

**Client** M.S. Resistances

**Address of the Client** Z.I. - Rue du Cret de la Perdrix 42400 Saint-Chamond - France

**Tested samples/items** Single-phase Neutral Earthing resistor 13,8 / $\sqrt{3}$  kV – 800A/5s - IP54 in a RAL 7038 painted enclosure c/w CT

**Tests carried out** Temperature-rise test

**Standards/Specifications** Client's request based on :  
-01-TMSS -01 rev. 0 (01/01/2006)  
-57-TMSS - 01 rev. 0(08/01/2007)  
-ANSI/IEEE Std. 32 & NFC 63-600

**Tests date** **from** April 20, 2009 **to** April 20, 2009

The results reported in this document relate only to the tested samples/items.  
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**No. of pages** 19 **No. of pages annexed** 4

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A9011308 821814 APP

**CESI S.p.A.**  
Energy Division  
Technical Area Components  
"Testing Laboratories"  
Mantova



**Tests witnessed by**

Mr. Hakam Ellassad  
Mr. Christian Millard  
Mr. Gianluca Spitaletta

M.S. Resistance  
M.S. Resistance  
Microelettrica Scientifica

**Identification of the object**      not requested

Only for laboratory requirement, in order to reproduce the test conditions, all the laboratory data are contained in the document marked: —

The measurement uncertainties of the test results reported in the document are the following:

**voltage:  $\pm 5\%$  ; current:  $\pm 5\%$  ; time:  $\pm 5\%$  ; temperature:  $\pm 2\text{ }^{\circ}\text{C}$**

The measurement uncertainties are estimated at the level of twice the standard deviation (corresponding, in the case of normal distribution, to a confidence level of about 95 %) and have to be considered as maximum values.

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**Laboratory information**

**Receipt date of the sample**      April 17, 2009

**CESI testing team**  
M. Cunego, T. Ghezzi

**Test laboratory**      P140

**Activity code**      AE09LAP015

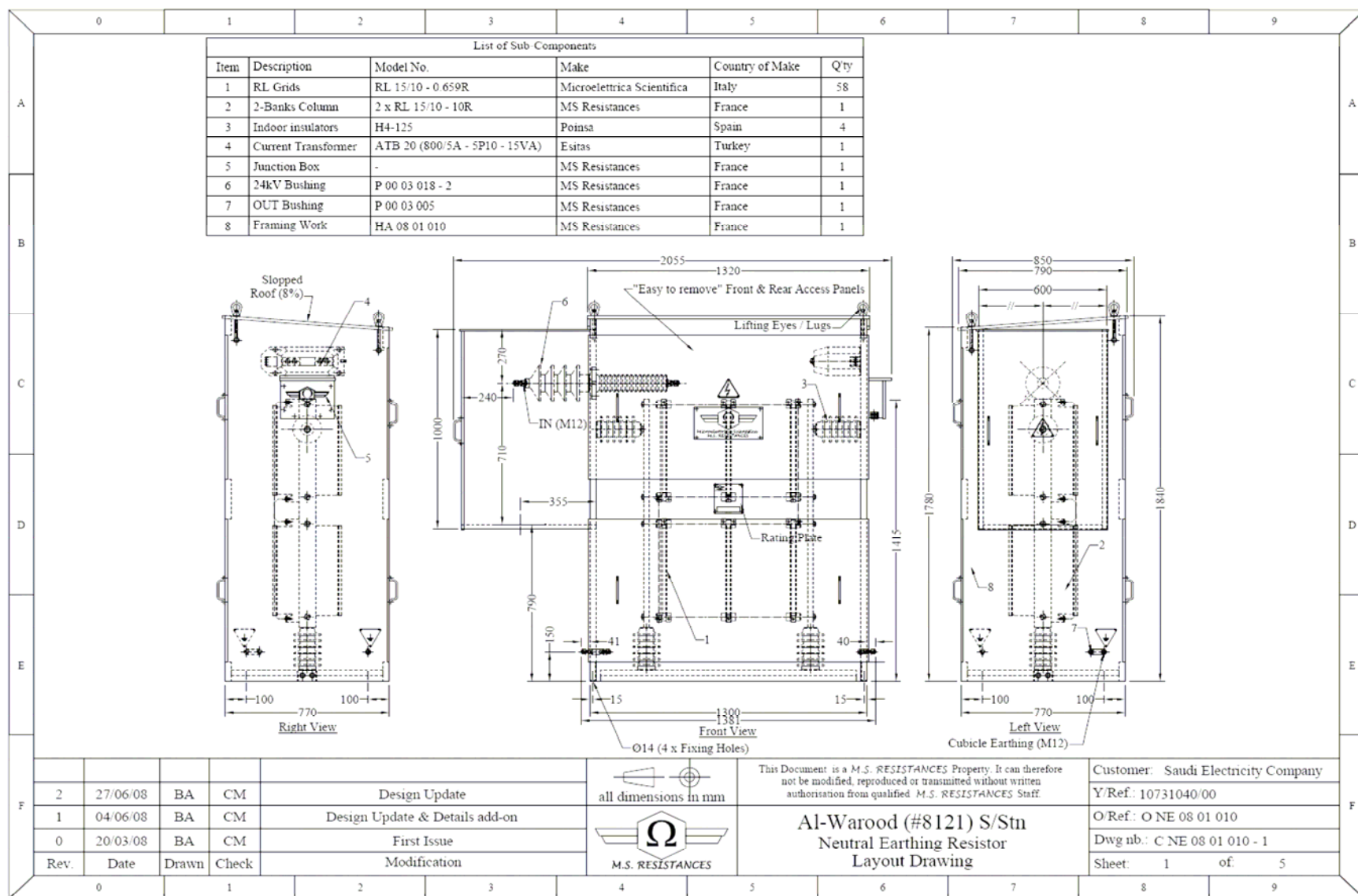
## Rated characteristics of the tested object assigned by the Client

