



Zkušebnictví, a. s.

# zkratovna

HIGH  
POWER  
LABORATORY

06 - 043

**zkratovna**  
Zkušebnictví, a. s.

Podnikatelská 547, 190 11 Praha 9, Běchovice, Czech Republic

# TEST REPORT

## No. 06 - 043

**Test object** : NEUTRAL GROUNDING RESISTOR  
Type : G-03-0400-10-C  
Serial No. : O NE 06 02 005-1

**Ratings**  
Rated voltage : 3,3/√3 kV  
Rated current : 400 A

**Manufacturer** : M. S. RESISTANCES  
Rue du Crêt de la Perdrix, Zone Industrielle du Coin  
42400 St CHAMOND, France

**Test performed** : Temperature-rise test

**Customer** : M. S. RESISTANCES  
Rue du Crêt de la Perdrix, Zone Industrielle du Coin  
42400 St CHAMOND, France

**Date of test** : 24.04. 2006

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Number of issued copies: 3  
Praha 9, Běchovice  
26.5.2006  
Tested by:

Martin Vaniš



Vladimír Mastný  
Head of the Laboratory



Copy No.: 1

## Description of the test object

Neutral grounding resistor for the purpose of controlling the ground of an alternating current system.  
The test object was identified according to the drawing:

C NE 06 02 005-1 Rev. 00 Neutral Earthing Resistor

layout drawing

Routine tests report No. ORT 06 02 005-1  
Date of the test: 18.04.2006

## Ratings assigned by the manufacturer

Type	: G-03-0400-10-C
Serial No.	: O NE 06 02 005-1
Rated voltage	: $3,3/\sqrt{3}$ kV
Rated current	: 400 A
Rated time	: 10 s
Resistance at 25 °C	: $4,763 \Omega \pm 10\%$
Temperature coefficient of resistance	: $1,45 \times 10^{-3} K^{-1}$
Rated energy	: 5,718 MJ
Rated insulation level	: 10 kV (AC-1 min), 40 kV (BIL)
Outline dimensions	: 1405 × 690 × 1100 mm
Weight	: 140 kg
Installation	: outdoor

## Test specification

The tests were carried out according to the customer's instructions. The test procedures, parameters and test assessment criteria are based on the IEEE-32 (1972).

## Test parameters

Test voltage	: 1,9 kV
Duration of the test current	: 10 s

## Summary

All the tests were carried out as required by the test specification.

More details of the tests performed are given in the enclosed tables and graphs.

## Test conditions

Working frequency  $f = 43,5 \text{ Hz} \rightarrow 49,5 \text{ Hz}$

The temperature-rise test was performed in a single-phase test circuit with a value of the supply no-load voltage of ca 2 kV. The tests were carried out in a test cell.

The values of the voltage and current were recorded for the purpose of calculation of the temperature-rise. Furthermore the temperature was measured by means of 2 thermocouples welded to the resistor's active parts. The temperature measurement started approximately 20 s after the temperature-rise test.

The measurement of the resistance was carried out before and after the tests. After the test, the measurement of the insulation resistance and the dielectric test between the frame and active part of the resistor were performed as well.

The test circuit, including measurement points, is illustrated in the diagram Sch. 1.

The connection of the test object to the test circuit is documented by the photograph in Fig. 1

The thermocouples positions during the temperature measurement are documented by the photographs in Figs. 3a and 3b.

## The tests were witnessed by

Hakam ELASSAD, M. S. RESISTANCES, France  
David Rousek, VELOSI/ISI, Prague 10, Czech Republic

