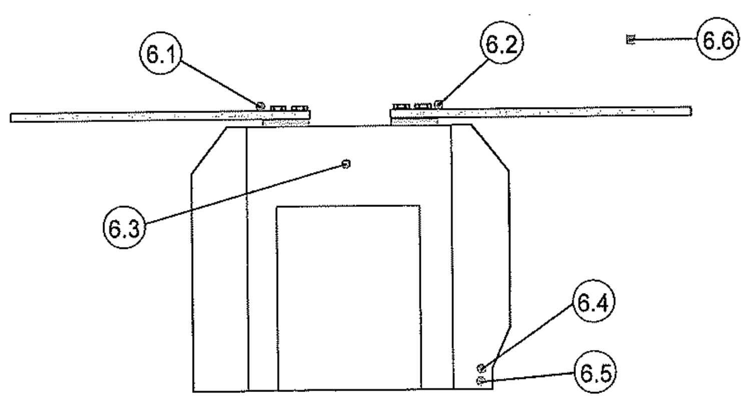

Figure 5: Arrangement of temperature measuring points

Test and measuring circuits (continued)

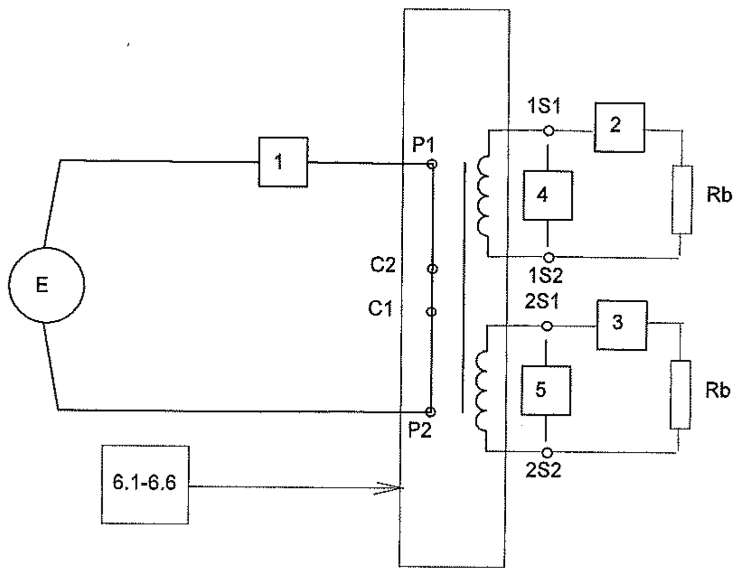

Figure 6: Circuit for the temperature-rise test

Technical data of measuring circuits

Measuring point	Measured quantity	Measuring sensor/device
1	Test current	Current transformer, digital display device
2 and 3	Secondary current	Digital display device
4 and 5	Winding resistance	Milliohmmeter PM 04
6.1 to 6.6	Temperature	Therm 5500-3, CoCo thermocouples

7.6 Test results

The test current was 1500 A (50 Hz). This is equivalent to the rated primary continuous thermal current of the current transformer.

Meas. point	Designation of the part	Material	Permissible temperature-rise limit K	Measured final temperature at ΔT≤1 K/h °C	Final temperature rise (related to average ambient air temperature) K
6.1	Current bar	Cu	80	69.9	52.4
6.2	Current bar	Cu	80	70.2	52.7
6.3	Transformer case	Insulating material	-	47.6	-
6.4	5-A winding 1	Cu wire	75	76.9	59.4
6.5	5-A winding 2	Cu wire	75	81.6	64.1
6.6	Ambient air	Air	-	17.5	-

Determination of the current transformer's winding temperature rise.

The current transformer was tested at rated burden. The temperature rise θ of the current transformer winding was determined on the basis of the rise of winding resistance from the cold state to the steady state of temperature rise of the complete assembly using the following formula given by DIN VDE 0532 Teil 2, Sub-clause 3.3 (transformers and reactors).

$$\theta_W = \frac{R_W}{R_K} (235 + \theta_K) - 235$$

Where:
- R_K Cold resistance of the winding at 18.5 °C
- R_W Warm resistance of the winding at 17.5 °C of ambient air temperature
- θ_K Cold temperature of winding
- θ_W Final temperature of the winding

The hot resistance of the secondary winding was calculated on the basis of the measurement of the cooling curve.

	R_K mΩ	R_W mΩ	R_W/R_K	θ_W °C	θ K	Permissible K
Core 1/5 A	137.8	169.6	1.23	76.9	59.4	75
Core 2/5 A	223.1	278.6	1.25	81.6	64.1	75

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Test results (continued)

Graphic representation of resistance variation (core 1)

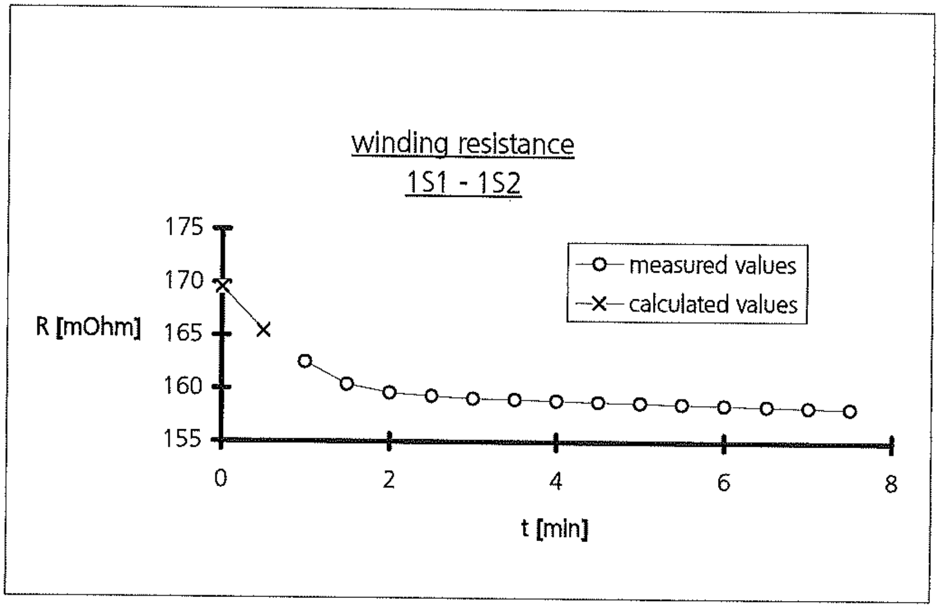

Figure 7: Cooling curve of core 1

Graphic representation of resistance variation (core 2)

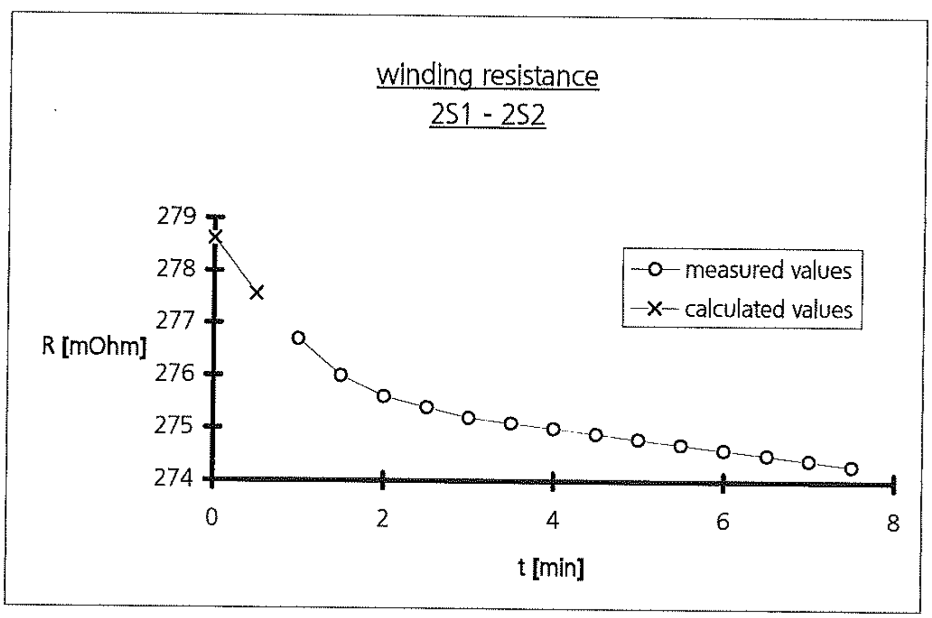

Figure 8: Cooling curve of core 2

8. Evaluation of all tests

- **Lightning impulse test**

During the test at 75-kV lightning impulse voltage, no disruptive discharge occurred. The recorded voltage curve did not present any significant variation between recordings at reference impulse and at full impulse level.
The routine tests have successfully been repeated.

The requirements specified by IEC 60044-1: 1996, Sub-clause 7.3.2 have been met.

The current transformer has PASSED the type test – impulse voltage test.

- **Determination of errors**

The measured current error and phase displacement values are within the limits permissible for accuracy class 0.5 for measuring current transformers and class 5P for protective current transformers.

The requirements specified by IEC 60044-1: 1996, Sub-clauses 11.4 and 12.4 have been met.

The current transformer has PASSED the type test – determination of errors.

- **Short-time current test**

The current transformer is capable of properly carrying its rated dynamic current of 80 kA and its rated short-time thermal current of 31.5 kA for a duration of short-circuit of 3 s.

- After test, the current transformer was not visibly damaged.
- The errors determined after test did not differ from those recorded before test by more than half the limits of error appropriate to its accuracy class.
- During the dielectric tests done after the short-time current test, no disruptive discharge occurred. The partial discharge magnitude was below the permissible limit of 50 pC at 1.2 x U_m.
- The visual inspection of the insulation of the primary winding was not necessary as the current density in the primary winding, related to the rated short-time thermal current, does not exceed 180 A/mm^2.

The requirements specified by IEC 60044-1: 1996-12, Sub-clause 7.1 have been met.

The current transformer has PASSED the type test – short-time current test.

- **Temperature-rise test**

Subjected to its rated primary continuous thermal current of 1500 A, the test object reaches a maximum final temperature rise of 64.1 K in the secondary windings. The final winding temperature-rise limit of 75 K permissible for the class of insulation "E" was not exceeded.

The requirements specified by IEC 60044-1: 1996, Sub-clause 7.2 have been met.

The current transformer has PASSED the type test – temperature-rise test.

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9. Appendices

9.1 Photos

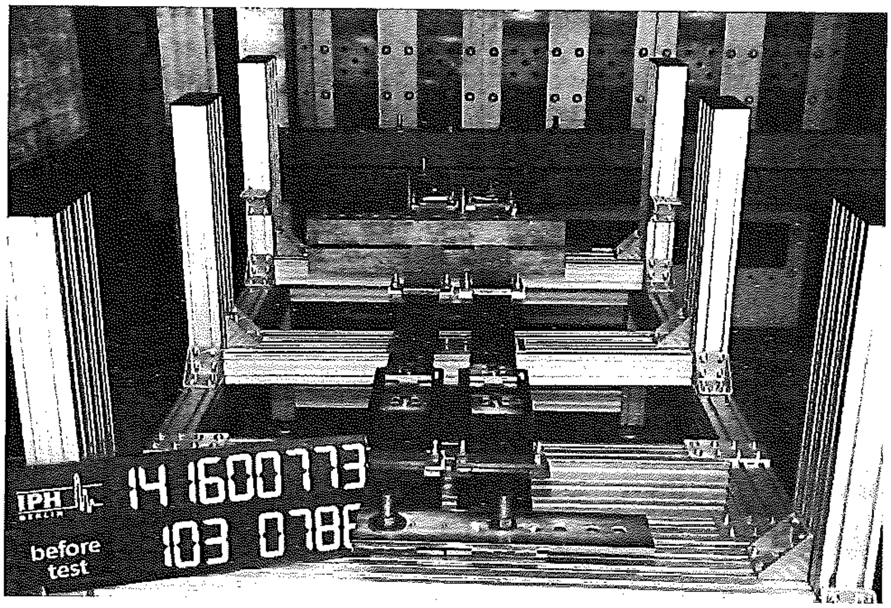


Figure 9: Test arrangement for the short-time current test

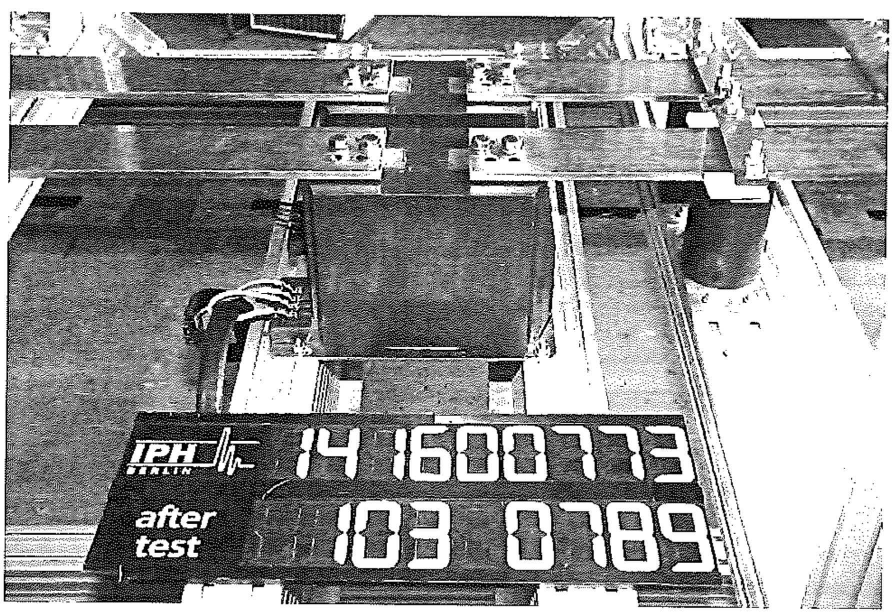
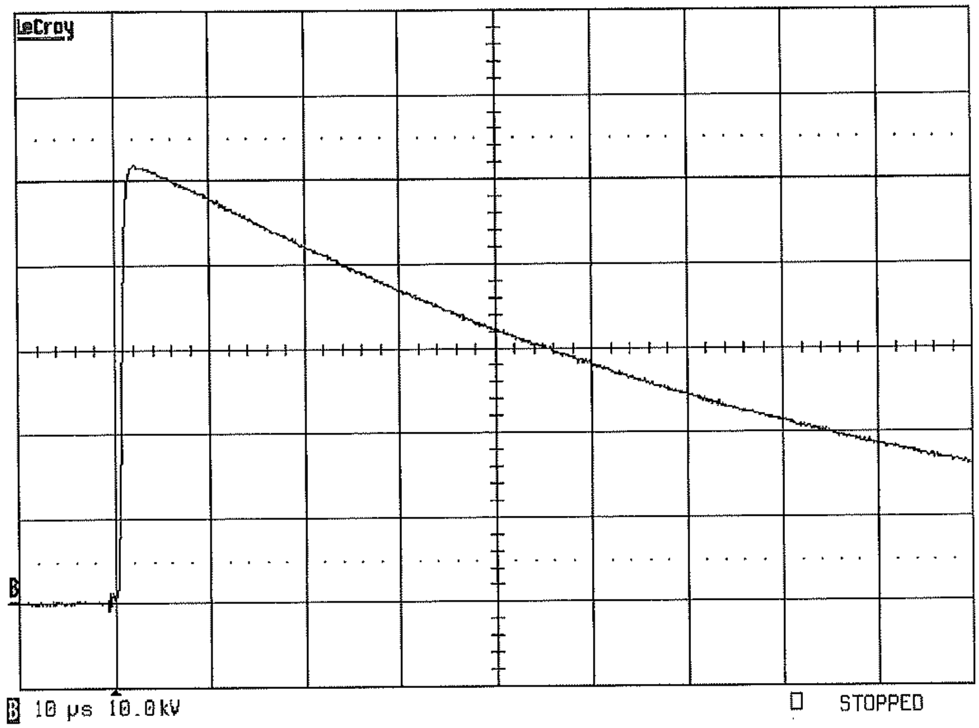


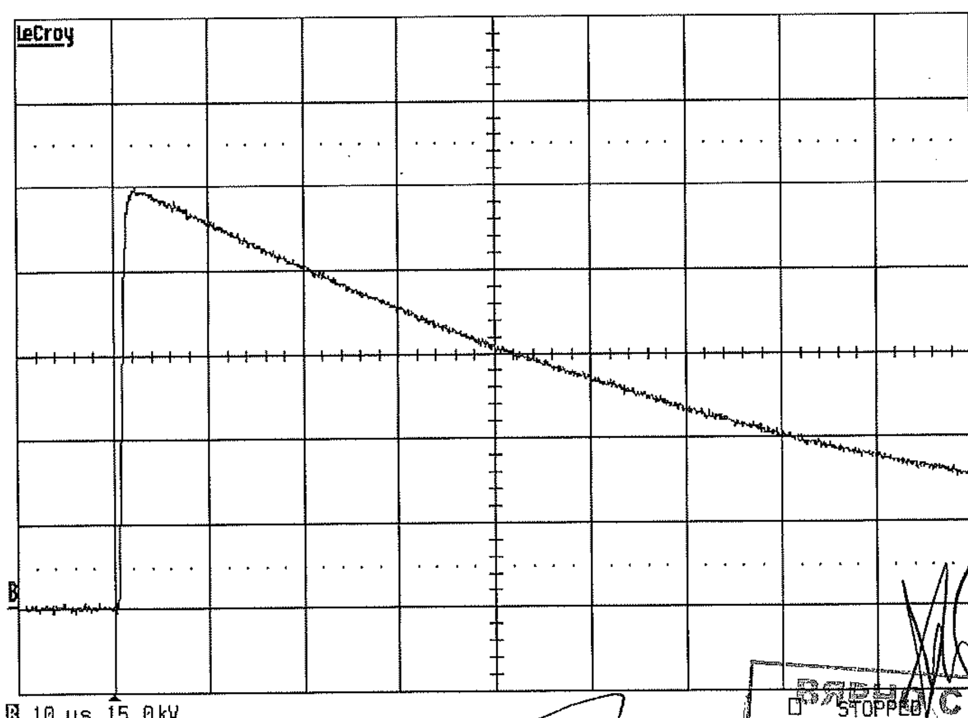
Figure 10: Test object after the short-time withstand current test

9.2 Oscillograms

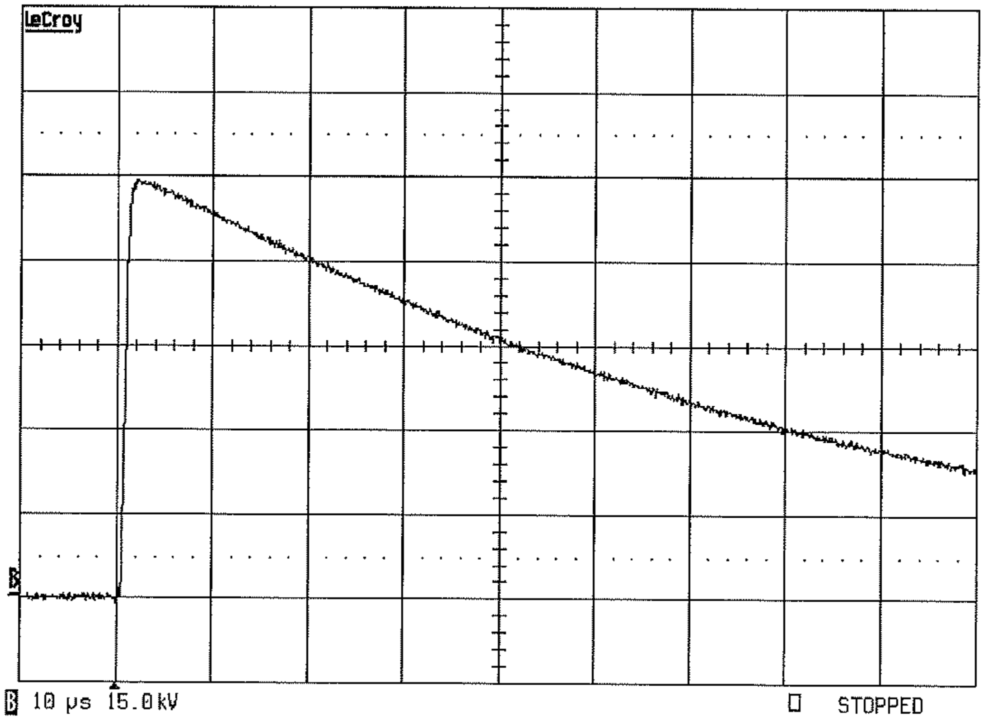
- **Impulse tests on the primary winding**



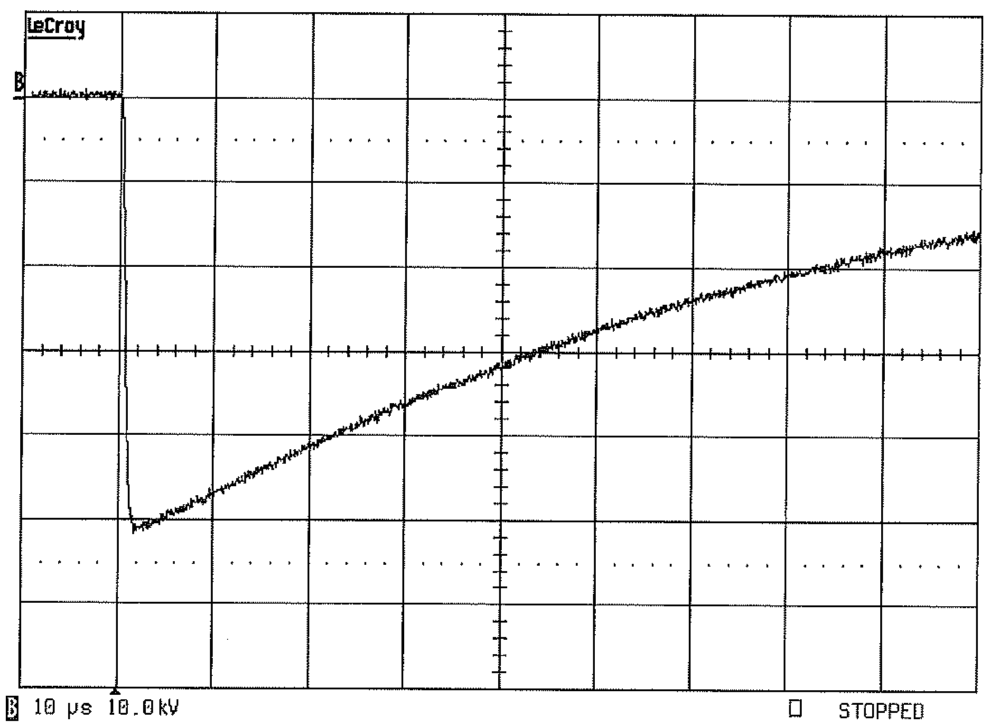
Test No. 1003 02129



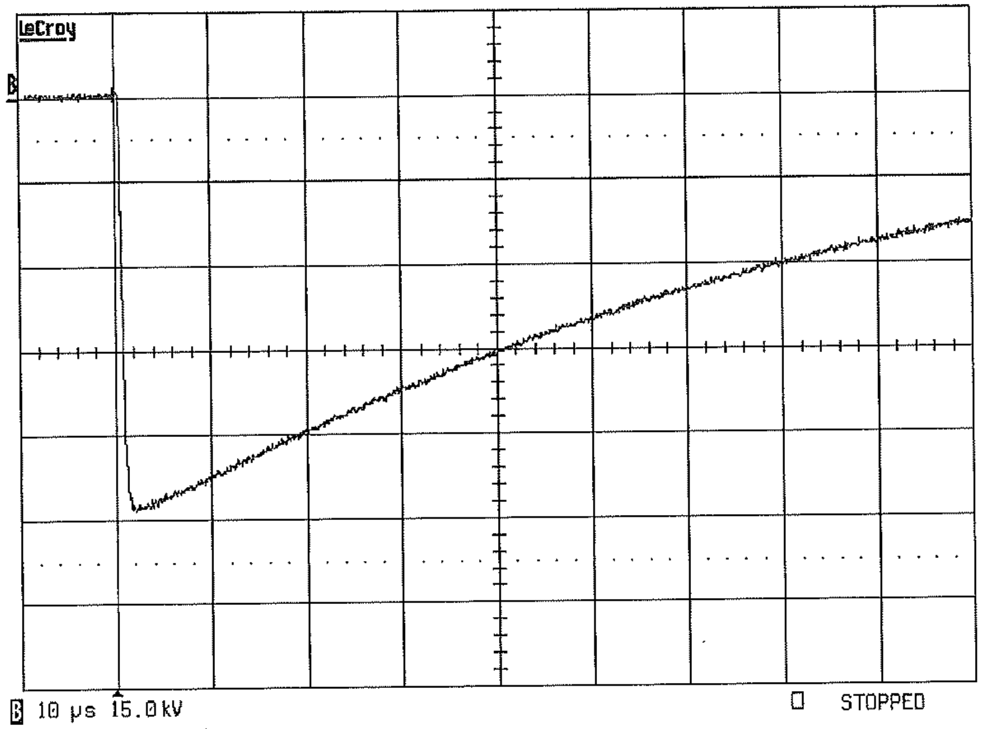
Test No. 1003 02130



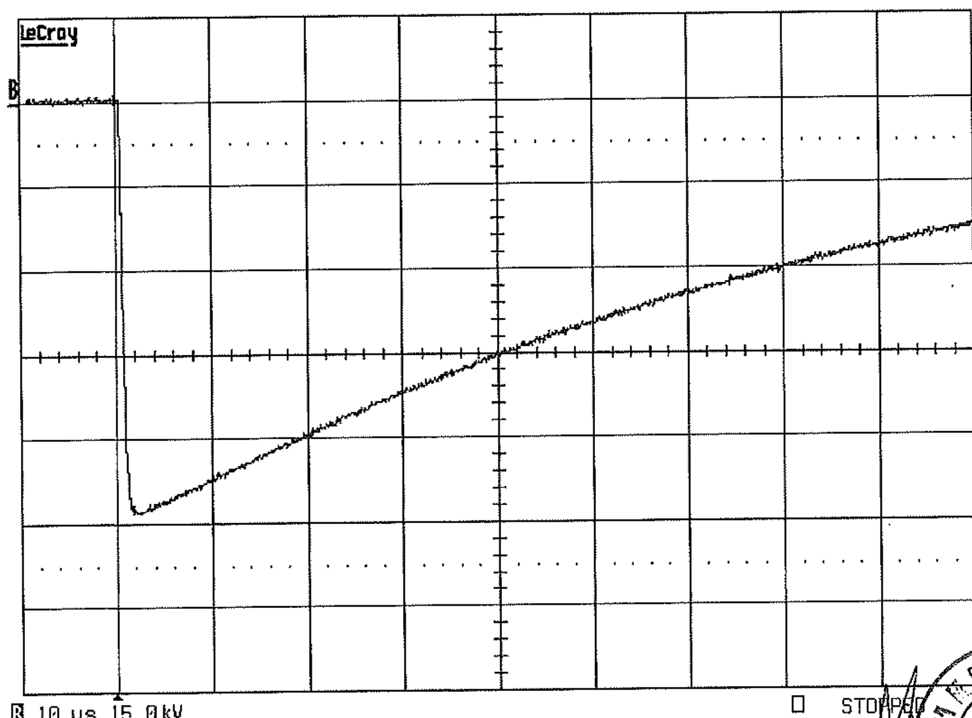
Test No. 1003 02144



Test No. 1003 02145



Test No. 1003 02146



Test No. 1003 02160

ВЯРНО С ОРИГИНАЛА

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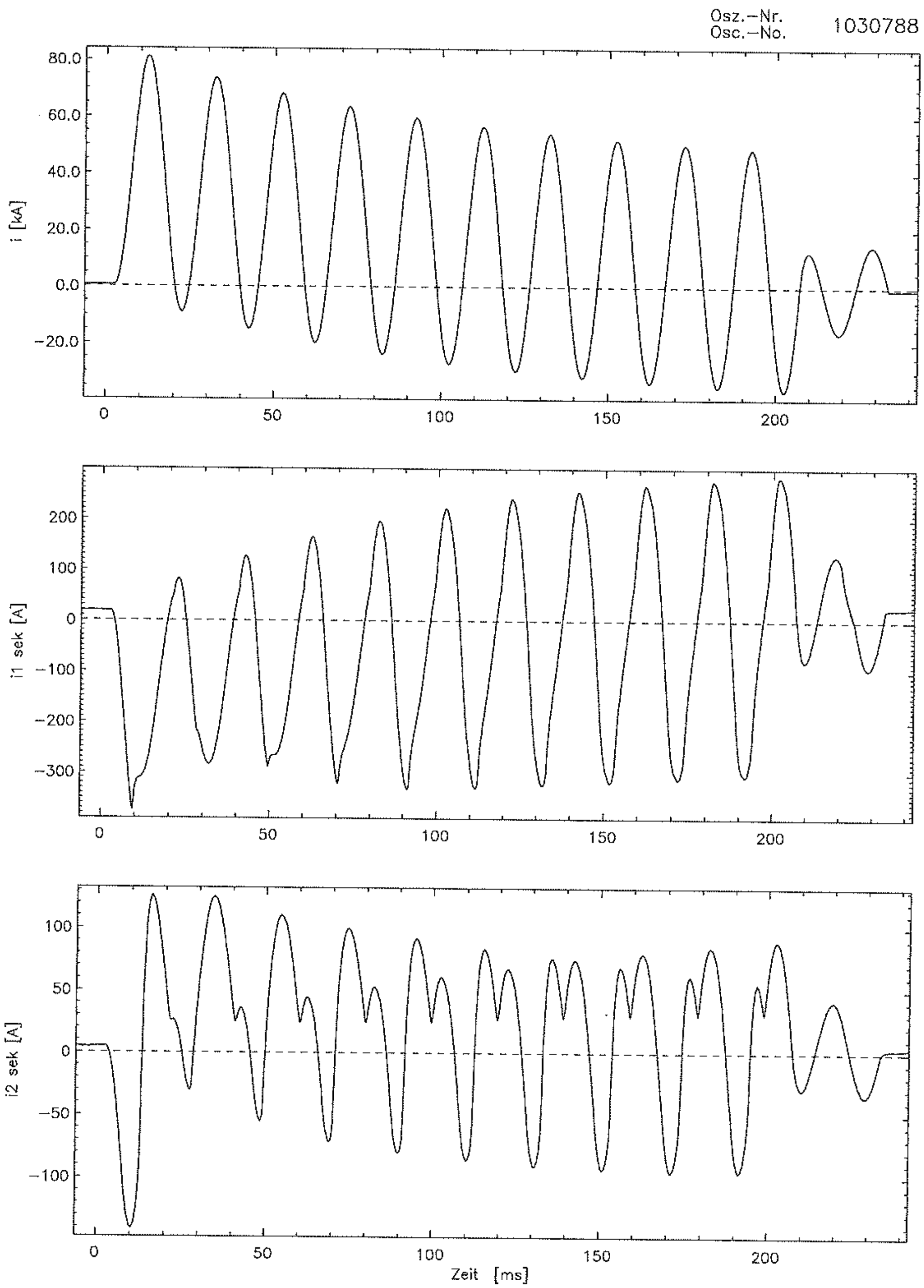
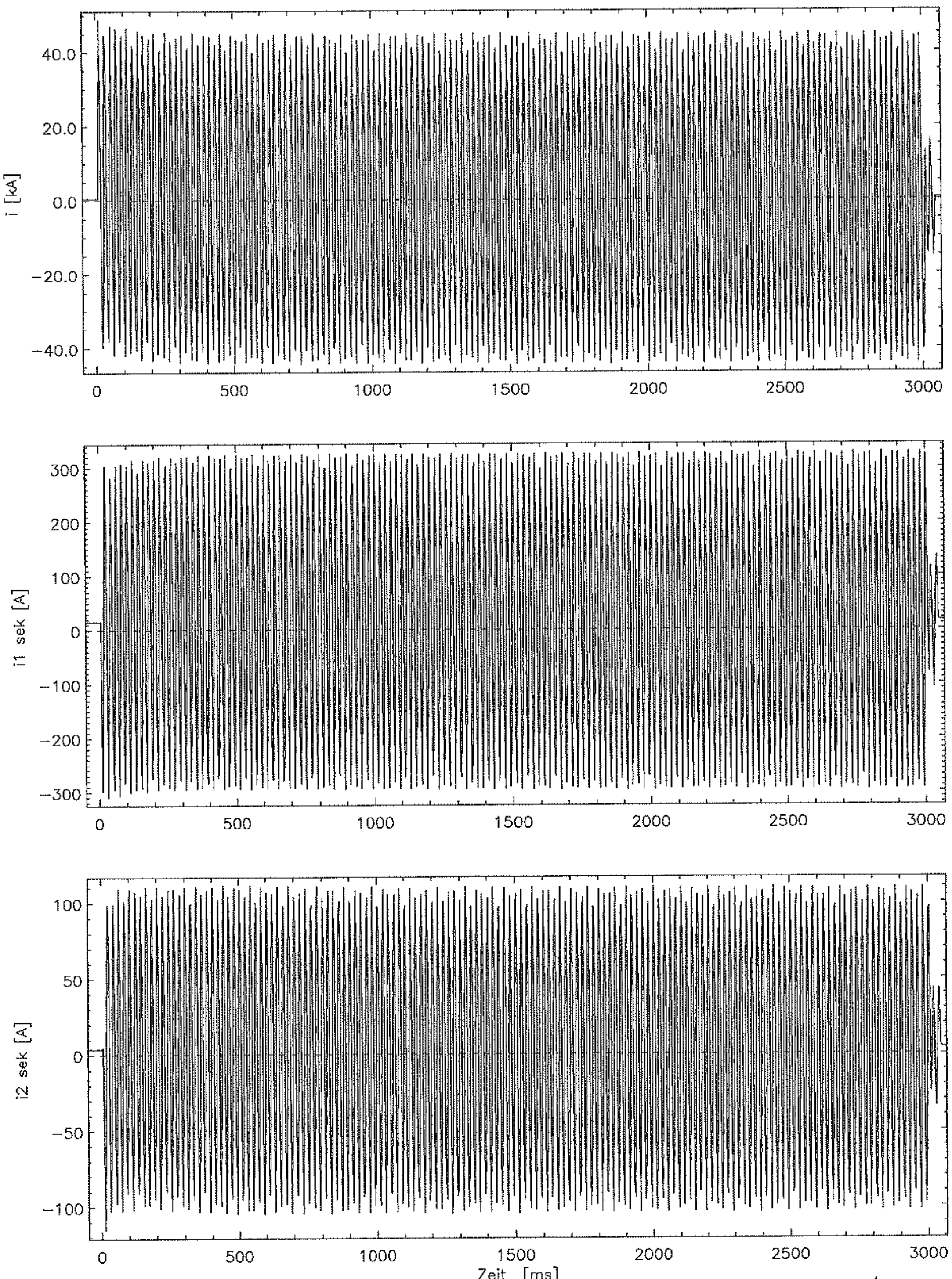
- **Short-circuit test**