### Single phase 50 Hz Neutral Earthing Resistor

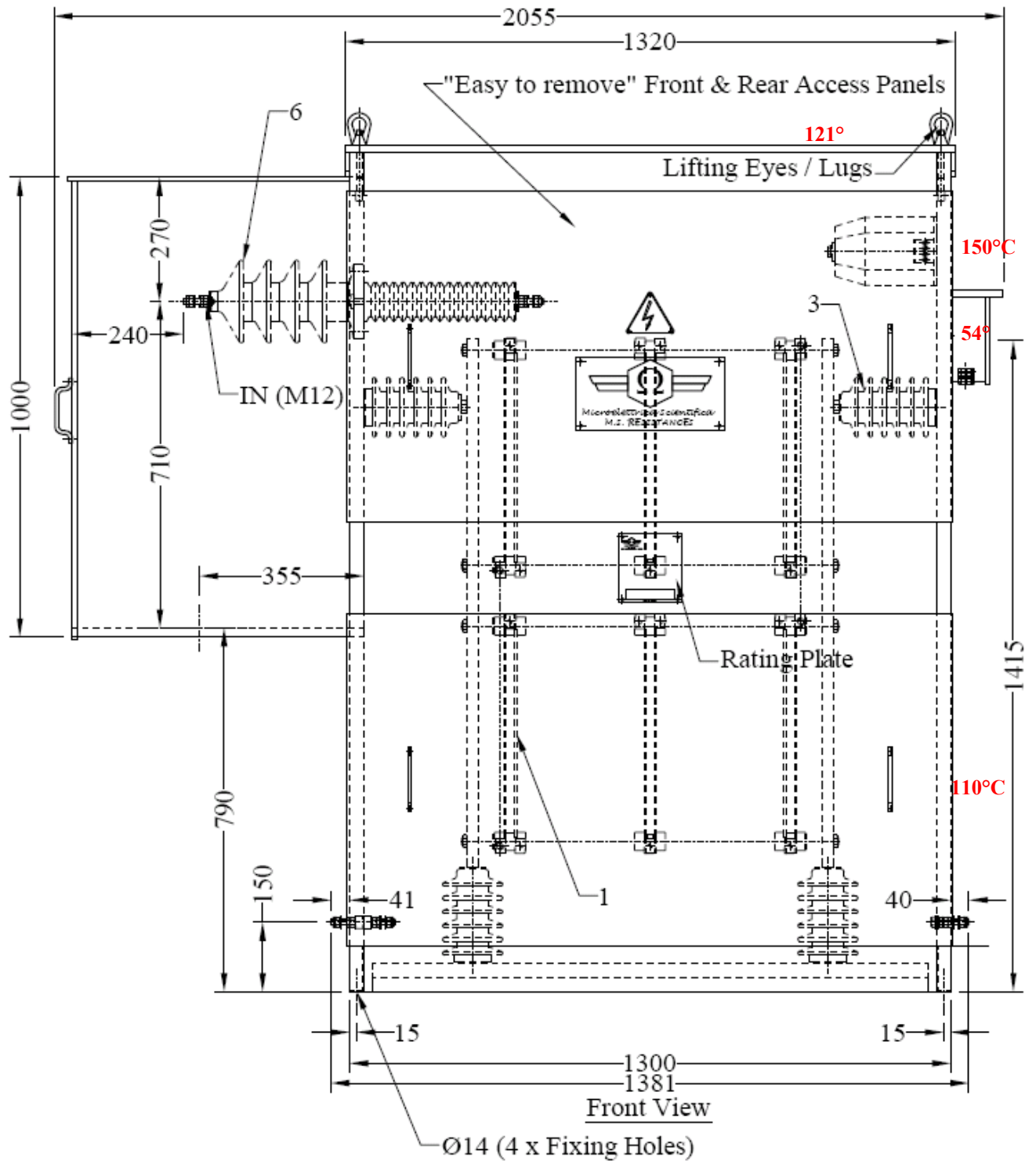
Manufacturer	M.S. Resistances
Drawing number	C NE 08 01 010
Serial number	O NE 08 01 010-1/013
Type	G-13-0800-05-S-HV-00-CT
Service (indoor or outdoor)	Outdoor
System voltage	13,8 kV
Voltage	13,8 / $\sqrt{3}$ kV
Rated short-circuit current	800 A x 5s
Resistance at 50°C	10 $\Omega$
Frequency	60 Hz
Insulation class	17,5 kV
power frequency withstand voltage	38 kV
lightning impulse voltage	95 kV
Degree of protection	IP54
Materials of elements	AISI 430 stainless steel
Average temperature coefficient at 580°C	0,00161 / °K <sup>-1</sup>
Overall dimension WxLxH	21,84 x 1,32 x 0,85 m
Weight	320 Kg
Indoor insulators	17,5 kV

Name and signature of Client's witness:

