Test Report

CESI Sinal n° 0030 Approved

Client	IZOELEKTRO d.o.o. Pesnica - SLOVENIA
Tested equipment	Polymer housed metal-oxide surge arrester
Tests carried out	Short-circuit tests
Standards/Specifications	IEC 60099-4 (2004)
Test date	**from** November 9, 2004 **to** November 9, 2004

Digitally signed by Nguyen Huu thuy
Date: 2024.03.18 16:44:49 EET
Reason: MoldSign Signature
Location: Moldova

No. of pages	15	**No. of pages annexed**	10
Issue date	March 17, 2005		
Prepared	PeC -. P. BECCARINI		
Verified	PeC - A. SIRONI		
Approved	PeC - M. de NIGRIS		

CESI
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Tests witnessed by —

Identification of the object effected.
The Manufacturer guarantees that the tested object is manufactured according to the submitted drawing.
CESI checked that this drawing adequately represents in shape and dimensions the essential details and the parts of the tested object.
This drawing identified by CESI and numbered A5/010293 No.1 is annexed to this document.

Only for laboratory requirement, in order to reproduce the test conditions, all the laboratory data are contained in the document marked: A4/518379

The measurement uncertainties of the test results reported in the document are the following:
voltage: ± 5 % ; current: ± 5 % ; time: ± 5 % temperature: ± 2 °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.

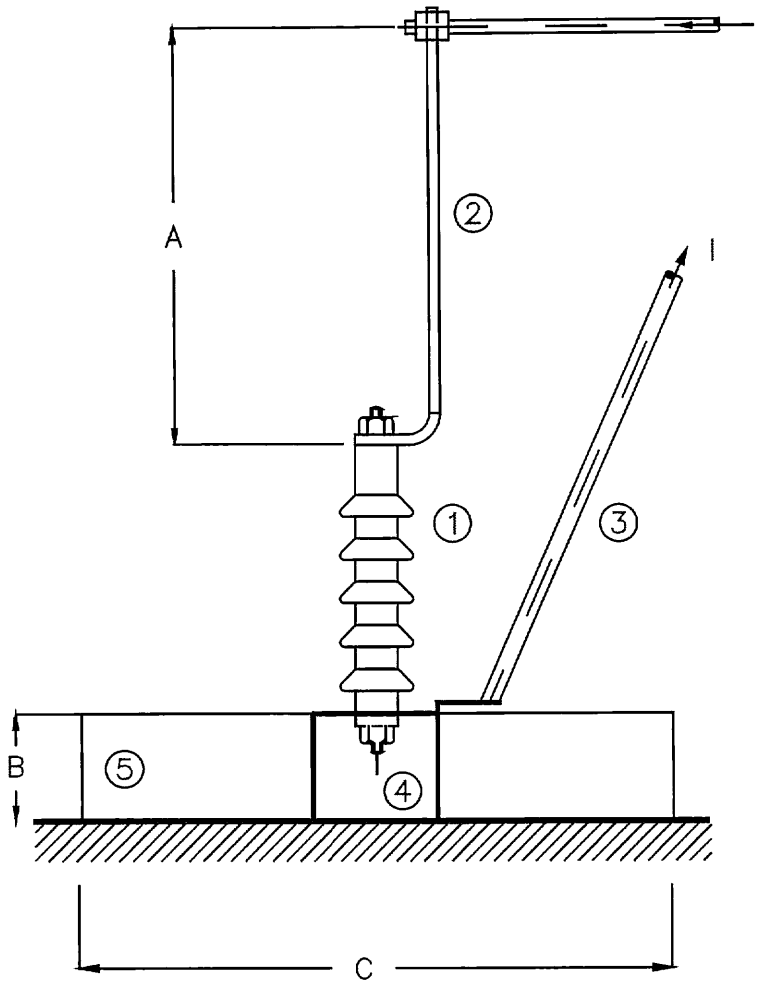
Receipt date of the sample October 8, 2004

Activity code 44836Q

Rated characteristics of the tested object assigned by the Client

Metal-oxide surge arrester		
Manufacturer		IZOELEKTRO
Type		2SS15N
Drawing		21-48-00
Rated voltage (Ur)		45,0 kV
Maximum continuous operating voltage (Uc)		36.0 kV
Rated frequency		50/60 Hz
Nominal discharge current (8/20 µs impulse shape)		10 kA
Line discharge class		1
Pressure relief class		
High current	for 0,20 s ;	20,0 kA

D8000 - Test arrangement



1 : Surge arrester
2 : Flexible conductor
3 : Rigid conductor
4 : Support
5 : Circular enclosure

A : 1,00 m
B : 0,40 m
C : 1,80 m

The arrester to be tested was fixed on a support at 0,40 m to ground in the middle of a circular enclosure of 1,80 m in diameter.
The live side of the supply was connected to the upper end of the arrester while the return circuit, earthed, was connected to the lower end.

High-current short-circuit test with 20,1 kA for 0,20 s

Test circuit : See D0046 Power factor : <0,15 Frequency : 50 Hz

Test arrangement : See D8000 and photo No.1.
To achieve the internal discharge, the surge arrester has been faulted by means of on overvoltage application using an auxiliary low power source.
The short-circuit current of the auxiliary low power source has been set at about 6,00 A.
The voltage applied to the arrester was risen in order to get a current equal to 50 mA (0-peak)(i.e. 68 kVpk) and kept at this value till arrester failure.
The pre-failure process duration was 6 minutes and 30 seconds.
The short-circuit test was performed 5 minutes after the completion of the pre-failure process.

Prospective test current			
Oscillogram		rms value	Peak value
No.	Sheets	kA	kA
4	1	20,1	52,7

Condition of the apparatus before the tests: new, see photo No.2.

Date: November 9, 2004

Test	Oscillogram		Arrester under test	Duration	Test voltage	Test current		Time of flame extinction after the test	Venting time	Notes
						Peak value	rms value			
No.	No.	Sheets	No.	S	kV	kA	kA	s	ms	No.
1	6	2	2	0,20	38,5	52,1	20,1	-	0,80	-

Condition of the apparatus after the tests: see photos No.3 to 5.

- The arrester remained connected to the supply and return circuit.
- The arrester structure was slightly damaged by the test.
- Some housing fragments were ejected inside the enclosure.
- Few housing fragments were ejected outside the enclosure.
- No flame was noted after the test.

High-current short-circuit test with 12,1 kA for 0,20 s

Test circuit : See D0046 Power factor : <0,15 Frequency : 50 Hz

Test arrangement : See D8000
To achieve the internal discharge, the surge arrester has been faulted by means of on overvoltage application using an auxiliary low power source.
The short-circuit current of the auxiliary low power source has been set at about 6,00 A.
The voltage applied to the arrester was risen in order to get a current equal to 50 mA (0-peak)(i.e. 68 kVpk) and kept at this value till arrester failure.
The pre-failure process duration was 6 minutes and 00 seconds.
The short-circuit test was performed 5 minutes after the completion of the pre-failure process.

Prospective test current			
Oscillogram		rms value	Peak value
No.	Sheets	kA	kA
3	1	12,1	31,6

Condition of the apparatus before the tests: new, see photo No.6.

Date: November 9, 2004

Test	Oscillogram		Arrester under test	Duration	Test voltage	Test current		Time of flame extinction after the test	Venting time	Notes
						Peak value	rms value			
No.	No.	Sheets	No.	S	KV	kA	kA	s	ms	No.
2	7	2	3	0,20	38,5	31,5	12,1	-	1,10	-

Condition of the apparatus after the tests: see photos No.7 to 9.

- The arrester remained connected to the supply and return circuit.
- The arrester structure was slightly damaged by the test.
- Some housing fragments were ejected inside the enclosure.
- Few housing fragments were ejected outside the enclosure.
- Time to flame extinction: 1 minute and 25 seconds.

High-current short-circuit test with 6,06 kA for 0,20 s

Test circuit : See D0046 Power factor : <0,15 Frequency : 50 Hz

Test arrangement : See D8000

To achieve the internal discharge, the surge arrester has been faulted by means of on overvoltage application using an auxiliary low power source.
The short-circuit current of the auxiliary low power source has been set at about 6,00 A.
The voltage applied to the arrester was risen in order to get a current equal to 50 mA (0-peak)(i.e. 68 kVpk) and kept at this value till arrester failure.
The pre-failure process duration was 6 minutes and 20 seconds.
The short-circuit test was performed 7 minutes after the completion of the pre-failure process.

Prospective test current			
Oscillogram		rms value	Peak value
No.	Sheets	kA	kA
2	1	6,06	15,7

Condition of the apparatus before the tests: new, see photo No.10.

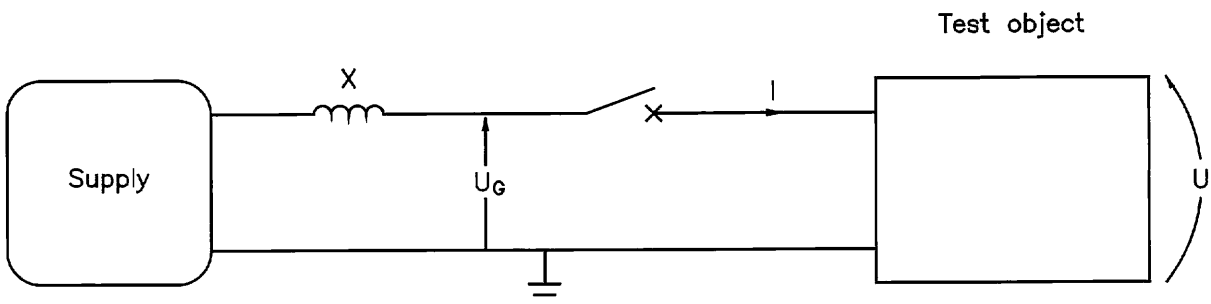
Date: November 9, 2004

Test	Oscillogram		Arrester under test	Duration	Test voltage	Test current		Time of flame extinction after the test	Venting time	Notes
						Peak value	rms value			
No.	No.	Sheets	No.	S	KV	kA	kA	s	ms	No.
3	8	2	4	0,20	38,5	15,7	6,06	-	1,80	-

Condition of the apparatus after the tests: see photo No.11.

- The arrester remained connected to the supply and return circuit.
- Light damages to the housing of the arrester.
- Some small pieces of porcelain were found only inside the enclosure.
- No flame was noted after the test.