Osz.–Nr.
Osc.–No. 1030789



ВЯРНО С ОРИГИНАЛА

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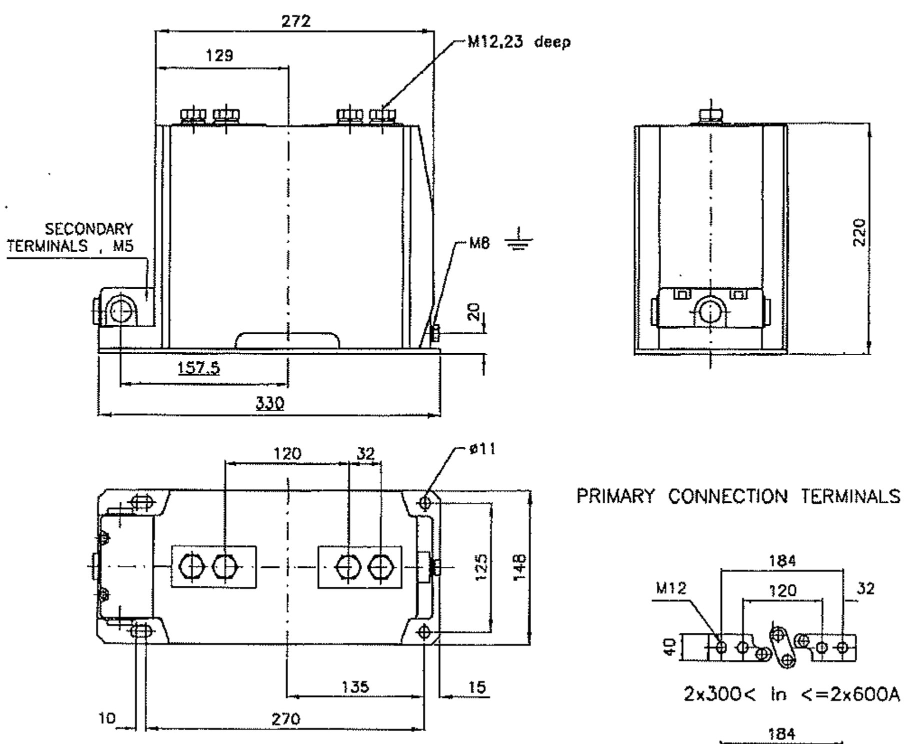
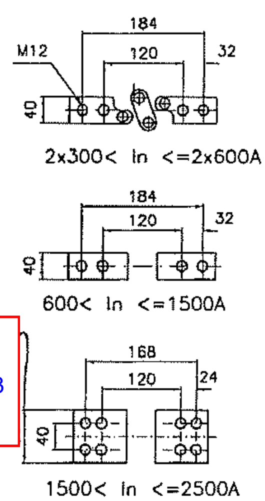
9.3 Drawing





TYPE : 4MA72 Nr: 03/00815
Um : 12/28/75kV 50–60Hz
Ratio : 1250/5–5A
Icont : 1,2xIn
1.Core : 0.5FS5 15VA
2.Core : 5P10 15VA
Ith : 31.5kA (3sec.)
Idyn : 2,5xIth
Copper cross–section
Primary winding : 660mm²
1.Secondary winding : 2,55mm²
2.Secondary winding : 2,54mm²

На основание чл.36а ал.3 от ЗОП

QTY	DESCRIPTION	POS	DIMENSIONS	WEIGHT	PART OR DIN NO.	MATERIAL
						Epoxy–resin

NO	DATE	NAME	MODIFICATION

TOLERANCES DIN 7168 9
SCALE 1:5

4MA72
BLOCK TYPE CURRENT TRANSFORMER

MATERIAL CODE 1181
415

REPLACES THE DRAWING NO.

DR'N 06-02-03
CH'D 06/02/2003
APP'D
INFORMATION
C.C

ДОКУМЕНТ 5.3

Deutsche Akkreditierungsstelle GmbH
(Германски акредитационен орган ГмбХ)

Упълномощен в съответствие с Подраздел 1 на Раздел 8 на AkkStelleG във връзка с Подраздел 1 на Раздел 1 на AkkStelleG
Подписал Многостранните споразумения на EA, ILAF и IAF за взаимно признаване

Акредитация

Deutsche Akkreditierungsstelle GmbH (Германски акредитационен орган ГмбХ) удостоверява, че изпитвателната лаборатория

IPH Institut "Prüffeld für elektrische Hochleistungstechnik" GmbH
Landsberger Alee 378 A, 12681 Berlin
(Институт ИПХ „Прюфелд фюр Електрише Хохлайщунгстехник" ГмбХ
Алея Ландсбергер 378 А, 12681 Берлин)

е компетентна по условията на DIN EN ISO/IEC 17025:2005 да извършва изпитания в следните области:

Апаратура и компоненти за високо напрежение
Апаратура и компоненти за ниско напрежение
Комутационна, защитна и управляваща апаратура
Кабели и кабелни аксесоари за високо, средно и ниско напрежение

Акредитационният сертификат важи във връзка с известието за акредитация от 11.11.2015 г. с акредитационен номер D-PL-12107-01 и е валиден до 10.11.2020 г. Той се състои от заглавния лист, обратната страна на заглавния лист и следващия анекс с общо 42 страници.

Регистрационен номер на сертификата: **D-PL-12107-01-00**

Франкфурт на Майн, 11.11.2015 г.

/подпис – не се чете/
инж. Ралф Егнер
Ръководител отделение

Този документ е превод. Определящата версия е оригиналният германски акредитационен сертификат.

Вж. забележките на обратната страна на листа.

МИГ 23 ЕООД СОФИЯ MIG 23 LTD

ВЯРНО С ОРИГИНАЛА

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Deutsche Akkreditierungsstelle GmbH
(Германски акредитационен орган ГмбХ)

Офис Берлин
Шпителмаркт 10
10117 Берлин

Офис Франкфурт на Майн
Еуропа алее 52
60327 Франкфурт на Майн

Офис Брауншвайг
Бундесалее 100
38116 Брауншвайг

Публикуването на извадки от акредитационния сертификат подлежи на предварително писмено одобрение от Deutsche Akkreditierungsstelle GmbH (DAkkS). Изключение е непромененаta форма на отделни разпространения на заглавния лист от споменатия на обратната страна на листа орган за оценка на съответствието.

Не трябва да се създава впечатление, че акредикацията е разширена до области извън обхвата на акредитация , удостоверен от DAkkS.

Акредитацията е дадена съгласно Закона за акредитационния орган (AkkStelleG) от 31 юли 2009 г. (Вестник за федерални закони I стр. 2625) и РЕГЛАМЕНТ (ЕО) № 765/2008 на Европейския парламент и на Съвета от 9 юли 2008 г. за определяне на изискванията за акредитация и надзор на пазара във връзка с предлагането на пазара на продукти (Официален вестник на Европейския съюз L 218 от 9 юли 2008 г., стр. 30). DAkkS е подписал Многостранното споразумение за взаимно признаване на европейското сътрудничество за акредитация (ЕА), Международния акредитационен форум (IAF) и Международното сътрудничество за акредитиране на лаборатории (ILAC). Подписалите тези споразумения признават взаимно своите акредитации.

Текущото състояние на членството може да бъде намерено на следните уебсайтове:
EA: www.european-accreditation.org
ILAC: www. ilac.org
IAF: www.iaf.nu

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DAkkS
Deutsche
Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH

Entrusted according to Section 8 subsection1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV
Signatory to the Multilateral Agreements of
EA, ILAC and IAF for Mutual Recognition

Accreditation

The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory

IPH Institut "Prüffeld für elektrische Hochleistungstechnik" GmbH
Landsberger Allee 378 A, 12681 Berlin

is competent under the terms of DIN EN ISO/IEC 17025:2005 to carry out tests in the following fields:

High-voltage equipment and components
Low-voltage equipment and components
Installation, switching, control and protective equipment
High-voltage, medium-voltage and low-voltage cables and their accessories

The accreditation certificate shall only apply in connection with the notice of accreditation of 2015-11-11 with the accreditation number D-PL-12107-01 and is valid until 2020-11-10. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 42 pages.

Registration number of the certificate: **D-PL-12107-01-00**

ВЯРНО С ОРИГИНАЛА

МИГ 23 ЕООД СОФИЯ MIG 23 LTD

Frankfurt, 2015-11-11

Dipl.-Ing. (FH) Ralf Egner
Head of Division

This document is a translation. The definitive version is the original German accreditation certificate.

See notes overleaf.

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Deutsche Akkreditierungsstelle GmbH

Office Berlin
Spittelmarkt 10
10117 Berlin

Office Frankfurt am Main
Gartenstraße 6
60594 Frankfurt am Main

Office Braunschweig
Bundesallee 100
38116 Braunschweig

The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAkkS is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations.

The up-to-date state of membership can be retrieved from the following websites:
EA: www.european-accreditation.org
ILAC: www.ilac.org
IAF: www.iaf.nu

ДОКУМЕНТ 5.4

MIG 23 Ltd www.mig23-bg.com
mv@mig23-bg.com

ДЕКЛАРАЦИЯ

че предложеното оборудване в процедурата отговаря на минималните технически изисквания на Възложителя, посочени в таблица 5

Долуподписаният Антон Иванов Илиев, в качеството ми на представляващ „МИГ 23" ЕООД, участник в процедура за изпълнение на обществена поръчка с реф. **№ PPD 19-103** и предмет: **„ Модернизация (ретрофит /проектиране, реконструкция, доставка и монтаж на машини и съоръжения, подготовка и въвеждане в експлоатация/) на възлови разпределителни станции 20 (10) kV и изграждане на вериги на телемеханика в регион „Ловеч - Враца", регион „Монтана – Видин" и регион „Плевен"**

ДЕКЛАРИРАМ, ЧЕ:

че предложеното от нас оборудване в процедурата, отговаря на минималните технически изисквания на Възложителя, **СТАНДАРТ НА МАТЕРИАЛА ЗА ТОКОВИ ТРАНСФОРМАТОРИ 12 KV ЗА МОНТИРАНЕ НА ЗАКРИТО, ФИКСИРАН.**, посочени в таблица 5, както следва:

Параметри на електрическата разпределителна мрежа:

№	Параметър	Стойност
1.	Обявено напрежение	10 000 V
2.	Максимално работно напрежение	12 000 V
3.	Обявена честота	50 Hz
4.	Начин на заземяване на звездния център	през активно съпротивление
5.	Ток на късо съединение	20 кА

Характеристики на работната среда и място на монтиране:

№	Характеристика /място на монтиране	Стойност/описание
1.	Максимална околна температура	+ 40°C
2.	Минимална околна температура	Минус 5°C
3.	Относителна влажност	До 95 %
4.	Замърсяване с прах, пушек, агресивни газове и пари	Умерено
5.	Надморска височина	До 1 000 m
6.	Място на монтиране	В ЗРУ/КРУ

Технически параметри на токови измервателни трансформатори 12 kV, 1250/5/5 A, подпорен тип, за монтиране на закрито, които се гарантират от Участника чрез Декларация *(съгласно образеца в документацията)*, че предложеното оборудване отговаря на посочените по-долу минималните технически изисквания на Възложителя:

№	Параметър	Минимални технически изисквания
1.	Обявен първичен ток, I_{pr}	1250 A
2.	Обявен първичен ток на термична устойчивост, I_{th}	≥ 20 кА/1 s
3.	Обявен първичен ток на динамична устойчивост, I_{dyn}	≥ 50 кА
4.	Обявени вторични токове:	-
-	за измервателната намотка	5 A
-	за намотката за защитата	5 A
5.	Обявени коефициенти на трансформация:	-

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-	за измервателната намотка	1250/5 A
-	за намотката за защита	1250/5 A

Технически параметри на токови измервателни трансформатори 12 kV, 400/5/5 A, подпорен тип, за монтиране на закрито, които се гарантират от Участника чрез Декларация *(съгласно образеца в документацията)*, че предложеното оборудване отговаря на посочените по-долу минималните технически изисквания на Възложителя:

№	Параметър	Минимални технически изисквания
1.	Обявен първичен ток, I_{pr}	400 A
2.	Обявен първичен ток на термична устойчивост, I_{th}	≥ 20 kA/1 s
3.	Обявен първичен ток на динамична устойчивост, I_{dyn}	≥ 50 kA
4.	Обявени вторични токове:	-
-	за измервателната намотка	5 A
-	за намотката за защитата	5 A
5.	Обявени коефициенти на трансформация:	-
-	за измервателната намотка	400/5 A
-	за намотката за защита	400/5 A

Конструктивни характеристики и др. данни за токови измервателни трансформатори 12 kV, 1250/5/5 A и 400/5/5 A, подпорен тип, за монтиране на закрито, които се гарантират от Участника чрез Декларация *(съгласно образеца в документацията)*, че предложеното оборудване отговаря на посочените по-долу минималните технически изисквания на Възложителя:

№	Характеристика	Минимални технически изисквания
1.	Конструкция	а) Токовите измервателни трансформатори трябва да бъдат защитени със синтетична, монолитна, твърда изолация, съответстваща на изискванията на БДС EN 60085 или еквивалент. За топлинен клас на изолацията – min 120 (E)
		б) Токовите измервателни трансформатори трябва да бъдат съоръжени с клеми с по две винтови съединения, за свързване на първичната намотка и клемен блок за свързване на вторичните вериги.
2.	Вторични намотки – брой и предназначение	а) Една вторична намотка за целите на измерването.
		б) Една вторична намотка за целите на защитата.
3.	Клеми за свързване на първичната намотка	Клемите трябва да бъдат изработени от мед или медна сплав недопускаща електрохимична корозия при свързването на трансформаторите с медни или алуминиеви шини.
4.	Клемен блок за свързване на вторичните вериги	а) Клемният блок трябва да бъде от винтов тип с възможност за свързване на многожични проводници на вторичните вериги със сечение до 4 mm^2.
		б) Клемният блок трябва да бъде защитен с прозрачен капак за визуален контрол с възможност за пломбиране.
		в) Клемите на клемният блок трябва да бъдат изработени от месинг или друга подходяща некорозираща медна сплав.
		г) Клемният блок трябва да осигурява възможност за заземяваме на изводите на вторичните намотки.
5.	Заземяване	Токовите измервателни трансформатори трябва да бъдат съоръжени със заземителен болт min M8, означен със знак „Защитна земя". ⏚

№	Характеристика	Минимални технически изисквания
6.	Резбови и скрепителни съединения	Всички резбови и скрепителни съединения трябва да бъдат изработени от месинг или други подходящи некорозиращи метали или метални сплави.
7.	Маркиране на обявените стойности	а) Токовите измервателни трансформатори трябва да бъдат маркирани от страната на клемния блок с информация за обявените стойности върху корпуса на трансформатора или върху табелка съгласно изискванията на т. 6.13 от БДС EN 61869-2 или еквивалент.
		б) Обявените стойности може да бъдат нанесени чрез гравиране върху корпуса на трансформатора или върху табелка изработена от анодизиран алуминий или от еквивалентен устойчив на корозия материал, като за целта не могат да бъдат използвани табелки (етикети) от самозалепващ се тип.
		в) Маркировката трябва да бъде нанесена трайно и четливо по начин, по който да не може да бъде заличена.
		г) Ако се използва табелка, тя трябва да бъде фиксирана здраво към корпуса на токовите измервателни трансформатори чрез устойчиви на корозия нитове.
		д) От страната на клемния блок, върху изолацията на токовите измервателни трансформатори допълнително трябва да бъде маркиран с вдлъбнат или релефен печат обявения коефициент на трансформация, с размер на шрифта min 20 mm.
8.	Маркиране на изводите	Изводите на токовите измервателни трансформатори трябва да бъдат маркирани трайно и четливо съгласно изискванията на т. 6.13 от БДС EN 61869-2 или еквивалент.
9.	Първоначална проверка и знаци за удостоверяване (съгласно разпоредбите на Закона за измерванията)	а) Токовите измервателни трансформатори трябва да бъдат доставени след извършване на първоначална метрологична проверка.
		б) Първоначална метрологична проверка трябва да бъде удостоверена със знак за първоначална проверка и копието на протокола от проведените изпитвания.
10.	Експлоатационна дълготрайност	≥ 25 години

Общи технически параметри, характеристики и др. данни токови измервателни трансформатори 10 kV, 1250/5/5/ А и 400/5/5 А, подпорен тип, за монтиране на закрито, които се гарантират от Участника чрез Декларация *(съгласно образеца в документацията)*, че предложеното оборудване отговаря на посочените по-долу минималните технически изисквания на Възложителя:

№	Параметър	Минимални технически изисквания
1.	Класове на точност:	-
-	за измервателната намотка	≤ 0,5 S
-	за намотката за защитата	≤ 10P20
2.	Обявен продължителен термичен ток, I_{cth}	≥ 1,2 x I_{pr}
3.	Номинален коефициент на безопасност – FS	≤ 5
4.	Номинална гранична кратност – ALF	≤ 10
5.	Обявени вторични товари:	-
-	за измервателната намотка	≥ 15 VA
-	за намотката за защитата	≥ 30 VA
6.	Обявено издържано напрежение с промишлена честота за изолацията на първичната намотка	≥ 28 kV (ефективна стойност)

MIG 23 Ltd

www.mig23-bg.com
mv@mig23-bg.com

№	Параметър	Минимални технически изисквания
7.	Обявено издържано напрежение с мълниев импулс за изолацията на първичната намотка	≥ 75 kV (върхова стойност)
8.	Обявено издържано напрежение с промишлена честота на изолацията за вторичните намотки	≥ 3 kV (ефективна стойност)
9.	Най-високо напрежение за съоръженията, U_m	12 kV (ефективна стойност)
10.	Топлинен клас на изолацията (съгл. БДС EN 60085:2008 или еквивалент)	≥ 120 (E)
11.	Допустими нива на частичния разряд:	-
-	при 1,2 U_m	≤ 50 pC
-	при 1,2 $U_m/\sqrt{3}$	≤ 20 pC

На основание чл.36а ал.3 от ЗОП

Дата 31.10.2019 г.

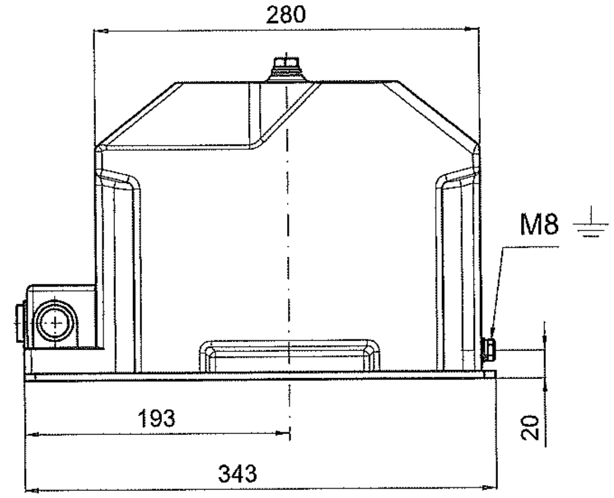
Декларатор

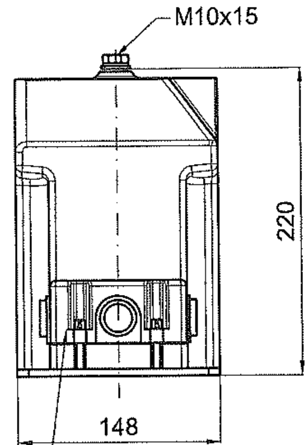
/име, подпис и печат/

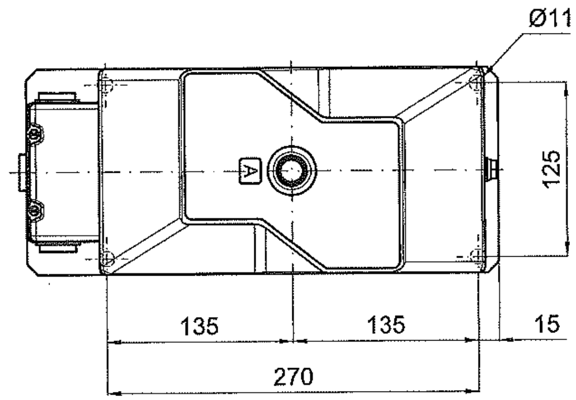
000282

ДОКУМЕНТ 3.1

SIEMENS Technical Specification No :2-A359-305

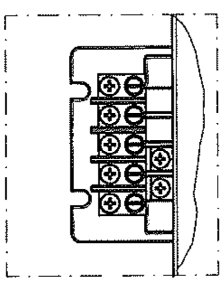






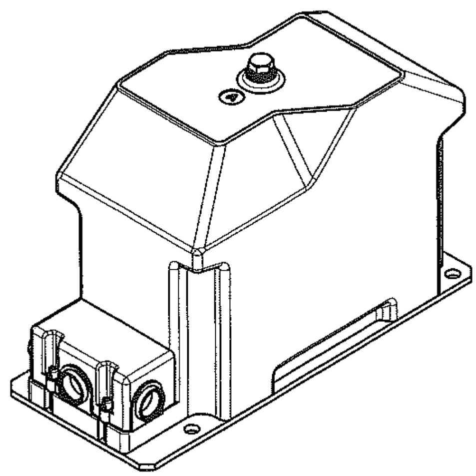
SECONDARY TERMINAL , M5
max. 7 TERMINAL

DEGISIKLIK
TEKNIK BÜRO
Tarih 23/06/2011



SECONDARY TERMINAL'S DETAIL

SCREW	TORQUE Nm
M5	4
M8	16-20
M10	30-40



QTY	DESCRIPTION	POS	DIMENSIONS	WEIGHT	PART OR DIN NO.	MATERIAL

NO	DATE	NAME	MODIFICATION
G	05-01-09	ARZU	Base plate dimension changed.
H	10-07-09	NİL	Secondary terminals changed.
I	10-07-09	NİL	Second plate code canceled.
J	09-11-10	AYŞE	Procedure no changed
K	10-02-11	AYŞE	Secondary terminals changed.

TOLERANCES DIN 7168 g

SCALE 1:5

4MR12
BLOCK TYPE VOLTAGE TRANSFORMER
SIEMENS

REPLACES THE DRAWING NO.

PLATE CODE: M PLK TRF ST 50

REV.: K

417

DR'N / CHP / APP'D / INFORMATION

ВЯРНО С ОРИГИНАЛА

СОФИЯ

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ДОКУМЕНТ 6.1

РЕПУБЛИКА БЪЛГАРИЯ
Български институт по метрология

REPUBLIC OF BULGARIA
Bulgarian Institute of Metrology

УДОСТОВЕРЕНИЕ
ЗА ОДОБРЕН ТИП СРЕДСТВО ЗА ИЗМЕРВАНЕ
Measuring Instrument Type-approval Certificate

№ 16.11.5110

Издадено на производител: *Issued to manufacturer:* SIEMENS AG - Germany
Wittelsbacherplatz 2, D-80333 Munich, Germany

На основание на: *In Accordance with:* чл. 32, ал. 1 от Закона за измерванията (ДВ, бр. 46 от 2002 г., изм. бр. 88 от 05 г., изм. и доп. бр. 95 от 2005 г.)

Относно: *In Respect of:* измервателни напреженови трансформатори тип 4MRxx

Знак за одобрен тип: *Type Approval Mark:*
BG 16
5110

Технически и метрологични характеристики: *Technical and metrological characteristics:* приложение, неразделна част от настоящото удостоверение за одобрен тип средство за измерване

Срок на валидност: *Valid until:* 15.11.2026 г.

Вписва се в регистъра на одобрените за използване типове средства за измерване под №: *Reference №:* 5110

Дата на издаване на удостоверението за одобрен тип: *Date:* 15.11.2016 г.

На основание чл.36а ал.3 от ЗОП

И. Д. ПРЕДСЕДА
Па

ВЯРНО С ОРИГИНАЛА

Г 23 ЕООД
СОФИЯ
G 23 LTD

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Приложение към удостоверение за одобрен тип № 16.11.5110

Издадено на производител: SIEMENS AG - Germany
Wittelsbacherplatz 2, D-80333 Munich, Germany

Относно: измервателни напреженови трансформатори тип 4MRxx

1. Описание на типа:

Измервателни напреженови трансформатори тип 4MRxx се използват за измерване и защита на електрически мрежи с максимално допустимо работно напрежение до 36 kV.

Измервателните трансформатори тип 4MRxx са предназначени за вътрешен монтаж. Монтират се на подходящи поставки, проектирани за тях, в зависимост от конкретната ситуация.

Измервателни напреженови трансформатори могат да имат няколко вторични намотки, с еднакви или различни характеристики. Изолирани са една от друга електрически, но на един и същи магнитопровод. Те могат да бъдат с различен коефициент на трансформация и с различна мощност.

Измервателните трансформатори тип 4MRxx се произвеждат обикновенно само с едно ядро, което може да нарасне четири пъти, в зависимост от мощността и броя на вторичните намотки.

Първичната намотка е свързана към земя в клемната кутия. Тази връзка не може да бъде разкачвана по време на работа. За заземяване на вторичната намотка има специални болтове, по един за всеки край на намотката.

Основата на измервателните напреженови трансформатори тип 4MRxx е горещо галванизирана метална плоча.

Кутията с клемите на вторичната намотка е излята заедно с тялото на трансформатора от същата смола. Капакът е херметически затворен. Изводите са бронзови, никелирани, предназначени за присъединяване на болт с размер M6. Всеки край може да се свърже към заземителна клема, намираща се вътре в клемната кутия. За преминаване на кабелите през стените на кутията са осигурени два отвора - по един от двете й страни, с диаметър от 10 mm до 14 mm. Уплътнението е чрез щуцер с размер PG 16.

Измервателните трансформатори тип 4MRxx могат да се монтират вертикално или хоризонтално.

2. Технически и метрологични характеристики:

Тип на трансформатора	4MR 12 (22)	4MR 14 (24)	4MR 56 (66)
Максимално работно напрежение, kV	до 12	до 24	до 36
Номинално първично напрежение, kV	от 3/√3 до 11/√3	от 13/√3 до 22/√3	от 20/√3 до 35/√3
Номинално вторично напрежение, V	100/3; 110/3; 120/3; 100/√3; 110/√3; 120/√3		
Номинална честота, Hz	50		
Клас на точност: - измервателна намотка - защитна намотка	0,2; 0,5; 1; 3 3P; 6P		
Мощност на вторичните намотки, VA/клас на точност: - измервателна намотка - защитна намотка	(от 5 до 70)/0,2; (от 5 до 200)/0,5; (от 5 до 200)/1; (от 5 до 300)/3; (от 5до 300)/3P; (от 5 до 300)/6P		

ВЯРНО С ОРИГИНАЛА

МИГ 23 ЕООД СОФИЯ MIG 23 LTD

Приложение към удостоверение за одобрен тип № 16.11.5110

3. Типово означение: 4MRxx:

4MR	x	x
Напреженов измервателен трансформатор	**1** - за вътрешен монтаж, еднофазен, малък; **2** - за вътрешен монтаж, двуфазен, малък; **5** - за вътрешен монтаж, еднофазен, голям; **6** - за вътрешен монтаж, двуфазен, голям	Максимално работно напрежение: **2** – до 12 kV **4** – до 24 kV **6** – до 36 kV

4. Описание на местата, предназначени за поставяне на знаци от метрологичен контрол:

- Знакът за одобрен тип (марка за залепване) се поставя до табелката с технически данни;
- Знакът за първоначална проверка (марка за залепване) се поставя до знака за одобрен тип.

ВЯРНО С ОРИГИНАЛА

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ДОКУМЕНТ 6.2

INSTITUT „PRÜFFELD FÜR ELEKTRISCHE HOCHLEISTUNGSTECHNIK" GMBH

IPH BERLIN

Independent, accredited testing station · Member laboratory of STL and LOVAG

TYPE TEST REPORT

NO. 1416.0004.4.012

CLIENT

Siemens Sanayi ve Ticaret A. Ş.
Power Transmission and Distribution (PTD)
Yakacik Yolu No: 111
81430 Kartal-ISTANBUL (TURKEY)

MANUFACTURER

ALCE Elektrik Sanayi ve Ticaret A. Ş.

TEST OBJECT

Indoor medium voltage single-pole cast-resin voltage transformer

TYPE

4MR12 AYC

MANUFACTURING NO.

03/57159

RATED CHARACTERISTICS GIVEN BY THE CLIENT

Rated insulation level	12/28/75	kV
Rated primary voltage A-N	10000/√3	V
Rated secondary voltage a-n	100/√3	V
Rated secondary voltage da-dn	100/3	V
Rated frequency	50 - 60	Hz
Rated output	50/45	VA
Accuracy class	0.5/3P	
Thermal limiting output	4/4	A

NORMATIVE DOCUMENT

IEC 60044-2: 1997 + A1: 2000 + A2: 2002

RANGE OF TESTS PERFORMED

- Lightning impulse test (type test)
  - Routine test after the lightning impulse test
- Short-circuit withstand capability test (type test)
  - Routine tests after the short-circuit withstand capability test
- Temperature-rise test (type test)
- Determination of errors (type test)

DATE OF TEST

26 January to 12 February 2004

TEST RESULT

The test object has PASSED the above-mentioned type tests performed at 50 Hz.

На основание чл.36а ал.3 от ЗОП

Berlin, 8 April 2004

Independent test laboratory, accredited by Deutsche Akkreditierungsstelle Technik (DATech) e.V. in the fields of h.v. apparatus and switchgear, power cables and power cable accessories, l.v. apparatus and switchgear, installation equipment and switching and control equipment

Deutscher Akkreditierungs Rat DAR

DAT - P - 019/92

Contents

ВЯРНО С ОРИГИНАЛА

МИГ 23 ЕООД СОФИЯ MIG 23 LTD

This test document consists of 39 sheets.

Distribution

Copies Nos. 1 and 2 in English: Copy No. 1 ALCE Elektrik Sanayi ve Ticaret A. Ş.

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1. Present at the test

Mr.	Staritz	IPH test engineer in charge
Mrs.	Hauschild	IPH test engineer
Mr.	Wittwer	IPH test engineer
Dr.	Wachholz	IPH test engineer
Mr.	Çiftçioğlu	ALCE Elektrik Sanayi ve Ticaret A. Ş.
Mr.	Yilmaz	ALCE Elektrik Sanayi ve Ticaret A. Ş.

2. Test performed

- Lightning impulse test (type test)
  - Routine test after the lightning impulse test
- Short-circuit withstand capability test (type test)
  - Routine tests after the short-circuit withstand capability test
- Temperature-rise test (type test)
- Determination of errors (type test)

3. Identity of the test object

3.1 Technical data and characteristics

The technical data and characteristics of the test object are defined by the following parameters and specified by the client.