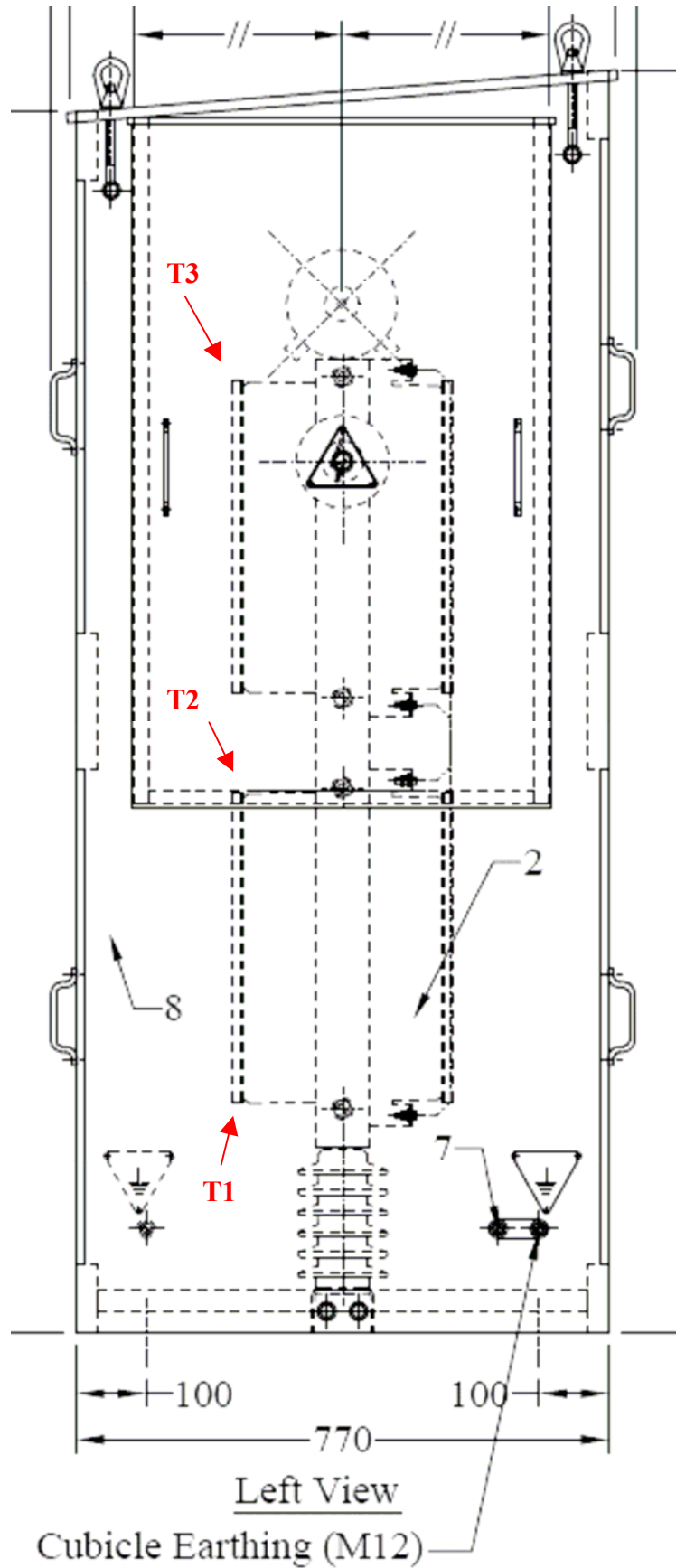
Composition of the tested object



D8013 - Test arrangement and values of the external thermal indicators



Disposition of the thermocouples



**Temperature-rise test**

**Test circuit :** See D0046      Frequency : 50 Hz      No-load voltage : 8,85 kV

**Test arrangement :** See page 5

**Test conditions and procedure :**

Ambient air temperature : 14,5 °C

During and after the test the grid temperature were measured for about 20 min. (see pages 10 and 11)

The  $\alpha$  coefficient was calculated at 580 ° as average of the max values recorded by the thermocouples inserted by the Client.

Four thermal indicators were applied to the metallic external surface (the maximum values are reported on the sketch on page 5).

The average temperature-rise of the resistor at end of the test has been calculated applying the following formula :

$$\Delta t = (R_t/R_0 - 1) \times 1/\alpha$$

were:

$\Delta t$  = Temperature-rise

$R_t$  = Hot resistance

$R_0$  = Cold resistance

$\alpha$  = Temperature coefficient of the stainless steel resistor equal to 0,0016 (referred to 580 °C).

The values of  $R_t$  and  $R_0$  have been calculated from the ratios of voltage across the resistor and the test current at the beginning and at the end of the test.

Condition of the apparatus before the tests: new.

Date: April 20, 2009

Test	Oscillogram		Duration	Voltage		Current		Resistance		Average temperature-rise at end of the test	Notes
				at beginning of the test	at end of the test	at beginning of the test	at end of the test	at beginning of the test (R0)	at end of the test (Rt)		
No.	No.	Sheets	s	kV	kV	A	A	$\Omega$	$\Omega$	K	No.
cal	3	1	0,1	8,1	-	854	-	9,55	-		-
1	5	3	0,1	8,17	8,93	841	513	9,71	16,81	430	-

Condition of the apparatus after the tests: as before the test.

**Measurement of the resistance**

Resistance measured with 100 A d.c.

Measurement effected	Resistance ( $\Omega$ )	Ambient air temperature °C
Before the test	9,17	13,7

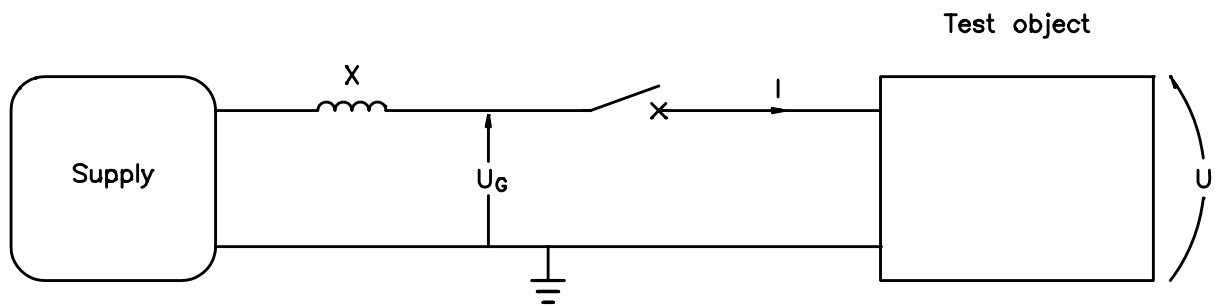
**Power frequency voltage withstand dry test on the main circuit**

Tests effected	Applied voltage (kV for 60 s at 50 Hz) applied from the HV terminal and the earthing point of the metallic enclosure ( the lower terminal was disconnected)
After the test No.1	38

Note: No discharge occurred during the test.