## List of symbols

### a) Used in the table of test results

$I_1$	-	test current at the beginning of the test ( $t = 0,05$ s)
$I_2$	-	test current at the middle of the test ( $t = 0,5 t_i$ )
$I_3$	-	test current at the end of the test ( $t = 0,99 t_i$ )
$U_1$	-	test voltage at the beginning of the test ( $t = 0,05$ s)
$U_2$	-	test voltage at the middle of the test ( $t = 0,5 t_i$ )
$U_3$	-	test voltage at the end of the test ( $t = 0,99 t_i$ )
$R_1$	-	resistance at the beginning of the test
$R_2$	-	resistance at the middle of the test
$R_3$	-	resistance at the end of the test
$W$	-	total injected energy
$W_r$	-	rated energy
$t_i$	-	duration of test current
$\Delta\theta$	-	temperature-rise
$\Delta\theta_c$	-	corrected temperature-rise
$\alpha$	-	temperature coefficient of resistance
$I_{ss}$	-	DC current
$U_{ss}$	-	DC voltage
$R$	-	resistance
$R_{25}$	-	resistance recalculated to 25 °C
$\theta_1$	-	temperature on top of the active part
$\theta_2$	-	temperature on bottom of the active part
$\theta_a$	-	ambient air temperature
$t$	-	time

### b) Used in the oscillograms

$I$	-	current course
$U$	-	voltage course
$t$	-	time

### c) Used in the graph

$\theta_1$	-	temperature on top of the active part
$\theta_2$	-	temperature on bottom of the active part
$t$	-	time

The Test Report contains: **16** sheets i.e.:

1	introductory sheet
1	title sheet
3	text sheets
4	table sheets
1	test circuit diagram
3	photo sheets
1	graph
2	oscillograms

## 1. Table of test results: Temperature-rise test

Test circuit diagram: Sch. 1

File denomination: resi24ds

### Measured values

Test No.	I <sub>1</sub> (A)	I <sub>2</sub> (A)	I <sub>3</sub> (A)	U <sub>1</sub> (kV)	U <sub>2</sub> (kV)	U <sub>3</sub> (kV)	W (MJ)	t <sub>i</sub> (s)	Observation
006	415	273	236	1,93	2,01	2,02	5,763	10,07	white smoke

### Temperature-rise calculation

- calculation of the resistance variation during the test

Test No.	R <sub>1</sub> (Ω)	R <sub>2</sub> (Ω)	R <sub>3</sub> (Ω)
006	4,651	7,362	8,559

- calculation of the temperature-rise

$$\Delta\theta = \frac{\frac{R_3}{R_1} - 1}{\alpha} \Rightarrow \Delta\theta = 580 \text{ K}$$

- correction to the injected energy

$$\frac{W}{W_r} = \frac{\Delta\theta}{\Delta\theta_c} \Rightarrow \Delta\theta_c = 576 \text{ K}$$

## 2. Table of test results: Temperature measurement after temperature-rise test

Ambient air temperature: 19 °C

t (min)	θ <sub>1</sub> (°C)	θ <sub>2</sub> (°C)
0,3	167,6	87,0
1,0	198,3	91,7
2,0	238,3	96,2
3,0	259,1	98,3
4,0	269,8	98,8
5,0	272,4	98,1
6,0	270,6	96,4
7,0	265,2	94,3
8,0	258,5	92,1
9,0	251,5	90,2
10,0	243,2	87,8
11,0	235,6	85,5
12,0	228,3	83,6
13,0	220,0	81,5
14,0	212,4	79,9
15,0	205,4	78,2

### 3. Table of test results: Resistance measurement at ambient air temperature

Before test				After test			
$I_{ss}$ (A)	$U_{ss}$ (V)	R ( $\Omega$ )	$\theta_a$ ( $^{\circ}$ C)	$I_{ss}$ (A)	$U_{ss}$ (V)	R ( $\Omega$ )	$\theta_a$ ( $^{\circ}$ C)
1,005	4,656	4,633	22,7	1,011	4,590	4,540	16,5
Correction to 25 $^{\circ}$ C							
$R_{25} = 4,648 \Omega$				$R_{25} = 4,596 \Omega$			

### 4. Test results: Measurement of insulation resistance

The measurement of insulation resistance was carried out between the frame and active part of the neutral grounding resistor at a voltage 500 V. The insulation resistance was **greater than 200 M $\Omega$** .

### 5. Test results: Dielectric test

The dielectric test was carried out between the frame and active part of the neutral grounding resistor. The test voltage 10 kV was applied for 60 s **with satisfactory result**.