Test object:	Indoor medium voltage single-pole cast-resin voltage transformer	
Type:	4MR12 AYC	
Manufacturer:	ALCE Elektrik Sanayi ve Ticaret A. Ş.	
Serial No.:	03/57159	
Year of manufacture:	2003	
Rated characteristics:	Rated primary voltage A-N	10000/√3 V
	Rated secondary voltage a-n	100/√3 V
	Rated secondary voltage da-dn	100/3 V
	Rated output	50/45 VA
	Accuracy class	0.5/3P
	Thermal limiting output	4/4 A
	Rated frequency	50 - 60 Hz
	Rated voltage factor	1.9 Un (8 h)
	Rated insulation level	
	Highest voltage for equipment	12 kV
	Rated power-frequency withstand voltage	28 kV
	Rated lightning impulse withstand voltage	75 kV
	Duration of short-circuit	1 s
Characteristics:	Class of insulating material	E
	Dimensions	See Sheet 39

3.2 Identity documents

The manufacturer confirms that the test object has been manufactured in compliance with the drawings given in this document. IPH did not verify this compliance in detail.
The identity of the test object is fixed by the following drawings and data submitted by the client:

Name of drawing	Drawing No.	Date of drawing	Author	Notes
4MR12 Block type voltage transformer	417	13.01.2004	ALCE	Sheet 39

ВЯРНО С ОРИГИНАЛА

СОФИЯ MIG 23 LTD

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4. Lightning impulse test

4.1 Test laboratory

High-voltage test laboratory, high-voltage test hall 2

4.2 Normative document

IEC 60044-2: 1997 + A1: 2000 + A2: 2002, Sub-clause 8.3.2

4.3 Required test parameters

Lightning impulse voltage 1.2/50 μs	75 kV	Peak value
Polarity		Positive and negative
Impulse sequence	1 impulse	Full wave at approx. 50 % of test voltage (reference impulse)
	15 impulses	Full wave at 100 % of test voltage
Atmospheric correction		Without

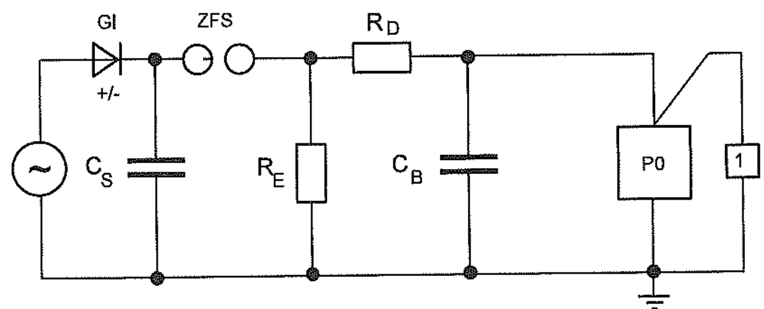
4.4 Test arrangement

Voltage application was between the high-voltage terminal of the primary winding and the earth-sided terminal of this winding. Both terminals of the secondary windings were directly earthed. The earth-sided terminal of the primary winding was connected over a shunt with the test earth in order to obtain an additional measuring quantity (current from this point to earth). This was useful for the assessment of the impulses ranging between 50 and 100 % of test voltage.

4.5 Test and measuring circuits

Technical data of test circuit

Impulse circuit:	Number of stages	n	=	2
	Impulse capacitance	C_S	=	70 nF
	Loading capacitance	C_B	=	1.5 nF
	Damping resistance	R_D	=	122 Ω
	Discharge resistance	R_E	=	1100 Ω



GI	Rectifier	C_B	Loading capacitance
C_S	Impulse capacitance	PO	Test object
ZFS	Spark gap	1	Voltage measurement
R_E	Parallel resistance		
R_D	Serial resistance		

Figure 1: Test and measuring circuit for the lightning impulse test

Technical data of measuring circuit

Measuring point	Measured quantity	Measuring sensor/device	Technical parameters
1	Test voltage	R divider of SMR 10/770 type (TuRD) with digital measuring instrument of DMI 551 type (Haefely) and TDS 220 digital oscilloscope type (Tektronix)	Ratio 472.4

ВЯРНО С ОРИГИНАЛА

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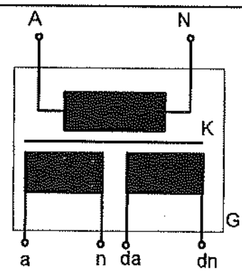
4.6 Test results

Front time of lightning impulse wave:	1.20 μs
Tail time of lightning impulse wave:	50.0 μs
Air temperature:	8.5 °C
Air pressure:	1007 hPa
Air humidity (relative):	45 %
Atmospheric correction of test voltage:	Without

Circuit diagram of the test object  			Test withstand voltage	Impulse	Result
Test No.	Voltage applied to	Earthed	kV		No. of impulses/ disruptive discharges
1004 0329 to 1004 0344	A	N, a, n, da, dn, G	+37.5 +75	50 % FW 100 % FW	1/0 [1)] 15/0 [1)]
1004 0345 to 1004 0360	A	N, a, n, da, dn, G	-37.5 -75	50 % FW 100 % FW	1/0 [1)] 15/0 [1)]

Notes:

1) The appendices include only the oscillograms of the reference impulse and of each first and last 100 % full wave (FW) impulse.

4.7 Routine test after the lightning impulse test

The routine tests to Sub-clause 7.2 of the normative document are part of the type test "lightning impulse test" and serve to assess the latter.

Test	Test parameters	Test results	
Interturn overvoltage test	Test voltage: 28 kV Test frequency: 150 Hz Duration of test: 40 s	No disruptive discharge	o.k.
Partial discharge (PD) measurement	Procedure B Prestress duration: 60 s Measuring voltage (points 1 to 3): $1.2 \times U_m$ = 14.4 kV U_m = 12 kV $1.2 \times U_m/\sqrt{3}$ = 8.8 kV Measuring time: 30 s	 PD 6 … 7 pC < 50 pC PD 5 pC < 50 pC PD 4 pC < 20 pC	o.k.
Power-frequency withstand test on the secondary windings	Test voltage: 3 kV Test frequency: 50 Hz Duration of test: 60 s	No disruptive discharge	o.k.
Power-frequency withstand test on the earth side of primary winding	Test voltage: 3 kV Test frequency: 50 Hz Duration of test: 60 s	No disruptive discharge	o.k.

ВЯРНО С ОРИГИНАЛА

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5. Short-circuit withstand capability test

5.1 Test laboratory

Low-voltage test laboratory, test room 4

5.2 Normative document

IEC 60044-2: 1997 + A1: 2000 + A2: 2002, Sub-clause 8.2

5.3 Required test parameters

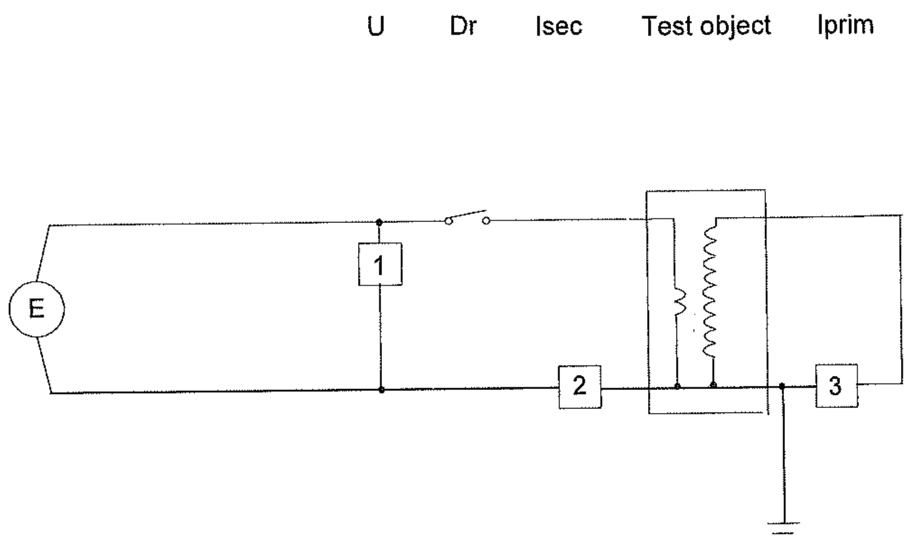
Test 1: Test voltage of 100/√3 V with supply on the secondary side a-n and short-circuit on the primary side. The duration of short-circuit was 1 s.

Test 2: Test voltage of 100/3 V with supply on the secondary side da-dn and short-circuit on the primary side. The duration of short-circuit was 1 s.

5.4 Test arrangement

The connection to the test current source was on the secondary terminals of the voltage transformer. The voltage transformer was short-circuited on its primary side.

5.5 Test and measuring circuits



E	Power supply		U	Test voltage measurement
Dr	Making switch		Isec	Current measurement, secondary side
1 - 3	Measuring points		Iprim	Current measurement, primary side

Figure 2: Test circuit for the test of short-circuit withstand capability of the voltage transformer

Technical data of measuring circuits

Test No.	Measuring point	Measured quantity	Measuring sensor/device	Technical parameters
404 0511	1	Voltage measurement	Divider	Ratio 199.3
and	2	Primary current	Shunt	2.406 A/V
404 0515	3	Secondary current	Shunt	241.2 A/V

5.6 Test results

Test requirement: Short-circuit withstand capability test

Condition of test object after test: Prestressed by previous tests

Connection of test object: By copper cable of 6 mm²

Ambient temperature: 18.5 °C

Test No.		404 0511	404 0515
Test voltage	V	58.3	34.4
Symmetrical short-circuit current, secondary side	A	105	121.9
Symmetrical short-circuit current, primary side	A	1.06	0.718
Duration of current flow	ms	1087	1090
Notes		1)	2)
Evaluation		o.k.	o.k.

Notes:

1) Power supply on secondary side to a-n, short-circuit on primary side
2) Power supply on secondary side to da-dn, short-circuit on primary side

o.k.: The test object is capable of properly carrying the short-circuit current.

5.7 Routine tests after the short-circuit withstand capability test

- **Determination of errors**

Terminals: a-n
Rated voltage: 10000/√3 V / 100/√3 V
Burden: 50 VA, power factor cos β = 0.8

At percentage of rated voltage	Difference between the errors measured before and after the circuit withstand capability test		Permissible errors for accuracy class 0.5	
	Voltage error	Phase displacement	Voltage error	Phase displacement
	%	Minutes	%	Minutes
80 %	0.02	-0.4	± 0.25	± 10
100 %	0.02	-0.5	± 0.25	± 10
120 %	0.02	-0.6	± 0.25	± 10

Notes:
The secondary winding da-dn was open.

Terminals: a-n
Rated voltage: 10000/√3 V / 100/√3 V
Burden: 50 VA, power factor cos β = 0.8

At percentage of rated voltage	Difference between the errors measured before and after the circuit withstand capability test		Permissible errors for accuracy class 0.5	
	Voltage error	Phase displacement	Voltage error	Phase displacement
	%	Minutes	%	Minutes
80 %	0.03	-0.2	± 0.25	± 10
100 %	0.02	-0.3	± 0.25	± 10
120 %	0.02	-0.2	± 0.25	± 10

Notes:
At secondary winding da-dn was 45 VA.

ВЯРНО С ОРИГИНАЛА

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• **Determination of errors (continued)**

Terminals: a-n
Rated voltage: 10000/√3 V / 100/√3 V
Burden: 12.5 VA, power factor cos β = 0.8

At percentage of rated voltage	Difference between the errors measured before and after the circuit withstand capability test		Permissible errors for accuracy class 0.5	
	Voltage error	Phase displacement	Voltage error	Phase displacement
	%	Minutes	%	Minutes
80 %	0.01	-0.2	± 0.25	± 10
100 %	0.01	-0.1	± 0.25	± 10
120 %	0.01	-0.2	± 0.25	± 10

Notes:
The secondary winding da-dn was open.

Terminals: a-n
Rated voltage: 10000/√3 V / 100/√3 V
Burden: 12.5 VA, power factor cos β = 0.8

At percentage of rated voltage	Difference between the errors measured before and after the circuit withstand capability test		Permissible errors for accuracy class 0.5	
	Voltage error	Phase displacement	Voltage error	Phase displacement
	%	Minutes	%	Minutes
80 %	0.02	-0.1	± 0.25	± 10
100 %	0.01	0.0	± 0.25	± 10
120 %	0.01	-0.1	± 0.25	± 10

Notes:
At secondary winding da-dn was 45 VA.

Determination of errors (continued)

Terminals: da-dn
Rated voltage: 10000/√3 V / 100/3 V
Burden: 45 VA, power factor cos β = 0.8

At percentage of rated voltage	Difference between the errors measured before and after the circuit withstand capability test		Permissible errors for accuracy class 3P	
	Voltage error	Phase displacement	Voltage error	Phase displacement
	%	Minutes	%	Minutes
5 %	0.00	-2.1	± 1.5	± 60
190 %	-0.13	1.8	± 1.5	± 60

Notes:
The secondary winding a-n was open.

Terminals: da-dn
Rated voltage: 10000/√3 V / 100/3 V
Burden: 45 VA, power factor cos β = 0.8

At percentage of rated voltage	Difference between the errors measured before and after the circuit withstand capability test		Permissible errors for accuracy class 3P	
	Voltage error	Phase displacement	Voltage error	Phase displacement
	%	Minutes	%	Minutes
5 %	0.04	-0.6	± 1.5	± 60
190 %	0.0	1.4	± 1.5	± 60

Notes:
At secondary winding a-n was 50 VA.

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Determination of errors (continued)

Terminals: da-dn
Rated voltage: 10000/√3 V / 100/3 V
Burden: 11.25 VA, power factor cos β = 0.8

At percentage of rated voltage	Difference between the errors measured before and after the circuit withstand capability test		Permissible errors for accuracy class 3P	
	Voltage error	Phase displacement	Voltage error	Phase displacement
	%	Minutes	%	Minutes
5 %	0.01	-0.2	± 1.5	± 60
190 %	0.03	0.8	± 1.5	± 60

Notes:
The secondary winding a-n was open.

Terminals: da - dn
Rated voltage: 10000/√3 V / 100/3 V
Burden: 11.25 VA, power factor cos β = 0.8

At percentage of rated voltage	Difference between the errors measured before and after the circuit withstand capability test		Permissible errors for accuracy class 3P	
	Voltage error	Phase displacement	Voltage error	Phase displacement
	%	Minutes	%	Minutes
5 %	0.00	0.3	± 1.5	± 60
190 %	0.25	-1.8	± 1.5	± 60

Notes:
At secondary winding a-n was 50 VA.

- **Dielectric routine test**

Test	Test parameters	Test results	
Interturn overvoltage test	Test voltage: 25.2 kV Test frequency: 150 Hz Duration of test: 40 s	No disruptive discharge	o.k.
Partial discharge (PD) measurement	Procedure B Prestress duration: 60 s Measuring voltage (points 1 to 3): $1.2 \times U_m$ = 14.4 kV U_m = 12 kV $1.2 \times U_m/\sqrt{3}$ = 8.8 kV Measuring time: 30 s	 PD 10 pC < 50 pC PD 4 pC < 50 pC PD 4 pC < 20 pC	o.k.
Power-frequency withstand test on the secondary windings	Test voltage: 2.7 kV Test frequency: 50 Hz Duration of test: 60 s	No disruptive discharge	o.k.
Power-frequency withstand test on the earth side of primary winding	Test voltage: 2.7 kV Test frequency: 50 Hz Duration of test: 60 s	No disruptive discharge	o.k.

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6. Temperature-rise test

6.1 Test laboratory

Low-voltage test laboratory, test room 4/5

6.2 Normative document

IEC 60044-2: 1997 + A1: 2000 + A2: 2002, Sub-clauses 8.1 and 13.6

6.3 Required test parameters

- Tests for the measuring winding

	1.2 times rated primary voltage	1.9 times rated primary voltage for 8 h	Thermal limiting output
Test voltage	1.2 * 10/√3 kV	1.9 * 10/√3 kV	10/√3 kV
Rated output at measuring winding a-n	50 VA	50 VA	4 A [1]
Rated output at residual voltage winding da-dn	45 VA	45 VA	- VA
Frequency	50 Hz	50 Hz	50 Hz

- Tests for the residual voltage winding

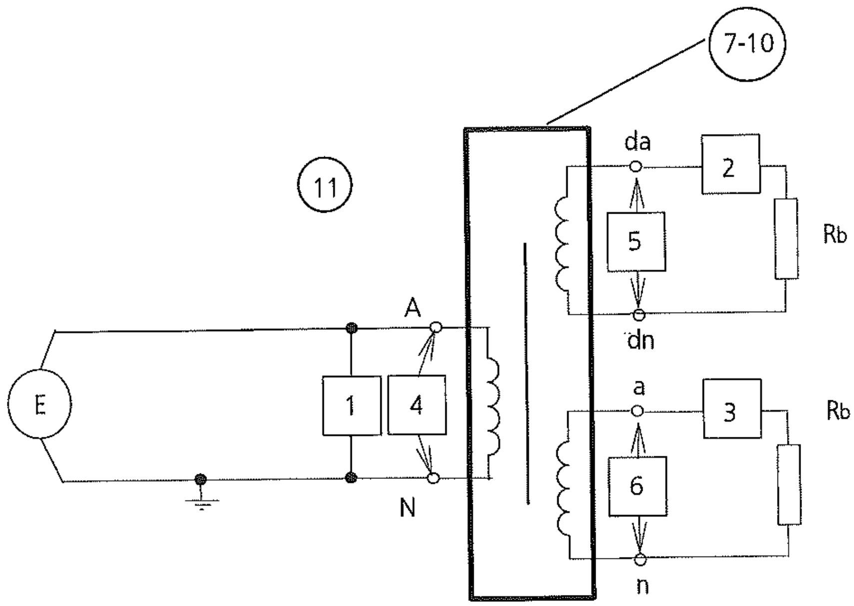
	1.2 times rated primary voltage	Thermal limiting output for 8 h
Test voltage	1.2 * 10/√3 kV	1.9 * 10/√3 kV
Rated output at measuring winding a-n	50 VA	50 VA
Rated output at residual voltage winding da-dn	- VA	4 A [1]
Frequency	50 Hz	50 Hz

Notes:
1) The thermal output limit given in "Ampere" is not in accordance with IEC 60044-2.

6.4 Test arrangement

The test object was set up in a room which was draught-free to a large extent. Voltage application was between the high-voltage terminal of the primary winding and the earth-sided terminal of this winding. The test object with its test arrangement is shown in Figure 7 on Sheet 33.

6.5 Test and measuring circuits



E	Power supply
1	Measurement of primary voltage
2 - 3	Current measurement on the secondary side
4 - 6	Resistance measurement
7 - 11	Temperature measurement
Rb	Burden

Figure 3: Test and measuring circuits

Technical data of measuring circuits

Measuring point	Measured quantity	Measuring sensor/device
1	Test voltage	Divider, digital display device
2 and 3	Secondary current	Digital display device
4 to 6	Winding resistance	Resistance measuring bridge
7 to 11	Temperature	Therm 5500-3 Constantan, constantan thermocouples

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6.6 Test results

The test voltage was 6930 V (50 Hz). This is equivalent to 1.2 times rated primary voltage of the transformer. The voltage transformers were tested at rated burden. Until the steady state temperature was reached.

Meas. point (Figure 3)	Designation of the part	Material	Permissible temperature-rise limit K	Measured final temperature at $\Delta T \leq 1 K/h$ °C	Final temperature rise (related to average ambient air temperature) K
4	Primary winding A-N	Cu wire	75	36.9	18.4
5	Secondary winding a-n	Cu wire	75	36.2	17.7
6	Secondary winding da-dn	Cu wire	75	37.0	18.5
7	Transformer case front	Insulating material	75	23.2	4.7
8	Transformer case left	Insulating material	75	22.9	4.4
9	Transformer case back	Insulating material	75	23.0	4.5
10	Transformer case right	Insulating material	75	22.9	4.4
11	Ambient air	Air	-	18.5	-

Class of insulation "E" allows a winding temperature-rise limit of 75 K at a maximum permissible ambient air temperature of 40 °C. The final winding temperature rise of 18.5 K is permissible for the class of insulation "E".

Test results (continued)

Afterwards the steady state temperature was reached, the test voltage was 10970 V (50 Hz). This is equivalent to 1.9 times rated primary voltage of the transformer. The voltage transformers were tested at rated burden for 8 hours.

Meas. point (Figure 3)	Designation of the part	Material	Permissible temperature-rise limit K	Measured final temperature at ΔT≤1K/h °C	Final temperature rise (related to average ambient air temperature) K
4	Primary winding A-N	Cu wire	75	49.8	30.7
5	Secondary winding a-n	Cu wire	75	51.1	32.0
6	Secondary winding da-dn	Cu wire	75	51.2	32.1
7	Transformer case front	Insulating material	75	30.5	11.4
8	Transformer case left	Insulating material	75	29.5	10.4
9	Transformer case back	Insulating material	75	30.2	11.1
10	Transformer case right	Insulating material	75	29.5	10.4
11	Ambient air	Air	-	19.1	-

Class of insulation "E" allows a winding temperature-rise limit of 75 K at a maximum permissible ambient air temperature of 40 °C. The final winding temperature rise of 32.1 K is permissible for the class of insulation "E".

Test results (continued)

Determination of the voltage transformer's winding temperature rise

The temperature rise θ of the voltage transformer winding was determined on the basis of the rise of winding resistance from the cold state to the steady state of temperature rise using the following formula given by DIN VDE 0532 Teil 2, Sub-clause 3.3 (transformers and reactors).

$$\theta_W = \frac{R_W}{R_k}\,(235 + \theta_k) - 235$$

Where:

- R_k Cold resistance of the winding at 17.5 °C
- R_W Warm resistance of the winding
- θ_k Cold temperature of winding
- θ_W Final temperature of the winding

The hot resistance of the secondary winding was calculated on the basis of the measurement of the cooling curve.

	1.2 times rated primary voltage	1.9 times rated primary voltage for 8 h
Primary voltage	6930 V	10970 V
Resistance of burden a-n	66.5 Ω	66.5 Ω
Current a-n	1.04 A	1.65 A
Resistance of burden da-dn	24.6 Ω	24.6 Ω
Current da-dn	1.62 A	2.57 A
Ambient air	18.5 °C	19.1 °C

1.2 times rated primary voltage	R_k Ω	R_W Ω	R_W/R_k	θ_W °C	θ K	Permissible K
Primary winding A-N	2600	2799	1.077	36.9	18.4	75
Secondary winding a-n	0.2163	0.2324	1.074	36.2	17.7	75
Secondary winding da-dn	0.1588	0.1710	1.077	37.0	18.5	75

1.9 times rated primary voltage	R_k Ω	R_W Ω	R_W/R_k	θ_W °C	θ K	Permissible K
Primary winding A-N	2600	2933	1.128	49.8	30.7	75
Secondary winding a-n	0.2163	0.2451	1.133	51.1	32.0	75
Secondary winding da-dn	0.1588	0.180	1.133	51.2	32.1	75

Test results (continued)

The temperature-rise test was performed with 5775 V (50Hz) and loaded with 4 A at winding a-n. Until the steady state temperature was reached.
This is equivalent to the rated primary voltage of the transformer. The resistance of burden a-n was 14.4 Ω, this is equivalent to the thermal limiting output The residual voltage winding da-dn was open.

Meas. point (Figure 3)	Designation of the part	Material	Permissible temperature-rise limit K	Measured final temperature at ΔT≤1K/h °C	Final temperature rise (related to average ambient air temperature) K
4	Primary winding A-N	Cu wire	75	45.3	26.6
5	Secondary winding a-n	Cu wire	75	45.3	26.6
6	Secondary winding da-dn	Cu wire	75	-	-
7	Transformer case front	Insulating material	75	25.4	6.7
8	Transformer case left	Insulating material	75	25.9	7.2
9	Transformer case back	Insulating material	75	25.3	6.6
10	Transformer case right	Insulating material	75	26.0	7.3
11	Ambient air	Air	-	18.7	-

Thermal limiting output	R_K Ω	R_W Ω	R_W/R_K	θ_W °C	θ K	Permissible K
Primary winding A-N	2600	2885	1.110	45.3	26.6	75
Secondary winding a-n	0.2163	0.240	1.110	45.3	26.6	75

Class of insulation "E" allows a winding temperature-rise limit of 75 K at a maximum permissible ambient air temperature of 40 °C. The final winding temperature rise of 26.6 K is permissible for the class of insulation "E".

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Test results (continued)

The test voltage was 10970 V (50 Hz). This is equivalent to 1.9 times rated primary voltage of the transformer. The resistance of burden da-dn was 8.3 Ω, this is equivalent to the thermal limiting output (test current residual voltage winding = 7.6 A for 8 hours). The measuring winding a-n was tested at rated burden.

Meas. point (Figure 3)	Designation of the part	Material	Permissible temperature-rise limit K	Measured final temperature at $\Delta T \leq 1 K/h$ °C	Final temperature rise (related to average ambient air temperature) K
4	Primary winding A-N	Cu wire	75	76.8	57.1
5	Secondary winding a-n	Cu wire	75	91.7	72.0
6	Secondary winding da-dn	Cu wire	75	76.6	56.9
7	Transformer case front	Insulating material	75	36.4	16.7
8	Transformer case left	Insulating material	75	36.4	16.7
9	Transformer case back	Insulating material	75	35.5	15.8
10	Transformer case right	Insulating material	75	37.2	17.5
11	Ambient air	Air	-	19.7	-

Notes: Before the residual voltage winding was subjected to thermal limiting output, only the measuring winding was tested at 1.2 times rated voltage and at rated burden until the thermal steady-state was reached.

Thermal limiting output	R_k Ω	R_w Ω	R_w/R_k	θ_w °C	θ K	**Permissible** K
Primary winding A-N	2600	3210	1.235	76.8	57.1	75
Secondary winding a-n	0.2163	0.280	1.294	91.7	72.0	75
Secondary winding da-dn	0.1588	0.196	1.234	76.6	56.9	75

Class of insulation "E" allows a winding temperature-rise limit of 75 K at a maximum permissible ambient air temperature of 40 °C. The final winding temperature rise of measuring winding of 72.0 K is permissible for the class of insulation "E".

7. Determination of errors

7.1 Test laboratory

Low-voltage test laboratory, test room 3

7.2 Normative document

IEC 60044-2: 1997 + A1: 2000 + A2: 2002, Sub-clauses 12.2 and 13.1

7.3 Required test parameters

Residual voltage winding: The voltage errors shall be determined at 5% and 190% of rated voltage and 25% and 100% of rated burden.

Measuring winding: The voltage errors shall be determined at 80%, 100% and 120% of rated voltage and 25% and 100% of rated burden with a power factor of cos β = 0.8.

The test frequency shall equal the rated frequency and be 50 Hz.

Maximum permissible error limits of voltage transformers for measuring and protecting purposes:

Accuracy class	Voltage error at percentage of rated voltage			Phase displacement at percentage of rated voltage		
	%			Minutes		
	80	100	120	80	100	120
0.5	± 0.5			± 20		
	5	190		5	190	
3P	± 3			± 120		

7.4 Test arrangement

To IEC 60044-2: 1997, Sub-clauses 12.2 and 13.1

The test object was connected via a matching transformer to an instrument transformer measuring device including a measurement standard transformer. An oscillographic null detector was used for the visual check of the comparison. The test object was subjected to the prescribed test conditions by connection of a standard burden.

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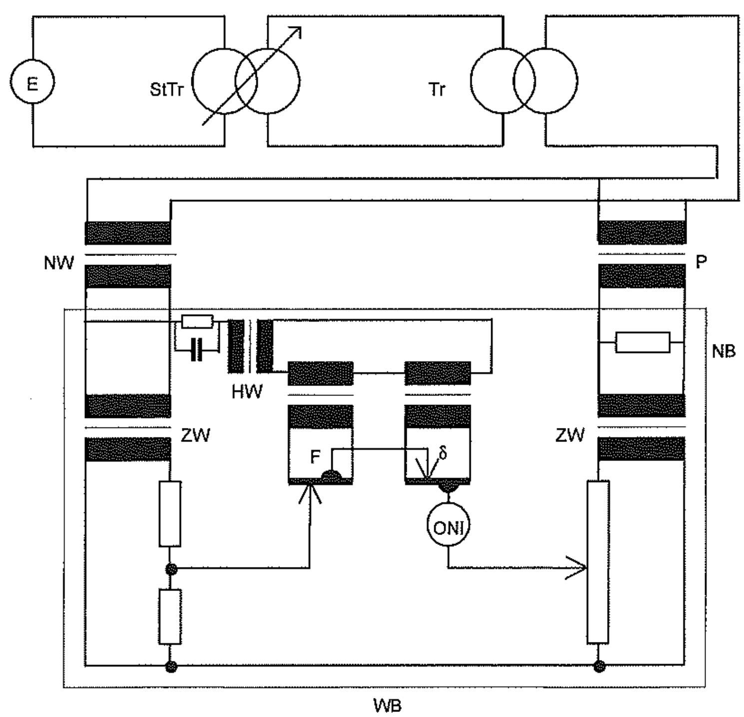
7.5 Test and measuring circuits

Technical data of test and measuring circuits

Device	Type	Technical data
Standard voltage transformer NW	UZON 30 (TuR Dresden)	Ratio 5 ... 30 kV / 110 and 100 V Class 0.2, 30 VA
Standard burden of voltage transformer NB	(AEG)	50 Hz, 1.25 ... 300 VA, ß = 0.8/1
Instrument transformer measuring bridge I	Hohle type (AEG)	16 $^{2}/_{3}$, 50 and 60 Hz
Matching transformer to the bridge ZW	Hohle type (AEG)	Matching transformer for 1, 2, 5, 10 A
Null detector ONI	OIK (MWB)	20 mm / µV



E Power supply
StTr Matching transformer

Figure 4: Test and measuring circuit for the determination of errors

7.6 Test results

Terminals: a-n
Rated voltage: 10000/√3 V / 100/√3 V
Burden: 50 VA, power factor cos β = 0.8

At percentage of rated voltage	Errors		Permissible difference for accuracy class 0.5		Result
	Voltage error	Phase displacement	Voltage error	Phase displacement	
%	%	Minutes	%	Minutes	
80	-0.19	3.2	± 0.5	± 20	o.k.
100	-0.19	3.2	± 0.5	± 20	o.k.
120	-0.20	4.0	± 0.5	± 20	o.k.

Notes:
At secondary winding da-dn was 11.25 VA.

Terminals: a-n
Rated voltage: 10000/√3 V / 100/√3 V
Burden: 50 VA, power factor cos β = 0.8

At percentage of rated voltage	Errors		Permissible difference for accuracy class 0.5		Result
	Voltage error	Phase displacement	Voltage error	Phase displacement	
%	%	Minutes	%	Minutes	
80	-0.45	-5.1	± 0.5	± 20	o.k.
100	-0.46	-5.1	± 0.5	± 20	o.k.
120	-0.47	-4.5	± 0.5	± 20	o.k.

Notes:
At secondary winding da-dn was 45 VA.

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Test results (continued)

Terminals: a-n
Rated voltage: 10000/√3 V / 100/√3 V
Burden: 12.5 VA, power factor cos β = 0.8

At percentage of rated voltage	Errors		Permissible difference for accuracy class 0.5		Result
	Voltage error	Phase displacement	Voltage error	Phase displacement	
%	%	Minutes	%	Minutes	
80	0.41	-1.0	± 0.5	± 20	o.k.
100	0.40	-0.9	± 0.5	± 20	o.k.
120	0.39	-0.3	± 0.5	± 20	o.k.

Notes:
At secondary winding da-dn was 11.25 VA.

Terminals: a-n
Rated voltage: 10000/√3 V / 100/√3 V
Burden: 12.5 VA, power factor cos β = 0.8

At percentage of rated voltage	Errors		Permissible difference for accuracy class 0.5		Result
	Voltage error	Phase displacement	Voltage error	Phase displacement	
%	%	Minutes	%	Minutes	
80	0.14	-9.5	± 0.5	± 20	o.k.
100	0.13	-9.3	± 0.5	± 20	o.k.
120	0.12	-8.8	± 0.5	± 20	o.k.

Notes:
At secondary winding da-dn was 45 VA.

Test results (continued)

Terminals: da-dn
Rated voltage: 10000/√3 V / 100/3 V
Burden: 45 VA, power factor cos β = 0.8

At percentage of rated voltage	Errors		Permissible difference for accuracy class 3P		Result
	Voltage error	Phase displacement	Voltage error	Phase displacement	
%	%	Minutes	%	Minutes	
5	0.45	11.2	± 3	± 120	o.k.
190	0.16	21.6	± 3	± 120	o.k.

Notes:
The secondary winding a-n was open.

Terminals: da-dn
Rated voltage: 10000/√3 V / 100/3 V
Burden: 45 VA, power factor cos β = 0.8

At percentage of rated voltage	Errors		Permissible difference for accuracy class 3P		Result
	Voltage error	Phase displacement	Voltage error	Phase displacement	
%	%	Minutes	%	Minutes	
5	0.02	-1.5	± 3	± 120	o.k.
190	-0.25	9.0	± 3	± 120	o.k.