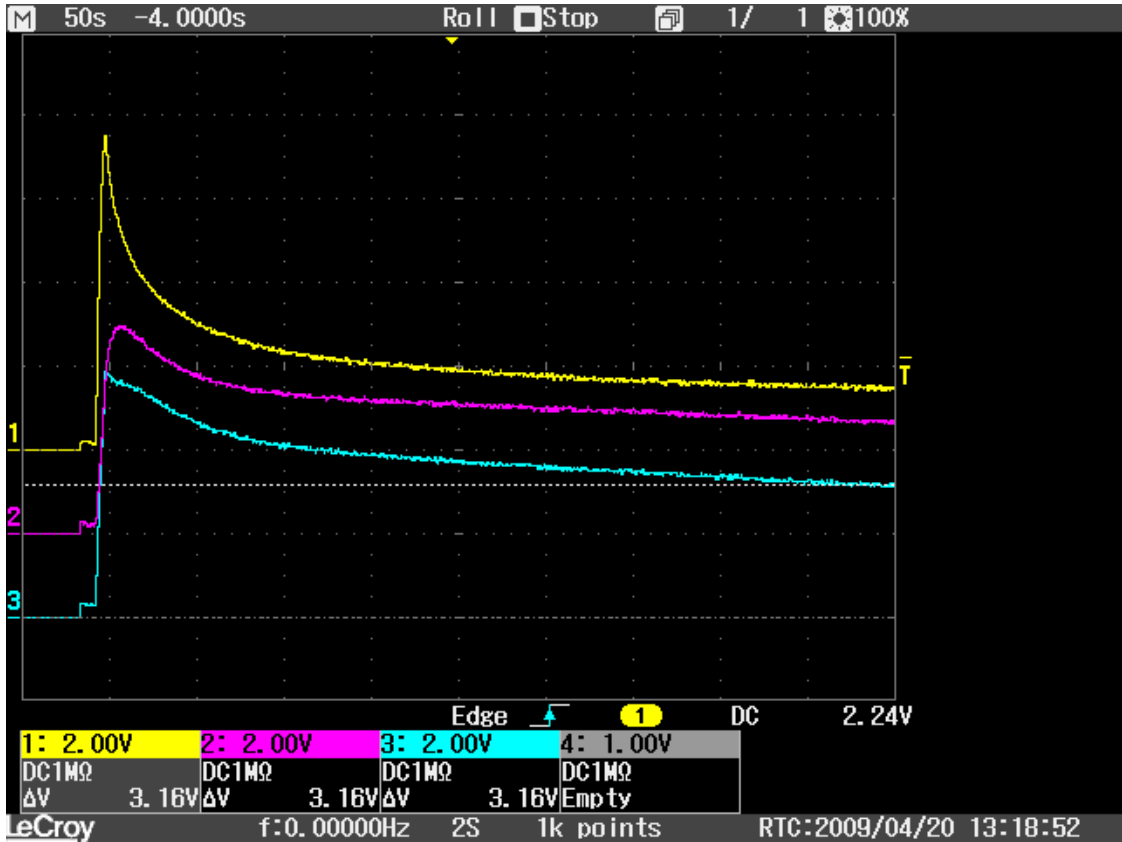
As per Client request the test has been performed with an actual duration equal to 72 s.

Test circuit D0046