### Meteorological conditions

Test No.	Date (dd.mm.yy)	Time (hh:mm)	Relative humidity (%)	Atmospheric pressure (hPa)
006	24.04.06	17:33	43	987

## Test circuit parameters

### Direct tests

File denomination		resi24ds
Test No.		006
Test circuit diagram		Sch. 1
<b>Generator</b>		J
Rated (phase to phase) voltage	(kV)	8
Phases connected		R, T
Inductance per phase	(mH)	0,133
Inductance of reactors per phase	(mH)	2,14
Resistance of resistors per phase	( $\Omega$ )	---
<b>Short-circuit transformer</b>		---
Connection		---
Transf. ratio		---
Inductance per phase	(mH)	---
<b>High-current transformer - Connection</b>		---
Transf. ratio		---
Inductance per phase	(mH)	---
Total inductance per phase of supply circuit	(mH)	2,27
Power factor		0,95
Capacity in parallel	( $\mu F$ )	---
Resistance in series	( $\Omega$ )	---
Neutral point of supply circuit		---
Short-circuit point		earthed
<b>Load transformer</b>		---
Connection		---
Transf. ratio		---
Resistance of load resistors	( $\Omega$ )	---
Inductance of load reactors	(mH)	---
Capacity of load capacitors	( $\mu F$ )	---
Neutral point of load circuit		---

## Measuring devices used

Test circuit diagram: Sch. 1

File denomination: resi24ds.001, 006

Measurand	Sensor	Sensor parameters	Serial No.	Calibration resi24ds.001	
				Calibration value	Evaluated value
I	cage shunt	5 kA / 2 V	006/95	1000 A	1002 A
U	resistance voltage divider	125 kV /150 V	DR 001/78	8,333 kV	8,353 kV

Recording devices:

- Measuring system with digital optoelectronic transmission (type TR-01M)

Optoelectronic transmissions:

- MAC

## Temperature measurement

Multichannel thermometer Microtherm, serial No. 8252002454

Multichannel thermometer Microtherm, serial No. 8252002451

Thermocouple, type K

Mercury thermometer Exatherm, type glass, serial No. T01/04

## Resistance measurement

Digital multimeter METEX, type M-4660A, serial No. EB290286

Digital multimeter METEX, type M-4660A, serial No. EB289901

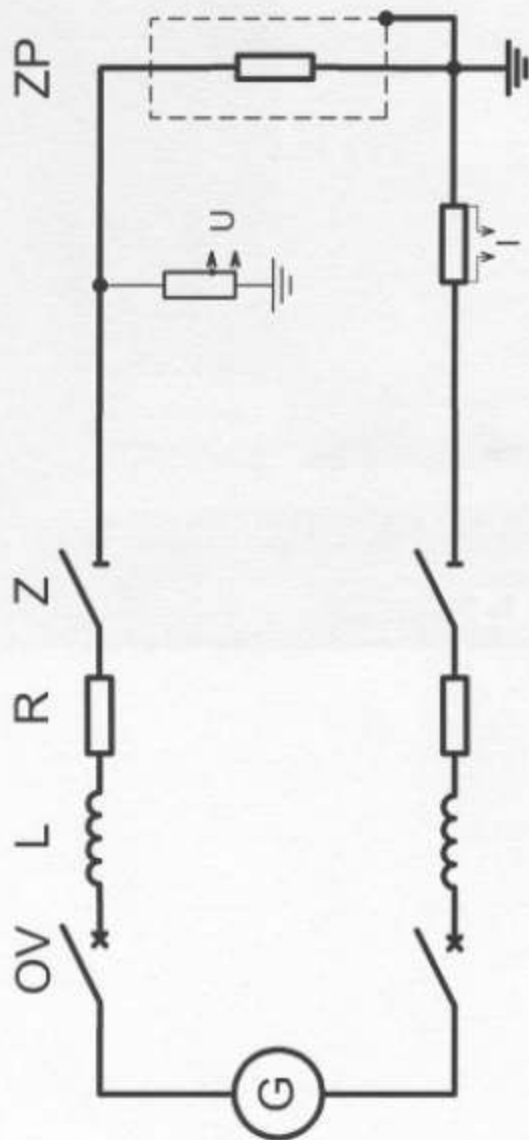
## Measurement of insulation resistance and dielectric test