Test circuit D0046



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

Photo no. 1

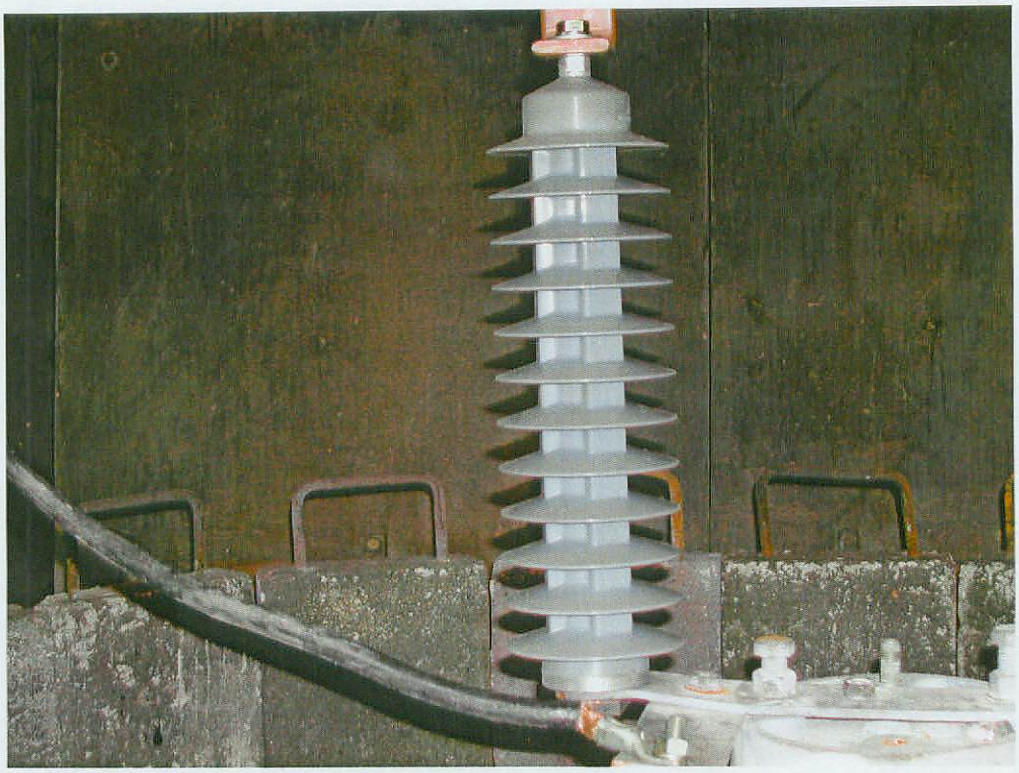


Photo no. 2

Photo no. 3

Photo no. 4

Photo no. 5

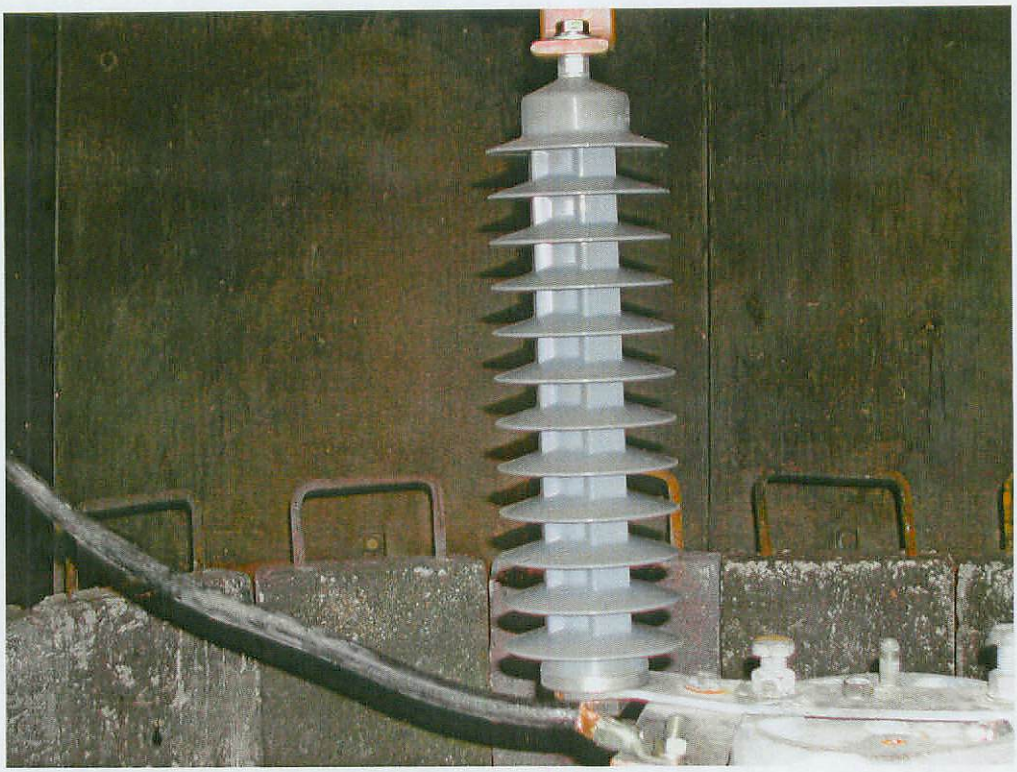