Notes:
At secondary winding a-n was 50 VA.

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Test results (continued)

Terminals: da-dn
Rated voltage: 10000/√3 V / 100/3 V
Burden: 11.25 VA, power factor cos β = 0.8

At percentage of rated voltage	Errors		Permissible difference for accuracy class 3P		Result
	Voltage error	Phase displacement	Voltage error	Phase displacement	
%	%	Minutes	%	Minutes	
5	1.2	3.3	± 3	± 120	o.k.
190	0.88	13.8	± 3	± 120	o.k.

Notes:
The secondary winding a-n was open.

Terminals: da-dn
Rated voltage: 10000/√3 V / 100/3 V
Burden: 11.25 VA, power factor cos β = 0.8

At percentage of rated voltage	Errors		Permissible difference for accuracy class 3P		Result
	Voltage error	Phase displacement	Voltage error	Phase displacement	
%	%	Minutes	%	Minutes	
5	0.81	-10.0	± 3	± 120	o.k.
190	1.0	1.0	± 3	± 120	o.k.

Notes:
At secondary winding a-n was 50 VA.

8. Evaluation of all tests

- **Lightning impulse test (type test)**

The voltage transformer was tested at 75-kV lightning impulse voltage on the primary side. There were no disruptive discharges and the recorded voltage curve did not present any significant variation between the recordings of reference impulse and full impulse level which could indicate an insulation failure.

All routine tests were repeated without errors.

The requirements specified by IEC 60044-2: 1997, Sub-clause 8.3.2 have been met.

The voltage transformer has PASSED the type test.

- **Short-circuit withstand capability test (type test)**

After test the voltage transformer was not visibly damaged.

The errors determined after test differed from those recorded before test by less than half the limits of error appropriate to its accuracy class.

During the dielectric tests done after the short-circuit withstand capability test, no disruptive discharge occurred.

The requirements specified by IEC 60044-2: 1997, Sub-clause 8.2 have been met.

The voltage transformer has PASSED the type test.

- **Temperature-rise test (type test)**

Class of insulation "E" allows a winding temperature-rise limit of 75 K at a maximum permissible ambient air temperature of 40 °C. The primary winding reached a temperature rise of 57.1 K. The secondary winding a-n reached a temperature rise of 72.0 K. The secondary winding da-dn reached a temperature rise of 56.9 K.

The final temperature-rise values of the windings determined at rated voltage and with the application of limit burden to the secondary winding are permissible for this class of insulation.
The temperature-rise limit of 75 K was also not exceeded when the test object's secondary windings were subjected to thermal limiting output.

The requirements specified by IEC 60044-2: 1997, Sub-clause 8.1 have been met.

The voltage transformer has PASSED the type test.

- **Determination of errors (type test)**

The voltage errors and phase displacements were within the permissible error limits of accuracy class 0.5 respectively 3P.

The requirements specified by IEC 60044-2: 1997, Sub-clauses 12.2 and 13.1 have been met.

The voltage transformer has PASSED the type test.

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9. Appendices

9.1 Photos

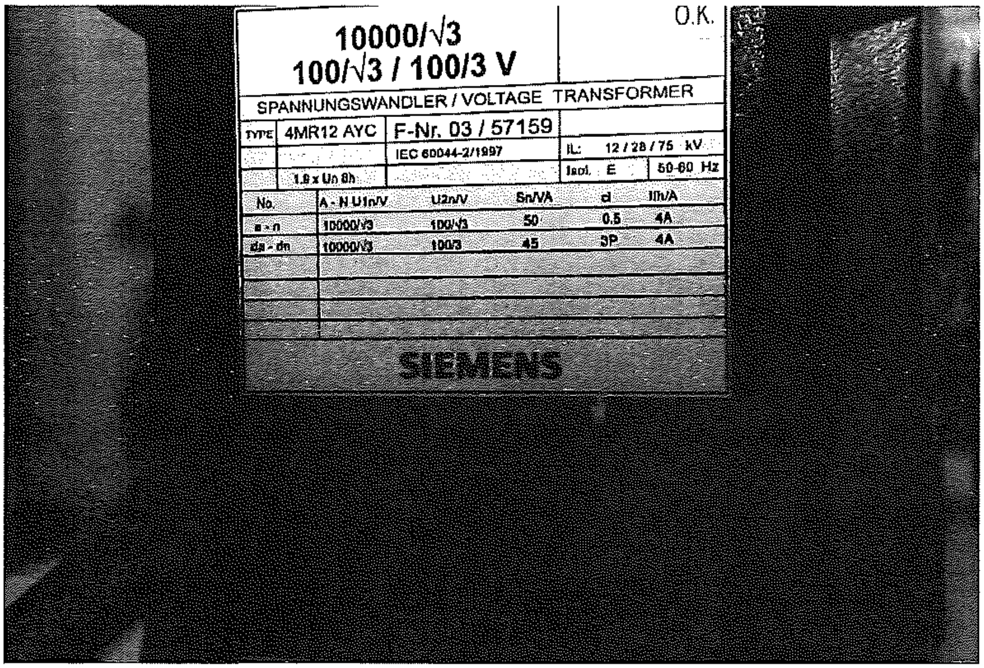

Figure 5: Nameplate of the test object

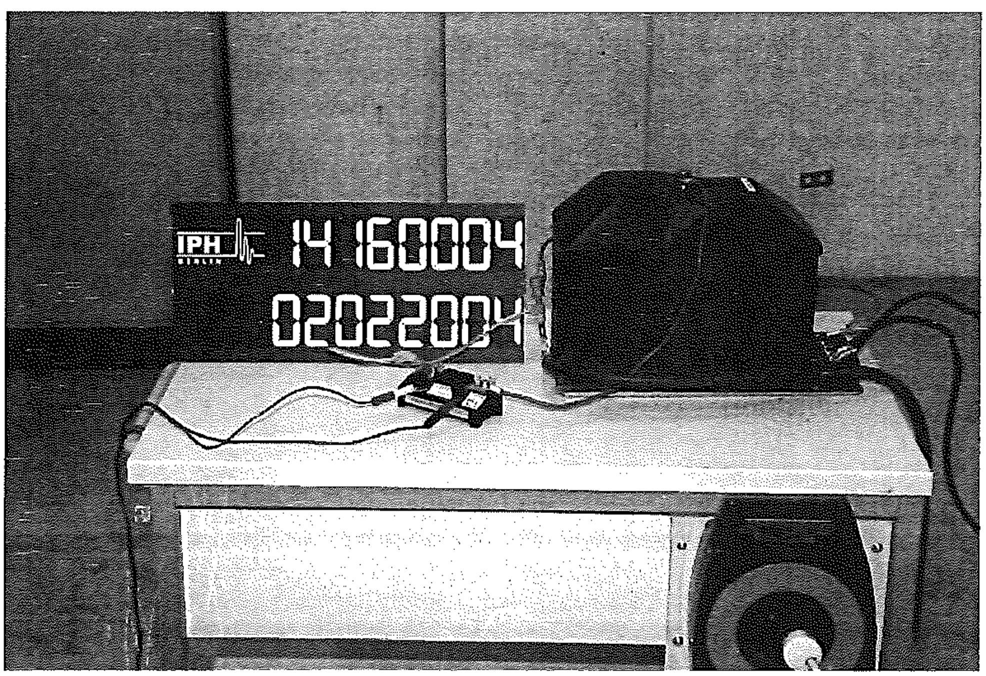

Figure 6: Test object after the short-circuit test

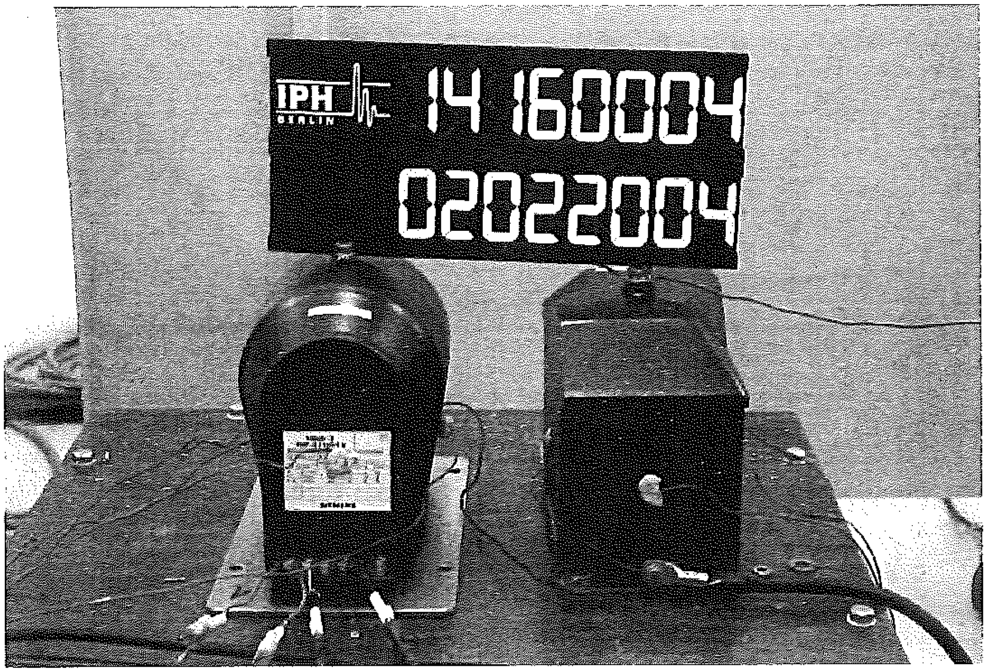

Figure 7: Test object during the temperature-rise test (right sample)

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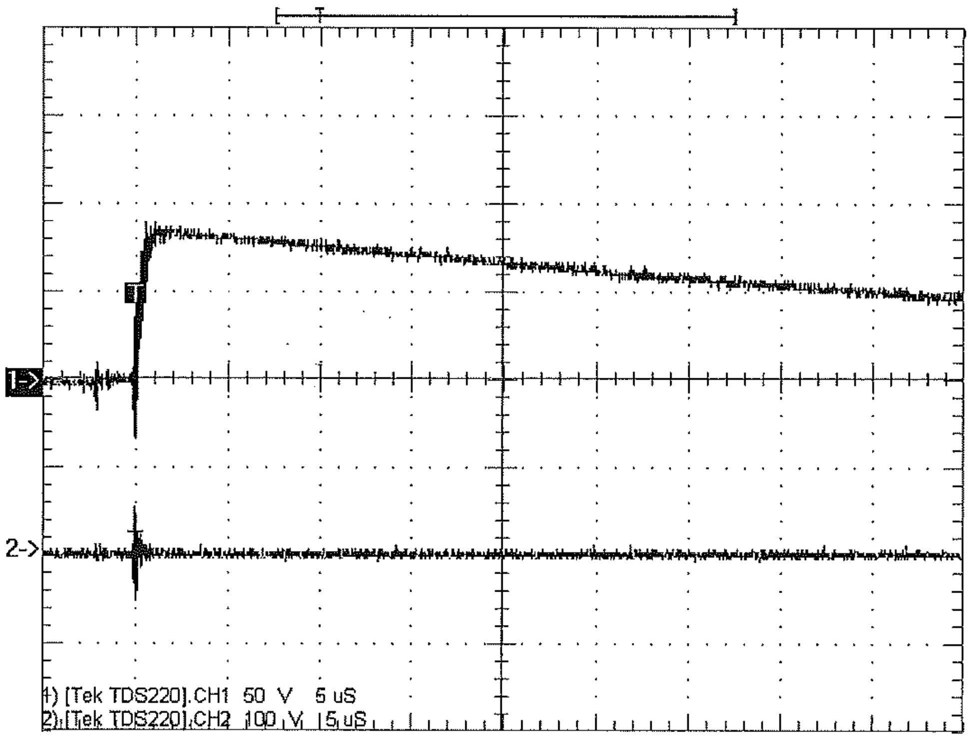
9.2 Oscillograms



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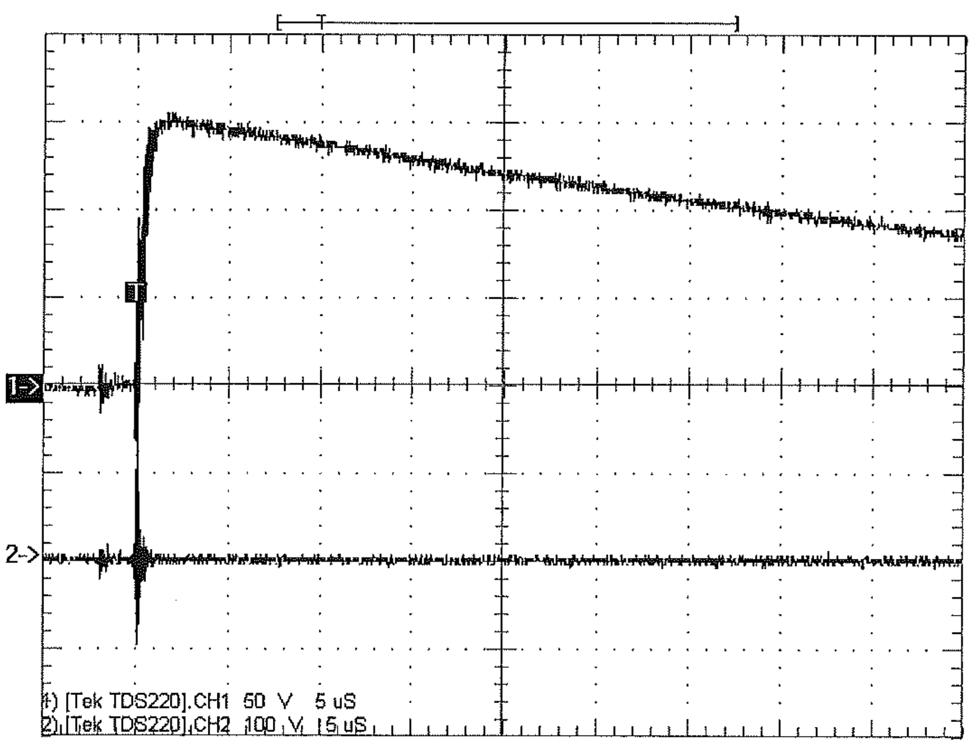

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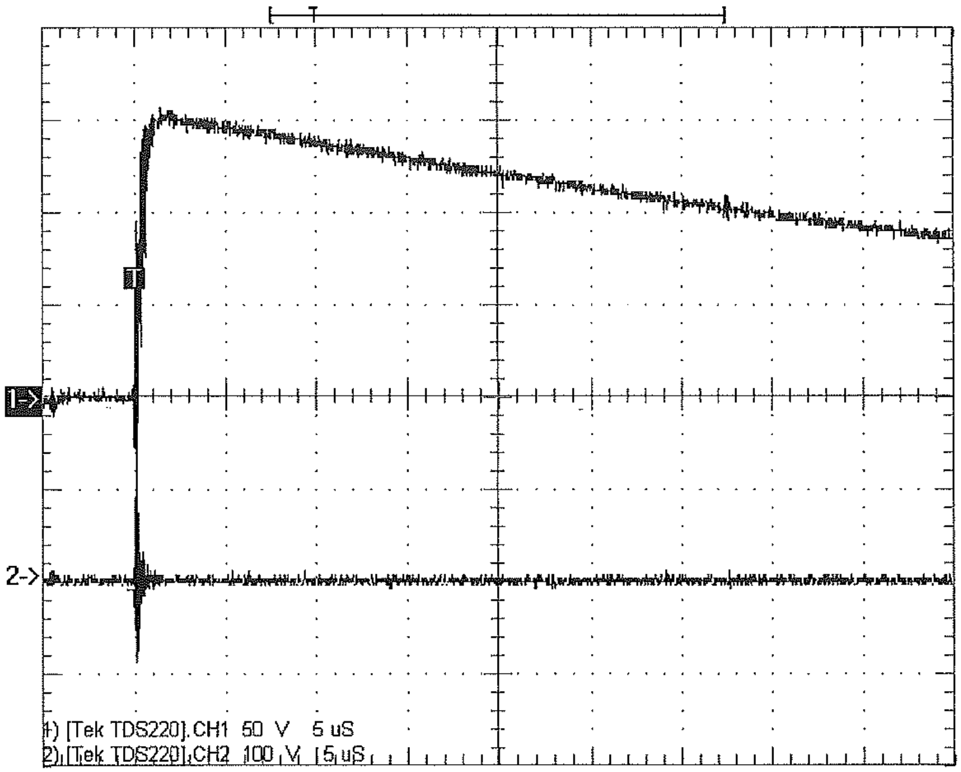

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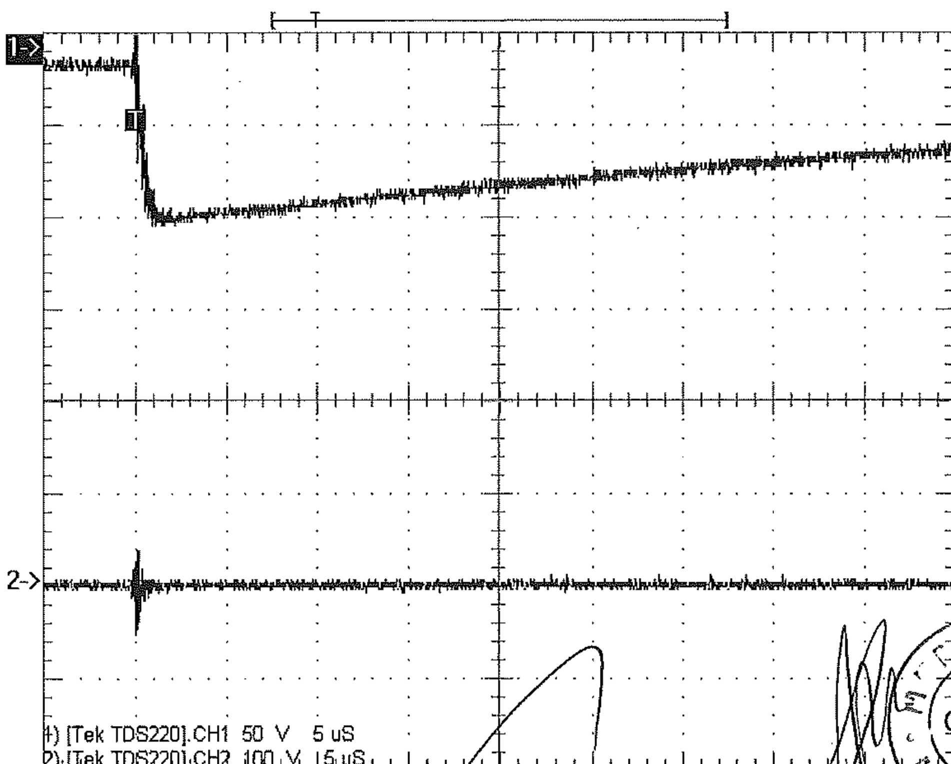

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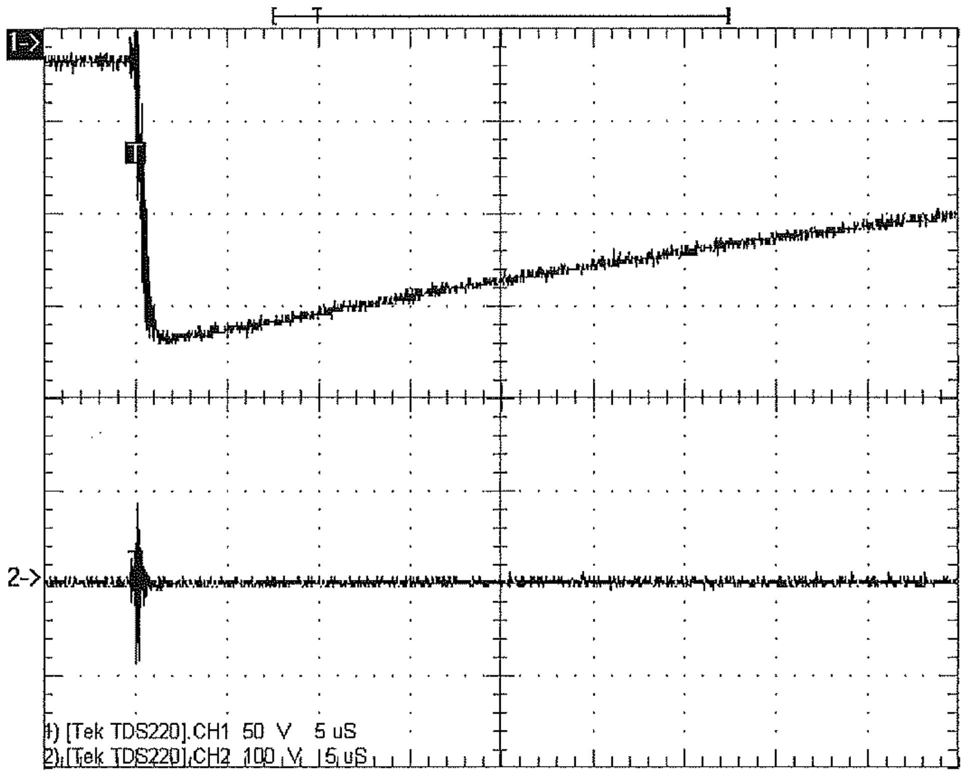

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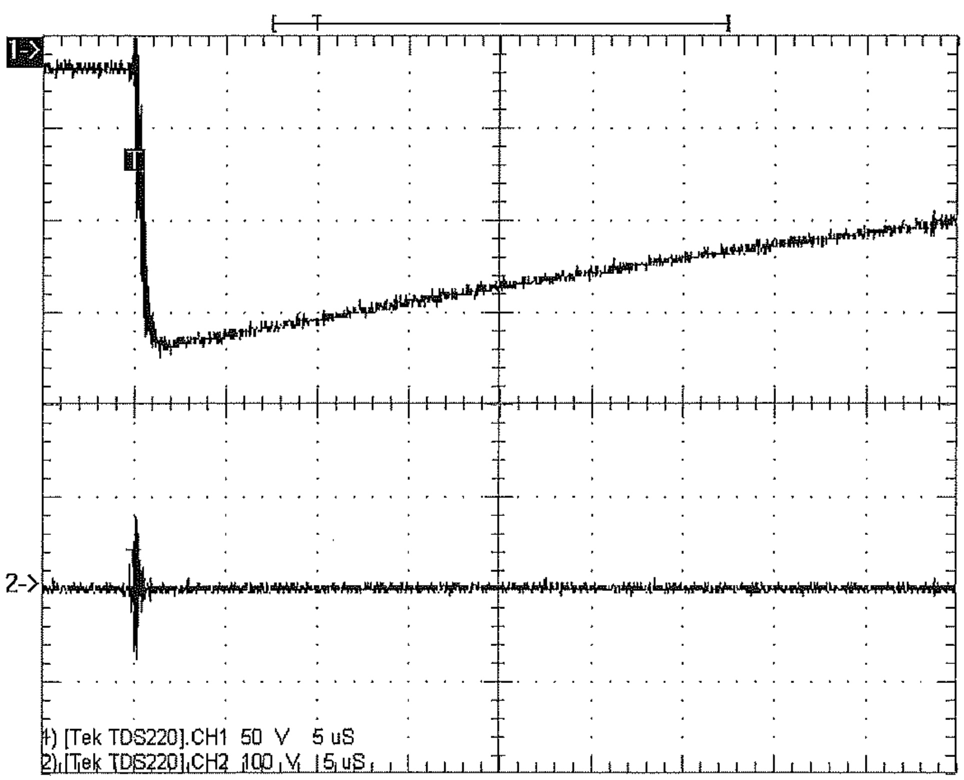
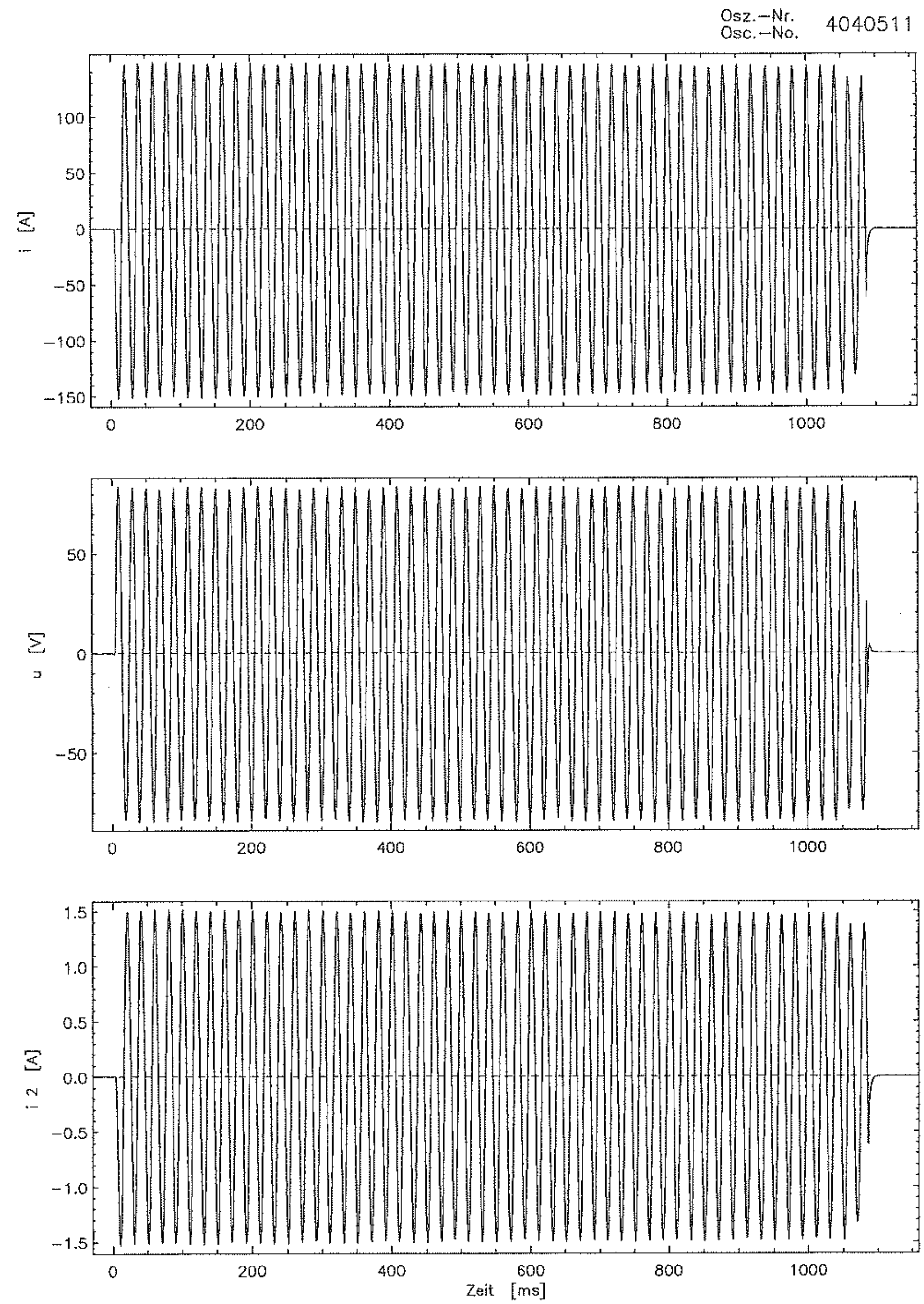


Test No. 1004 0360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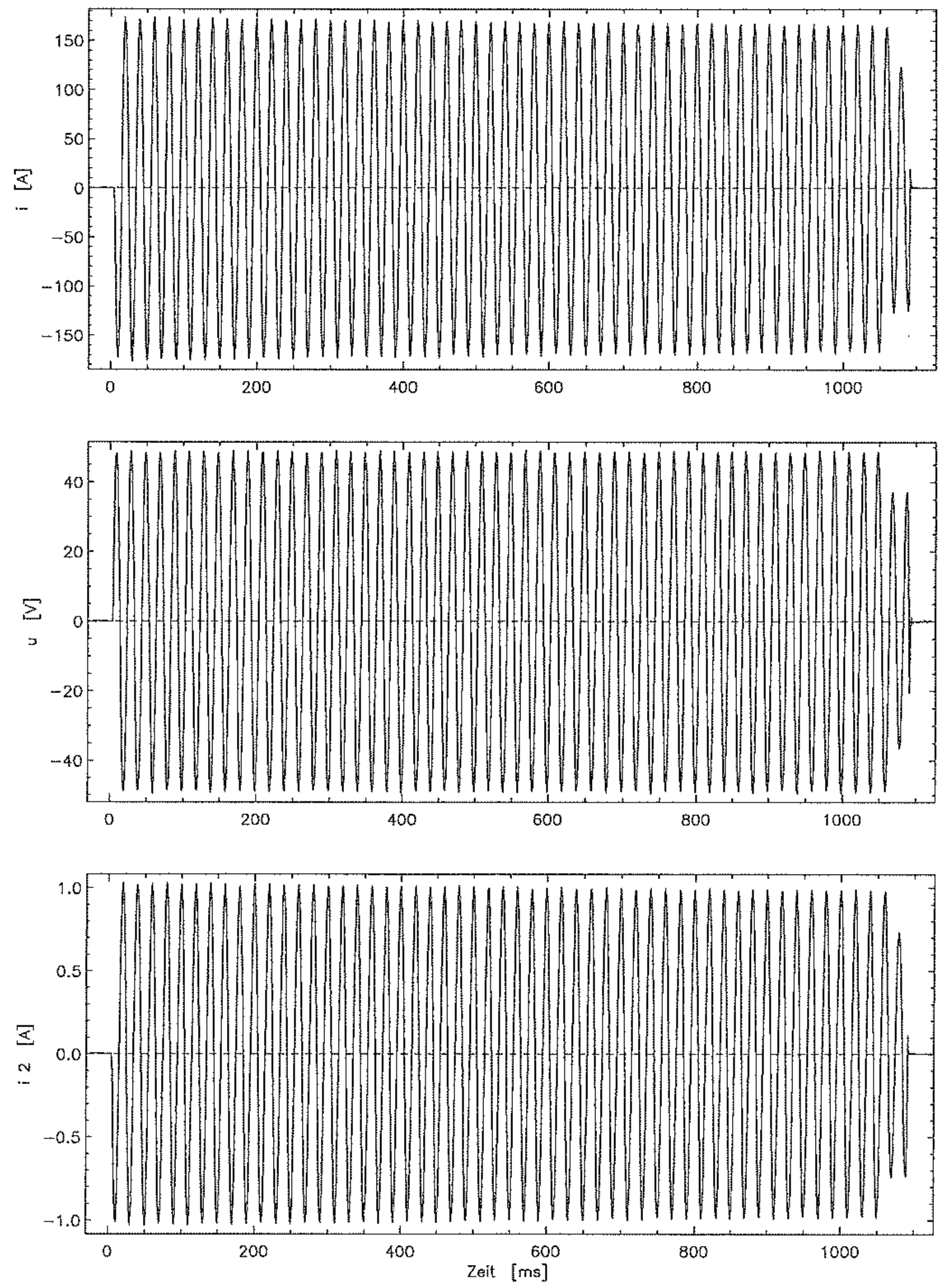
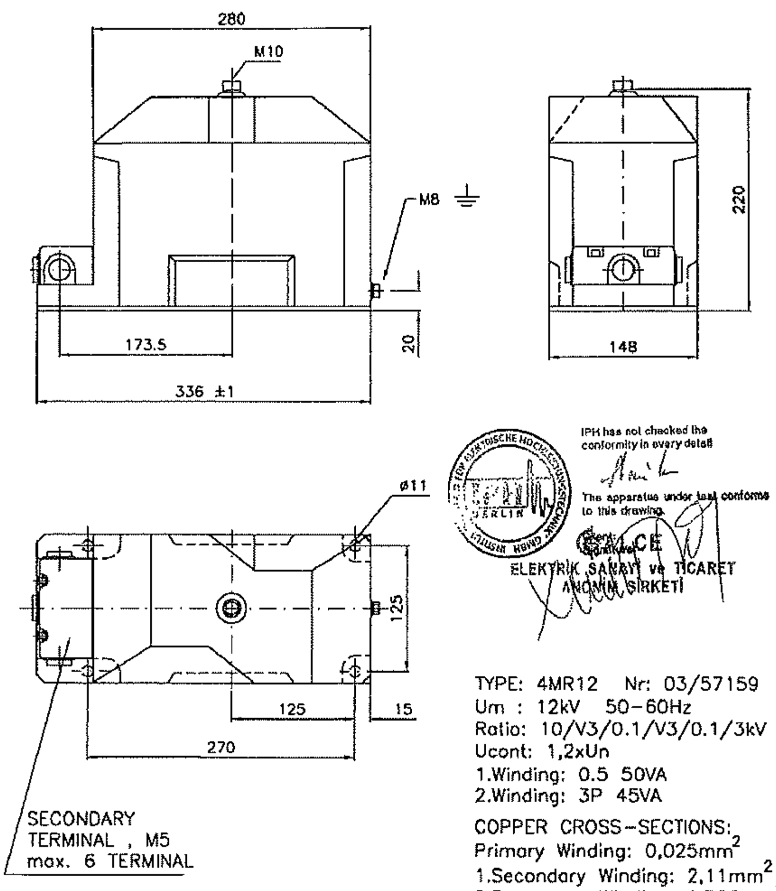
Osz.–Nr.
Osc.–No. 4040515



9.3 Drawing



IPH has not checked the conformity in every detail

The apparatus under test conforms to this drawing.