Multichannel insulating resistance METRA, type PU186; serial No. 9713779

Digital multimeter METEX, type M-4660A, serial No. EB290286

## Meteorological conditions measurement

Meteorological station, type Vantage Pro 2, serial No. 3788-6312



G - Short-circuit generator  
 OV - Master breaker  
 L, R - Reactors and resistors

Z - Make switch  
 ZP - Test object  
 I, U - Current and voltage measurement

Test circuit diagram Sch. 1



Fig. 1  
Connection of the test object to the test circuit

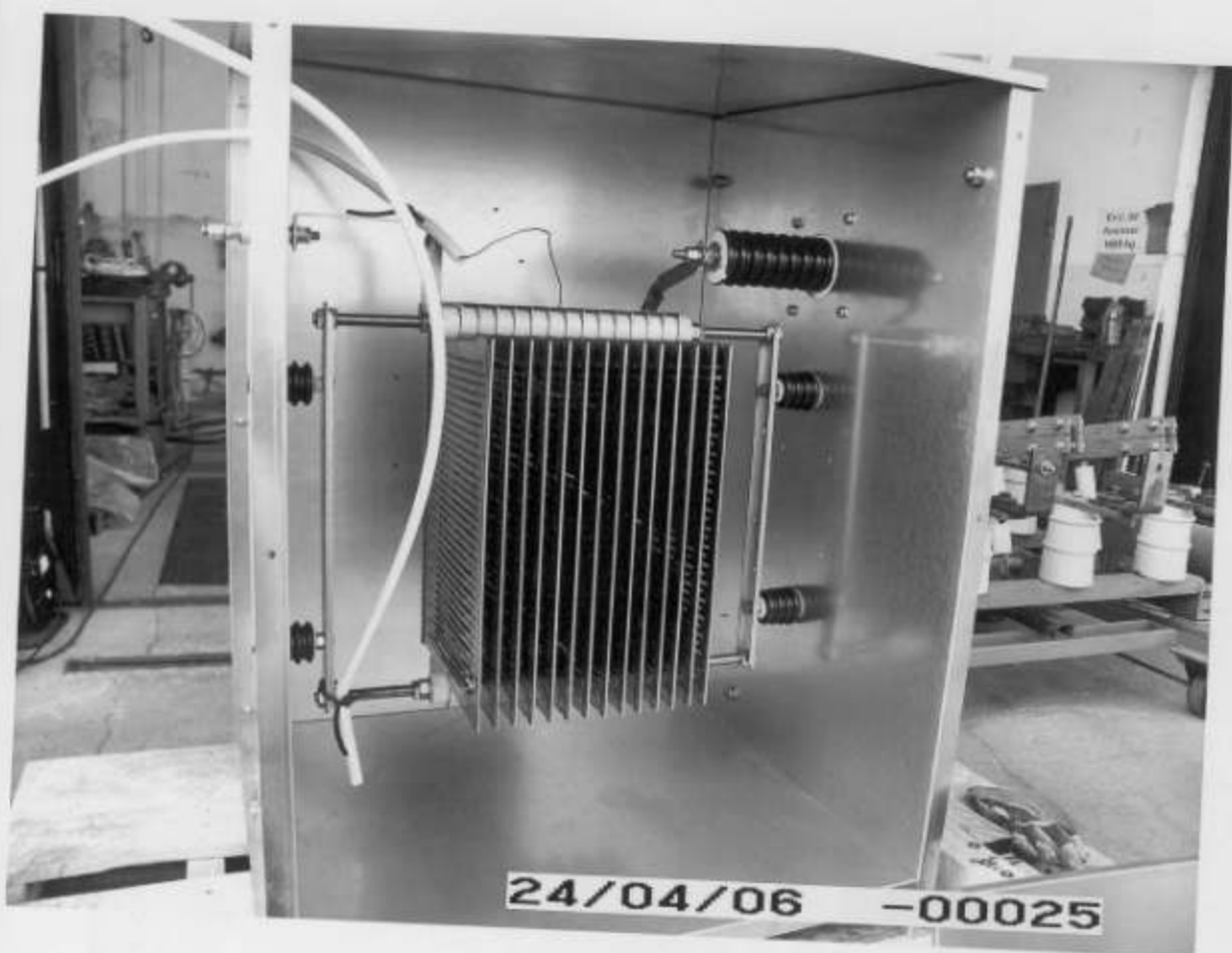


Fig. 2  
Test object after the test

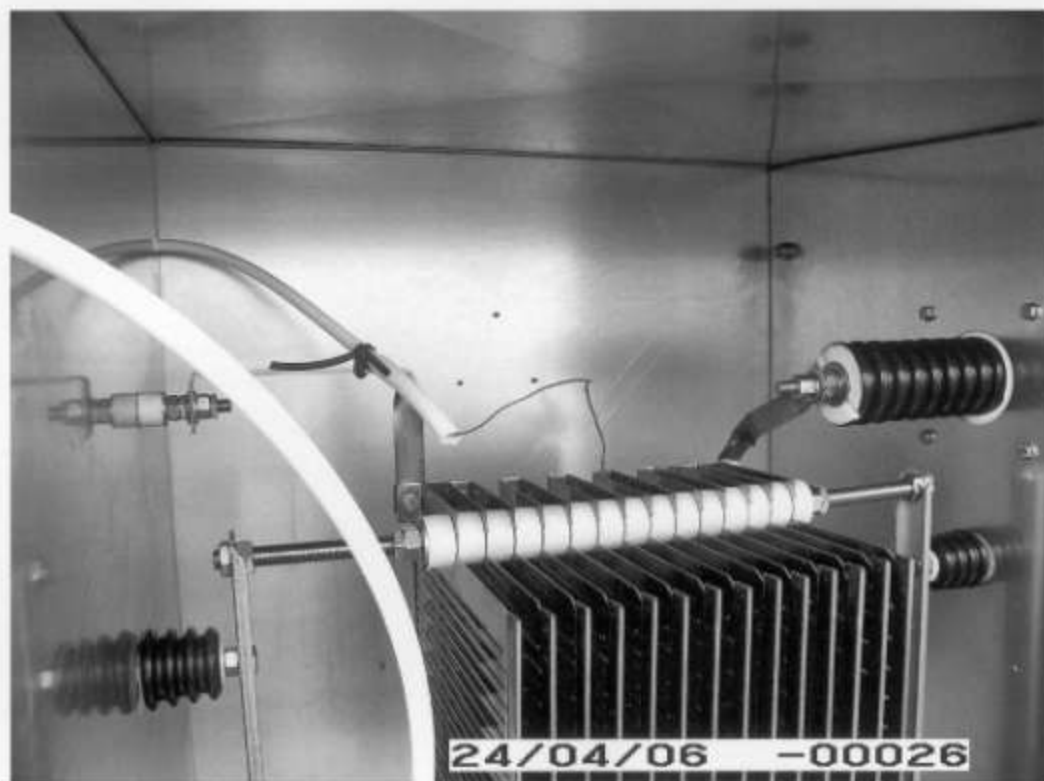


Fig. 3a  
Position of the thermocouples (upper part of the resistor)