Photo no. 6

Photo no. 7

Photo no. 8

Photo no. 9

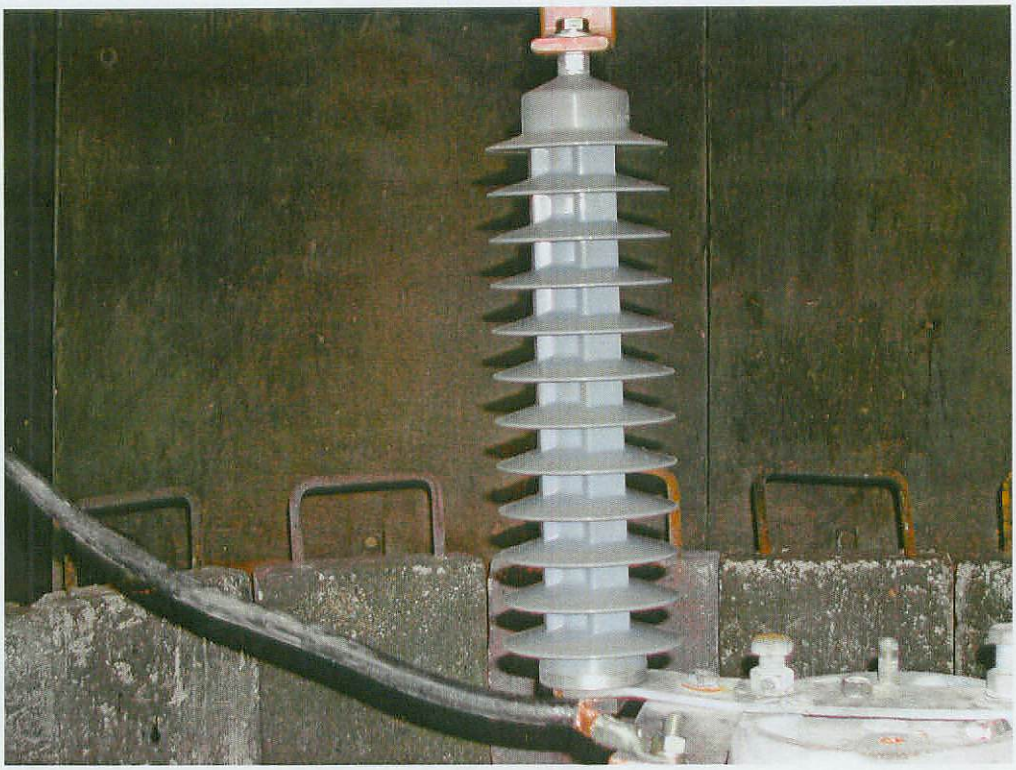


Photo no. 10

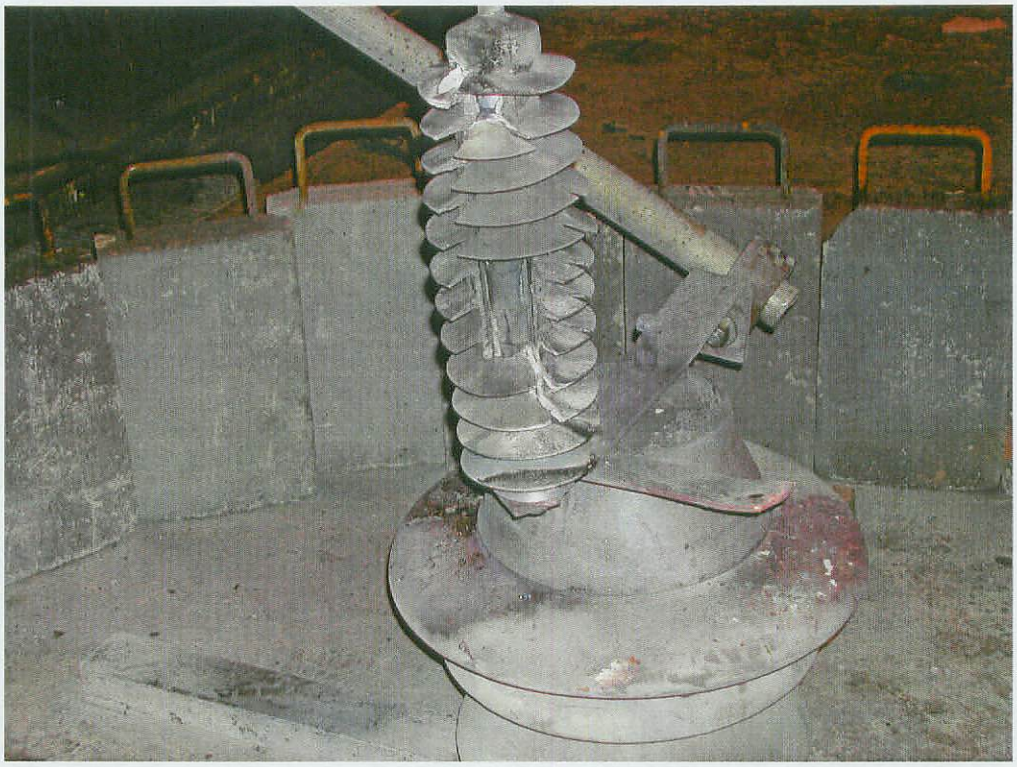
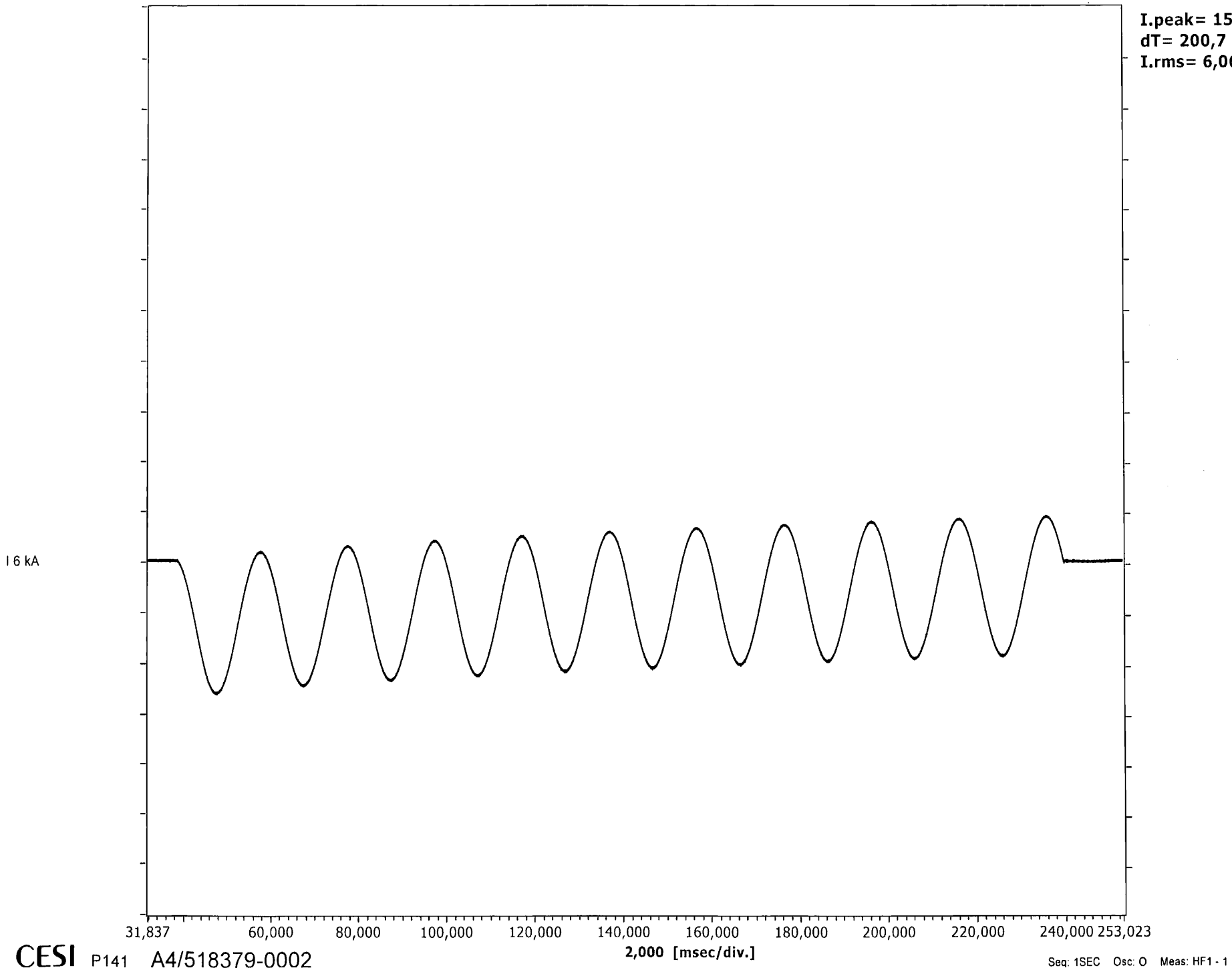
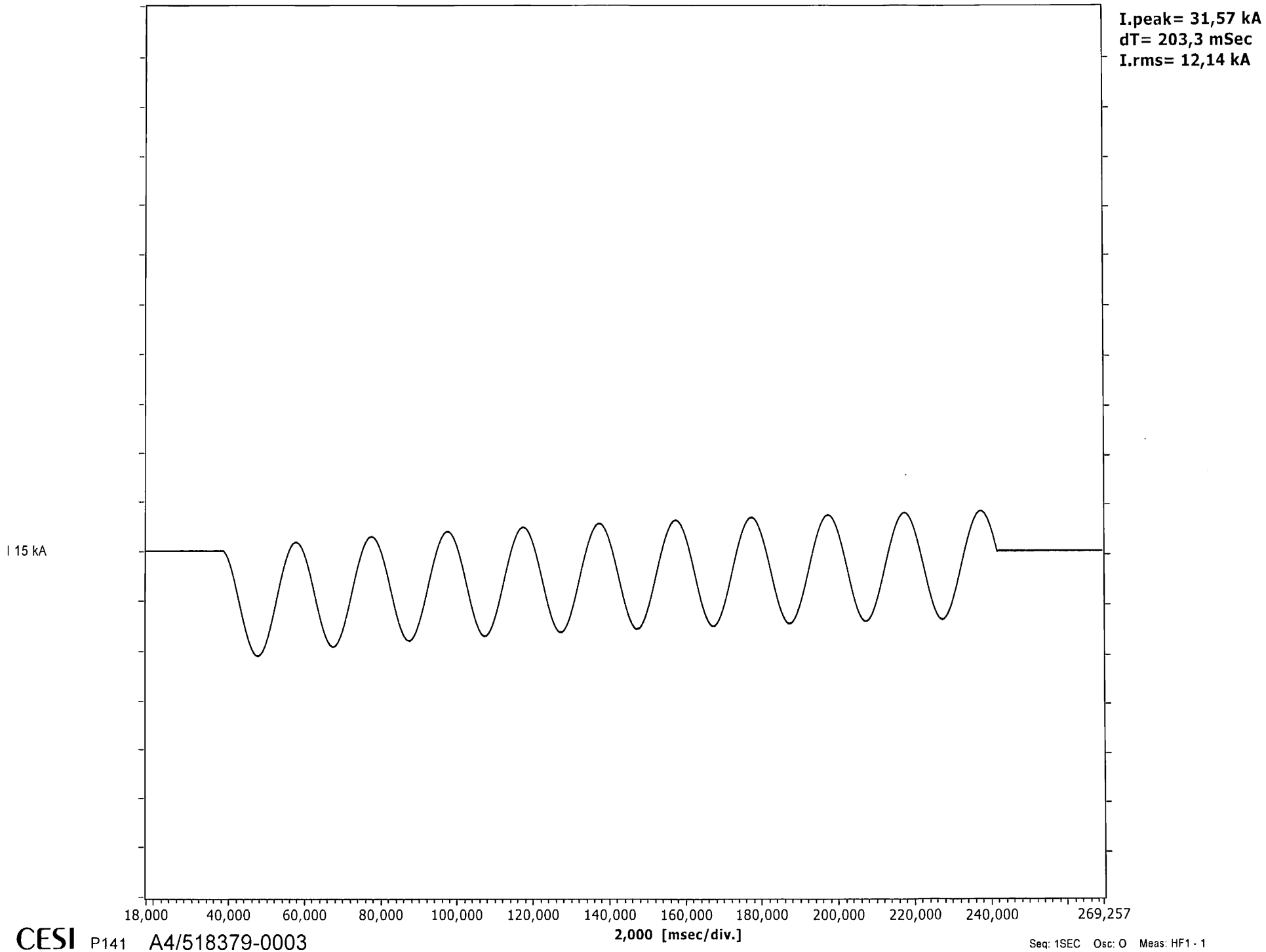