ALCE ELEKTRIK SANAYI ve TICARET ANONIM SIRKETI

TYPE: 4MR12 Nr: 03/57159
Um : 12kV 50-60Hz
Ratio: 10/V3/0.1/V3/0.1/3kV
Ucont: 1,2xUn
1.Winding: 0.5 50VA
2.Winding: 3P 45VA
COPPER CROSS-SECTIONS:
Primary Winding: 0,025mm^2
1.Secondary Winding: 2,11mm^2
2.Secondary Winding: 1,766mm^2
I_2 sec: 4A 1,9xUn (8h)

QTY	DESCRIPTION	POS	DIMENSIONS	WEIGHT	PART OR DIN NO.	MATERIAL
						Epoxy-resin

NO	DATE	NAME	MODIFICATION

TOLERANCES DIN 7168 g	4MR12 BLOCK TYPE VOLTAGE TRANSFORMER	PLATE CODE	417
SCALE 1:5	REPLACES THE DRAWING NO.	DR'N	13-01-04
ALCE	OLCU TRAFO	CH'D	
		APP'D	13.01.04
C.C		INFORMATION	

ВЯРНО С ОРИГИНАЛА

23 EOOD СОФИЯ MIG 23 LTD

000306

ДОКУМЕНТ 6.3

Deutsche Akkreditierungsstelle GmbH
(Германски акредитационен орган ГмбХ)

Упълномощен в съответствие с Подраздел 1 на Раздел 8 на AkkStelleG във връзка с Подраздел 1 на Раздел 1 на AkkStelleG
Подписал Многостранните споразумения на EA, ILAF и IAF за взаимно признаване

Акредитация

Deutsche Akkreditierungsstelle GmbH (Германски акредитационен орган ГмбХ) удостоверява, че изпитвателната лаборатория

IPH Institut "Prüffeld für elektrische Hochleistungstechnik" GmbH
Landsberger Alee 378 A, 12681 Berlin
(Институт ИПХ „Прюфелд фюр Електрише Хохлайщунгстехник" ГмбХ
Алея Ландсбергер 378 А, 12681 Берлин)

е компетентна по условията на DIN EN ISO/IEC 17025:2005 да извършва изпитания в следните области:

Апаратура и компоненти за високо напрежение
Апаратура и компоненти за ниско напрежение
Комутационна, защитна и управляваща апаратура
Кабели и кабелни аксесоари за високо, средно и ниско напрежение

Акредитационният сертификат важи във връзка с известието за акредитация от 11.11.2015 г. с акредитационен номер D-PL-12107-01 и е валиден до 10.11.2020 г. Той се състои от заглавния лист, обратната страна на заглавния лист и следващия анекс с общо 42 страници.

Регистрационен номер на сертификата: **D-PL-12107-01-00**

Франкфурт на Майн, 11.11.2015 г.

/подпис – не се чете/
инж. Ралф Егнер
Ръководител отделение

Този документ е превод. Определящата версия е оригиналният германски акредитационен сертификат.

Вж. забележките на обратната страна на листа.

ВЯРНО С ОРИГИНАЛА

МИГ 23 ЕООД СОФИЯ MIG 23 LTD

000307

Deutsche Akkreditierungsstelle GmbH
(Германски акредитационен орган ГмбХ)

Офис Берлин
Шпителмаркт 10
10117 Берлин

Офис Франкфурт на Майн
Еуропа алее 52
60327 Франкфурт на Майн

Офис Брауншвайг
Бундесалее 100
38116 Брауншвайг

Публикуването на извадки от акредитационния сертификат подлежи на предварително писмено одобрение от Deutsche Akkreditierungsstelle GmbH (DAkkS). Изключение е непромененaта форма на отделни разпространения на заглавния лист от споменатия на обратната страна на листа орган за оценка на съответствието.

Не трябва да се създава впечатление, че акредикацията е разширена до области извън обхвата на акредитация , удостоверен от DAkkS.

Акредитацията е дадена съгласно Закона за акредитационния орган (AkkStelleG) от 31 юли 2009 г. (Вестник за федерални закони I стр. 2625) и РЕГЛАМЕНТ (ЕО) № 765/2008 на Европейския парламент и на Съвета от 9 юли 2008 г. за определяне на изискванията за акредитация и надзор на пазара във връзка с предлагането на пазара на продукти (Официален вестник на Европейския съюз L 218 от 9 юли 2008 г., стр. 30). DAkkS е подписал Многостранното споразумение за взаимно признаване на европейското сътрудничество за акредитация (EA), Международния акредитационен форум (IAF) и Международното сътрудничество за акредитиране на лаборатории (ILAC). Подписалите тези споразумения признават взаимно своите акредитации.

Текущото състояние на членството може да бъде намерено на следните уебсайтове:
EA: www.european-accreditation.org
ILAC: www. ilac.org
IAF: www.iaf.nu

ВЯРНО С ОРИГИНАЛА

МИГ 23 ЕООД СОФИЯ MIG 23 LTD

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DAkkS
Deutsche
Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH

Entrusted according to Section 8 subsection1 AkkStelleG in connection with Section 1 subsection 1 AkkStelleGBV
Signatory to the Multilateral Agreements of
EA, ILAC and IAF for Mutual Recognition

Accreditation

The Deutsche Akkreditierungsstelle GmbH attests that the testing laboratory

IPH Institut "Prüffeld für elektrische Hochleistungstechnik" GmbH
Landsberger Allee 378 A, 12681 Berlin

is competent under the terms of DIN EN ISO/IEC 17025:2005 to carry out tests in the following fields:

High-voltage equipment and components
Low-voltage equipment and components
Installation, switching, control and protective equipment
High-voltage, medium-voltage and low-voltage cables and their accessories

The accreditation certificate shall only apply in connection with the notice of accreditation of 2015-11-11 with the accreditation number D-PL-12107-01 and is valid until 2020-11-10. It comprises the cover sheet, the reverse side of the cover sheet and the following annex with a total of 42 pages.

Registration number of the certificate: **D-PL-12107-01-00**

ВЯРНО С ОРИГИНАЛА

МИГ 23 ЕООД СОФИЯ MIG 23 LTD

Frankfurt, 2015-11-11

Dipl.-Ing. (FH) Ralf Egner
Head of Division

This document is a translation. The definitive version is the original German accreditation certificate.

See notes overleaf.

000309

Deutsche Akkreditierungsstelle GmbH

Office Berlin
Spittelmarkt 10
10117 Berlin

Office Frankfurt am Main
Gartenstraße 6
60594 Frankfurt am Main

Office Braunschweig
Bundesallee 100
38116 Braunschweig

The publication of extracts of the accreditation certificate is subject to the prior written approval by Deutsche Akkreditierungsstelle GmbH (DAkkS). Exempted is the unchanged form of separate disseminations of the cover sheet by the conformity assessment body mentioned overleaf.

No impression shall be made that the accreditation also extends to fields beyond the scope of accreditation attested by DAkkS.

The accreditation was granted pursuant to the Act on the Accreditation Body (AkkStelleG) of 31 July 2009 (Federal Law Gazette I p. 2625) and the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products (Official Journal of the European Union L 218 of 9 July 2008, p. 30). DAkkS is a signatory to the Multilateral Agreements for Mutual Recognition of the European co-operation for Accreditation (EA), International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC). The signatories to these agreements recognise each other's accreditations.

The up-to-date state of membership can be retrieved from the following websites:
EA: www.european-accreditation.org
ILAC: www.ilac.org
IAF: www.iaf.nu

ДОКУМЕНТ 6.4

ДЕКЛАРАЦИЯ

че предложеното оборудване в процедурата отговаря на минималните технически изисквания на Възложителя, посочени в таблица 6

Долуподписаният Антон Иванов Илиев, в качеството ми на представляващ „МИГ 23" ЕООД, участник в процедура за изпълнение на обществена поръчка с реф. **№ PPD 19-103** и предмет: **„ Модернизация (ретрофит /проектиране, реконструкция, доставка и монтаж на машини и съоръжения, подготовка и въвеждане в експлоатация/) на възлови разпределителни станции 20 (10) kV и изграждане на вериги на телемеханика в регион „Ловеч - Враца", регион „Монтана – Видин" и регион „Плевен"**

ДЕКЛАРИРАМ, ЧЕ:

че предложеното от нас оборудване в процедурата, отговаря на минималните технически изисквания на **СТАНДАРТ НА МАТЕРИАЛА ЗА НАПРЕЖЕНОВИ ТРАНСФОРМАТОРИ 12 KV, ЕДНОПОЛЮСЕН, ЗА МОНТИРАНЕ НА ЗАКРИТО, ФИКСИРАН**, посочени в таблица 6, както следва:

Параметри на електрическата разпределителна мрежа

№	Параметър	Стойност
1.	Обявено напрежение	10000 V
2.	Максимално работно напрежение	12000 V
3.	Обявена честота	50 Hz
4.	Брой на фазите	3
5.	Заземяване на електрическата мрежа	- през активно съпротивление
6.	Максимално времетраене на земно съединение	2 часа
7.	Максимална стойност на временно пренапрежение при земно съединение	12 kV за 2 часа

Характеристика на работната среда и място на монтиране

№	Характеристика /място на монтиране	Стойност/описание
1.	Максимална околна температура	+ 40°C
2.	Минимална околна температура	Минус 5°C
3.	Средна стойност на относителната влажност, измерена за период от 24 ч.	До 95%
4.	Замърсяване с прах, пушек, агресивни газове и пари	Умерено
5.	Надморска височина	До 1000 m
6.	Място на монтиране	В КРУ, ЗРУ, ТП

Технически параметри на напреженови измервателни трансформатори 12 kV, подпорен тип, за монтиране на закрито, които се гарантират от Участника чрез Декларация *(съгласно образеца в документацията)*, че предложеното оборудване отговаря на посочените по-долу минималните технически изисквания на Възложителя:

№	Параметър	Минимални технически изисквания
1.	Присъединяване към електроразпределителната мрежа	Между фаза и земя
2.	Обявено първично напрежение	10000:√3 V
3.	Обявени вторични напрежения:	
-	за измервателната намотка	100:√3 V
-	за намотката за защитата	100:3 V

4.	Обявена честота	50 Hz
5.	бявени коефициенти на трансформация:	
-	за измервателната намотка	10000:√3 V / 100:√3 V
-	за намотката за защитата	10000:√3 V / 100:3 V
6.	ласове на точност:	
-	за измервателната намотка	≤ 0,5
-	за намотката за защитата	≤ 6P
7.	бявени вторични товари:	
-	за измервателната намотка	≥ 50 VA
-	за намотката за защитата	≥ 50 VA
8.	Обявено ниво на изолацията	≥ 12 kV ефективна стойност
9.	Обявено издържано напрежение с мълниев импулс за изолацията на първичната намотка	≥ 75 kV върхова стойност
10.	Обявено издържано напрежение с промишлена честота под дъжд за изолацията на първичната намотка	≥ 28 kV ефективна стойност
11.	Допустими нива на частичния разряд: (U_m - най-високо напрежение за съоръженията)	
-	при 1,2 U_m (най-високо напрежение за съоръженията)	≤ 50 pC
-	при 1,2 $U_m/\sqrt{3}$	≤ 20 pC
12.	Обявено издържано напрежение с промишлена честота за изолацията на вторичните намотки	≥ 3 kV ефективна стойност
13.	бявен коефициент на напрежение и обявено време на прилагане:	
-	за измервателната намотка	≥ 1,2 продължително и ≥ 1,9 за 8 h
-	за намотката за защитата	≥ 1,2 продължително и ≥ 1,9 за 8 h
14.	Експлоатационна дълготрайност	≥ 25 години

Конструктивни характеристики и др. данни за напреженови измервателни трансформатори 12 kV, подпорен тип, за монтиране на закрито, които се гарантират от Участника чрез Декларация *(съгласно образеца в документацията)*, че предложеното оборудване отговаря на посочените по-долу минималните технически изисквания на Възложителя:

№	Параметър	Минимални технически изисквания
1.	Размери	Размерите на НИТ трябва да съответстват на посочените размери в DIN 42600-9 "Instruments transformers for 50 Hz, Um 0,6 to 52 kV; voltage transformers Um 12 and 24 kV; narrow design, main dimensions, indoor type" или еквивалент
2.	Изолация между първичната и вторичната намотки и външна изолация	Трудногорим синтетичен материал - епоксидна смола или др. подходящ материал.
3.	Положение на монтиране	Произволно
4.	Клеми за свързване на първичната намотка на НИТ	Клемите да бъдат изработени от мед или медна сплав с покритие от калай с минимална дебелина на слоя 50 µm или с покритие от сребро с минимална дебелина на слоя 20 µm.
5.	Клемен блок за свързване на вторичните вериги	а) Клемният блок трябва да позволява възможност за свързване на гъвкави проводници на вторичните вериги със сечение до 4 mm².
		б) Клемният блок трябва да бъде защитен с прозрачен капак за извършване на визуален контрол с възможност за пломбиране.
		в) Клемният блок трябва да бъде съоръжен с клема за заземяваме на вторичната намотка.
6.	Монтажна основа за фиксиране на НИТ към конструкцията на разпределителната уредба	Монтажната основа трябва да бъде изработена от устойчиви на корозия материали или метали и метални сплави или от листова стомана, която е поцинкована съгласно БДС EN ISO 1461 или еквивалент.
7.	Заземяване	НИТ трябва да бъде съоръжен със заземителна клема с болт min M8, който трябва да бъде означен със знак „Защитна земя"

8.	Резбови и скрепителни съединения	Всички резбови и скрепителни съединения, винтове и гайки трябва да бъдат изработени от месинг или други подходящи некорозиращи метали или метални сплави.
9.	Табелка за маркиране на обявените стойности	Информация за обявените стойности на НИТ съгласно БДС EN 61869-3 или еквивалент трябва да бъде нанесена трайно и четливо по начин, по който да не може да бъде заличена: върху самия трансформатор (за предпочитане с вдлъбнат или релефен печат), без да се използват самозалепващи етикети; или върху табелка, изработена от анодизиран алуминий или от еквивалентен устойчив на корозия материал, която да бъде фиксирана здраво към корпуса на НИТ с устойчиви на корозия скрепителни елементи.
10.	Маркировка на изводите	Изводите на НИТ трябва да бъдат маркирани трайно и четливо съгласно БДС EN 61869-3 или еквивалент.
11.	Първоначална проверка на НИТ	а) НИТ трябва да е преминал през първоначална проверка по реда и при условията на Закона за измерванията.
		б) Извършената първоначална проверка да бъде удостоверена със знак за първоначална проверка.
12.	Транспортна опаковка	НИТ трябва да бъдат защитени посредством подходяща опаковка, предпазваща ги от повреди и въздействия на околната среда, подредени и закрепени на транспортни палети.

Параметри на електрическата разпределителна мрежа

№	Параметър	Стойност
8.	Обявено напрежение	10000 V
9.	Максимално работно напрежение	12000 V
10.	Обявена честота	50 Hz
11.	Брой на фазите	3
12.	Заземяване на електрическата мрежа	- през активно съпротивление
13.	Максимално времетраене на земно съединение	2 часа
14.	Максимална стойност на временно пренапрежение при земно съединение	12 kV за 2 часа

Характеристика на работната среда и място на монтиране

№	Характеристика /място на монтиране	Стойност/описание
7.	Максимална околна температура	+ 40°C
8.	Минимална околна температура	Минус 5°C
9.	Средна стойност на относителната влажност, измерена за период от 24 ч.	До 95%
10.	Замърсяване с прах, пушек, агресивни газове и пари	Умерено
11.	Надморска височина	До 1000 m
12.	Място на монтиране	В КРУ, ЗРУ, ТП

Технически параметри на напреженови измервателни трансформатори 12 kV, подпорен тип, за монтиране на закрито, които се гарантират от Участника чрез Декларация *(съгласно образеца в документацията)*, че предложеното оборудване отговаря на посочените по-долу минималните технически изисквания на Възложителя:

№	Параметър	Минимални технически изисквания

15.	Присъединяване към електроразпределителната мрежа	Между фаза и земя
16.	Обявено първично напрежение	10000:√3 V
17.	бявени вторични напрежения:	
-	за измервателната намотка	100:√3 V
-	за намотката за защитата	100:3 V
18.	Обявена честота	50 Hz
19.	бявени коефициенти на трансформация:	
-	за измервателната намотка	10000:√3 V / 100:√3 V
-	за намотката за защитата	10000:√3 V / 100:3 V
20.	ласове на точност:	
-	за измервателната намотка	≤ 0,5
-	за намотката за защитата	≤ 6P
21.	бявени вторични товари:	
-	за измервателната намотка	≥ 50 VA
-	за намотката за защитата	≥ 50 VA
22.	Обявено ниво на изолацията	≥ 12 kV ефективна стойност
23.	Обявено издържано напрежение с мълниев импулс за изолацията на първичната намотка	≥ 75 kV върхова стойност
24.	Обявено издържано напрежение с промишлена честота под дъжд за изолацията на първичната намотка	≥ 28 kV ефективна стойност
25.	Допустими нива на частичния разряд: (U_m - най-високо напрежение за съоръженията)	
-	при 1,2 U_m (най-високо напрежение за съоръженията)	≤ 50 pC
-	при 1,2 $U_m/\sqrt{3}$	≤ 20 pC
26.	Обявено издържано напрежение с промишлена честота за изолацията на вторичните намотки	≥ 3 kV ефективна стойност
27.	бявен коефициент на напрежение и обявено време на прилагане:	
-	за измервателната намотка	≥ 1,2 продължително и ≥ 1,9 за 8 h
-	за намотката за защитата	≥ 1,2 продължително и ≥ 1,9 за 8 h
28.	Експлоатационна дълготрайност	≥ 25 години

Конструктивни характеристики и др. данни за напреженови измервателни трансформатори 12 kV, подпорен тип, за монтиране на закрито, които се гарантират от Участника чрез Декларация *(съгласно образеца в документацията)*, че предложеното оборудване отговаря на посочените по-долу минималните технически изисквания на Възложителя:

№	Параметър	Минимални технически изисквания
13.	Размери	Размерите на НИТ трябва да съответстват на посочените размери в DIN 42600-9 "Instruments transformers for 50 Hz, Um 0,6 to 52 kV; voltage transformers Um 12 and 24 kV; narrow design, main dimensions, indoor type" или еквивалент
14.	Изолация между първичната и вторичната намотки и външна изолация	Трудногорим синтетичен материал - епоксидна смола или др. подходящ материал.
15.	Положение на монтиране	Произволно
16.	Клеми за свързване на първичната намотка на НИТ	Клемите да бъдат изработени от мед или медна сплав с покритие от калай с минимална дебелина на слоя 50 µm или с покритие от сребро с минимална дебелина на слоя 20 µm.
17.	Клемен блок за свързване на вторичните вериги	а) Клемният блок трябва да позволява възможност за свързване на гъвкави проводници на вторичните вериги със сечение до 4 mm^2.
		б) Клемният блок трябва да бъде защитен с прозрачен капак за извършване на визуален контрол с възможност за пломбиране.
		в) Клемният блок трябва да бъде съоръжен с клема за заземяваме на вторичната намотка.
18.	Монтажна основа за фиксиране на НИТ към конструкцията на разпределителната уредба	Монтажната основа трябва да бъде изработена от устойчиви на корозия материали или метали и метални сплави или от листова стомана, която е

		поцинкована съгласно БДС EN ISO 1461 или еквивалент.
19.	Заземяване	НИТ трябва да бъде съоръжен със заземителна клема с болт min M8, който трябва да бъде означен със знак „Защитна земя” ⏚
20.	Резбови и скрепителни съединения	Всички резбови и скрепителни съединения, винтове и гайки трябва да бъдат изработени от месинг или други подходящи некорозиращи метали или метални сплави.
21.	Табелка за маркиране на обявените стойности	Информация за обявените стойности на НИТ съгласно БДС EN 61869-3 или еквивалент трябва да бъде нанесена трайно и четливо по начин, по който да не може да бъде заличена: върху самия трансформатор (за предпочитане с вдлъбнат или релефен печат), без да се използват самозалепващи етикети; или върху табелка, изработена от анодизиран алуминий или от еквивалентен устойчив на корозия материал, която да бъде фиксирана здраво към корпуса на НИТ с устойчиви на корозия скрепителни елементи.
22.	Маркировка на изводите	Изводите на НИТ трябва да бъдат маркирани трайно и четливо съгласно БДС EN 61869-3 или еквивалент.
23.	Първоначална проверка на НИТ	а) НИТ трябва да е преминал през първоначална проверка по реда и при условията на Закона за измерванията.
		б) Извършената първоначална проверка да бъде удостоверена със знак за първоначална проверка.
24.	Транспортна опаковка	НИТ трябва да бъдат защитени посредством подходяща опаковка, предпазваща ги от повреди и въздействия на околната среда, подредени и закрепени на транспортни палети.

Дата 31.10.2019 г.

Декларатор: На основание чл.36а ал.3 от ЗОП

ДОКУМЕНТ 7.1

ЦИФРОВА ЗАЩИТА 7SJ66

SIPROTEC 4 Мултифункционална релейна защита и контролер за присъединение

Поръчков No: **7SJ6615-6JB90-1FC1 L0R**

Приложение: **Посочна цифрова защита за въздушни и кабелни електропроводни линии Ср.Н.**

Поръчков No.	6	7	-	8	9	10	11	12	-	13	14	15	16
7SJ66			-						-				

Кутия, входове и изходи (6)

Кутия 1/3 19"; 4xU, 4xI, 16 BI, 7 BO, 1 "Готовност", 9 W	1
Кутия 1/3 19"; 4xU, 4xI, 22 BI, 10 BO, 1 "Готовност", 9 W	2
Кутия 1/2 19"; 4xU, 4xI, 36 BI, 23 BO, 1 "Готовност", 4 функционални бутона, 12 W	3

Измервателни входове (3xU/4xU, 4xI) (7)

IPh = 1 A, IN = 1 A (min. = 0.05 A); (на позиция 15 с A, C, E, G)	1
IPh = 1 A, IN = sensitive (min. = 0.001 A); на позиция 15 с B, D, F, H	2
IPh = 5 A, IN = 5 A (min. = 0.25 A); на позиция 15 с A, C, E, G	5
IPh = 5 A, IN = sensitive (min. = 0.001 A); на позиция 15 с B, D, F, H	6

Оперативно напрежение (захранване, цифрови входове) (8)

110 - 250 V DC, 115 - 230 V AC, праг на заработване на входа 69 V DC	5
110 - 250 V DC, 115 to 230 V AC, праг на заработване на входа 138 V DC	6

Конструкция (9)

Кутия за вграждане, винтови клеми, 8-редов дисплей	D
Кутия за вграждане, пружинен тип клеми (директа връзка), винтови клеми за TT (direct connection/ring-type cable lugs),, 8-редов дисплей	E
Кутия за вграждане, винтови клеми, графичен дисплей	J
Кутия за вграждане, пружинен тип клеми (директа връзка), винтови клеми за TT (direct connection/ring-type cable lugs), графичен дисплей	K

Специални настройки по подразбиране за региона / функции и езикови настройки (10)

50/60 Hz, IEC/ANSI, английски език (езикът може да се променя)	B
50/60 Hz, IEC/ANSI, испански език (езикът може да се променя)	E
50/60 Hz, IEC/ANSI, руски език (езикът може да се променя)	G

Port B (системен интерфейс) (11)

Виж следващите страници	

Port C (сервизен интерфейс) (12)

Виж следващите страници	

Функции (13 14 15 16)

представени на следващите страници	

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ЦИФРОВА ЗАЩИТА 7SJ66

SIPROTEC 4 Мултифункционална релейна защита и контролер за присъединение

Поръчков No: **7SJ6615-6JB90-1FC1 L0R**

Приложение: **Посочна цифрова защита за въздушни и кабелни електропроводни линии Ср.Н.**

Поръчков No. 7SJ66 (позиции 6 7 - 8 9 10 11 12 - 13 14 15 16 -)

Port B (системен интерфейс)

		11			
Без системен порт		0			
IEC 60870-5-103 протокол, RS485	1)	2			
Modbus, RS485	1)	9	L	0	D
DNP3, RS485	1)	9	L	0	G
IEC 61850, 100 Mbit Ethernet, електрически, двоен, RJ45-куплунг	2)	9	L	0	R
IEC 61850, 100 Mbit Ethernet, оптичен, двоен, LC-куплунг	2)	9	L	0	S
DNP3 + IEC 61850, 100 Mbit Ethernet, електрически, двоен, RJ45-куплунг	2)	9	L	2	R
DNP3 + IEC 61850, 100 Mbit Ethernet, оптичен, двоен, LC-куплунг	2)	9	L	2	S

Port C (сервизен интерфейс)

	12
Без порт	0
DIGSI 4/Модем/RTD-кутия, електрически RS485	2
Ethernet порт (DIGSI порт, връзка с RTD кутия, без IEC61850), RJ45 куплунг	6

1) възможен, ако позиция 12 = 0 или 2
2) възможен, ако позиция 12 = 0 или 6

ВЯРНО С ОРИГИНАЛА

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ЦИФРОВА ЗАЩИТА 7SJ66

SIPROTEC 4 Мултифункционална релейна защита и контролер за присъединение

Поръчков No: **7SJ6615-6JB90-1FC1 L0R**

Приложение: **Посочна цифрова защита за въздушни и кабелни електропроводни линии Ср.Н.**

		13	14	15	16
	Поръчков No. 7SJ66				
ANSI-Nr.	Функции		14	15	
	Базова версия		F	A	
	Управление				
50/51	Максимално токова защита (МТЗ - без и с времезакъс.): I>, I>>, I>>>, Ip				
50N/51N	Земна защита (33 -без и с времезакъс.): IE>, IE>>, IE>>>, IEp				
50N/51N	Чувствителна 33: IEE>, IEE>>, IEEp 1)				
50/50N	Гъвкави защитни функции (входни величини - ток): допълнителни максималкотокови стъпала I(E)>>>>, I2>				
51V	МТЗ с контрол по напрежение				
49	Overload protection (with 2 time constants)				
46	Фазна защита от небаланс (защита от обратна последователност)				
37	Контрол понижен ток				
47	Следене последователността на фазите				
59N/64	Заместващо напрежение (напрежение на Н.П.)				
50BF	Защита срещу отказ на прекъсвача				
74TC	Контрол на изключвателните вериги				
	4 групи с настройки, Динамично студено пускане				
	Ограничаване на втория хармоник при включване				
86	Блокиращи функции				
	Базова версия+ V,P,f		F	E	
	Базова версия (виж по-горе)				
27/59	Минимално/максимално напреженова защита				
81U/O	Минимално/максимално честотна защита				
	QU защити				
27/47/59(N)	Гъвкави защитни функции (входни величини токове и напрежения):				
32/55/81R	Защити - Напреженова, Мощностна, Косинус фи, Скорст на изменение на честотата				
	Базова версия+ V,P,f IEF		P	E	
	Базова версия (виж по-горе)				
	Интермитентна земна защита				
27/59	Минимално/максимално напреженова защита				
81U/O	Минимално/максимално честотна защита				
	QU защити				
27/47/59(N)	Гъвкави защитни функции (входни величини токове и напрежения):				
32/55/81R	Защити - Напреженова, Мощностна, Косинус фи, Скорст на изменение на честотата				
	Базова версия+ Dir		F	C	
	Базова версия (виж по-горе)				
67/67N	Посочни максималнотокови фазни и земни защити				
	Базова версия+ Dir V,P,f		F	G	
	Базова версия (виж по-горе)				
67/67N	Посочни максималнотокови фазни и земни защити				
27/59	Минимално/максимално напреженова защита				
81U/O	Минимално/максимално честотна защита				
	QU защити				
27/47/59(N)	Гъвкави защитни функции (входни величини токове и напрежения):				
32/55/81R	Защити - Напреженова, Мощностна, Косинус фи, Скорст на изменение на честотата				
	Базова версия+ Посочни V,P,f IEF		P	G	
	Базова версия (виж по-горе)				
67/67N	Посочни максималнотокови фазни и земни защити				
27/59	Минимално/максимално напреженова защита				
81U/O	Минимално/максимално честотна защита				
	QU защити				
27/47/59(N)	Гъвкави защитни функции (входни величини токове и напрежения):				
32/55/81R	Защити - Напреженова, Мощностна, Косинус фи, Скорст на изменение на честотата				
	Интермитентна земна защита				
	Базова версия+ Посочни IEF		P	C	
	Базова версия (виж по-горе)				
67/67N	Посочни максималнотокови фазни и земни защити				
	Интермитентна земна защита				
	Базова версия+ Чувствителна земна-f.det. Посочна REF		F	D	2)
	Базова версия (виж по-горе)				
67/67N	Посочни максималнотокови фазни и земни защити				
67Ns	Посочна чувствителна земна защита				
67Ns	Посочна интермитентна земна защита				
87N	Високоимпедансна диференциална защита от з.к.с.				
	Базова версия+ Чувствителна земна-f.det. Посочна IEF REF		P	D	2)
	Basic version (see above)				
67/67N	Посочни максималнотокови фазни и земни защити				
67Ns	Посочна чувствителна земна защита				
67Ns	Посочна интермитентна земна защита				
87N	Високоимпедансна диференциална защита от з.к.с.				
	Интермитентна земна защита				
	Базова версия+ Чувствителна земна-f.det. V,P,f REF		F	F	2)
	Базова версия (виж по-горе)				
67Ns	Посочна чувствителна земна защита				
67Ns	Посочна интермитентна земна защита				

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87N	Високоимпедансна диференциална защита от з.к.с.			
27/59	Минимално/максимално напреженова защита			
81U/O	Минимелно/максимално честотна защита			
	QU защити			
27/47/59(N)	Гъвкави защитни функции (входни величини токове и напрежения):			
32/55/81R	Защити - Напреженова, Мощностна, Косинус фи, Скорст на изменение на честотата			
	Базова версия+ Чувствителна земна-f.det. REF	F	B	2)
	Базова версия (виж по-горе)			
67Ns	Посочна чувствителна земна защита			
67Ns	Посочна интермитентна земна защита			7)
87N	Високоимпедансна диференциална защита от з.к.с.			
	Базова версия+ Чувствителна земна-f.det. Двигателни функции V,P,f REF	H	F	2)
	Базова версия (виж по-горе)			
67Ns	Посочна чувствителна земна защита			
67Ns	Посочна интермитентна земна защита			
87N	Високоимпедансна диференциална защита от з.к.с.			
48/14	Контрол пусковия режим на двигателя, блокиран ротор			
66/86	Забрана за рестартиране на двигателя			
51M	Защита от блокиране на ротора при претоварване			
	Статистики			
27/59	Минимално/максимално напреженова защита			
81U/O	Минимално/максимално честотна защита			
	QU защити			
27/47/59(N)	Гъвкави защитни функции (входни величини токове и напрежения):			
32/55/81R	Защити - Напреженова, Мощностна, Косинус фи, Скорст на изменение на честотата			
	Базова версия+ Чувствителна земна-f.det. Двигатели Посочни V,P,f REF	H	H	2)
	Базова версия (виж по-горе)			
67/67N	Посочни максималнотокови фазни и земни защити			
67Ns	Посочна чувствителна земна защита			
67Ns	Посочна интермитентна земна защита			
87N	Високоимпедансна диференциална защита от з.к.с.			
48/14	Контрол пусковия режим на двигателя, блокиран ротор			
66/86	Забрана за рестартиране на двигателя			
51M	Защита от блокиране на ротора при претоварване			
	Статистики			
27/59	Минимално/максимално напреженова защита			
81U/O	Минимално/максимално честотна защита			
	QU защити			
27/47/59(N)	Гъвкави защитни функции (входни величини токове и напрежения):			
32/55/81R	Защити - Напреженова, Мощностна, Косинус фи, Скорст на изменение на честотата			