Symbols used in this diagram are the same as those on the oscillograms.

Recording of thermocouples T1 to T3



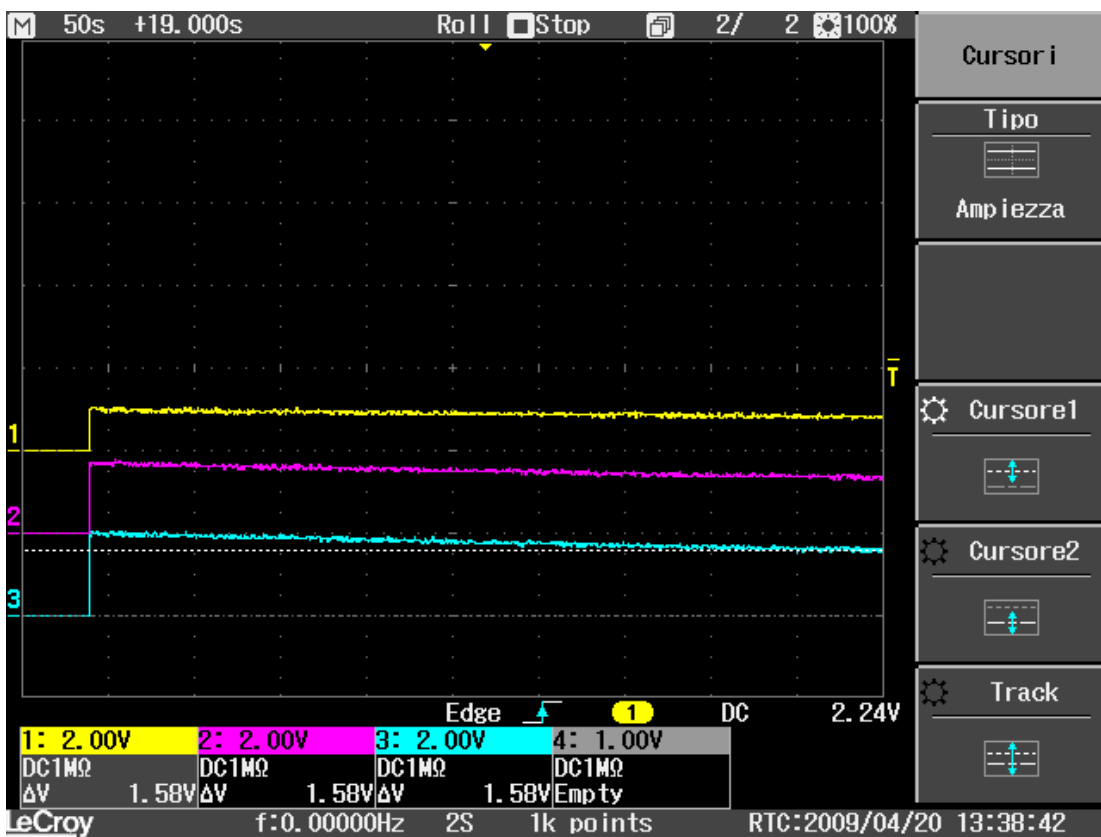
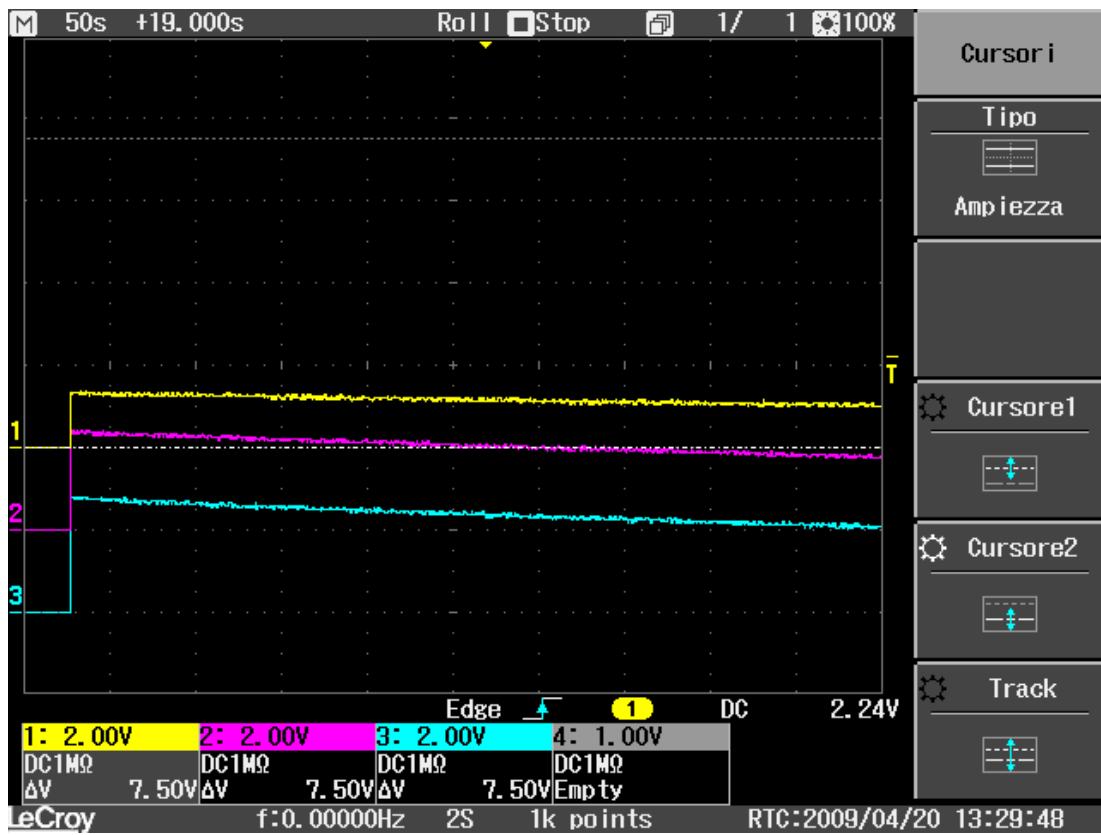