Photo no. 11



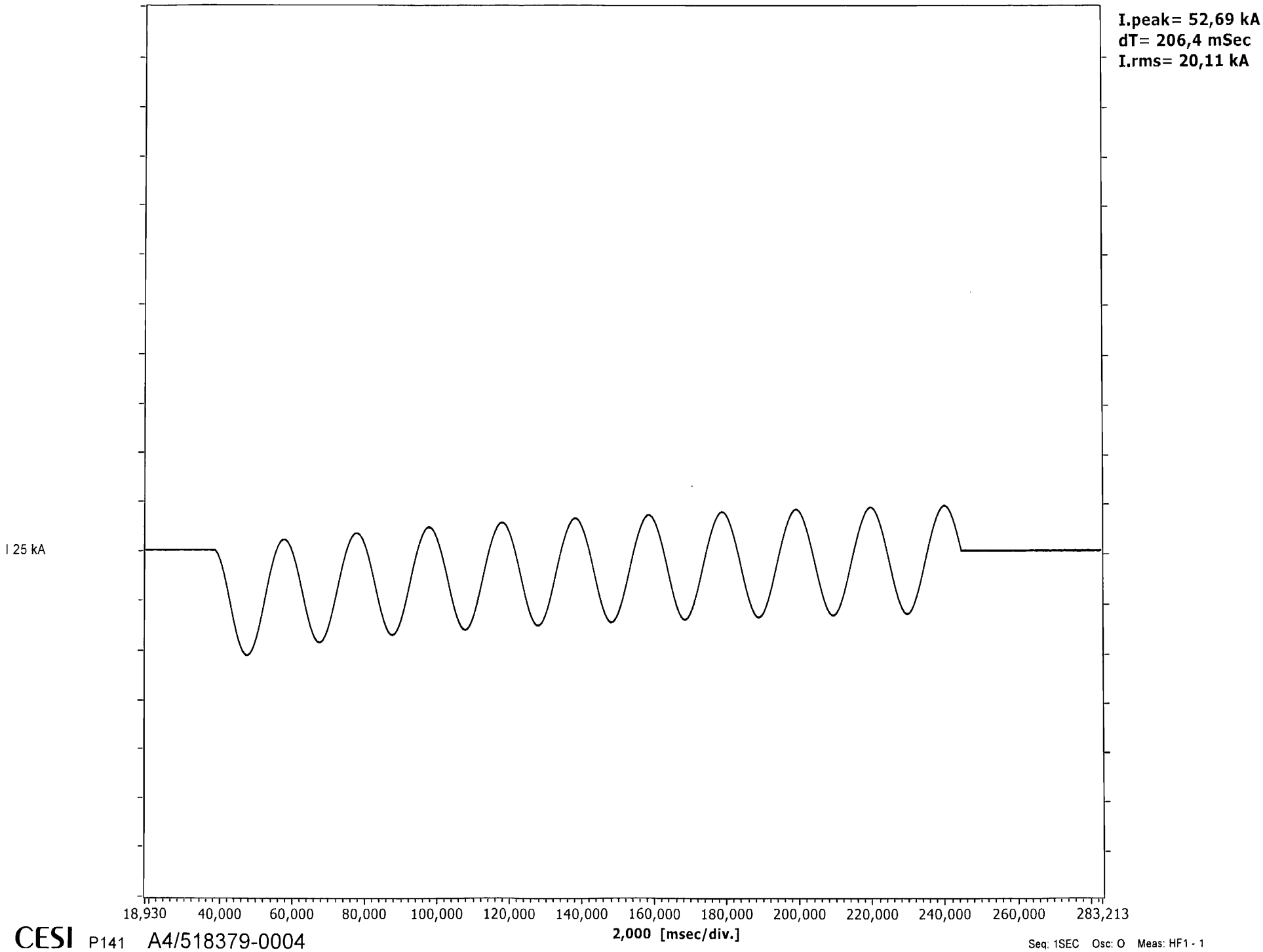
CESI P141 A4/518379-0002

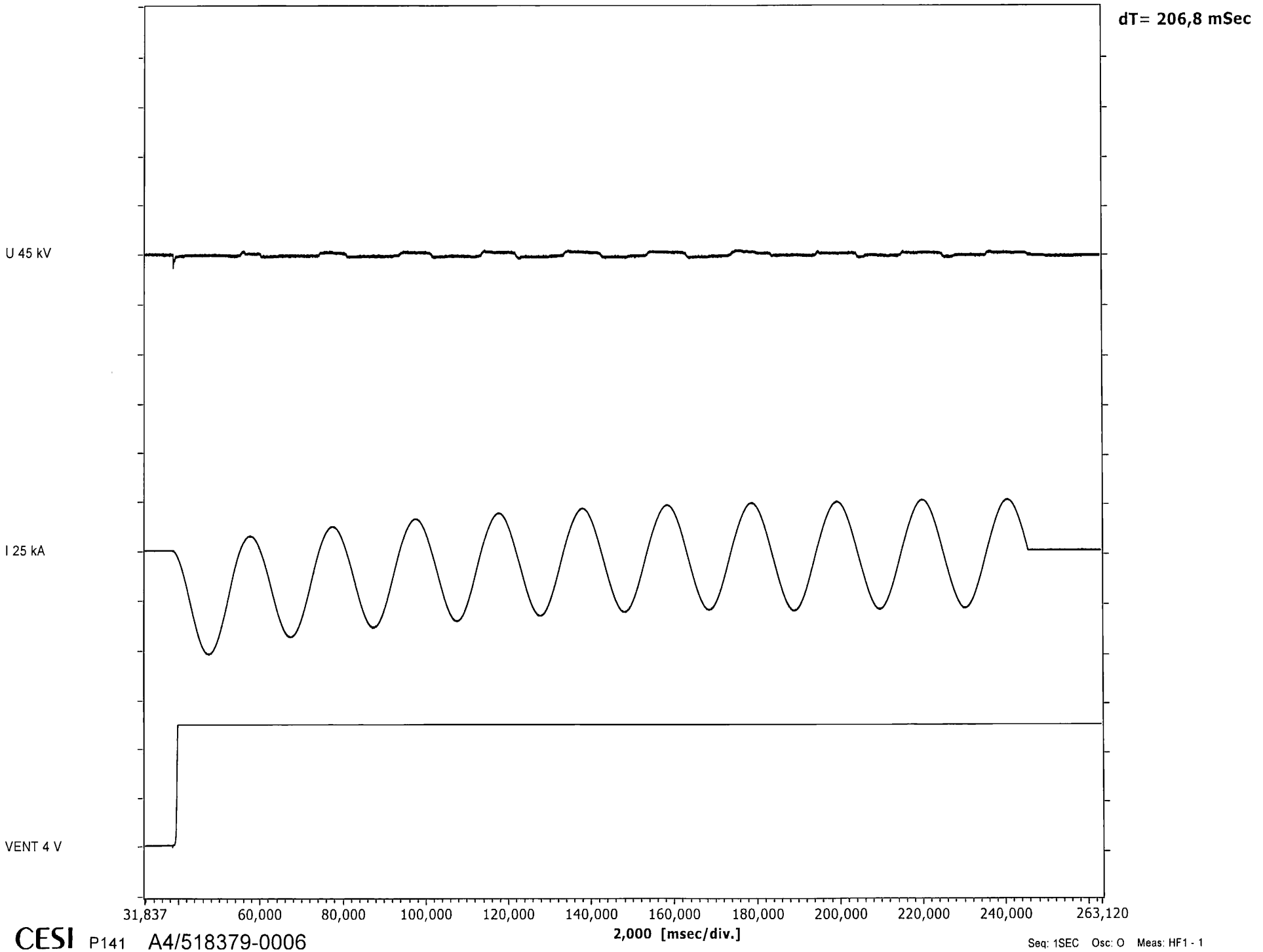
Seq: 1SEC Osc: O Meas: HF1 - 1



CESI P141 A4/518379-0003

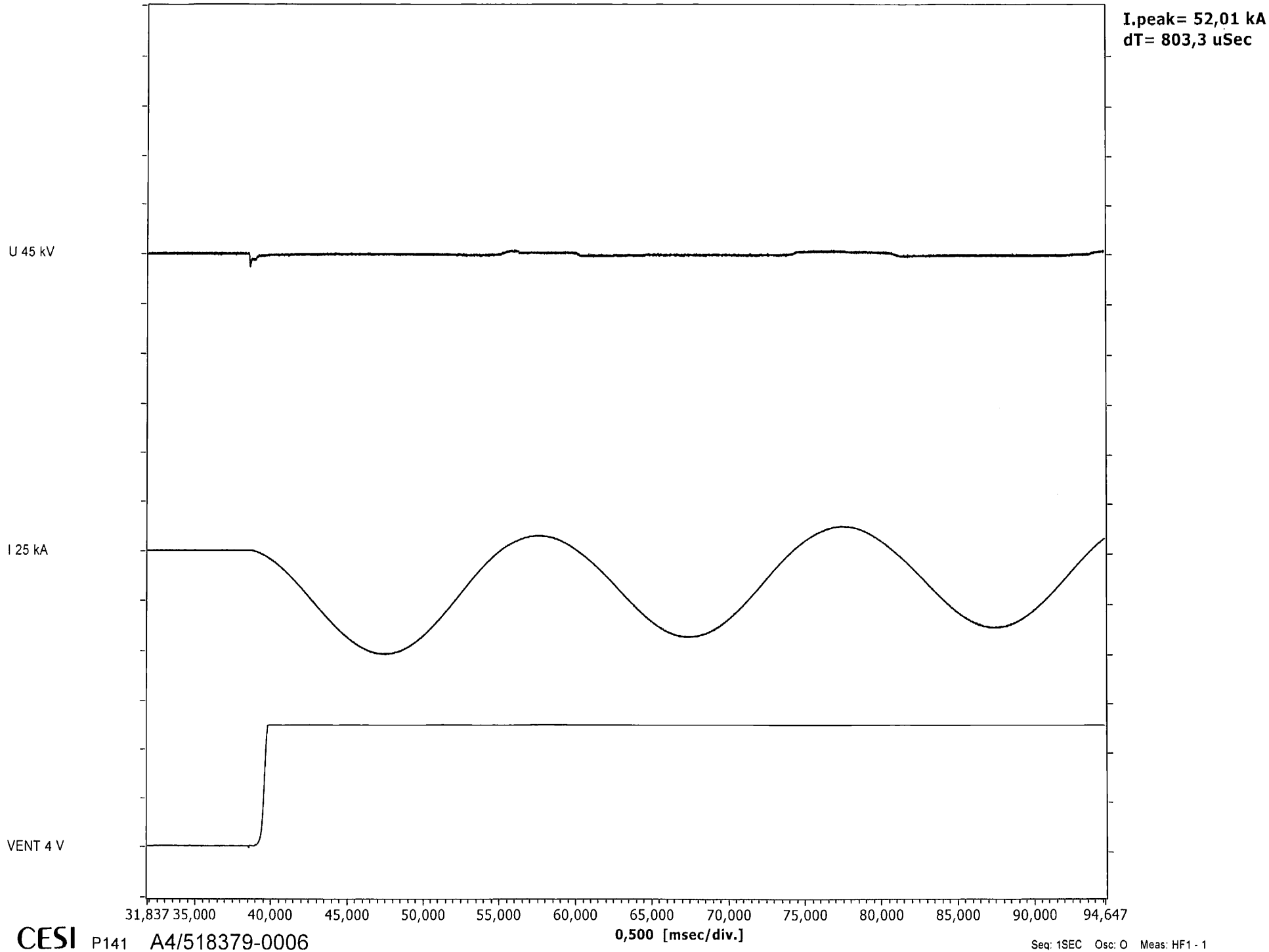
Seq: 1SEC Osc: O Meas: HF1 - 1


I.peak= 52,69 kA
dT= 206,4 mSec
I.rms= 20,11 kA
I 25 kA
18,930
40,000
60,000
80,000
100,000
120,000
140,000
160,000
180,000
200,000
220,000
240,000
260,000
283,213
2,000 [msec/div.]
CESI P141 A4/518379-0004
Seq: 1SEC Osc: O Meas: HF1 - 1