ВЯРНО С ОРИГИНАЛА

МИГ 23 ЕООД СОФИЯ MIG 23 LTD

	Базова версия+ Чувствит.земна-f.det. Двигателни Посочни IEF V,P,f REF	R	H	2)
	Базова версия (виж по-горе)			
67/67N	Посочни максималнотокови фазни и земни защити			
67Ns	Посочна чувствителна земна защита			
67Ns	Посочна интермитентна земна защита			
87N	Високоимпедансна диференциална защита от з.к.с.			
	Интермитентна земна защита			
48/14	Контрол пусковия режим на двигателя, блокиран ротор			
66/86	Забрана за рестартиране на двигателя			
51M	Защита от блокиране на ротора при претоварване			
	Статистики			
27/59	Минимално/максимално напреженова защита			
81U/O	Минимално/максимално честотна защита			
	QU защити			
27/47/59(N)	Гъвкави защитни функции (входни величини токове и напрежения):			
32/55/81R	Защити - Напреженова, Мощностна, Косинус фи, Скорст на изменение на честотата			
	Базова версия+ Двигателни Посочни V,P,f	H	G	
	Базова версия (виж по-горе)			
67/67N	Посочни максималнотокови фазни и земни защити			
48/14	Контрол пусковия режим на двигателя, блокиран ротор			
66/86	Забрана за рестартиране на двигателя			
51M	Защита от блокиране на ротора при претоварване			
	Статистики			
27/59	Минимално/максимално напреженова защита			
81U/O	Минимално/максимално честотна защита			
	QU защити			
27/47/59(N)	Гъвкави защитни функции (входни величини токове и напрежения):			
32/55/81R	Защити - Напреженова, Мощностна, Косинус фи, Скорст на изменение на честотата			
	Базова версия+ Двигателни	H	A	
	Базова версия (виж по-горе)			
48/14	Контрол пусковия режим на двигателя, блокиран ротор			
66/86	Забрана за рестартиране на двигателя			
51M	Защита от блокиране на ротора при претоварване			
	Статистики			

	Измервания/ Осцилографни записи	13
	С регистратор на осцилографни записи	1
	С регистратор на осц.записи, средни стойности, min/max стойности	3

	Автоматично повторно включване, локатор на к.с., синхронизъм		16
	Без		0
79	С АПВ		1
21FL	С локатор на к.с.		2
79, 21FL	С АПВ и с локатор на к.с.		3
25	С проверка за синхронизъм	3)	4
25, 79, 21FL	с проверка за синхронизъм, с АПВ, с локатор на к.с.	3)	7

IEF: Интермитентна 33
V,P,f: Защити по Напрежение-, Мощност-, Честота
Dir: Посочна МТЗ
Motor: Двигателна защита
REF: Диференциална 33

1) ако позиция 7=1,5 (non-sensitive ground current input)
2) За изолирана/ компенсирана мрежа, позиция 7=2,6 (чувствителен вход за ТЗЗ)
3) Проверка за синхронизъм, една функционална група

ВЯРНО С ОРИГИНАЛА

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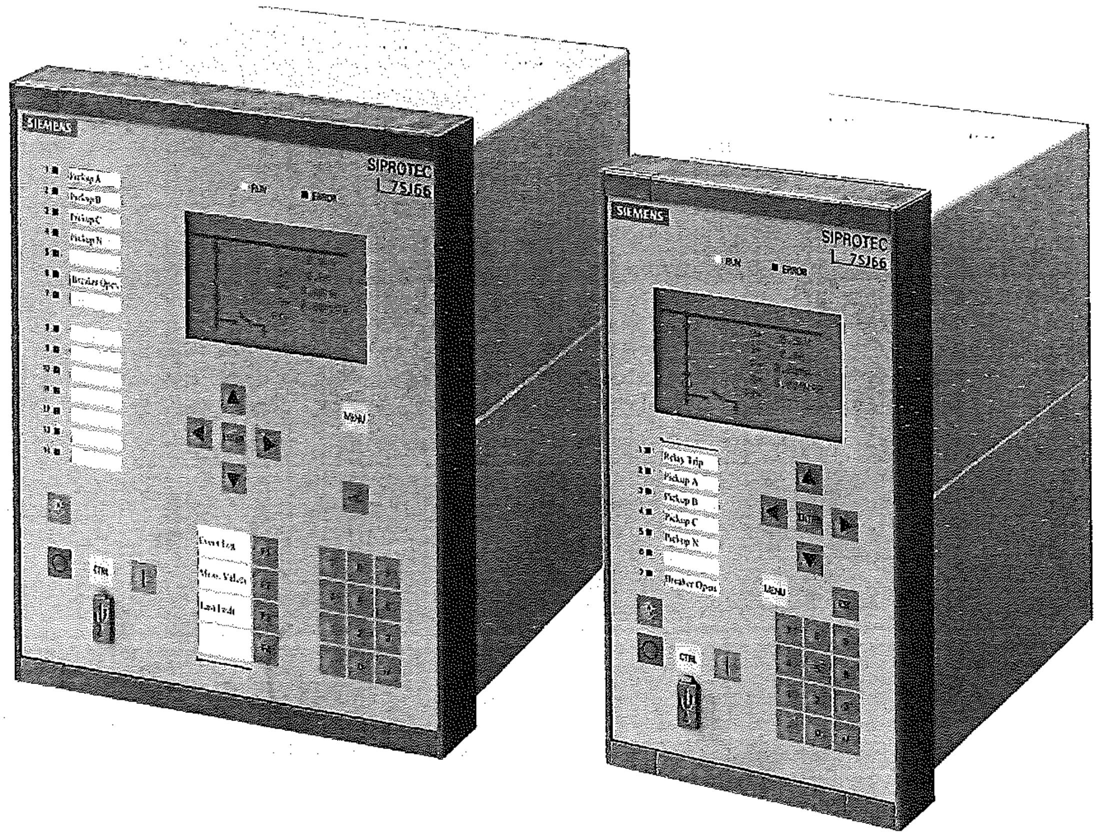

Protection Systems

ВЯРНО С ОРИГИНАЛА

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SIPROTEC 7SJ66

You will find a detailed overview of the technical data under www.siemens.com/siprotec

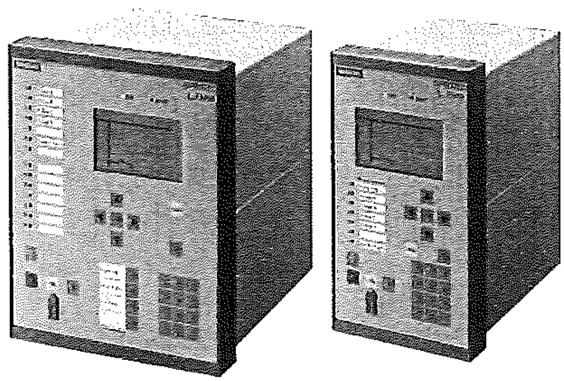

Fig. 1 SIPROTEC 4 7SJ66 multifunction protection relay

Description

The SIPROTEC 7SJ66 unit is a numerical protection, control and monitoring device, designed to use in Medium Voltage and Industry applications.

SIPROTEC 7SJ66 is featuring the "flexible protection functions". Up to 20 protection functions can be added according to individual requirements. Thus, for example, a rate-of-frequency-change protection or reverse power protection can be implemented.

The relay provides control of the circuit-breaker, further switching devices and automation functions. The integrated graphical logic editor (CFC) allows the user to implement its own functions, e. g. for the automation of switchgear (interlocking).

The communication interfaces support the easy integration into modern communication networks.

Function overview

Protection functions

- Overcurrent protection
- Directional overcurrent protection
- Sensitive directional ground-fault detection
- Displacement voltage
- Intermittent ground-fault protection
- Directional intermittent ground fault protection
- High-impedance restricted ground fault

Protection functions (continued)

- Inrush restraint
- Motor protection
- Overload protection
- Temperature monitoring
- Under-/overvoltage protection
- Under-/overfrequency protection
- Rate-of-frequency-change protection
- Power protection (e.g. reverse, factor)
- Undervoltage controlled reactive power protection
- Breaker failure protection
- Negative-sequence protection
- Phase-sequence monitoring
- Synchro-check
- Fault locator
- Lockout
- Auto-reclosure

Control functions/programmable logic

- Commands f. ctrl of CB and of isolators
- Position of switching elements is shown on the graphic display
- Control via keyboard, binary inputs, DIGSI 4 or SCADA system
- User-defined logic with CFC (e.g. interlocking)

Monitoring functions

- Operational measured values V, I, f
- Energy metering values W_p, W_q
- Circuit-breaker wear monitoring
- Slave pointer
- Trip circuit supervision
- Fuse failure monitor
- 8 oscillographic fault records
- Motor statistics

Communication (build in interfaces)

- System interface
  IEC 60870-5-103 / IEC 61850 / Modbus RTU / DNP3
- Service interface for DIGSI 4/ RTD-Box
- Electrical and optical interface
- RSTP, PRP (Redundancy Protocol for Ethernet)
- Front USB interface for DIGSI 4
- Time synchronization via IRIG B/DCF77

Hardware

- Screw-type current terminals
- Spring or Screw-type Voltage and Binary I/O terminals
- 4 current and 4 voltage transformers
- 16/22/36 binary inputs
- 7/10/23 output relays
- Graphical or 8 line text display

ВЯРНО С ОРИГИНАЛА

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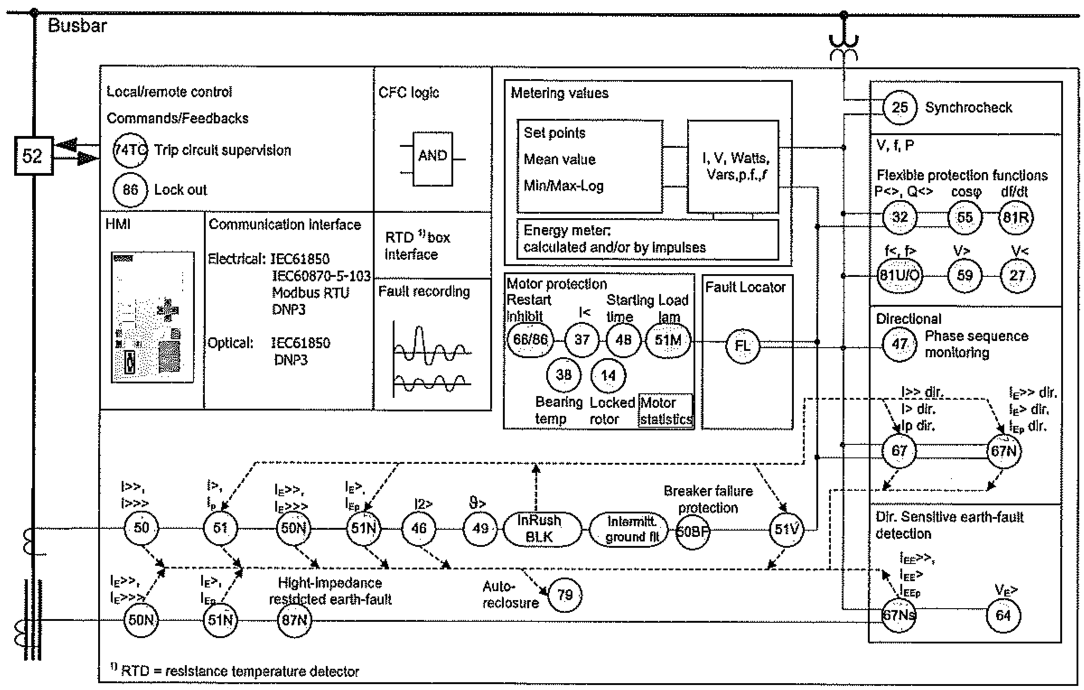

Fig. 2 Function diagram

Application

The SIPROTEC 7SJ66 unit is a numerical protection relay that also performs control and monitoring functions and therefore supports the user in cost-effective power system management. The relay ensures reliable supply of electric power to the customers. Local operation has been designed according to ergonomic criteria. A large, easy-to-read display was a major design aim.

Control

The integrated control function permits control of disconnect devices, grounding switches or circuit-breakers via the integrated operator panel, binary inputs, DIGSI 4 or the control and protection system (e.g. SICAM). The present status (or position) of the primary equipment can be displayed, in case of devices with graphic display. A full range of command processing functions is provided.

Programmable logic

The integrated logic characteristics (CFC) allow the user to implement their own functions for automation of switchgear (interlocking) or a substation via a graphic user interface. The user can also generate user-defined messages.

Line protection

The SIPROTEC 7SJ66 units can be used for line protection of high and medium-voltage networks with earthed (grounded), low-resistance grounded, isolated or compensated neutral point.

Synchro-check

In order to connect two components of a power system, the relay provides a synchro-check function which verifies that switching ON does not endanger the stability of the power system.

Motor protection

When protecting motors, the SIPROTEC 7SJ66 relay is suitable for asynchronous machines of all sizes.

Transformer protection

The relay performs all functions of backup protection supplementary to transformer differential protection. The inrush suppression effectively prevents tripping by inrush currents. The high-impedance restricted ground-fault protection detects short-circuits and insulation faults on the transformer.

Backup protection

The SIPROTEC 7SJ66 can be used universally for backup protection.

Flexible protection functions

By configuring a connection between a standard protection logic and any measured or derived quantity, the functional scope of the relays can be easily expanded by up to 20 protection stages or protection functions.

Metering values

Extensive measured values, limit values and metered values permit improved system management.

ANSI	IEC	Protection functions
50, 50N	$I>, I>>, I>>>, I_E>, I_E>>, I_E>>>$	Definite-time overcurrent protection (phase/neutral)
50, 51V, 51N	I_p, I_{Ep}	Inverse overcurrent protection (phase/neutral), phase function with voltage-dependent option
67, 67N	$I_{dir}>, I_{dir}>>, I_{p\ dir}$ $I_{Edir}>, I_{Edir}>>, I_{Ep\ dir}$	Directional overcurrent protection (definite/inverse, phase/neutral), Directional comparison protection
67Ns/50Ns	$I_{EE}>, I_{EE}>>, I_{EEp}$	Directional/non-directional sensitive ground-fault detection
–		Cold load pick-up (dynamic setting change)
59N/64	$V_E, V_0>$	Displacement voltage, zero-sequence voltage
–	$I_{IE}>$	Intermittent ground fault
67Ns	$I_{IE\ dir}>$	Directional intermittent ground fault protection
87N		High-impedance restricted ground-fault protection
50BF		Breaker failure protection
79		Auto-reclosure
25		Synchro-check
46	$I_2>$	Phase-balance current protection (negative-sequence protection)
47	$V_2>$, phase-sequence	Unbalance-voltage protection and/or phase-sequence monitoring
49	$\vartheta>$	Thermal overload protection
48		Starting time supervision
51M		Load jam protection
14		Locked rotor protection
66/86		Restart inhibit
37	$I<$	Undercurrent monitoring
38		Temperature monitoring via external device (RTD-box), e.g. bearing temperature monitoring
27, 59	$V<, V>$	Undervoltage/overvoltage protection
59R	dV/dt	Rate-of-voltage-change protection
32	$P<>, Q<>$	Reverse-power, forward-power protection
27/Q	$Q>/V<$	Undervoltage-controlled reactive power protection
55	$\cos\varphi$	Power factor protection
81O/U	$f>, f<$	Overfrequency/underfrequency protection
81R	df/dt	Rate-of-frequency-change protection
21FL		Fault locator

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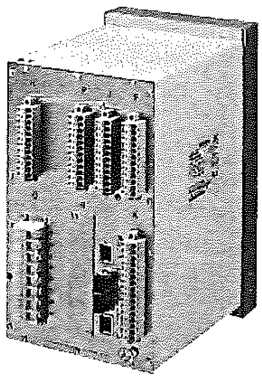

Fig. 3 SIPROTEC 7SJ66 rear view with optical Ethernet system interfaces

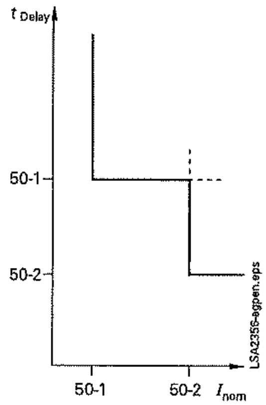

Fig. 4 Definite-time overcurrent protection

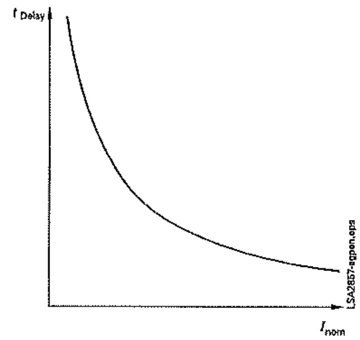

Fig. 5 Inverse-time overcurrent protection

Construction

Connection techniques and housing with many advantages

1/3-rack size and 1/2-rack size are the available housing widths of the SIPROTEC 7SJ66 relays, referred to a 19" module frame system. This means that previous models can always be replaced. The height is a uniform 244 mm for flush-mounting housing. All CT-cables can be connected with or without ring lugs.

Protection functions

Overcurrent protection (ANSI 50, 50N, 51, 51V, 51N)

This function is based on the phase-selective measurement of the three phase currents and the ground current (four transformers). Three definite-time overcurrent protection elements (DMT) exist both for the phases and for the ground. The current threshold and the delay time can be set within a wide range.
In addition, inverse-time overcurrent protection characteristics (IDMTL) can be activated.
The inverse-time function provides – as an option – voltage-restraint or voltage-controlled operating modes.

Available inverse-time characteristics		
Characteristics acc. to	*ANSI/IEEE*	*IEC 60255-3*
Inverse	•	•
Short inverse	•	
Long inverse	•	•
Moderately inverse	•	
Very inverse	•	•
Extremely inverse	•	•

Reset characteristics

For easier time coordination with electromechanical relays, reset characteristics according to ANSI C37.112 and IEC 60255-3 / BS 142 standards are applied.

When using the reset characteristic (disk emulation), a reset process is initiated after the fault current has disappeared. This reset process corresponds to the reverse movement of the Ferraris disk of an electromechanical relay (thus: disk emulation).

User-definable characteristics

Instead of the predefined time characteristics according to ANSI, tripping characteristics can be defined by the user for phase and ground units separately. Up to 20 current/time value pairs may be programmed. They are set as pairs of numbers or graphically in DIGSI 4.

Inrush restraint

The relay features second harmonic restraint. If the second harmonic is detected during transformer energization, pickup of non-directional and directional normal elements are blocked.

Cold load pickup/dynamic setting change

For directional and non-directional overcurrent protection functions the initiation thresholds and tripping times can be switched via binary inputs or by time control.

Directional overcurrent protection (ANSI 67, 67N)

Directional phase and ground protection are separate functions. They operate in parallel to the non-directional overcurrent elements. Their pickup values and delay times can be set separately. Definite-time and inverse-time characteristics are offered. The tripping characteristic can be rotated about ± 180 degrees.

By means of voltage memory, directionality can be determined reliably even for close-in (local) faults. If the switching device closes onto a fault and the voltage is too low to determine direction, directionality (directional decision) is made with voltage from the voltage memory. If no voltage exists in the memory, tripping occurs according to the coordination schedule.

For ground protection, users can choose whether the direction is to be determined via zero-sequence system or negative-sequence system quantities (selectable). Using negative-sequence variables can be advantageous in cases where the zero voltage tends to be very low due to unfavorable zero-sequence impedances.

Directional comparison protection (cross-coupling)

It is used for selective protection of sections fed from two sources with instantaneous tripping, i.e. without the disadvantage of time coordination. The directional comparison protection is suitable if the distances between the protection stations are not significant and pilot wires are available for signal transmission. In addition to the directional comparison protection, the directional coordinated overcurrent protection is used for complete selective backup protection. If operated in a closed-circuit connection, an interruption of the transmission line is detected.

(Sensitive) directional ground-fault detection (ANSI 64, 67Ns, 67N)

For isolated-neutral and compensated networks, the direction of power flow in the zero sequence is calculated from the zero-sequence current I_0 and zero-sequence voltage V_0.

For networks with an isolated neutral, the reactive current component is evaluated; for compensated networks, the active current component or residual resistive current is evaluated. For special network conditions, e.g. high-resistance grounded networks with ohmic-capacitive ground-fault current or low-resistance grounded networks with ohmic-inductive current, the tripping characteristics can be rotated approximately ± 45 degrees.

Two modes of ground-fault direction detection can be implemented: tripping or "signalling only mode".

It has the following functions:

- TRIP via the displacement voltage V_E.
- Two instantaneous elements or one instantaneous plus one user-defined characteristic.
- Each element can be set in forward, reverse, or non-directional.
- The function can also be operated in the insensitive mode as an additional short-circuit protection.

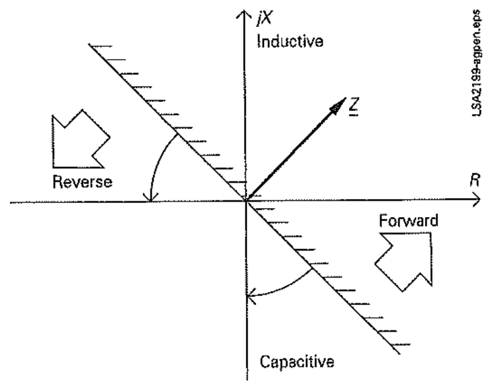

Fig. 6 Directional characteristic of the directional overcurrent protection

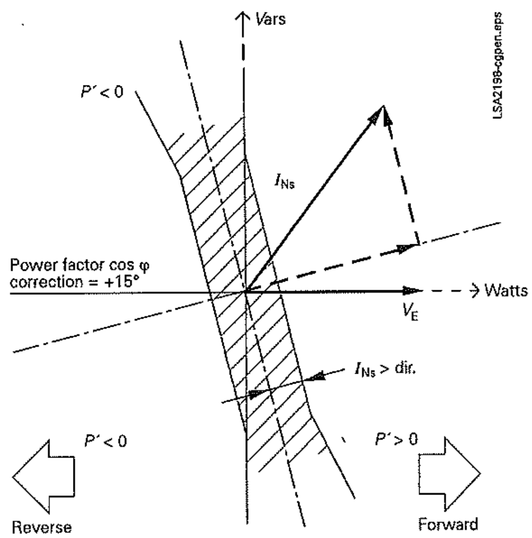

Fig. 7 Directional determination using cosine measurements for compensated networks

(Sensitive) ground-fault detection (ANSI 50Ns, 51Ns / 50N, 51N)

For high-resistance grounded networks, a sensitive input transformer is connected to a phase-balance neutral current transformer (also called core-balance CT).

The function can also be operated in the insensitive mode as an additional short-circuit protection.

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Intermittent ground-fault protection

Intermittent (re-striking) faults occur due to insulation weaknesses in cables or as a result of water penetrating cable joints. Such faults either simply cease at some stage or develop into lasting short-circuits. During intermittent activity, however, star-point resistors in networks that are impedance-grounded may undergo thermal overloading. The normal ground-fault protection cannot reliably detect and interrupt the current pulses, some of which can be very brief.
The selectivity required with intermittent ground faults is achieved by summating the duration of the individual pulses and by triggering when a (settable) summed time is reached. The response threshold I_{IE}> evaluates the r.m.s. value, referred to one systems period.

Directional intermittent ground fault protection (ANSI 67Ns)

The directional intermittent ground fault protection has to detect intermittent ground faults in resonant grounded cable systems selectively. Intermittent ground faults in resonant grounded cable systems are usually characterized by the following properties:

- A very short high-current ground current pulse (up to several hundred amperes) with a duration of under 1 ms
- They are self-extinguishing and re-ignite within one halfperiod up to several periods, depending on the power system condi tions and the fault characteristic.
- Over longer periods (many seconds to minutes), they can develop into static faults.

Such intermittent ground faults are frequently caused by weak insulation, e.g. due to decreased water resistance of old cables. Ground fault functions based on fundamental component measured values are primarily designed to detect static ground faults and do not always behave correctly in case of intermittent ground faults. The function described here evaluates specifi cally the ground current pulses and puts them into relation with the zero-sequence voltage to determine the direction.

Phase-balance current protection (ANSI 46) (Negative-sequence protection)

In line protection, the two-element phase-balance current/ negative-sequence protection permits detection on the high side of high-resistance phase-to-phase faults and phase-to-ground faults that are on the low side of a transformer (e.g. with the switch group Dy 5). This provides backup protection for high-resistance faults beyond the transformer.

Breaker failure protection (ANSI 50BF)

If a faulted portion of the electrical circuit is not disconnected upon issuance of a trip command, another command can be initiated using the breaker failure protection which operates the circuit-breaker, e.g. of an upstream (higher-level) protection relay. Breaker failure is detected if, after a trip command, current is still flowing in the faulted circuit. As an option, it is possible to make use of the circuit-breaker position indication.

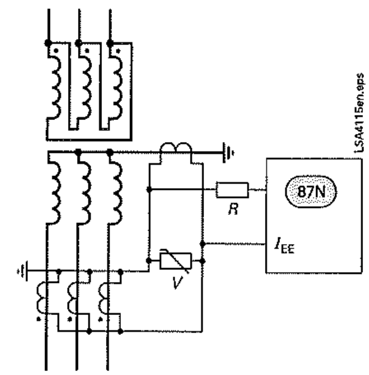

Fig. 8 High-impedance restricted ground-fault protection

High-impedance restricted ground-fault protection (ANSI 87N)

The high-impedance measurement principle is an uncomplicated and sensitive method for detecting ground faults, especially on transformers. It can also be applied to motors, generators and reactors when these are operated on an grounded network.

When the high-impedance measurement principle is applied, all current transformers in the protected area are connected in parallel and operated on one common resistor of relatively high R whose voltage is measured (see Fig. 8). In the case of 7SJ6 units, the voltage is measured by detecting the current through the (external) resistor R at the sensitive current measurement input I_{EE}. The varistor V serves to limit the voltage in the event of an internal fault. It cuts off the high momentary voltage spikes occurring at transformer saturation. At the same time, this results in smoothing of the voltage without any noteworthy reduction of the average value.

If no faults have occurred and in the event of external faults, the system is at equilibrium, and the voltage through the resistor is approximately zero. In the event of internal faults, an imbalance occurs which leads to a voltage and a current flow through the resistor R.

The current transformers must be of the same type and must at least offer a separate core for the high-impedance restricted ground-fault protection. They must in particular have the same transformation ratio and an approximately identical knee-point voltage. They should also demonstrate only minimal measuring errors.

Flexible protection functions

The SIPROTEC 7SJ66 units enable the user to easily add on up to 20 protective functions. To this end, parameter definitions are used to link a standard protection logic with any chosen characteristic quantity (measured or derived quantity). The stand- ard logic consists of the usual protection elements such as the pickup message, the parameter-definable delay time, the TRIP command, a blocking possibility, etc. The mode of operation for current, voltage, power and power factor quantities can be three-phase or single-phase. Almost all quantities can be operated as greater than or less than stages. All stages operate with protection priority.

Protection stages/functions attainable on the basis of the available characteristic quantities:

Function	*ANSI No.*
$I>, I_E>$	50, 50N
$V<, V>, V_E>, dV/dt$	27, 59, 59R, 64
$3I_0>, I_1>, I_2>, I_2/I_1,$ $3V_0>, V_1><, V_2><$	50N, 46, 59N, 47
$P><, Q><$	32
cos ▯ (p.f.)><	55
$f><$	81O, 81U
$df/dt><$	81R

For example, the following can be implemented:

- Reverse power protection (ANSI 32R)
- Rate-of-frequency-change protection (ANSI 81R)

Undervoltage-controlled reactive power protection (ANSI 27/Q)

The undervoltage-controlled reactive power protection protects the system for mains decoupling purposes. To prevent a voltage collapse in energy systems, the generating side, e.g. a generator, must be equipped with voltage and frequency protection devices. An undervoltage-controlled reactive power protection is required at the supply system connection point. It detects critical power system situations and ensures that the power generation facility is disconnected from the mains. Furthermore, it ensures that reconnection only takes place under stable power system conditions. The associated criteria can be parameterized.

Synchro-check (ANSI 25)

In case of switching ON the circuit- breaker, the units can check whether the two subnetworks are synchronized.
Voltage-, frequency- and phase-angle-differences are being checked to determine whether synchronous conditions are existent.

Auto-reclosure (ANSI 79)

Multiple reclosures can be defined by the user and lockout will occur if a fault is present after the last reclosure. The following functions are possible:

- 3-pole ARC for all types of faults
- Separate settings for phase and ground faults
- Multiple ARC, one rapid auto-reclosure (RAR) and up to nine delayed auto-reclosures (DAR)

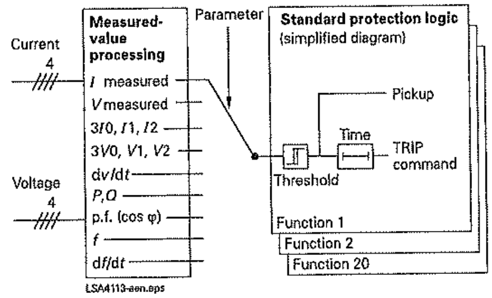

Fig. 9 Flexible protection functions

- Starting of the ARC depends on the trip command selection (e.g. 46, 50, 51, 67)
- Blocking option of the ARC via binary inputs
- ARC can be initiated externally or via CFC
- The directional and non-directional elements can either be blocked or operated non-delayed depending on the auto-reclosure cycle
- Dynamic setting change of the directional and non-directional elements can be activated depending on the ready AR

Thermal overload protection (ANSI 49)

For protecting cables and transformers, an overload protection with an integrated pre-warning element for temperature and current can be applied. The temperature is calculated using a thermal homogeneous-body model (according to IEC 60255-8), which takes account both of the energy entering the equipment and the energy losses. The calculated temperature is constantly adjusted accordingly. Thus, account is taken of the previous load and the load fluctuations.

For thermal protection of motors (especially the stator) a further time constant can be set so that the thermal ratios can be detected correctly while the motor is rotating and when it is stopped. The ambient temperature or the temperature of the coolant can be detected serially via an external temperature monitoring box (resistance-temperature detector box, also called RTD-box). The thermal replica of the overload function is automatically adapted to the ambient conditions. If there is no RTD-box it is assumed that the ambient temperatures are constant.

Settable dropout delay times

If the devices are used in parallel with electromechanical relays in networks with intermittent faults, the long dropout times of the electromechanical devices (several hundred milliseconds) can lead to problems in terms of time grading. Clean time grading is only possible if the dropout time is approximately the same. This is why the parameter of dropout times can be defined for certain functions such as time-over-current protection, ground short-circuit and phase-balance current protection.

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■ **Motor protection**

Restart inhibit (ANSI 66/86)

If a motor is started up too many times in succession, the rotor can be subject to thermal overload, especially the upper edges of the bars. The rotor temperature is calculated from the stator current. The reclosing lockout only permits start-up of the motor if the rotor has sufficient thermal reserves for a complete start-up (see Fig. 10).

Emergency start-up

This function disables the reclosing lockout via a binary input by storing the state of the thermal replica as long as the binary input is active. It is also possible to reset the thermal replica to zero.

Temperature monitoring (ANSI 38)

One temperature monitoring box with a total of 12 measuring sensors can be used for temperature monitoring and detection by the protection relay. The thermal status of motors, generators and transformers can be monitored with this device. Additionally, the temperature of the bearings of rotating machines are monitored for limit value violation. The temperatures are being measured with the help of temperature detectors at various locations of the device to be protected. This data is transmitted to the protection relay via one or two temperature monitoring boxes (see "Accessories", page 5/115).

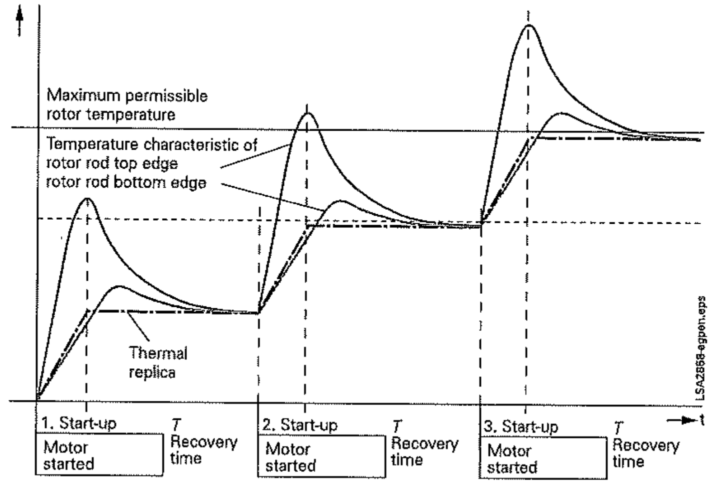

Fig. 10

Starting time supervision (ANSI 48/14)

Starting time supervision protects the motor against long unwanted start-ups that might occur in the event of excessive load torque or excessive voltage drops within the motor, or if the rotor is locked. Rotor temperature is calculated from measured stator current. The tripping time is calculated according to the following equation:

for $I > I_{\text{MOTOR START}}$

$$t = \left(\frac{I_A}{I}\right)^2 \cdot T_A$$

I = Actual current flowing

$I_{\text{MOTOR START}}$ = Pickup current to detect a motor start

t = Tripping time

I_A = Rated motor starting current

T_A = Tripping time at rated motor starting current (2 times, for warm and cold motor)

The characteristic (equation) can be adapted optimally to the state of the motor by applying different tripping times T_A in dependence of either cold or warm motor state. For differentiation of the motor state the thermal model of the rotor is applied.