Photo No.1  
right side



Photo No.2  
left side



Photo no. 3  
terminals side



Photo no. 4  
right side



Photo no. 5  
Name plate

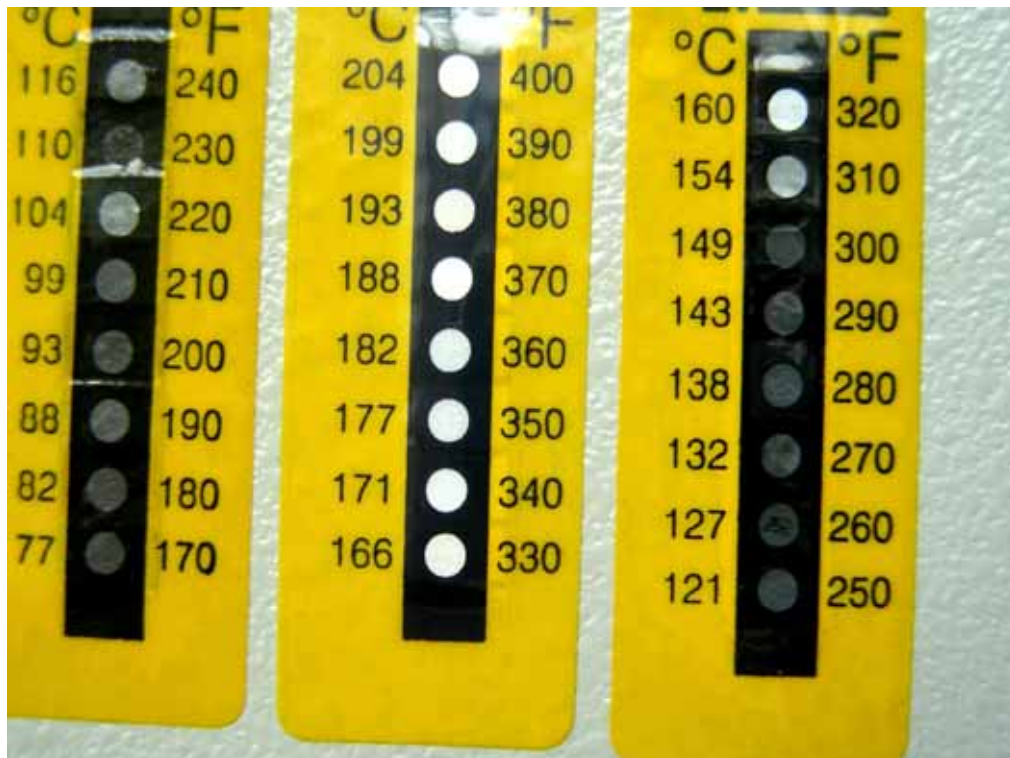


Photo no. 6  
sample of thermal indicators



Photo no. 7  
Thermocouple T1



Photo no. 8  
Thermocouple T2 and T3



## Test circuit parameters

From test ..... to test .....		No.	1	2				
Test circuit		No	D0046	D0046				
Test laboratory		Ref.						
Supply	Generator	Voltage	kV					
		Over excitation current	kA					
		Frequency	Hz					
		X-14-1	mΩ					
		X-14-2	Ω					
		TA 14-1 ratio	K					
	Transformers	Ref.	No.	1 – 2	1 – 2			
		Ratio	K	260/10	260/10			
		Connection	Type	S/P	S/P			
		Neutral condition	T - I					
		Ref.	No.					
		Ratio	K					
		Connection	Type					
		Neutral condition	T – I					
	Circuit	Supply	X-supply network (prospective)	Ω	11,5	11,5		
			X-supply network (actual)	Ω	11,5	11,5		
X-AT			Ω	22 x 2	22 x 2			
X-MT (X-30)			Ω	3,16x2	2,23x2			
C-MT (C-30)			nF					
R-MT (R-30)			Ω					
CM (capacity)			μF					
Connection / Neutral			S-D / T-I					
Load		Transformers	No.					
			K					
			Neutral condition	T – I				
		R (resistance)	Ω					
			Connection / Neutral	S-D / T-I				
			X (reactance)	Ω				
				Connection / Neutral	S-D / T-I			
				CV1 (capacity)	μF			
	Connection / Neutral		S-D / T-I					
	CV2 (capacity)		μF					
	Connection / Neutral		S-D / T-I					
	Results		Current	kA				
U <sub>c</sub>		kV						
t <sub>3</sub>		μs						
t <sub>d</sub>		μs						

**Legend :** S = Star - D = Delta - T = Earthed - I = Insulated

**Warning :** Reactance values are referred to 50 Hz.

## Laboratory P140

### Measuring system characteristics

Ref.	Type	CESI No.
A1	Current transformer TA(220)3	14381
A2	Current transformer TA(220)3	9309
A3	Current transformer TA(220)3	9308
B1	Current transformer TA(30)1	9302
B2	Current transformer TA(30)1	9303
B3	Current transformer TA(30)1	9304
C1	Capacitive divider DC(220)1	4924
C2	Capacitive divider DC(220)1	4923
C3	Capacitive divider DC(220)1	4922
D1	Capacitive divider DC(30)1	4931
D2	Capacitive divider DC(30)1	4930
D3	Capacitive divider DC(30)1	4929
E2	RCR divider 100kV	4905
E3	RCR divider 100kV	4906
E4	RCR divider 100kV	4907
E5	RCR divider 100kV	4908
E6	RCR divider 100kV	4909
W1	Shunt 200 $\mu\Omega$ – 60kA – 0,5s	5796
W2	Shunt 200 $\mu\Omega$ – 60kA – 0,5s	5797
W3	Shunt 200 $\mu\Omega$ – 60kA – 0,5s	5798
G1	Shunt 2m $\Omega$ – 2kA – 0,2s	5807
G2	Shunt 2m $\Omega$ – 2kA – 0,2s	5808
H1	Current transformer K=1000/5	11291
H2	Current transformer K=1000/5	11293
K1	Current transformer K=1200/5	6812
J1	Optical link	4806
J2	Optical link	4808
J3	Optical link	4810
J4	Optical link	4812
J5	Optical link	4814
J6	Optical link	4816
J7	Optical link	4818
J8	Optical link	4820
J9	Optical link	4822
J10	Optical link	5990
J11	Optical link	5986
J12	Optical link	5956
J13	Optical link	22333
J14	Optical link	22331
J15	Optical link	22329
J16	Optical link	38223

Ref.	Type	CESI No.
J17	Optical link	38225
J18	Optical link	38227
N1	Shunt 160m $\Omega$ 2A	9782
N2	Shunt 160m $\Omega$ 2A	9886
N3	Shunt 50,263 $\mu\Omega$	22020
N4	Shunt 50,118 $\mu\Omega$	22021
N5	Shunt 50,169 $\mu\Omega$	22022
N6	Shunt 4,003m $\Omega$	22018
N7	Shunt 3,3994m $\Omega$	22024
N8	Shunt 4,004m $\Omega$	22028
N9	Shunt 19,90 $\mu\Omega$	5556
N10	Shunt 19,80 $\mu\Omega$	5557
N11	Shunt 19,98 $\mu\Omega$	5558
N12	Shunt 1,6 m $\Omega$	7963
N13	Shunt	-
R1	Current transformer K=10	14191
R2	Current transformer K=800	14383
S1	Current transformer K=20-40/5	14822
S2	Current transformer K=20-40/5	14823
S3	Current transformer K=20-40/5	14824
T1	Shunt 60m $\Omega$ – 5A	9783
T2	Shunt 60m $\Omega$ – 5A	9885
U1	RCR divider 400kV	4918
U2	RCR divider 600 kV	4919
=	Main Frame NICOLET BE256-M7	14403
=	Digitizer NICOLET BE612 (ch.1÷4)	14406
=	Digitizer NICOLET BE612 (ch.5÷8)	14407
=	Digitizer NICOLET BE612 (ch.9÷12)	14408
=	Digitizer NICOLET BE612 (ch.13÷16)	14410
=	Digitizer NICOLET BE612 (ch.17÷20)	14411
Add.1	Movable current transformer	-
Add.2	Movable current transformer	-
Add.3	Movable current transformer	-
Add.4	Movable RCR divider	-
Add.5	Movable RCR divider	-
Add.6	Movable RCR divider	-
Z1	RCR divider 250kV	31156
Z2	RCR divider 250kV	31157
Z3	RCR divider 250kV	31158