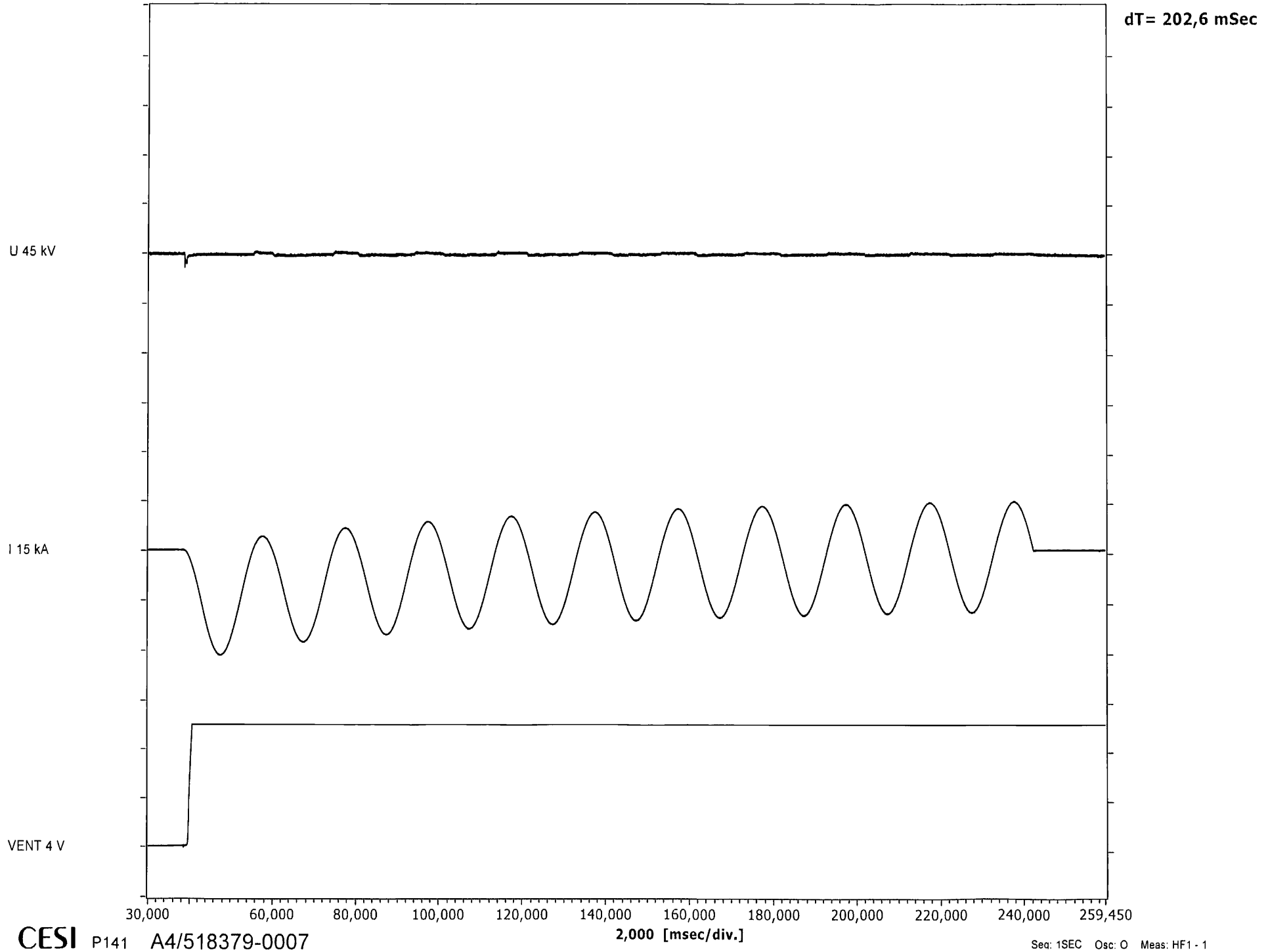
CESI P141 A4/518379-0006

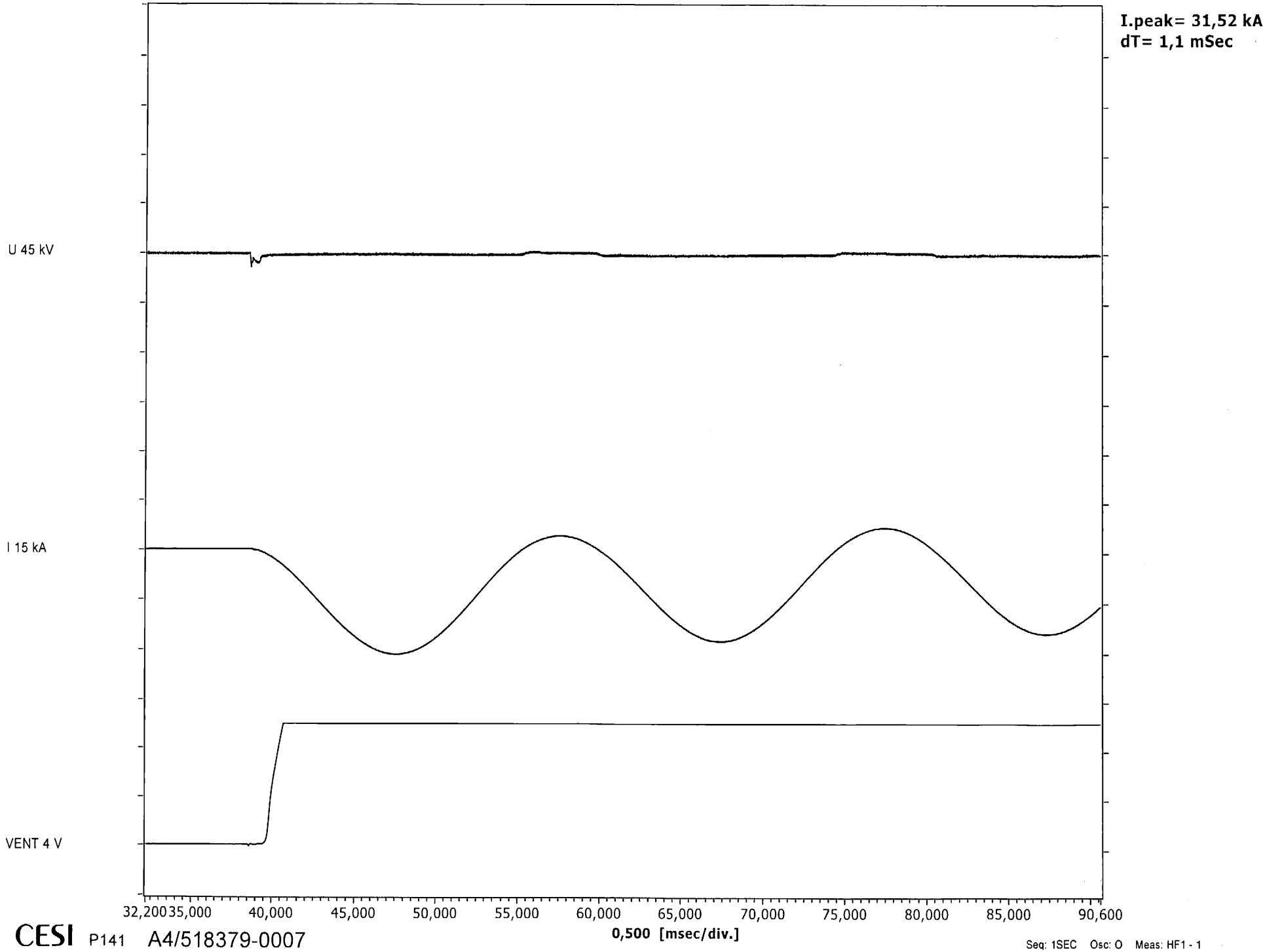
Seq: 1SEC Osc: O Meas: HF1 - 1



CESI P141 A4/518379-0006

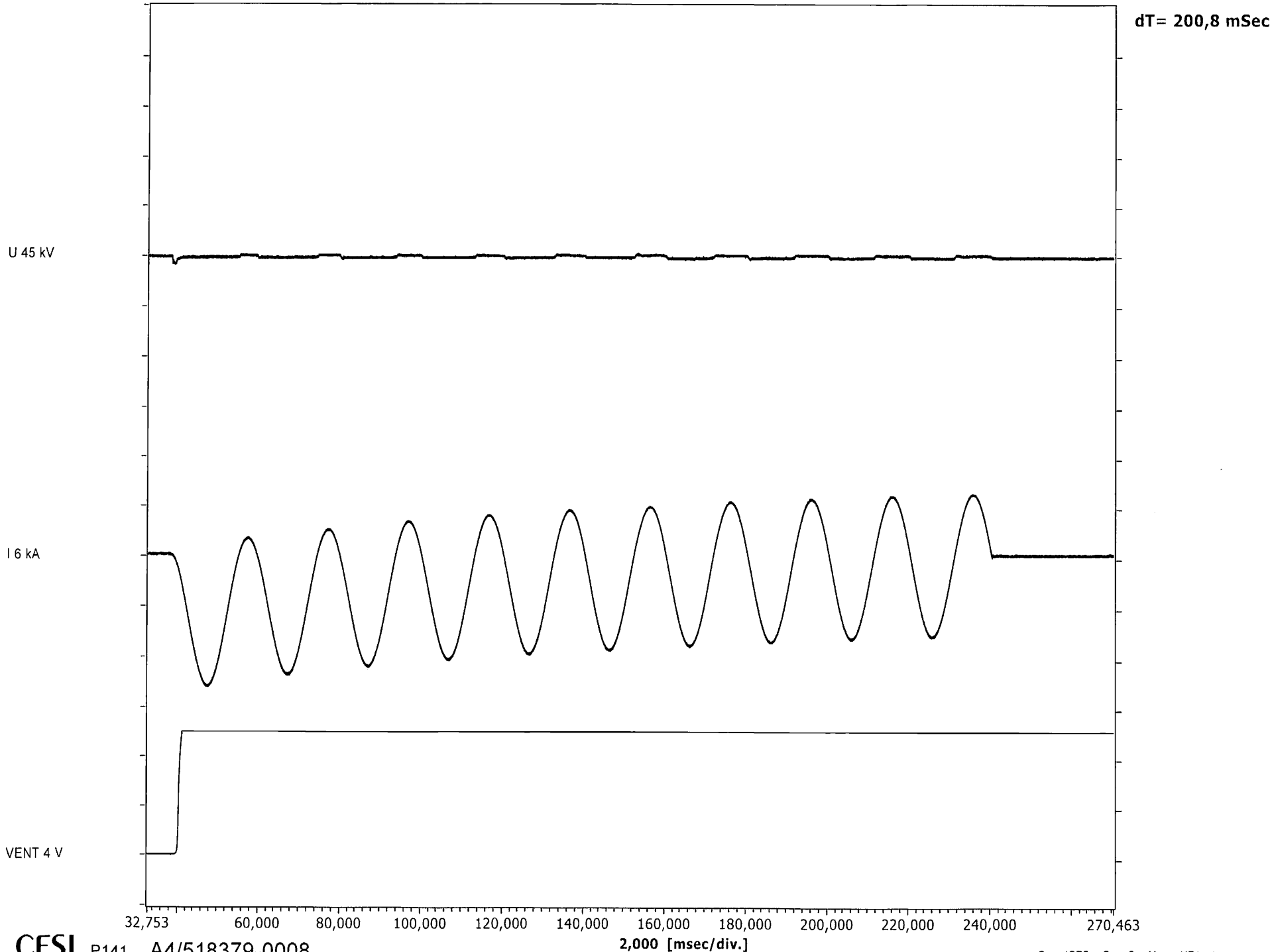
Seq: 1SEC Osc: O Meas: HF1 - 1


dT= 202,6 mSec
U 45 kV
I 15 kA
VENT 4 V
30,000
60,000
80,000
100,000
120,000
140,000
160,000
180,000
200,000
220,000
240,000
259,450
2,000 [msec/div.]
CESI P141 A4/518379-0007
Seq: 1SEC Osc: O Meas: HF1 - 1