If the trip time is rated according to the above formula, even a prolonged start-up and reduced voltage (and reduced start-up current) will be evaluated correctly. The tripping time is inverse (current dependent).

A binary signal is set by a speed sensor to detect a blocked rotor. An instantaneous tripping is effected.

Load jam protection (ANSI 51M)

Sudden high loads can cause slowing down and blocking of the motor and mechanical damages. The rise of current due to a load jam is being monitored by this function (alarm and tripping).

The overload protection function is too slow and therefore not suitable under these circumstances.

Phase-balance current protection (ANSI 46) (Negative-sequence protection)

The negative-sequence / phase-balance current protection detects a phase failure or load unbalance due to network asymmetry and protects the rotor from impermissible temperature rise.

Undercurrent monitoring (ANSI 37)

With this function, a sudden drop in current, which can occur due to a reduced motor load, is detected. This may be due to shaft breakage, no-load operation of pumps or fan failure.

Motor statistics

Essential information on start-up of the motor (duration, current, voltage) and general information on number of starts, total operating time, total down time, etc. are saved as statistics in the device.

■ **Voltage protection**

Overvoltage protection (ANSI 59)

The two-element overvoltage protection detects unwanted network and machine overvoltage conditions. The function can operate either with phase-to-phase, phase-to-ground, positive phase-sequence or negative phase-sequence system voltage. Three-phase and single-phase connections are possible.

Undervoltage protection (ANSI 27)

The two-element undervoltage protection provides protection against dangerous voltage drops (especially for electric machines). Applications include the isolation of generators or motors from the network to avoid undesired operating states and a possible loss of stability. Proper operating conditions of electrical machines are best evaluated with the positive-sequence quantities. The protection function is active over a wide frequency range (25 to 70 Hz). Even when falling below this frequency range the function continues to work, however, with a greater tolerance band.

The function can operate either with phase-to-phase, phase-to-ground or positive phase-sequence voltage and can be monitored with a current criterion. Three-phase and single-phase connections are possible.

Frequency protection (ANSI 81O/U)

Frequency protection can be used for over- frequency and under-frequency protection. Electric machines and parts of the system are protected from unwanted speed deviations. Unwanted frequency changes in the network can be detected and the load can be removed at a specified frequency setting.

There are four elements (select- able as overfrequency or underfrequency) and each element can be delayed separately. Blocking of the frequency protection can be performed if using a binary input or by using an undervoltage element.

Fault locator (ANSI 21FL)

The integrated fault locator calculates the fault impedance and the distance-to-fault. The results are displayed in Ω, kilometers (miles) and in percent of the line length.

Circuit-breaker wear monitoring

Methods for determining circuit-breaker contact wear or the remaining service life of a circuit-breaker (CB) allow CB maintenance intervals to be aligned to their actual degree of wear. The benefit lies in reduced maintenance costs.

There is no mathematically exact method of calculating the wear or the remaining service life of circuit-breakers that takes into account the arc-chamber's physical conditions when the CB opens. This is why various methods of determining CB wear have evolved which reflect the different operator philosophies. To do justice to these, the devices offer several methods:

- ΣI
- ΣI^x, with x = 1... 3
- Σi^2t

The devices additionally offer a new method for determining the remaining service life:

- Two-point method

The CB manufacturers double-logarithmic switching cycle diagram (see Fig. 11) and the breaking current at the time of contact opening serve as the basis for this method. After CB opening, the two-point method calculates the number of still possible switching cycles. To this end, the two points P1 and P2 only have to be set on the device. These are specified in the CB's technical data.

All of these methods are phase-selective and a limit value can be set in order to obtain an alarm if the actual value falls below or exceeds the limit value during determination of the remaining service life.

Customized functions (ANSI 32, 51V, 55, etc.)

Additional functions, which are not time critical, can be implemented via the CFC using measured values. Typical functions include reverse power, voltage controlled overcurrent, phase angle detection, and zero-sequence voltage detection.

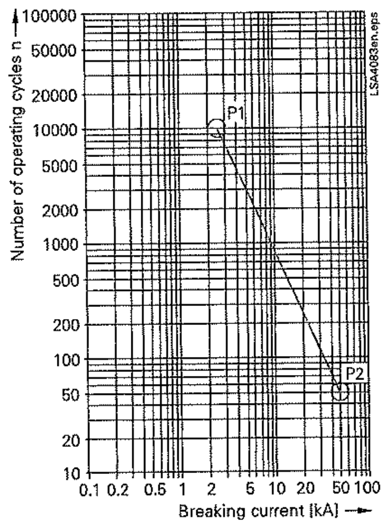

Fig. 11 CB switching cycle diagram

Commissioning

Commissioning could hardly be easier and is fully supported by DIGSI 4. The status of the binary inputs can be read individually and the state of the binary outputs can be set individually. The operation of switching elements (circuit-breakers, disconnect devices) can be checked using the switching functions of the bay controller. The analog measured values are represented as wide-ranging operational measured values. To prevent transmission of information to the control center during maintenance, the bay controller communications can be disabled to prevent unnecessary data from being transmitted. During commissioning, all indications with test marking for test purposes can be connected to a control and protection system.

Test operation

During commissioning, all indications can be passed to an automatic control system for test purposes.

Control and automatic functions

Control

In addition to the protection functions, the SIPROTEC 4 units also support all control and monitoring functions that are required for operating medium-voltage or high-voltage substations.

The main application is reliable control of switching and other processes.

The status of primary equipment or auxiliary devices can be obtained from auxiliary contacts and communicated to the SIPROTEC 7SJ66 via binary inputs. Therefore it is possible to detect and indicate both the OPEN and CLOSED position or a fault or intermediate circuit-breaker or auxiliary contact position.

The switchgear or circuit-breaker can be controlled via:
– integrated operator panel
– binary inputs
– substation control and protection system
– DIGSI 4

Automation / user-defined logic

With integrated logic, the user can set, via a graphic interface (CFC), specific functions for the automation of switchgear or substation. Functions are activated via function keys, binary input or via communication interface.

Switching authority

Switching authority is determined according to parameters and communication.

If a source is set to "LOCAL", only local switching operations are possible. The following sequence of switching authority is laid down: "LOCAL"; DIGSI PC program, "REMOTE".

Command processing

All the functionality of command processing is offered. This includes the processing of single and double commands with or without feedback, sophisticated monitoring of the control hardware and software, checking of the external process, control actions using functions such as runtime monitoring and automatic command termination after output. Here are some typical applications:

- Single and double commands using 1, 1 plus 1 common or 2 trip contacts
- User-definable bay interlocks
- Operating sequences combining several switching operations such as control of circuit-breakers, disconnectors and grounding switches
- Triggering of switching operations, indications or alarm by combination with existing information

Assignment of feedback to command

The positions of the circuit-breaker or switching devices and transformer taps are acquired by feedback. These indication inputs are logically assigned to the corresponding command outputs. The unit can therefore distinguish whether the indication change is a consequence of switching operation or whether it is a spontaneous change of state.

Chatter disable

Chatter disable feature evaluates whether, in a configured period of time, the number of status changes of indication input exceeds a specified figure. If exceeded, the indication input is blocked for a certain period, so that the event list will not record excessive operations.

Indication filtering and delay

Binary indications can be filtered or delayed.

Filtering serves to suppress brief changes in potential at the indication input. The indication is passed on only if the indication voltage is still present after a set period of time. In the event of indication delay, there is a wait for a preset time. The information is passed on only if the indication voltage is still present after this time.

Indication derivation

A further indication (or a command) can be derived from an existing indication. Group indications can also be formed. The volume of information to the system interface can thus be reduced and restricted to the most important signals.

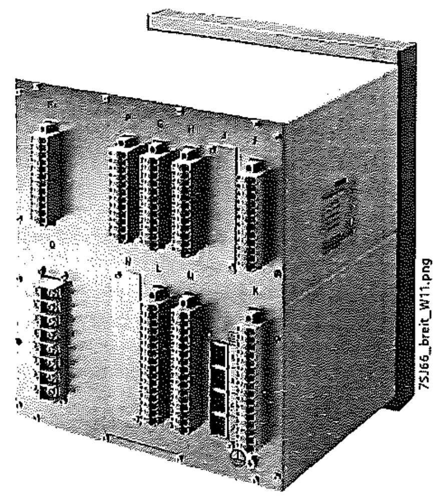

Fig. 12 SIPROTEC 7SJ663 rear view with communication ports

Switchgear cubicles for high/medium voltage

All units are designed specifically to meet the requirements of high/medium-voltage applications.

In general, no separate measuring instruments (e.g., for current, voltage, frequency, ...) or additional control components are necessary.

Measured values

The r.m.s. values are calculated from the acquired current and voltage along with the power factor, frequency, active and reactive power. The following functions are available for measured value processing:

- Currents I_{L1}, I_{L2}, I_{L3}, I_E, I_{EE} (67Ns)
- Voltages V_{L1}, V_{L2}, V_{L3}, V_{L1L2}, V_{L2L3}, V_{L3L1}
- Symmetrical components I_1, I_2, $3I_0$; V_1, V_2, V_0
- Power Watts, Vars, VA/P, Q, S (P, Q: total and phase selective)
- Power factor (cos φ), (total and phase selective)
- Frequency
- Energy ± kWh, ± kVarh, forward and reverse power flow
- Mean as well as minimum and maximum current and voltage values
- Operating hours counter
- Mean operating temperature of overload function
- Limit value monitoring
  Limit values are monitored using programmable logic in the CFC. Commands can be derived from this limit value indication.
- Zero suppression
  In a certain range of very low measured values, the value is set to zero to suppress interference.

Communication

In terms of communication, the units offer substantial flexibility in the context of connection to industrial and power automation standards.

USB interface

There is a USB interface on the front of the relay. All the relay functions can be parameterized on PC by using DIGSI. Commissioning tools and fault analysis are built into the DIGSI program and are used through this interface.

Rear interfaces

- Time synchronization interface
  All units feature a permanently integrated electrical time synchronization interface. It can be used to feed timing telegrams in IRIG-B or DCF77 format into the units via time synchronization receivers.
- System interface
  Communication with a central control system takes place through this interface. The units can exchange data through this interface via Ethernet and IEC 61850 protocol and can also be operated by DIGSI.
- Service interface
  The service interface was conceived for remote access to a number of protection units via DIGSI. It also allows communication via modem. For special applications, a temperature monitoring box (RTD box) can be connected to this interface.

System interface protocols

IEC 61850 protocol

The Ethernet-based IEC 61850 protocol is the worldwide standard for protection and control systems used by power supply corporations. Siemens was the first manufacturer to support this standard. By means of this protocol, information can also be exchanged directly between bay units so as to set up simple masterless systems for bay and system interlocking. Access to the units via the Ethernet bus is also possible with DIGSI.

IEC 60870-5-103 protocol

The IEC 60870-5-103 protocol is an international standard for the transmission of protective data and fault recordings. All messages from the unit and also control commands can be transferred by means of published, Siemens-specific extensions to the protocol.

Redundant solutions are also possible. Optionally it is possible to read out and alter individual parameters (only possible with the redundant module).

Modbus RTU protocol

This serial protocol is mainly used in industry and by power supply corporations, and is supported by a number of unit manufacturers. SIPROTEC units function as Modbus slaves, making their information available to a master or receiving information from it. A time-stamped event list is available.

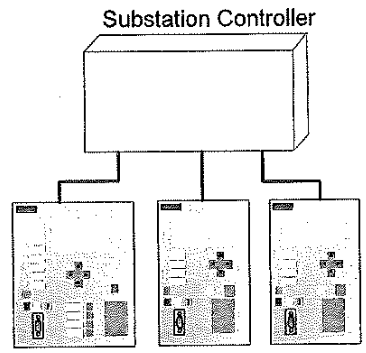

Fig. 13 IEC 60870-5-103: Radial electrical connection

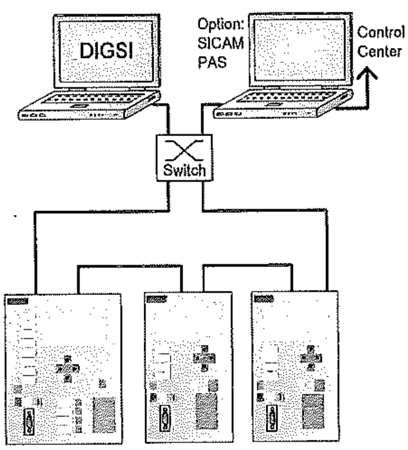

Fig. 14 Bus structure for station bus with Ethernet and IEC 61850, electrical and optical ring

DNP3

DNP (Distributed Network Protocol, version 3) is a messaging-based communication protocol. SIPROTEC 7SJ66 is fully Level 1 and Level 2-compliant with DNP3, which is supported by a number of protection units manufactures.

5

SIPROTEC 7SJ66

Selection table

Selection table for multifunctional overcurrent protection devices							
Device	7SJ80	7SJ61	7SJ62	7SJ63	7SJ64	7SJ82	7SJ66
Multifunctional protection functions	✓	✓	✓	✓	✓	✓	✓
CTs	4	4	4	4	4	4	4
VTs	0/3	0	3/4	3	4	0/4	4
Binary inputs incl. Life contact	3 - 11	3 - 11	8 - 11	11 - 37	7 - 48	11 - 23	16 - 36
Binary outputs	5 - 9	4 - 9	6 - 9	8 - 19	5 - 26	8 - 16	7 - 24
Spring-type terminals	-	-	-	-	-	-	✓
Auxiliary voltage	DC 24 - 250 V AC 115 - 230 V	DC 24 - 250 V AC 115 - 230 V	DC 24 - 250 V AC 115 - 230 V	DC 24 - 250 V AC 115 - 230 V	DC 24 - 250 V AC 115 - 230 V	DC 24 - 250 V AC 115 - 230 V	DC 110 - 250 V AC 115 - 230 V
UL listing	✓	✓	✓	✓	✓	✓	-
Surface mounting case	●	●	●	●	●	-	-
Detached operator panel	-	-	-	●	●	-	-
Languages	ge/en/es/fr/it/ru/ch	ge/en/es/fr/it/ru	ge/en/es/fr/it/ru	ge/en/es/fr	ge/en/es/fr/it/ru	ge/en/pt/es/ru	en/es/ru
Front USB	✓	-	-	-	-	✓	✓
Interfaces exchangeable	✓	✓	✓	✓	✓	✓	-
IEC 61850	●	●	●	●	●	●	●
IEC 60870-5-103	●	●	●	●	●	●	● (elec.)
Modbus RTU	●	●	●	●	●	●	● (elec.)
Profibus FMS	-	●	●	●	●	-	-
Profibus DP	●	●	●	●	●	-	-
PROFINET I/O	●	●	●	-	●	-	-
DNP3 serial/TCP	●	●	●	-	●	●	●
RSTP	✓	✓	✓	✓	✓	✓	✓
PRP	✓	✓	✓	✓	✓	✓	✓
HSR	✓	✓	✓	✓	✓	✓	-

✓ basic
- not available
● optional

Typical connections

Connection of current and voltage transformers

Standard connection

For grounded networks, the ground current is obtained from the phase currents by the residual current circuit.

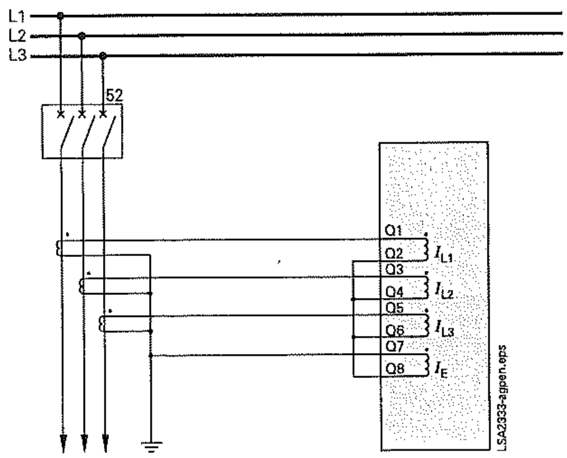

Fig. 15 Residual current circuit without directional element

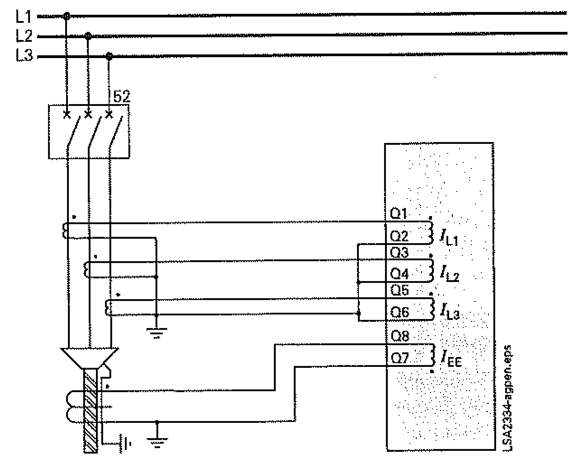

Fig. 16 Sensitive ground-current detection without directional element

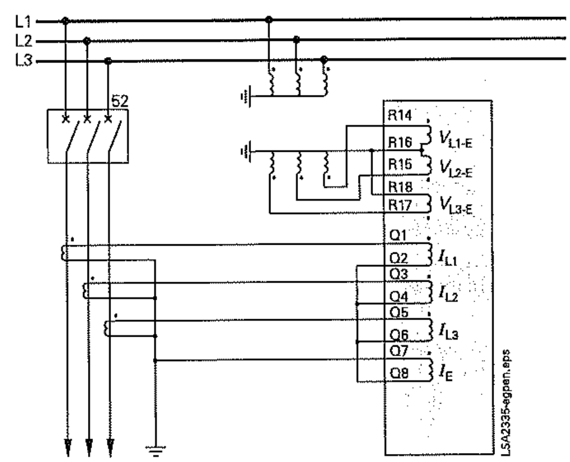

Fig. 17 Residual current circuit with directional element

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Typical connections

Connection for compensated networks

The figure shows the connection of two phase-to-ground voltages and the V_E voltage of the open delta winding and a phase-balance neutral current transformer for the ground current. This connection maintains maximum precision for directional ground-fault detection and must be used in compensated networks. Fig. 19 shows sensitive directional ground-fault detection.

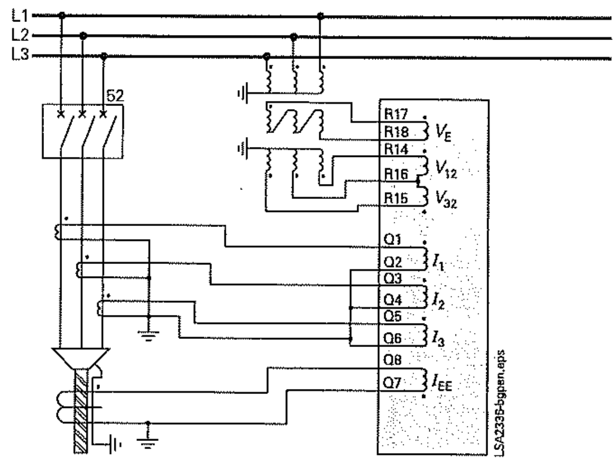


Fig. 18 Sensitive directional ground-fault detection with directional element for phases

Connection for isolated-neutral or compensated networks only

If directional ground-fault protection is not used, the connection can be made with only two phase current transformers. Directional phase short-circuit protection can be achieved by using only two primary transformers.

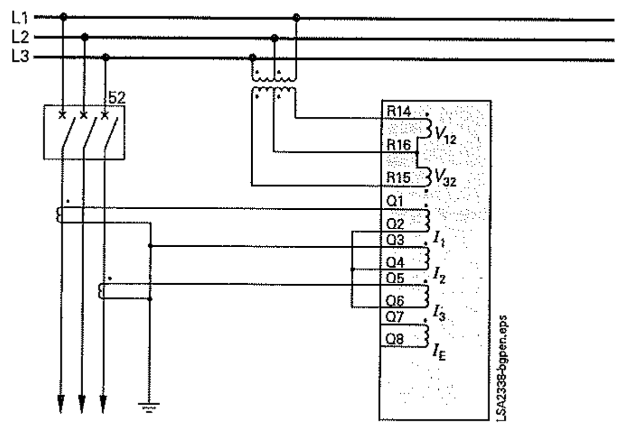


Fig. 19 Isolated-neutral or compensated networks

Connection for the synchro-check function

The 3-phase system is connected as reference voltage, i. e. the outgoing voltages as well as a single-phase voltage, in this case a busbar voltage, that has to be checked for synchronism.

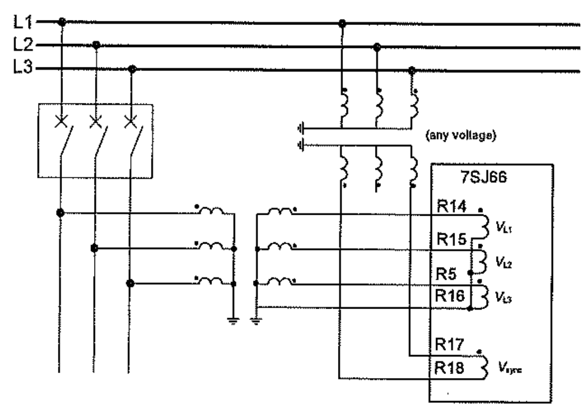


Fig. 20 Measuring of the busbar voltage and the outgoing feeder voltage for the synchro-check

Overview of connection types			
Type of network	*Function*	*Current connection*	*Voltage connection*
(Low-resistance) grounded network	Overcurrent protection phase/ground non-directional	Residual circuit, with 3 phase-current transformers required, phase-balance neutral current transformer possible	–
(Low-resistance) grounded networks	Sensitive ground-fault protection	Phase-balance neutral current transformers required	–
Isolated or compensated networks	Overcurrent protection phases non-directional	Residual circuit, with 3 or 2 phase current transformers possible	–
(Low-resistance) grounded networks	Overcurrent protection phases directional	Residual circuit, with 3 phase-current transformers possible	Phase-to-ground connection or phase-to-phase connection
Isolated or compensated networks	Overcurrent protection phases directional	Residual circuit, with 3 or 2 phase-current transformers possible	Phase-to-ground connection or phase-to-phase connection
(Low-resistance) grounded networks	Overcurrent protection ground directional	Residual circuit, with 3 phase-current transformers required, phase-balance neutral current transformers possible	Phase-to-ground connection required
Isolated networks	Sensitive ground-fault protection	Residual circuit, if ground current > 0.05 I_N on secondary side, otherwise phase-balance neutral current transformers required	3 times phase-to-ground connection or phase-to-ground connection with open delta winding
Compensated networks	Sensitive ground-fault protection cos φ measurement	Phase-balance neutral current transformers required	Phase-to-ground connection with open delta winding required

5

Typical applications

Connection of circuit-breaker

Undervoltage releases

Undervoltage releases are used for automatic tripping of high-voltage motors.

Example:
DC supply voltage of control system fails and manual electric tripping is no longer possible.

Automatic tripping takes place when voltage across the coil drops below the trip limit. In Fig. 21, tripping occurs due to failure of DC supply voltage, by automatic opening of the live status contact upon failure of the protection unit or by short-circuiting the trip coil in event of network fault.

In Fig. 22 tripping is by failure of auxiliary voltage and by interruption of tripping circuit in the event of network failure. Upon failure of the protection unit, the tripping circuit is also interrupted, since contact held by internal logic drops back into open position.

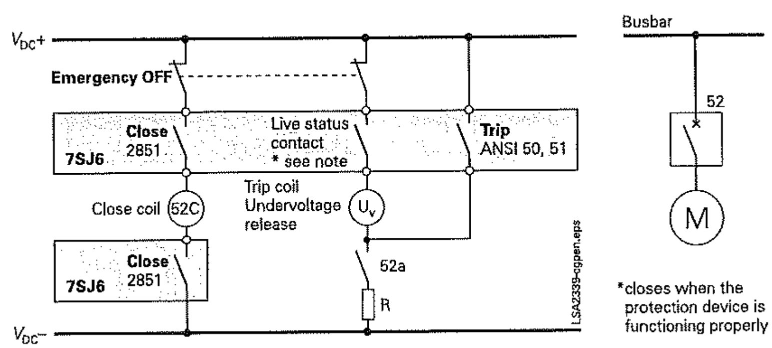


Fig. 21 Undervoltage release with make contact (50, 51)

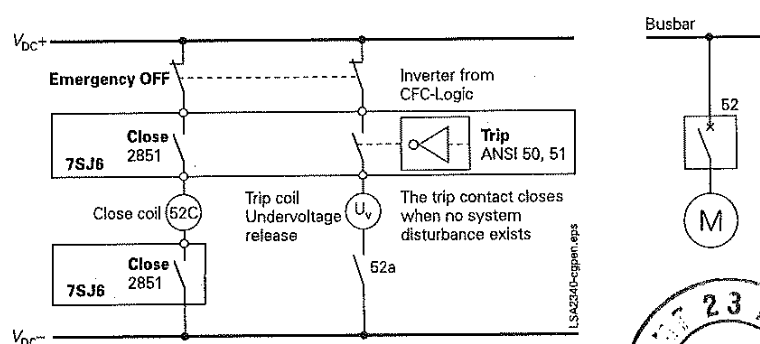


Fig. 22 Undervoltage trip with locking contact (trip signal 50 is inverted).

Typical applications

Trip circuit supervision (ANSI 74TC)

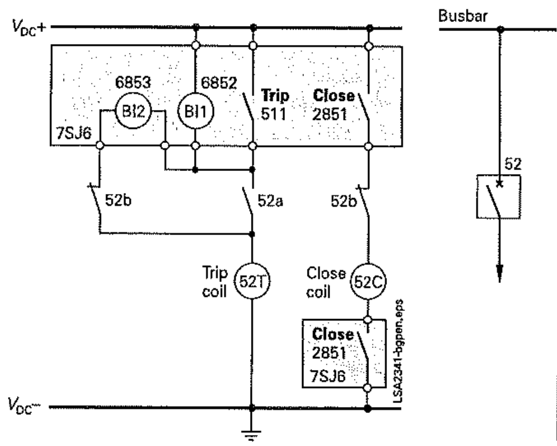
One or two binary inputs can be used for monitoring the circuit-breaker trip coil including its incoming cables. An alarm signal occurs whenever the circuit is interrupted.

Lockout (ANSI 86)

All binary outputs can be stored like LEDs and reset using the LED reset key. The lockout state is also stored in the event of supply voltage failure. Reclosure can only occur after the lockout state is reset.

Reverse-power protection for dual supply (ANSI 32R)

If power is fed to a busbar through two parallel infeeds, then in the event of any fault on one of the infeeds it should be selectively interrupted. This ensures a continued supply to the busbar through the remaining infeed. For this purpose, directional devices are needed which detect a short-circuit current or a power flow from the busbar in the direction of the infeed. The directional overcurrent protection is usually set via the load current. It cannot be used to deactivate low-current faults. Reverse-power protection can be set far below the rated power. This ensures that it also detects power feedback into the line in the event of low-current faults with levels far below the load current.
Reverse-power protection is performed via the "flexible protection functions" of the SIPROTEC 7SJ66.



Protection indications
511* General trip
2851* CB close command
6852* Trip circuit supervision: Trip relay
6853* Trip circuit supervision: CB aux
52a open, when CB is open
52b open, when CB is closed
BI Binary input

TRIP contact	Breaker	BI1	BI2
open	closed	H	L
open	open	H	H
closed	closed	L	L
closed	open	L	H

Fig. 23 Trip circuit supervision with 2 binary inputs

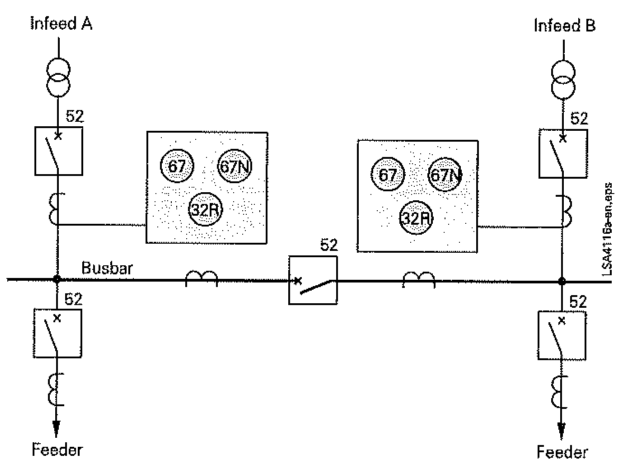


Fig. 24 Reverse-power protection for dual supply

Description	Order No.	
	1 2 3 4 5 6 7 - 8 9 10 11 12 - 13 14 15 16 - 17 18 19	
SIPROTEC 7SJ66 multifunction protection relay and bay controller	7SJ66□□-□□□□□-□□□□-□□□	
Housing, inputs, outputs		
Housing 1/3 19", 4 x U, 4 x I, 16 BI, 7 BO, 1 life contact	1	
Housing 1/3 19", 4 x U, 4 x I, 22 BI, 10 BO, 1 life contact	2	
Housing 1/2 19", 4 x U, 4 x I, 36 BI, 23 BO, 1 life contact, 4 function keys	3	
Measuring inputs		
I_{ph} = 1 A, I_N = 1 A (min. = 0.05 A) Position 15 only with **A, C, E, G**	1	
I_{ph} = 1 A, I_N = sensitive (min. = 0.001 A) Position 15 only with **B, D, F, H**	2	
I_{ph} = 5 A, I_N = 5 A (min. = 0.25 A) Position 15 only with **A, C, E, G**	5	
I_{ph} = 5 A, I_N = sensitive (min. = 0.001 A) Position 15 only with **B, D, F, H**	6	
Rated auxiliary voltage (power supply, indication voltage)		
DC 110 to 250 V, AC 115 to 230 V, threshold binary input DC 69 V	5	
DC 110 to 250 V, AC 115 to 230 V, threshold binary input DC 138V	6	
Construction		
Flush-mounting case, screw-type terminals, 8-line text display	D	
Flush-mounting case, spring-type terminals (direct connection), screw-type terminals for CT connection (direct connection/ring-type cable lugs), 8-line text display	E	
Flush-mounting case, screw-type terminals, graphical display	J	
Flush-mounting case, spring-type terminals (direct connection), screw-type terminals for CT connection (direct connection/ring-type cable lugs), graphical display	K	
Region-specific default settings/function versions and language settings		
Region World, 50/60 Hz, IEC/ANSI, language: English (language can be changed)	B	
Region World, 50/60 Hz, IEC/ANSI, language: Spanish (language can be changed)	E	
Region RU, 50/60 Hz, IEC/ANSI, language: Russian (language can be changed)	G	
System interface (Port B)		
No system interface	0	
IEC 60870-5-103, electrical RS485, RJ45-connector [1]	2	
Modbus RTU, electrical RS485, RJ45-connector [1]	9	L 0 D
DNP3, RS485 [1]	9	L 0 G
IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45-connector [2]	9	L 0 R
IEC 61850, 100 Mbit Ethernet, optical, double, LC-connector [2]	9	L 0 S
DNP3 + IEC 61850, 100 Mbit Ethernet, electrical, double, RJ45-connector [2]	9	L 2 R
DNP3 + IEC 61850, 100 Mbit Ethernet, optical, double, LC-connector [2]	9	L 2 S
Service interface (Port C)		
No interface	0	
DIGSI 4/Modem/RTD-box, electrical RS485, RJ45-connector	2	
Ethernet port (DIGSI port, RTD box connection, not IEC 61850), RJ45-connector	6	