Prepared by: G. Zuccalà

Date: 23/12/2005

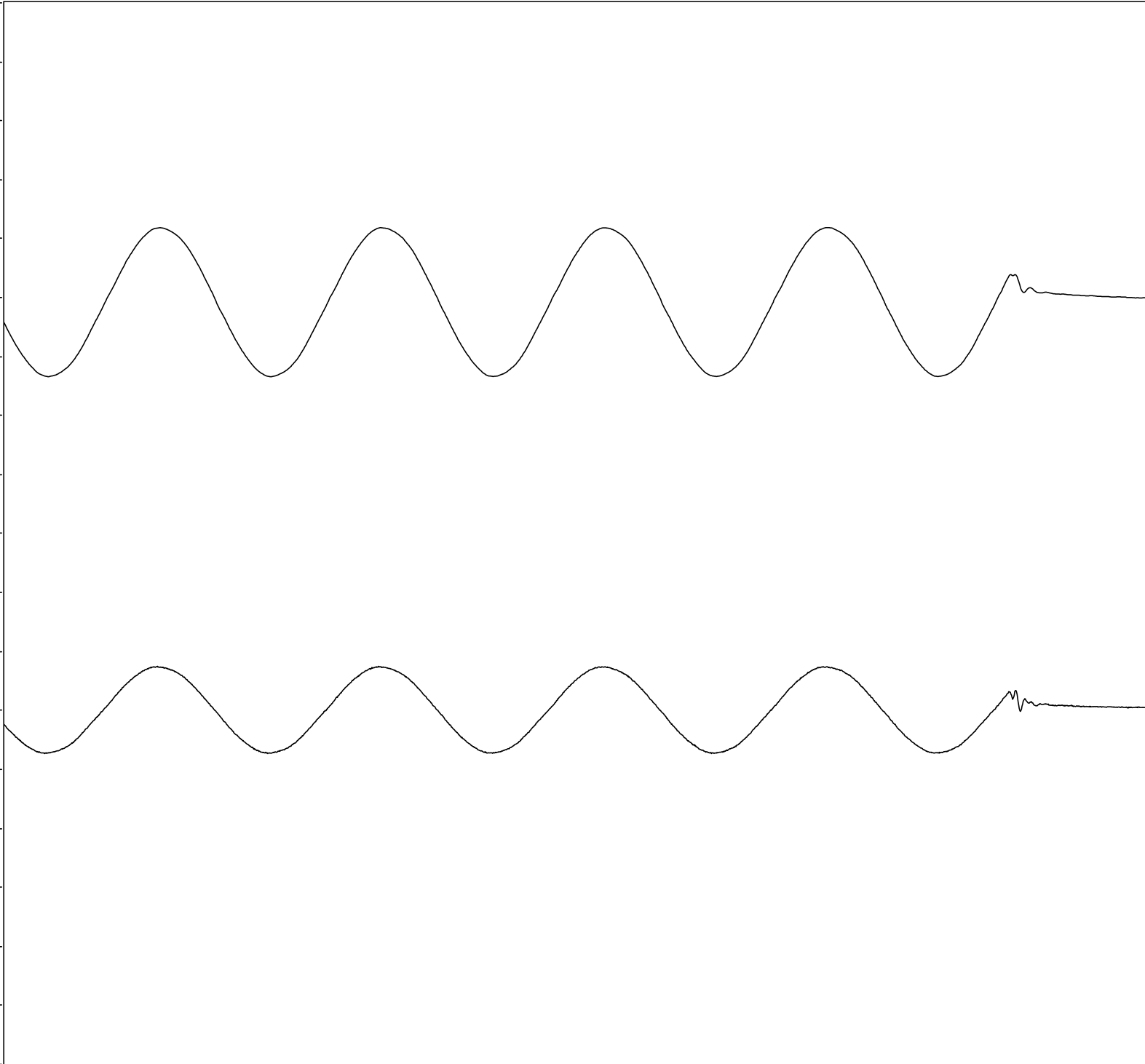
**dT= 5 s**  
**U= 8,17 kV**  
**I= 841 A**  
**I= 513 A**  
**U= 8,93 kV**

U 10 kV

I 1 kA

5185 5190 5195 5200 5205 5210 5215 5220 5225 5230 5235 5240 5245 5250 5255 5260 5265 5270 5275 5280 5288

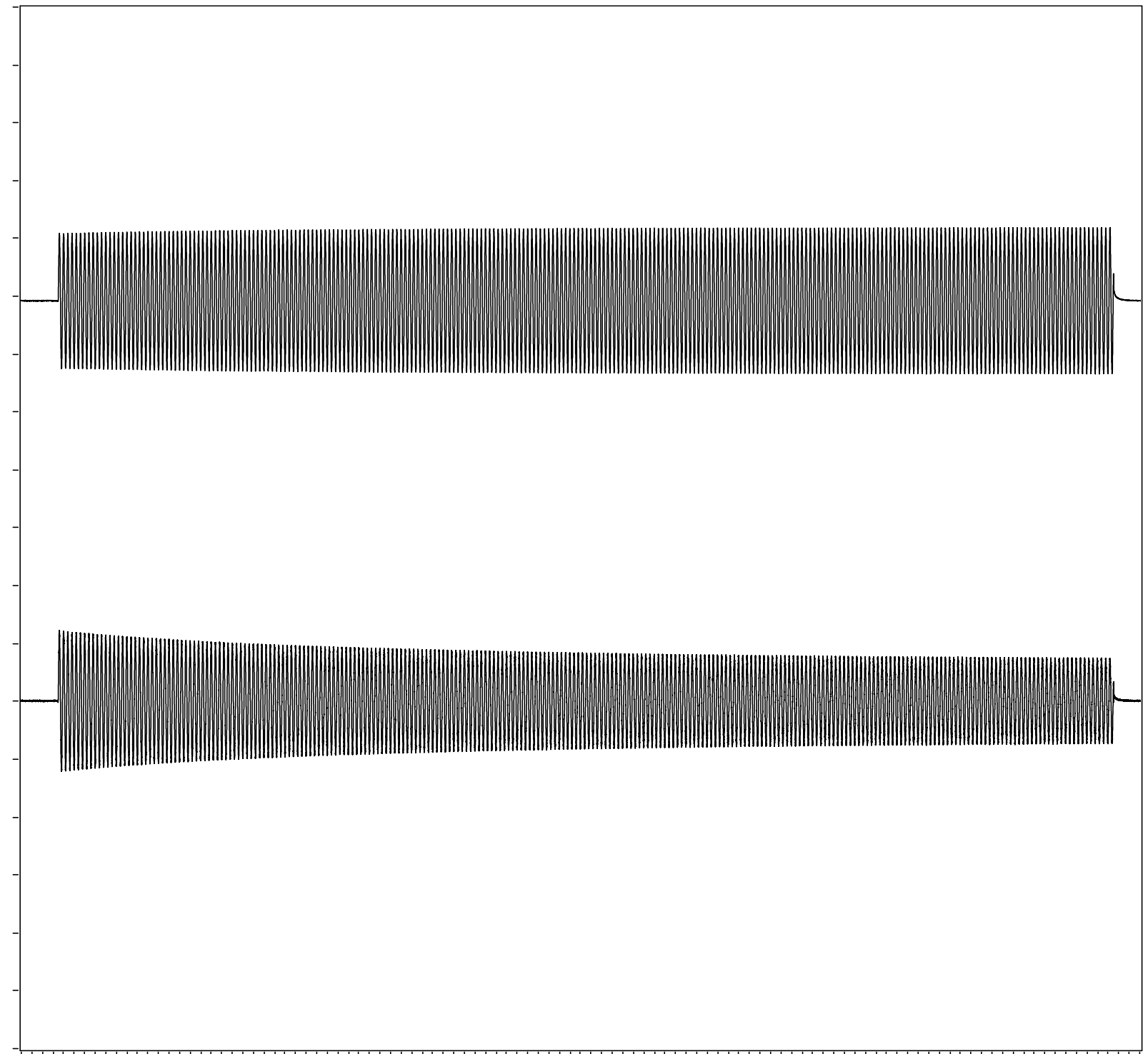
1 [ms/div.]