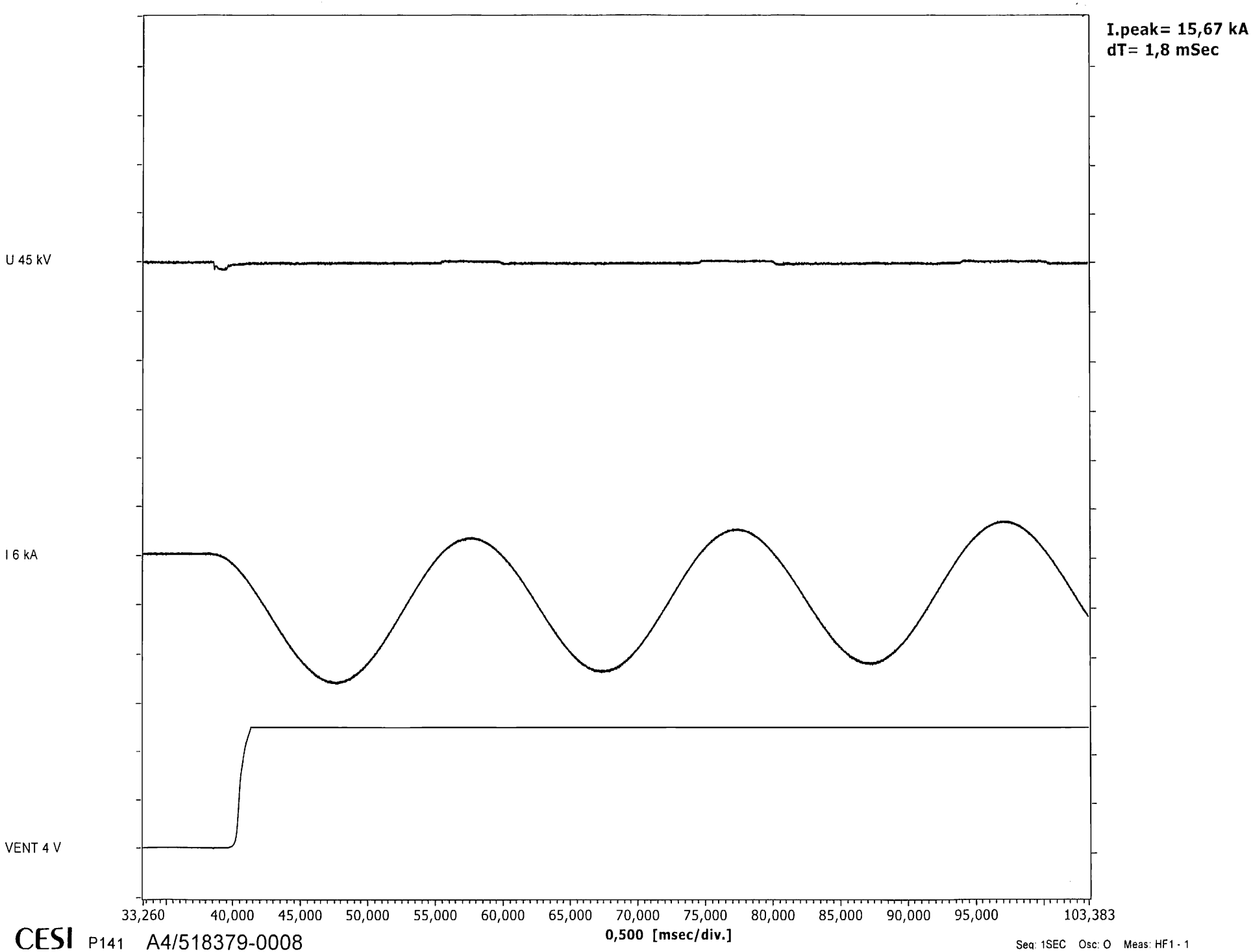
CESI P141 A4/518379-0007

Seq: 1SEC Osc: O Meas: HF1 - 1



CESI P141 A4/518379-0008

Seq: 1SEC Osc: O Meas: HF1 - 1



CESI P141 A4/518379-0008

Seq: 1SEC Osc: O Meas: HF1 - 1

CESI

PROTOCOLLO DATA

A 5/ 0 1 0 2 9 3 n.0 1 1 8 MAR. 2005

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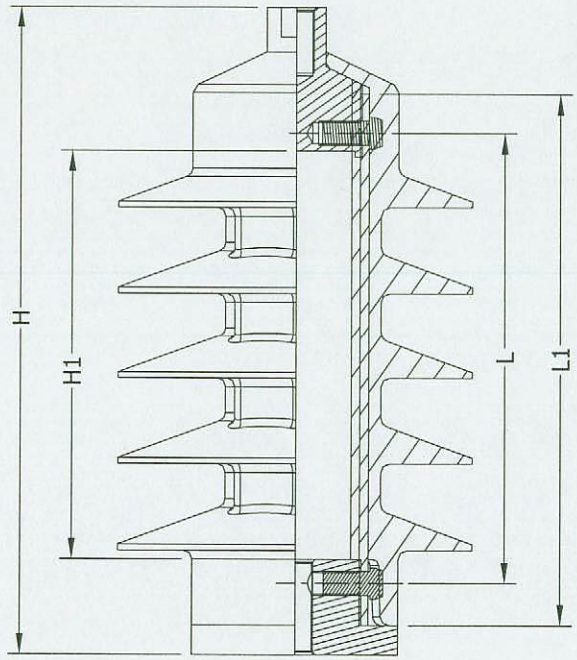


Code	Ur (kV)	Arrester heigh H (mm)	Number of ribs (pcs)	Area for ZnO bloks H1 (mm)	Lenght of strips L1 (mm)	Lenght L (mm)
21-48-01	3,75	147	3	67	107	81
21-48-02	5	147	3	67	107	81
21-48-03	7,50	147	3	67	107	81
21-48-04	10	193	5	113	153	127
21-48-05	12,5	193	5	113	153	127
21-48-06	15	193	5	113	153	127
21-48-07	17,5	243	6	163	203	177
21-48-08	20	243	6	163	203	177
21-48-09	22,5	243	6	163	203	177
21-48-10	25	270	7	190	230	204
21-48-11	26,25	270	7	190	230	204
21-48-12	27,5	270	7	190	230	204
21-48-13	30	317	8	237	277	251
21-48-14	32,5	317	8	237	277	251
21-48-15	35	317	8	237	277	251
21-48-16	37,5	370	11	290	330	304
21-48-17	40	370	11	290	330	304
21-48-18	42,5	404	12	324	364	338
21-48-19	45	404	12	324	364	338

ZO EKTRO ...

ISO2768 -

	Date:	Name:	Signature:
Izdelal:	27.8.03	R. Kurnik	
Pregledal:	1.9.03	P. Pungercar	
Odobril:	1.9.03	P. Pungercar	

Opombe:

Measure: 7:10 Weight:

Materiali:

Type:

SURGE ARRESTER 2SS15N

Code:

21-48-00

Sheet: 1/1

Izdelek: Prip.:

Pro/ENGINEER

Test Report

CESI Sinal n° 0030 Approved

Client	IZOELEKTRO d.o.o. – Pesnica Pri Mariboru (Slovenia)
Tested equipment	Housing for polymer housed metal-oxide surge arrester type 2SS15N
Tests carried out	Insulation withstand tests
Standards/Specifications	IEC 60099-4 (2004-05)
Test date	**from** January 31, 2005 **to** January 31, 2005

No. of pages	13	**No. of pages annexed**	5
Issue date	February 23, 2005		
Prepared	BU PeC - L. Podavitte		
Verified	BU PeC - A. Sironi		
Approved	BU PeC - M. de Nigris		

CESI
CENTRO ELETTROTECNICO SPERIMENTALE ITALIANO
Business Unit
Prove e Componenti
Il Responsabile del Laboratorio

Tests witnessed by:-----

Identification of the object:

The Manufacturer guarantees that the tested object is manufactured according to the submitted drawing.
CESI checked that this drawing adequately represents in shape and dimensions the essential details and the parts of the tested object.
This drawing, identified by CESI and numbered A5006707 No. 1, is annexed to this document.

The data necessary to permit repetition of the tests are contained in the document marked: ---

- dielectric tests with impulse voltage	: **peak voltage: ± 3 %; time parameters: ± 10 %**
- dielectric tests with impulse current	: **peak value: ± 3 %; time parameters: ± 10 %**
- dielectric tests with alternating voltage	: **voltage (rms): ± 3 %**
dielectric tests with direct voltage	: **voltage: ± 3 %**

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

Laboratory information

Receipt date of the sample	November 26, 2004
Test location	CESI – Via Rubattino 54 – Milan
CESI testing team	Mr L. Podavitte , Mr I. Guacci, Mr M. Gregori
Test laboratory	P180
Activity code	19774B

Rated characteristics of the tested object assigned by the Client

Metal-oxide surge arrester	
Manufacturer	IZOELEKTRO d.o.o. – Pesnica Pri Maboru (Slovenia).
Year of manufacture	2004

Electrical and mechanical characteristics	
Nominal discharge current (I_r)	10 kA
Line discharge class	1
Rated voltage (U_r)	45 kV
Continuous operating voltage (U_c)	36 kV
Lightning impulse protection level - U_{LIPL}	**114.3 kV**
Rated frequency	50-60 Hz

Geometrical characteristics	
Total height	405 mm
Number of sheds	12
Shed diameter	116 mm
Shed spacing	29 mm
Arcing distance	380 mm
Creepage (leakage)distance	910 mm

Other characteristics	
Housing material	silicone
Housing color	grey

Note 1:
The sample was suitably prepared for the test by replacing active parts with insulating material

Note 2:
The switching impulse protection level U_{SIPL} is calculated on the base of UL_{IPL} claimed by the manufacturer and of the residual voltage test (see CESI report A4/522503) as:

$U_{SIPL} = UL_{IPL}$ X (30.50/38.78) = 114.3 X (30.50/38.78) = 89.9 kV

Name and signature of Client's witness:

Photograph of the test object

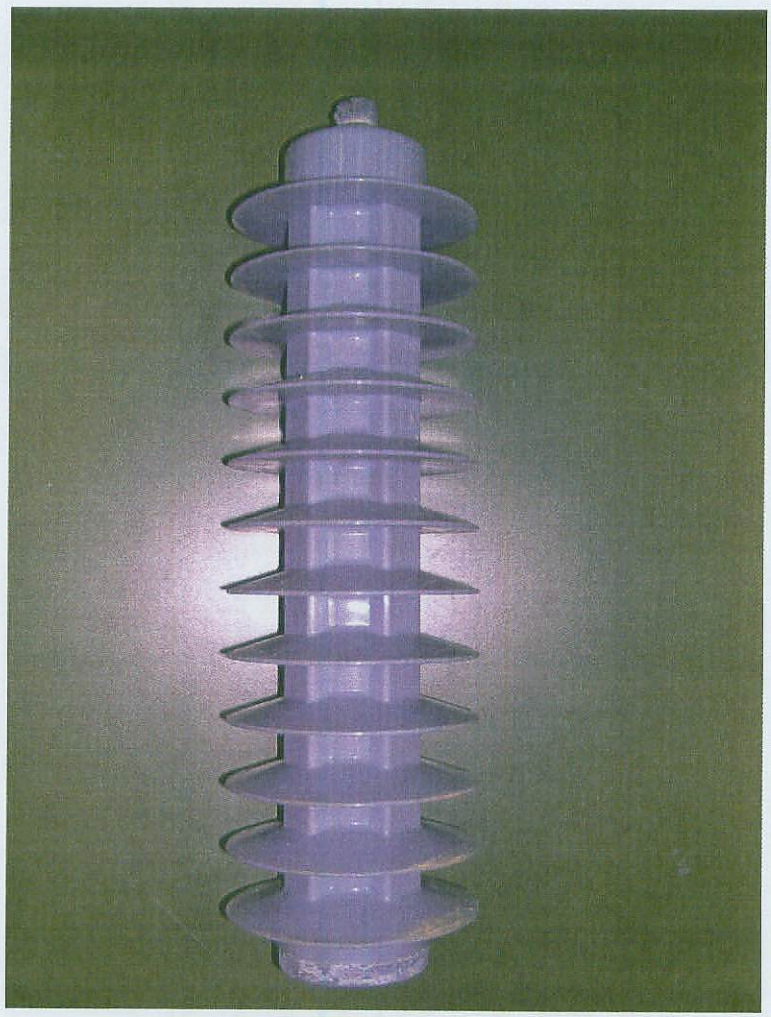


Photo no. 1

Photograph of the test arrangement

Photo no. 2

Reference Standard

IEC 60099-4 (2004-05): "Metal-oxide surge arrester without gaps for a.c. system", clause 8.2

Test carried out and identification of the test objects

Test carried out	Number of test objects	Test object identification
Dry lightning impulse withstand tests	1	IWT1
Wet power frequency withstand tests		

Test procedure

Dry lightning impulse withstand test

The test sample has been submitted to fifteen voltage impulses for each polarity having waweshape 1,2/50 μs and peak value equal to 148,6 kVpeak . The test has been performed in dry condition.