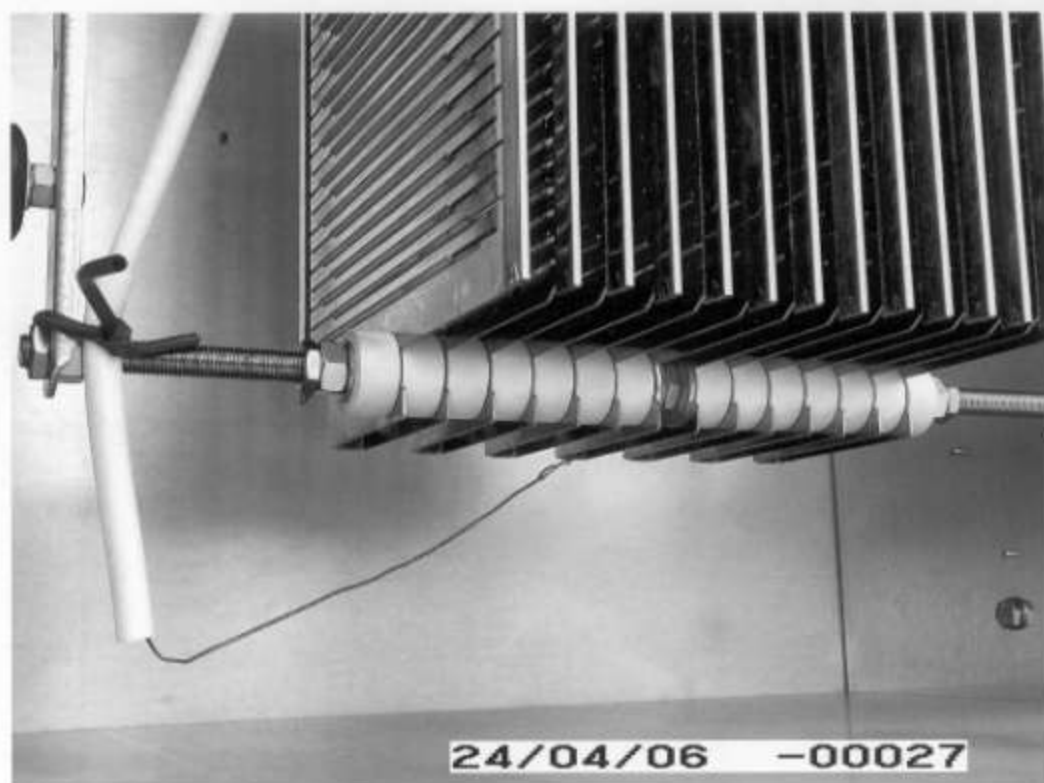
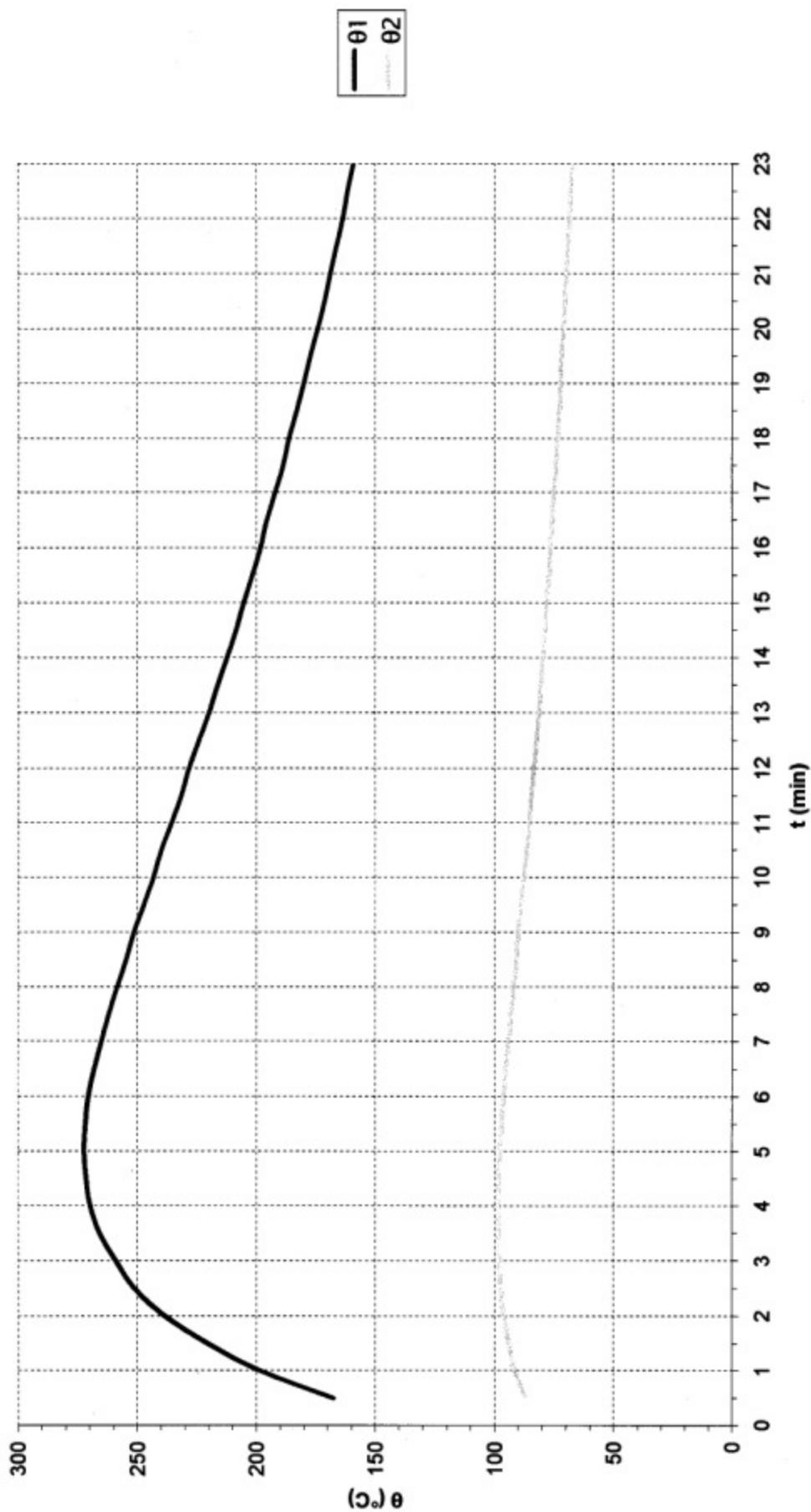
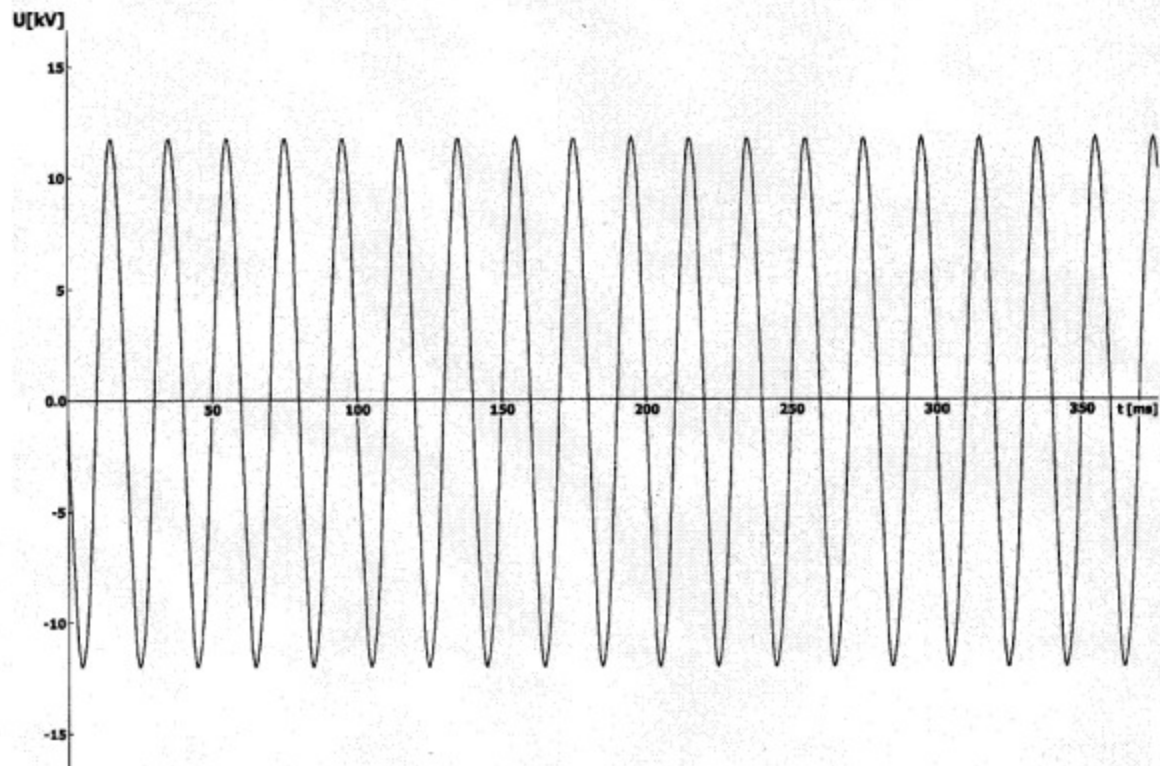