dT= 5 s  
U= 8,17 kV  
I= 841 A  
I= 513 A  
U= 8,93 kV

U 10 kV

I 1 kA



**U = 8,14 kV**  
**I = 852 A**  
**dT = 103 ms**

U 10 kV

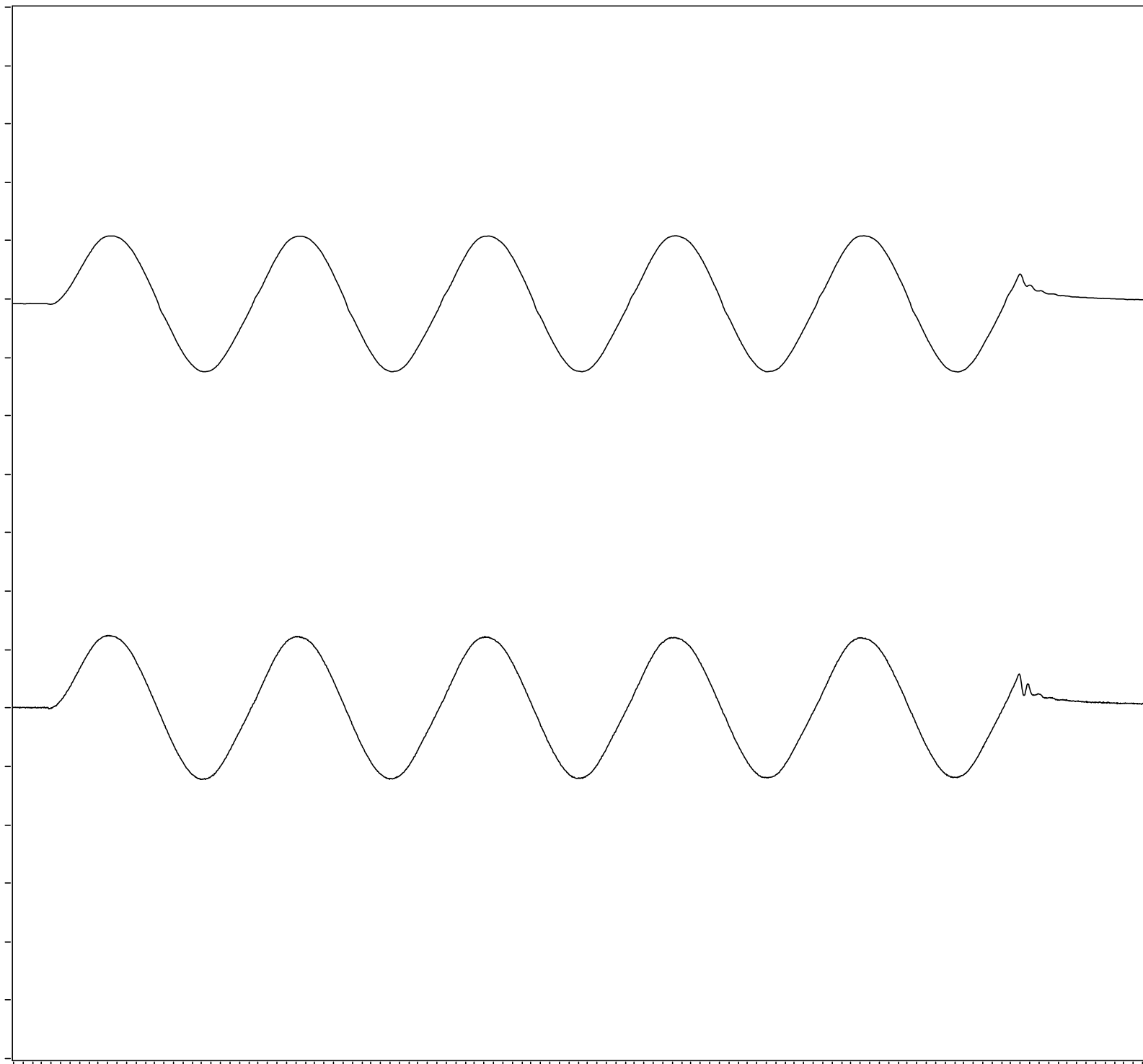
I 1 kA

270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390

1 [ms/div.]

**CESI** P140 A9011308, Oscill. No. 0003

Sam: 6SEC, Osc: BD1F, Cal:



**dT= 5 s**  
**U= 8,17 kV**  
**I= 841 A**

U 10 kV

I 1 kA

270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390

1 [ms/div.]

**CESI** P140 A9011308, Oscill. No. 0005

Sam: 6SEC, Osc: BD1F, Cal: BD3F