The test voltage is calculated as 1.3 times $\mathbf{UL_{IPL}}$

Wet power frequency withstand test

The power frequency voltage has been applied for 60 second on the sample at the value equal to 95,3 kVpk (67.4 kVrms).
The test has been performed in wet condition (as defined by IEC st. 60060-1 (1989))

The test voltage (peak value) is calculate as 1.06 times $\mathbf{U_{SIPL}}$

Summary of test results

Dry lightning impulse withstand test
No flashover occurred during any of the impulse application

Wet power frequency withstand test
Non flashover occurred

The test result positive

Dry lightning impulse withstand voltage test

Test No.: 1

Test object: HOusing for polymer housed metal-oxide surge arrester
Test circuit: A0002
Arrangement: see photograph pag n.6

Atmospheric conditions and correction factor			
b	t_d/t_w	h	K_t
kPa	°C	g / m³	
101,3	12/5	2,99	0,965

Date: January 31, 2005

test condition	polarity	impulse generator charging voltage	voltage required U	voltage applied U x K_t	A: (o) withstand (x) flashover B: oscillogram No. C: peak voltage [kV] D: time to discharge (μs)														
		kV	kV_{peak}	kV_{peak}															
IWT1	NEG	72,6	148,6	143,4	A	o	o	o	o	o	o	o	o	o	o	o	o	o	o
					B	03													
					C	143,1	143,5	144	143,7	143,5	144	144	143,8	143,6	143,6	144	144	143,8	143,6	144
					D														
IWT1	POS.	72,6	148,6	143,4	A	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
					B	04													
					C	143,4	143,6	144	143,8	144	144	143,9	144	143,6	143	144	143,7	143,5	144	143,7
					D														

continued

Wet power frequency withstand voltage test

Test No.: 2

Test object: Housing for polymer housed metal-oxide surge arrester
Test circuit: A0058-A0059
Arrangement: see photograph pag n.6

Atmospheric conditions and correction factor			
b	t_d/t_w	h	K_t
kPa	°C	g / m³	
101,03	12/5	2,99	1,0

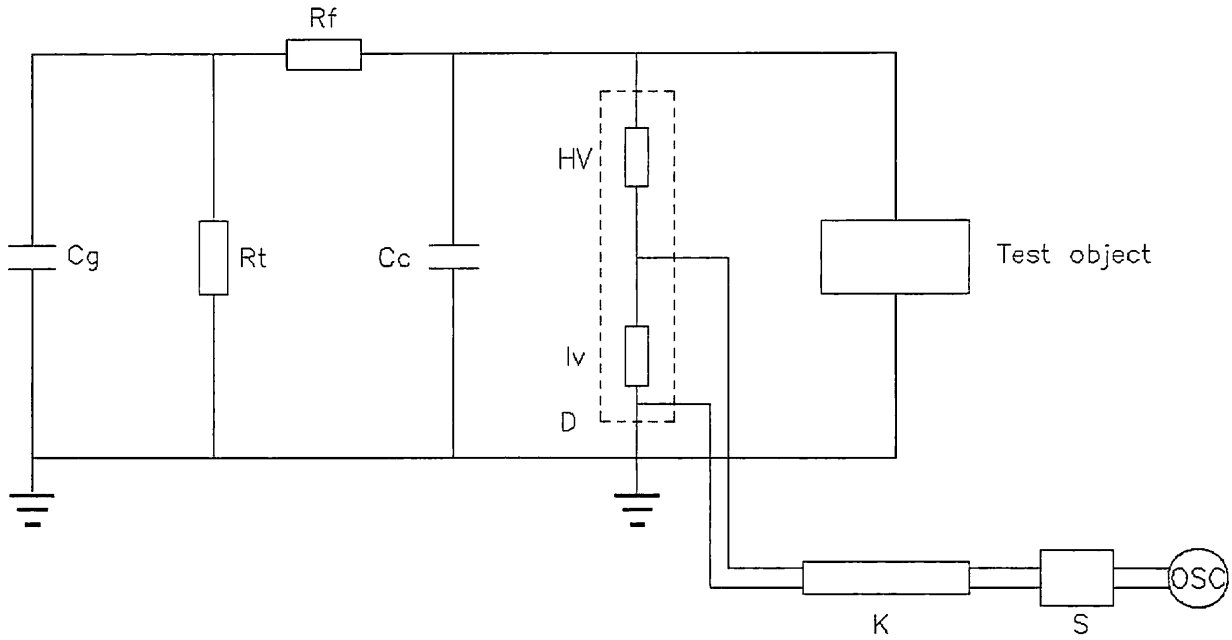
Precipitation conditions					
	Precipitation rate (mm/min)			Water temperature	Water resistivity
	top	center	bottom	°C	Ω * m
vertical	1,2	1,2	1,2	11	100
horizontal	1,2	1,2	1,2		

Date: January 31, 2005

test condition	voltage		test voltage				test duration	Test result	Notes
	required U	applied U x K_t	V_1	$V_{AT} = k_1 V_1$ (k_1 = 3500)	V_2	$V_{AT} = k_2 V_2$ (k_2 = ---)			
	kV_{rms}	kV_{rms}	V_{rms}	kV_{rms}	V_{rms}	kV_{rms}	s		
IWT1	67,4	67,4	19,25	67,4	---	---	60	withstand	

continued

Circuit A0002



Impulse generator

No. of stages: 2
C_g: 250 nF
R_t: 280 Ω (140 x 2)
R_f: 320 Ω (140+60+40+80)
C_C: 0,6 nF

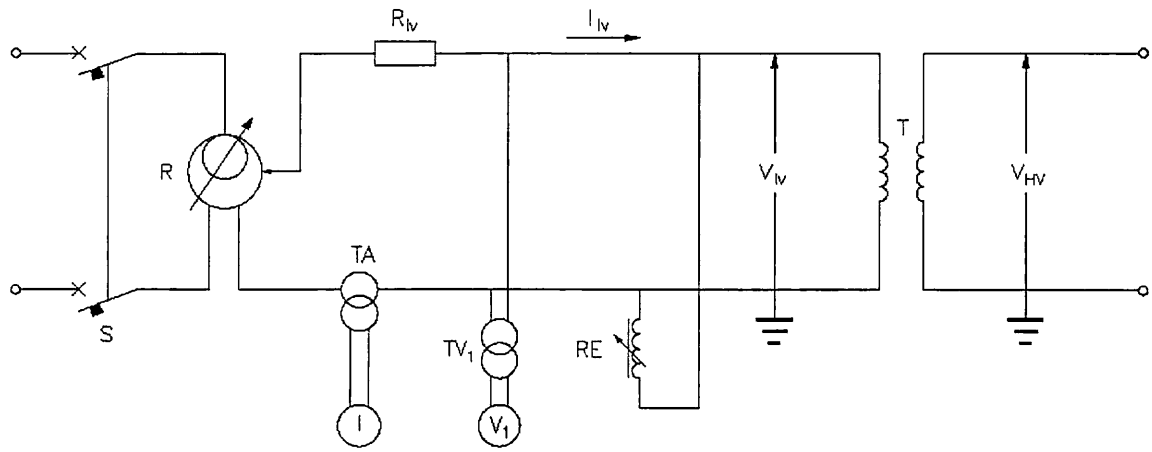
Voltage measuring system CESI No. 9792

D - divider PASSONI & VILLA type RC series CESI No. 6700; scale factor 25662,7
HV - high voltage capacitance 600 pF
lv - low voltage unit CESI No. 6704
K - coaxial cable
S - attenuation and termination unit CESI No. 14924
OSC - digital oscilloscope type TEKTRONIX TDS 430A CESI No. 14232

	Measured waveshape		
	polarity	time	oscillogram
		µs	No.
front	negative	1,06	01
tail		54,6	02

	Check of the test circuit		
	Charging voltage V_c	Measured voltage V_m	η $V_m / (V_c \cdot n_{stages})$
polarity	kV/stage	kV	
negative	58,3	114,5	0,981

Circuit A0058



Power frequency test circuit

R - regulation group PIVI composed by:
- single-phase voltage converter PIVI; power 210 kVA; voltage 380 V/0÷610 V
- booster transformer PIVI; power 200 kVA; voltage 600 V /6 kV