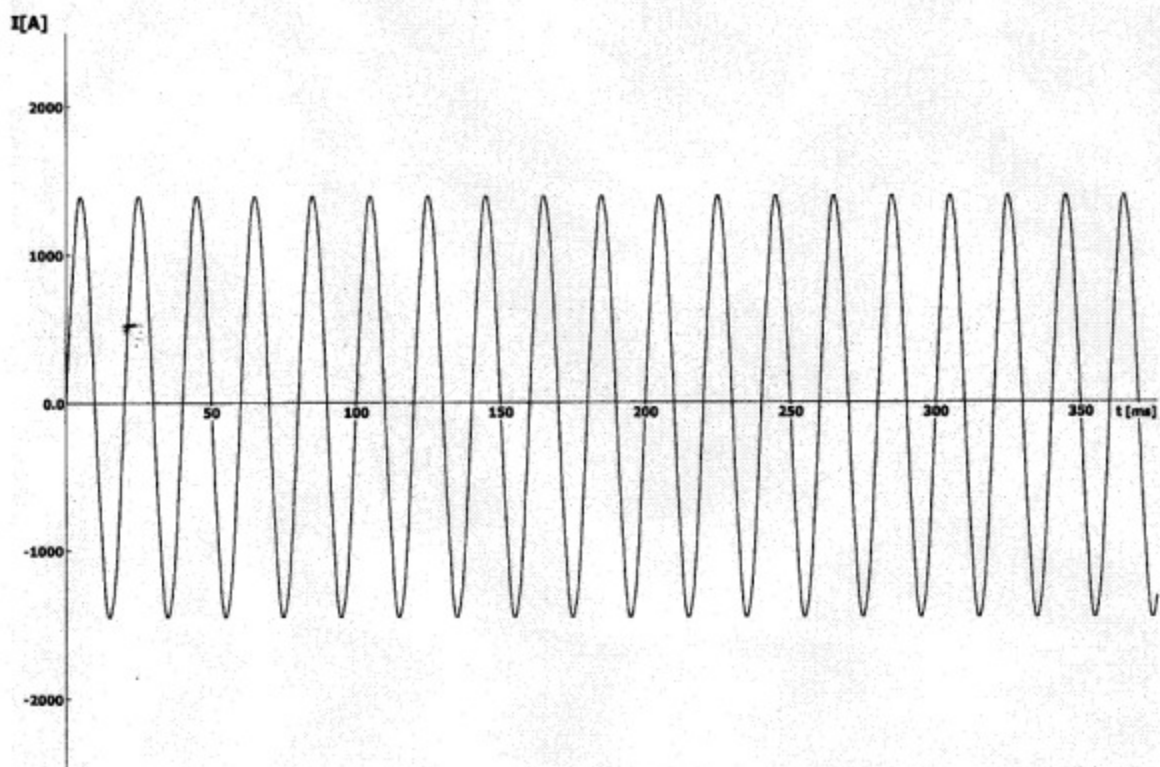


Fig. 3b  
Position of the thermocouples (bottom part of the resistor)

Graph: Temperature curves after the temperature-rise test



resi24ds.001



resi24ds.006