Continued on next page

Functionality

See next page

1) only available with position 12 = 0 or 2

2) only available with position 12 = 0 or 6

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Selection and ordering data

Description			Order No.	Order code
SIPROTEC 7SJ66 multifunction protection relay and bay controller			1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 7SJ66□□-□□□□□-□□□□-□□□	
Basic version	ANSI No.	Description		
	Control			
	50/51	Overcurrent protection $I>$, $I>>$, $I>>>$, I_p	F A	
	50N/51N	Ground-fault protection $I_E>$, $I_E>>$, $I_E>>>$, I_{Ep}		
	50N/51N	Insensitive ground-fault protection via IEE function: $I_{EE}>$, $I_{EE}>>$, I_{EEp} [1)]		
	50/50N	Flexible protection functions (index quantities derived from current): Additional time-overcurrent protection stages $I_2>$, $I>>>>$, $I_E>>>>$		
	51 V	Voltage-dependent inverse-time overcurrent protection		
	49	Overload protection (with 2 time constants)		
	46	Phase balance current protection (negative-sequence protection)		
	37	Undercurrent monitoring		
	47	Phase sequence		
	59N/64	Displacement voltage		
	50BF	Breaker failure protection		
	74TC	Trip circuit supervision, 4 setting groups, cold-load pickup Inrush blocking		
	86	Lockout		
Basic+ V,P,f		Basic version (see above)	F E	
	27/59	Under-/overvoltage		
	81O/U	Under-/overfrequency		
	27Q	Undervoltage-controlled reactive power protection		
	27/47/59(N) 32/55/81R	Flexible protection (index quantities derived from current and voltages): Voltage, power, p.f., rate-of-frequency-change protection		
Basic + V,P,f IEF		Basic version (see above)	P E	
	27/59	Under-/overvoltage		
	81O/U	Under-/overfrequency		
	27Q	Undervoltage-controlled reactive power protection		
	27/47/59(N) 32/55/81R	Flexible protection (index quantities derived from current and voltages): Voltage, power, p.f., rate-of-frequency-change protection		
Basic + Dir		Basic version (see above)	F C	
	67/67N	Direction determination for overcurrent, phases and ground		
Basic + Dir V,P,f		Basic version (see above)	F G	
	67/67N	Direction determination for overcurrent, phases and ground		
	27/59	Under-/overvoltage		
	81O/U	Under-/overfrequency		
	27Q	Undervoltage-controlled reactive power protection		
	27/47/59(N) 32/55/81R	Flexible protection (index quantities derived from current and voltages): Voltage, power, p.f., rate-of-frequency-change protection		
Basic + Dir V,P,f IEF		Basic version (see above)	P G	
	67/67N	Direction determination for overcurrent, phases and ground		
	27/59	Under-/overvoltage		
	81O/U	Under-/overfrequency		
	27Q	Undervoltage-controlled reactive power protection		
	27/47/59(N) 32/55/81R	Flexible protection (index quantities derived from current and voltages): Voltage, power, p.f., rate-of-frequency-change protection		
Basic + Dir IEF		Basic version (see above)	P C	
	67/67N	Direction determination for overcurrent, phases and ground		

Continued on next page

V, P, f = Voltage, power, frequency protection
Dir = Directional overcurrent protection
IEF = Intermittent ground fault

1) only with position 7 = 1 or 5 (non-sensitive ground current input)

5

Description			Order No.	Order code
			1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	
SIPROTEC 7SJ66 multifunction protection relay and bay controller			7SJ66□□-□□□□□-□□□□-□□□	

	ANSI No.	Description	Pos. 14	Pos. 15
Basic + Sens.earth-f-det. Dir REF		Basic version (see page before)	F	D 2)
	67/67N	Direction determination for overcurrent, phases and ground		
	67Ns	Directional sensitive ground-fault detection		
	67Ns	Directional intermittent ground fault protection		
Basic + Sens.earth-f-det. Dir IEF REF		Basic version (see page before)	P	D 2)
	67/67N	Direction determination for overcurrent, phases and ground		
	67Ns	Directional sensitive ground-fault detection		
	67Ns	Directional intermittent ground fault protection		
	87N	High-impedance restricted ground fault		
		Intermittent earth-fault		
Basic + Sens.earth-f-det. V,P,f REF		Basic version (see page before)	F	F 2)
	67Ns	Directional sensitive ground-fault detection		
	67Ns	Directional intermittent ground fault protection		
	87N	High-impedance restricted ground fault		
	27/59	Under-/overvoltage		
	81O/U	Under-/overfrequency		
	27Q	Undervoltage-controlled reactive power protection		
	27/47/59(N) 32/55/81R	Flexible protection (index quantities derived from current and voltages): Voltage, power, p.f., rate-of-frequency-change protection		
Basic + Sens.earth-f-det. REF		Basic version (see page before)	F	B 2)
	67Ns	Directional sensitive ground-fault detection		
	67Ns	Directional intermittent ground fault protection		
	87N	High-impedance restricted ground fault		
Basic + Sens.earth-f-det. Motor V,P,f REF		Basic version (see page before)	H	F 2)
	67Ns	Directional sensitive ground-fault detection		
	67Ns	Directional intermittent ground fault protection		
	87N	High-impedance restricted ground fault		
	48/14	Starting ime supervision, locked rotor		
	66/86	Restart inhibit		
	51M	Motor load jam protection		
		Motor statistics		
	27/59	Under-/overvoltage		
	81O/U	Under-/overfrequency		
	27Q	Undervoltage-controlled reactive power protection		
	27/47/59(N) 32/55/81R	Flexible protection (index quantities derived from current and voltages): Voltage, power, p.f., rate-of-frequency-change protection		
Basic + Sens.earth-f-det. Motor Dir V,P,f REF		Basic version (see page before)	H	H 2)
	67/67N	Direction determination for overcurrent, phases and ground		
	67Ns	Directional sensitive ground-fault detection		
	67Ns	Directional intermittent ground fault protection		
	87N	High-impedance restricted ground fault		
	48/14	Starting ime supervision, locked rotor		
	66/86	Restart inhibit		
	51M	Motor load jam protection		
		Motor statistics		
	27/59	Under-/overvoltage		
	81O/U	Under-/overfrequency		
	27Q	Undervoltage-controlled reactive power protection		
	27/47/59(N) 32/55/81R	Flexible protection (index quantities derived from current and voltages): Voltage, power, p.f., rate-of-frequency-change protection		

Continued on next page

V, P, f = Voltage, power, frequency protection
Dir = Directional overcurrent protection
IEF = Intermittent ground fault
REF = Restricted earth fault

2) For isolated/compensated networks, only with position 7=2,6 (sensitive earth current input)

ВЯРНО С ОРИГИНАЛА

СОФИЯ

000325

SIPROTEC 7SJ66

Selection and ordering data

Description			Order No.	Order code
SIPROTEC 7SJ66 multifunction protection relay and bay controller			12345 6 7 8 9 101112 13141516 171819 7SJ66□□-□□□□□-□□□□ □□□	
	ANSI No.	Description		
Basic + Sens.earth-f-det. Motor Dir IEF V,P,f REF		Basic version (see page 20)	R H 2)	
	67/67N	Direction determination for overcurrent, phases and ground		
	67Ns	Directional sensitive ground-fault detection		
	67Ns	Directional intermittent ground fault protection		
	87N	High-impedance restricted ground fault		
	48/14	Starting ime supervision, locked rotor		
	66/86	Restart inhibit		
	51M	Motor load jam protection		
		Motor statistics		
	27/59	Under-/overvoltage		
	81O/U	Under-/overfrequency		
	27Q	Undervoltage-controlled reactive power protection		
	27/47/59(N) 32/55/81R	Flexible protection (index quantities derived from current and voltages): Voltage, power, p.f., rate-of-frequency-change protection		
Basic + Motor Dir V,P,f		Basic version (see page 20)	H G	
	67/67N	Direction determination for overcurrent, phases and ground		
	48/14	Starting ime supervision, locked rotor		
	66/86	Restart inhibit		
	51M	Motor load jam protection		
		Motor statistics		
	27/59	Under-/overvoltage		
	81O/U	Under-/overfrequency		
	27Q	Undervoltage-controlled reactive power protection		
	27/47/59(N) 32/55/81R	Flexible protection (index quantities derived from current and voltages): Voltage, power, p.f., rate-of-frequency-change protection		
Basic + Motor		Basic version (see page 20)	H A	
	48/14	Starting ime supervision, locked rotor		
	66/86	Restart inhibit		
	51M	Motor load jam protection		
		Motor statistics		
		Measuring/fault recording	13 □	
		With fault recording	1	
		With fault recording, average values, min/max values	3	
		Auto reclosing, fault locator, synchro-check	16 □	
		Without	0	
	79	With 79	1	
	21FL	With fault locator	2	
	79,21FL	With 79 and fault locator	3	
	25	With synchronization	4 3)	
	25, 79, 21FL	With synchronization, 79 and fault locator	7 3)	

V, P, f = Voltage, power, frequency protection
Dir = Directional overcurrent protection
IEF = Intermittent ground fault

3) Synchrocheck (no asynchronous switching), one function group

Accessories	Description	Order No.
	DIGSI 4 Software for engineering and operation of all Siemens protection devices up to SIPROTEC 4 and SIPROTEC Compact. Supports MS Windows 7 Professional/Ultimate/Enterprise and MS Windows Server 2008 R2.	
	Basic Full version with license for 10 computers, on CD-ROM (authorization by serial number)	7XS5400-0AA00
	Professional DIGSI 4 Basic and additionally SIGRA (fault record analysis), CFC Editor (logic editor), Display Editor (editor for default and control displays) and DIGSI 4 Remote (remote operation)	7XS5402-0AA00
	Professional + IEC 61850 Complete version: DIGSI 4 Basic and additionally SIGRA (fault record analysis), CFC Editor (logic editor), Display Editor (editor for control displays), DIGSI 4 Remote (remote operation) + IEC 61850 system configurator	7XS5403-0AA00
	IEC 61850 System configurator Software for configuration of stations with IEC 61850 communication under DIGSI, running under MS Windows Server 2008 / XP Professional Edition / Windows 7 Ultimate / Enterprise Optional package for DIGSI 4 Basis or Professional License for 10 PCs. Authorization by serial number. On CD-ROM	7XS5460-0AA00
	SIGRA 4 Software for engineering and operation of all Siemens protection devices up to SIPROTEC 4 and SIPROTEC Compact. Supports MS Windows 7 Professional/Ultimate/Enterprise and MS Windows Server 2008 R2.	7XS5410-0AA00
	Temperature monitoring box	
	RTD-box TR1200 (RS 485)	7XV5662-6AD10
	RTD-box TR1200 IP (Ethernet)	7XV5662-8AD10
	Varistor/Voltage Arrester Voltage arrester for high-impedance REF protection	
	125 Vrms; 600 A; 1S/S 256	C53207-A401-D76-1
	240 Vrms; 600 A; 1S/S 1088	C53207-A401-D77-1
	Manual for 7SJ66	
	English	C53000-B1140-C383-x [1)]

1) x = please inquire for latest edition (exact Order No.)

ВЯРНО С ОРИГИНАЛА

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Connection diagram

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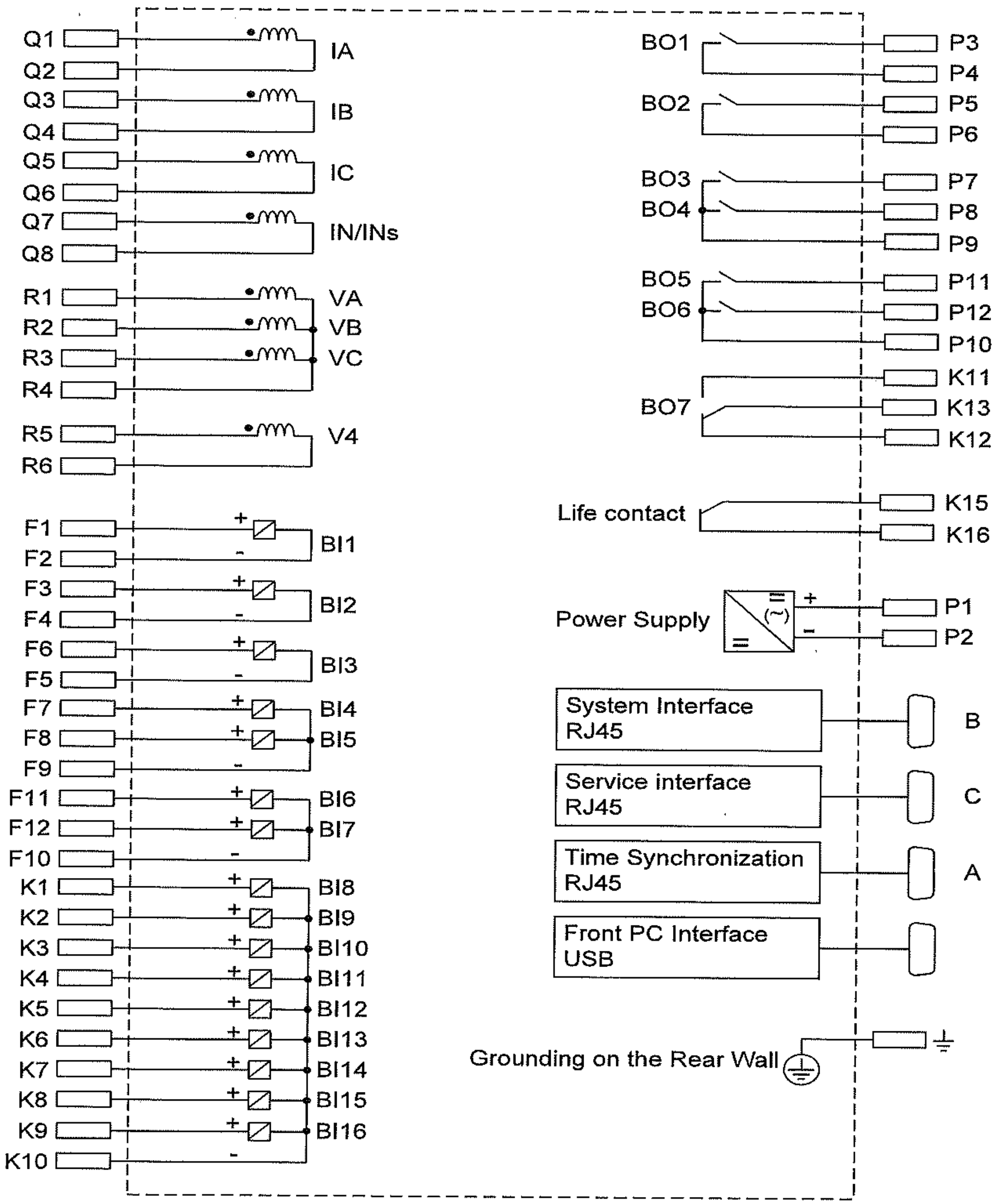

Fig. 25 SIPROTEC 7SJ661 connection diagram

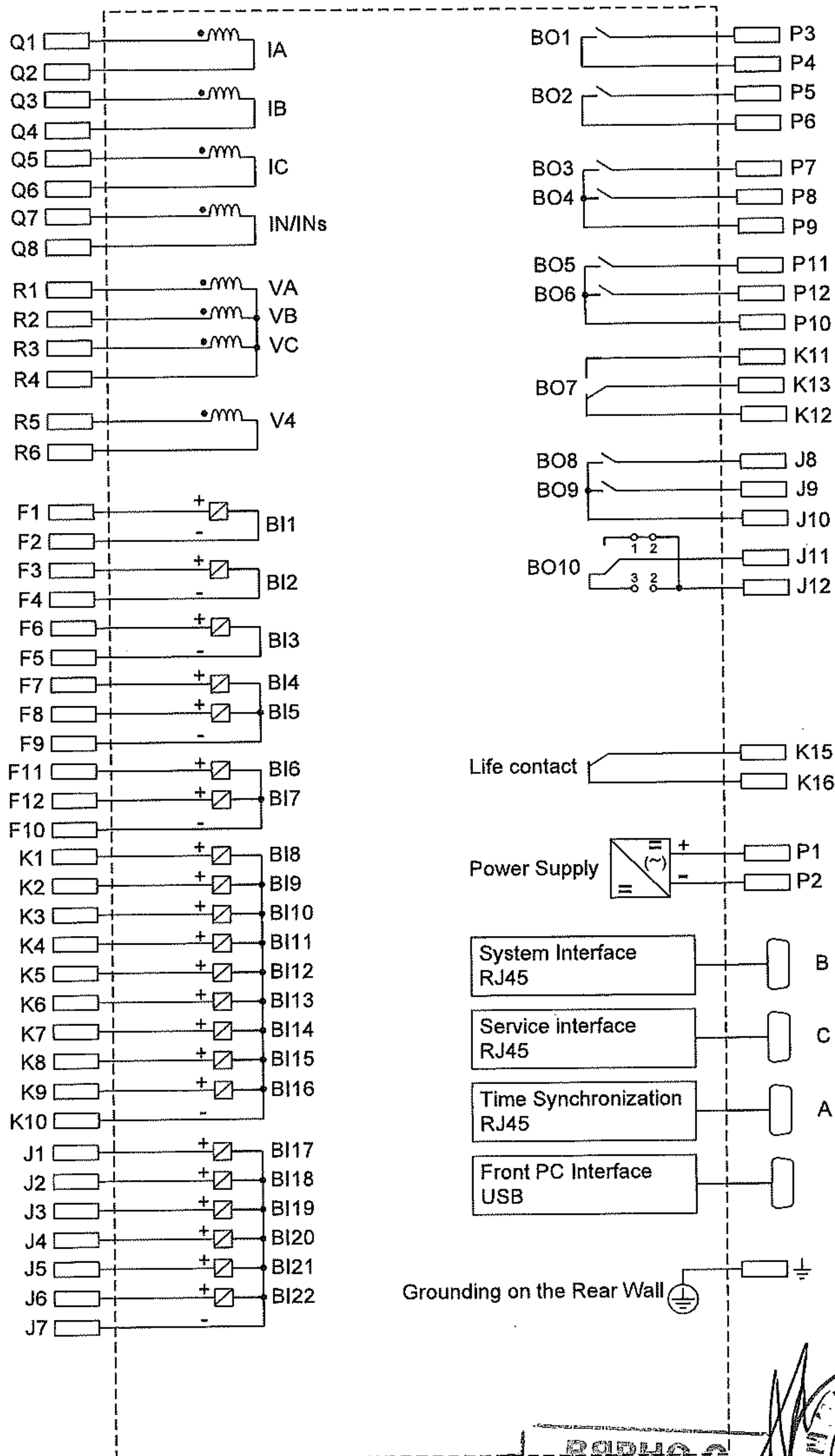

Fig. 26 SIPROTEC 7SJ662 connection diagram

ВЯРНО С ОРИГИНАЛА

МИС 23 ЕООД СОФИЯ MIS 23 LTD

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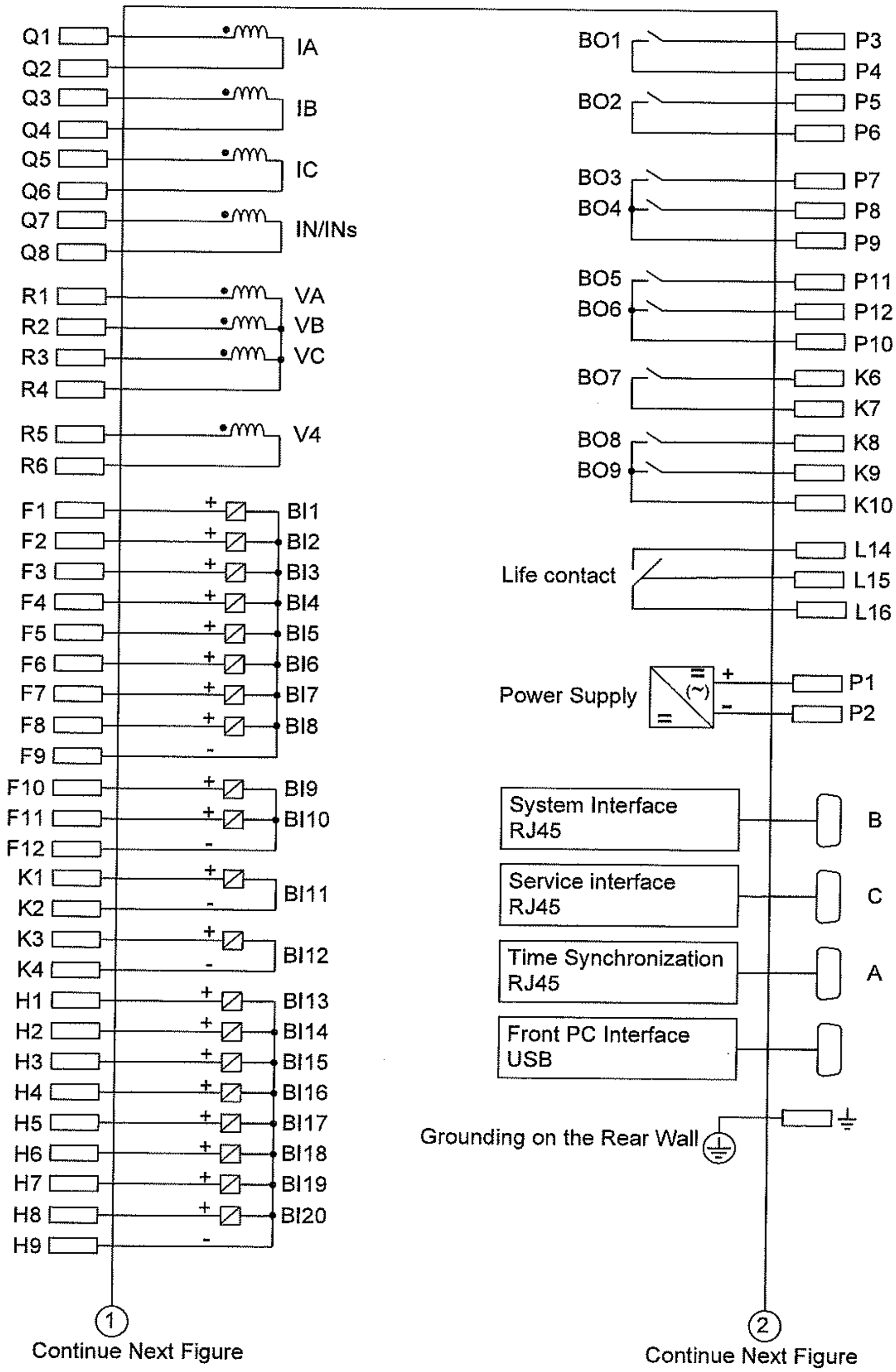

Fig. 27 SIPROTEC 7SJ663 connection diagram

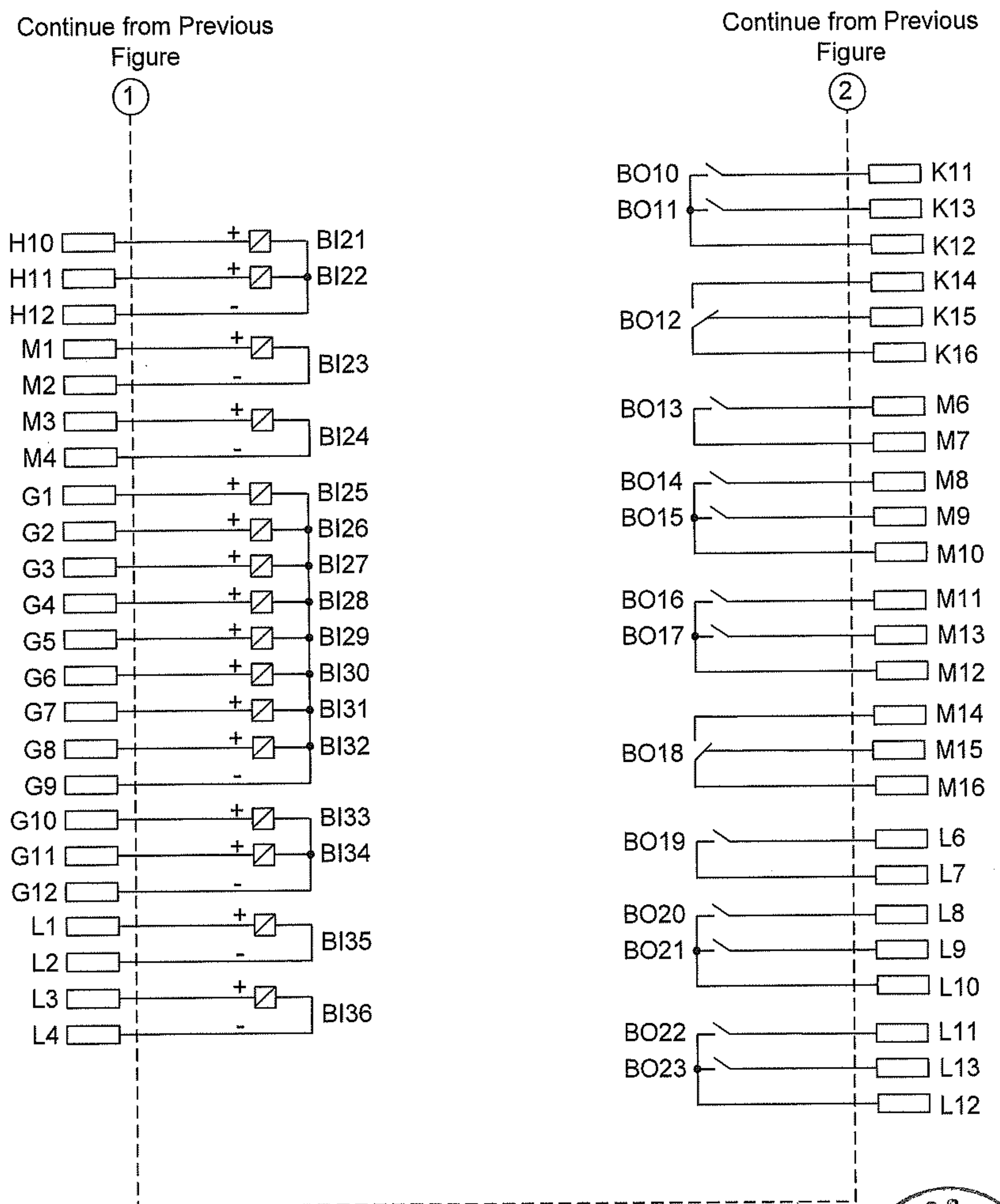

Fig. 28 SIPROTEC 7SJ663 connection diagram

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Dimensions

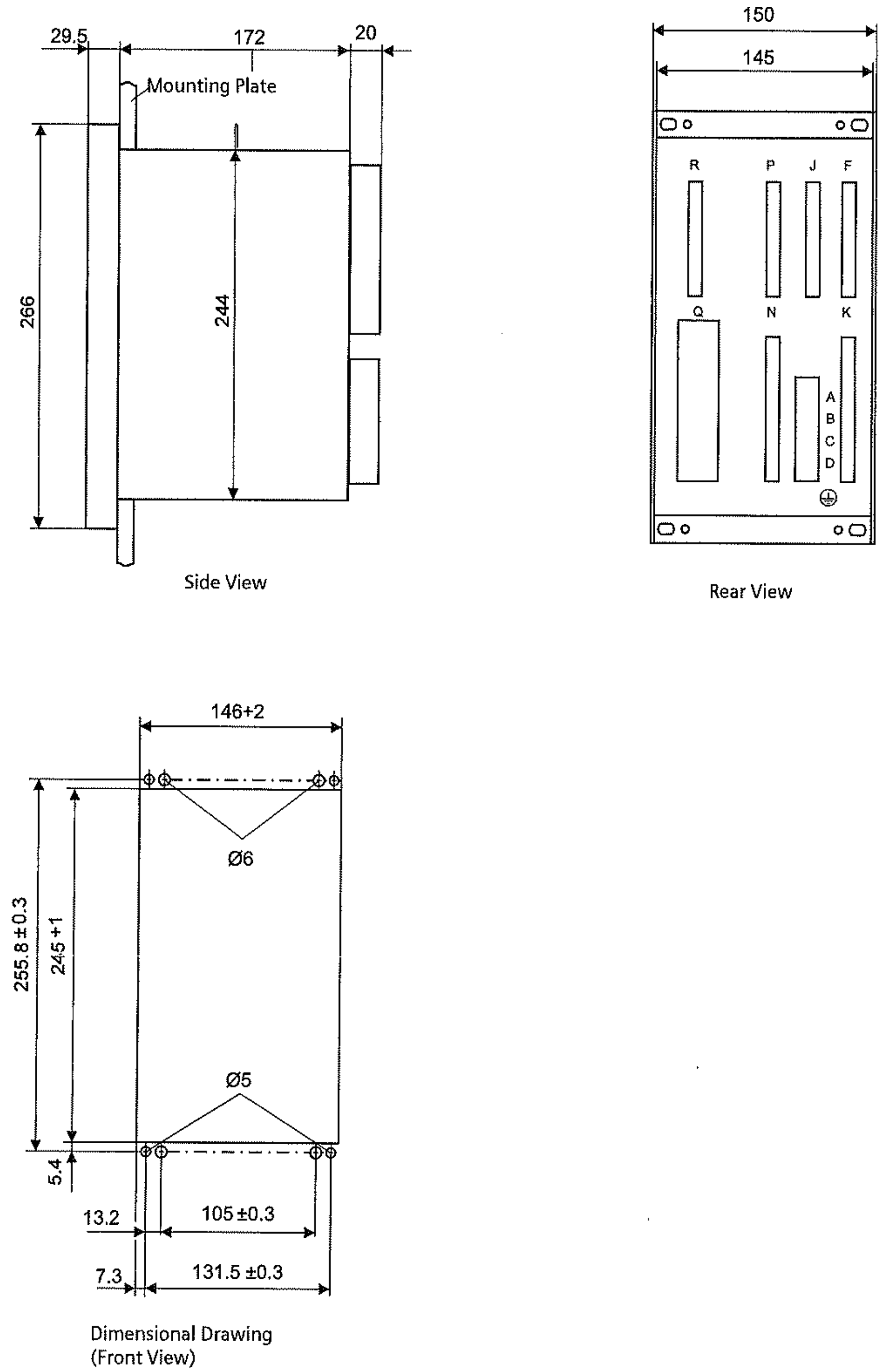

Fig. 29 Dimensional drawing for SIPROTEC 7SJ66 (housing size 1/3)

Dimensions in mm

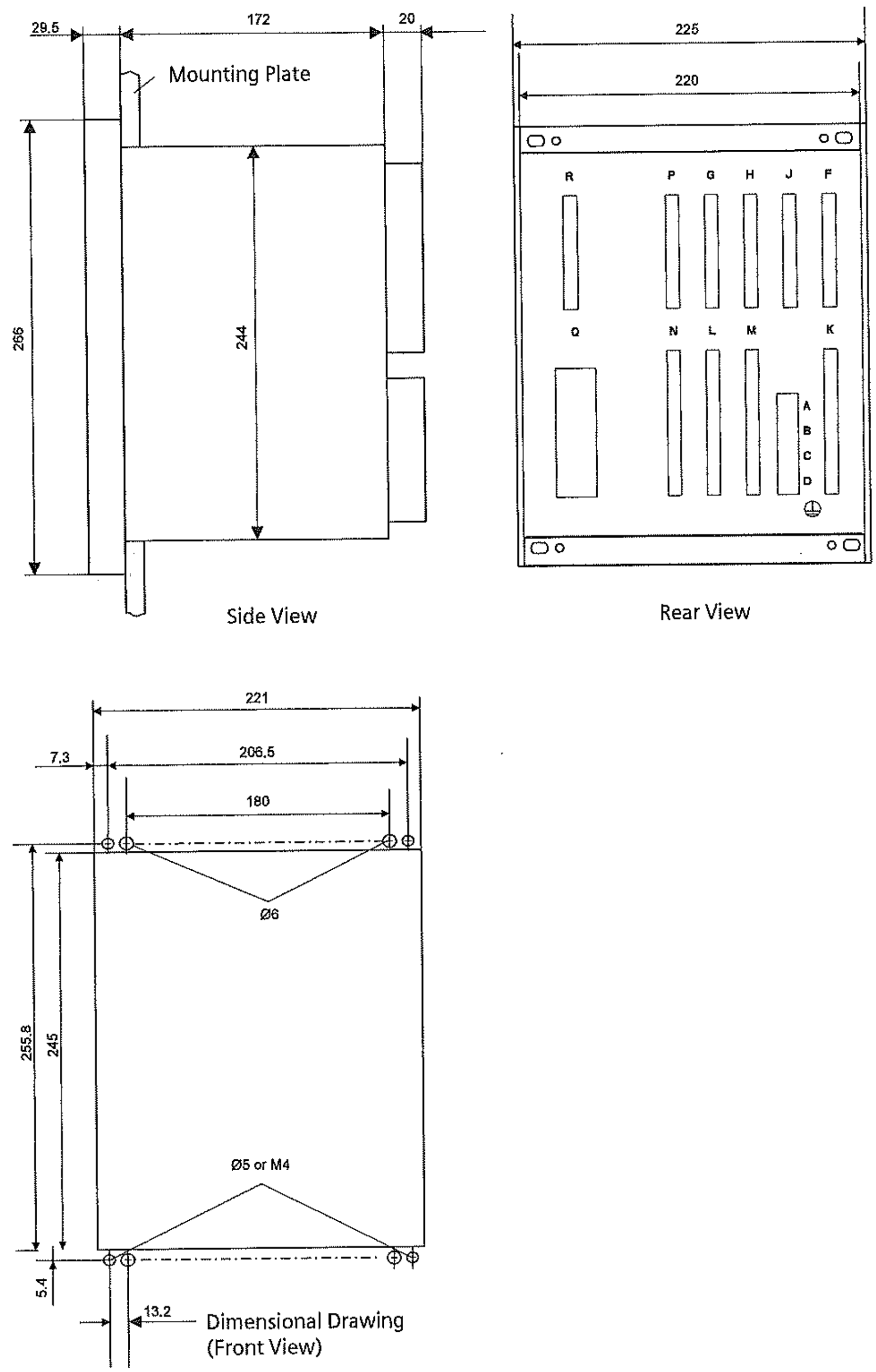

Fig. 30 Dimensional drawing of a SIPROTEC 7SJ66 (housing size 1/2)

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