R_{lv} - protection resistor TELEMA; R= 2 Ω

TA - current transformer type CGS; ratio 50 A/5 A; CESI No. 03399

I - direct reading digital amperometer

TV_1 - voltage transformer type ALSTOM; ratio 6 kV/100 V

V_1 - digital voltmeter AGILENT 34401A; CESI No. 23082

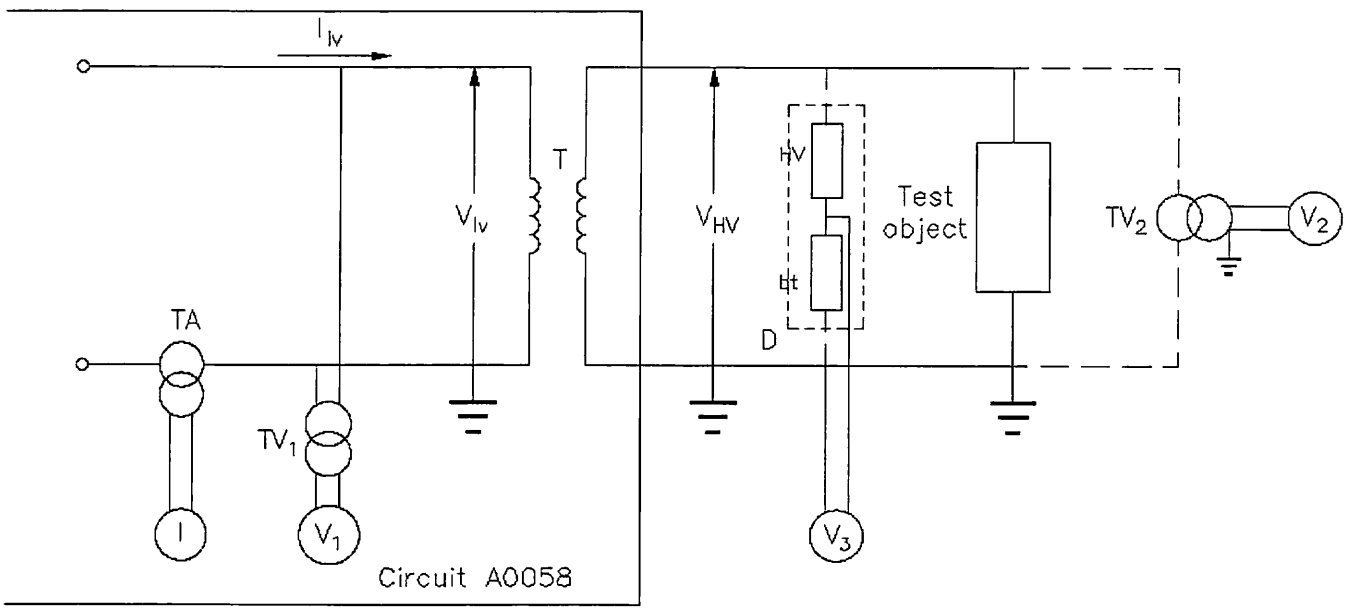
T - booster transformer CGE mod. KOC; secondary winding power 700 kVA; voltage 6 kV /350 kV; No. of units 1; ratio /

RE - variable reactor PIVI; power 600 kVA; voltage / kV; No. of units /

Tripping of the circuit breaker S

I_N	k_{TA}	instantaneous tripping			time delayed tripping		
		setting			setting		
		s_1	$s_1 \times I_N$	t_1	s_2	$s_2 \times I_N$	t_2
5	10	1	5	0,05	0,5	2,5	0,05

Circuit A0059



Power frequency measuring circuit

TA - current transformer type CGS; ratio 50 A/5 A; CESI No. 03399
I - direct reading digital amperometer
TV_1 - voltage transformer type ALSTOM; ratio 6 kV/100 V
V_1 - digital voltmeter AGILENT 34401A CESI No. 23082

D - voltage divider / type RC series; voltage / kV; HV capacitance / pF; CESI No. /; low voltage arm CESI No. / scale factor /
V_3 - voltmeter CESI No. Not used

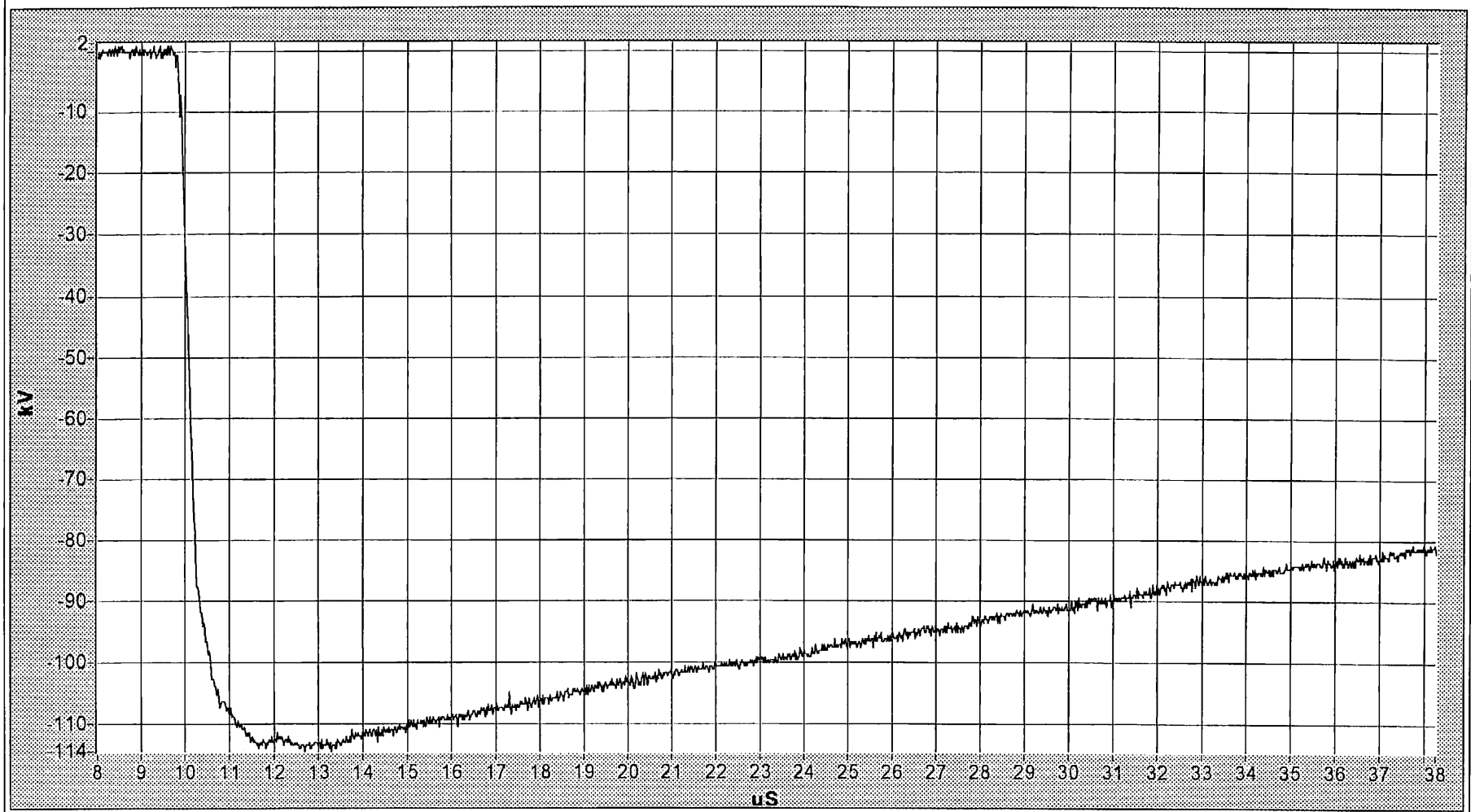
TV_2 - voltage transformer type SCARPA & MAGNANO; ratio 130/100 V; CESI No.5133
V_2 - digital voltmeter AGILENT 34401A CESI No. 23083

Functional check of the test circuit Date: January 31, 2005

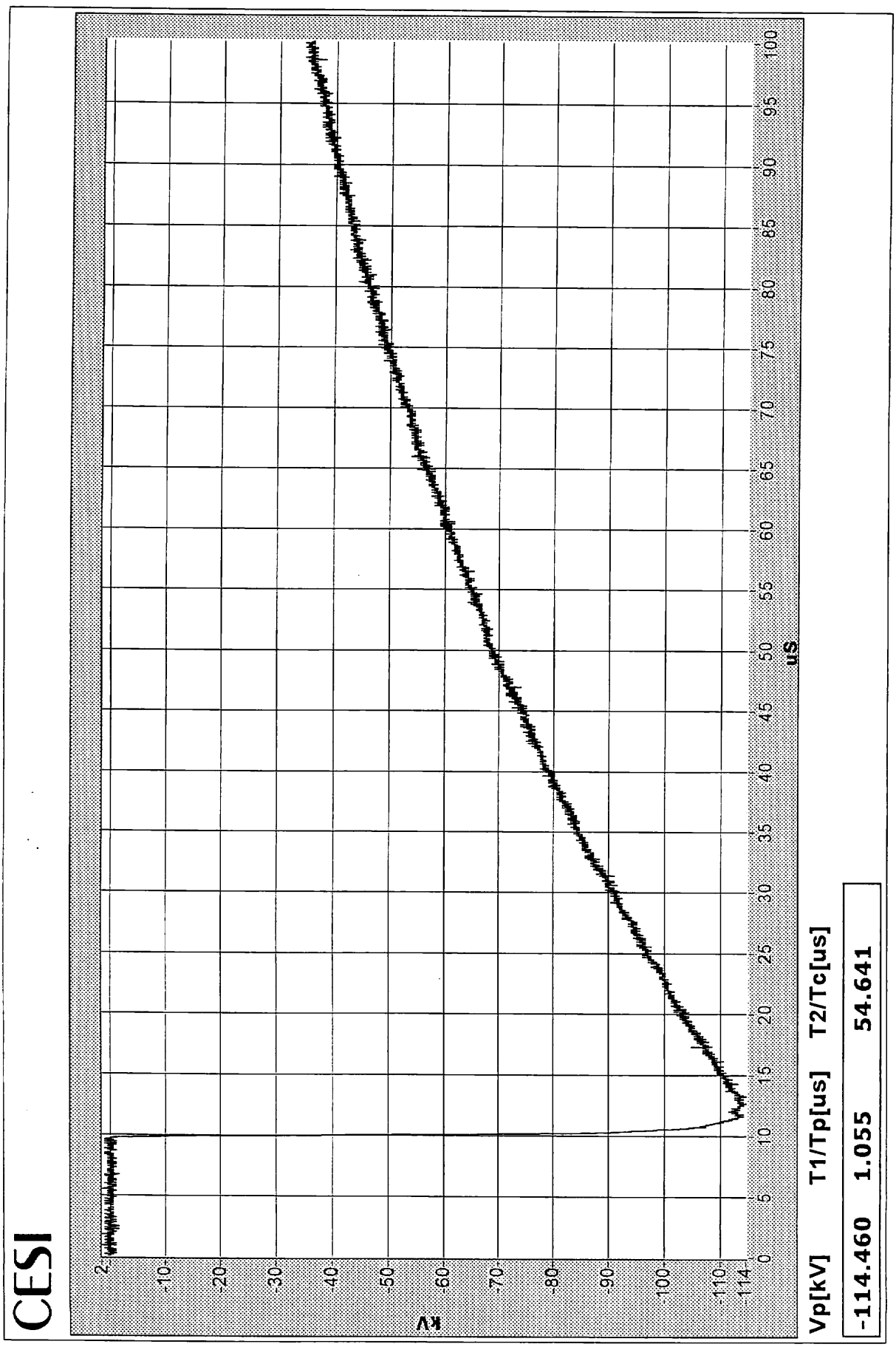
Low voltage				High voltage k_2 = 1300		k_3 =		k_t
V_1	V_{lv}	I	I_{lv}	V_2	V_{HV}	V_3	V_{HV}	V_{HV} / V_1
V	V	A	A	V	kV	V	kV	3500
14,27	856,2	--	1,0	38,34	48,83	-	-	3492

CESI PeC A5003349 oscillogram n. 1

CESI



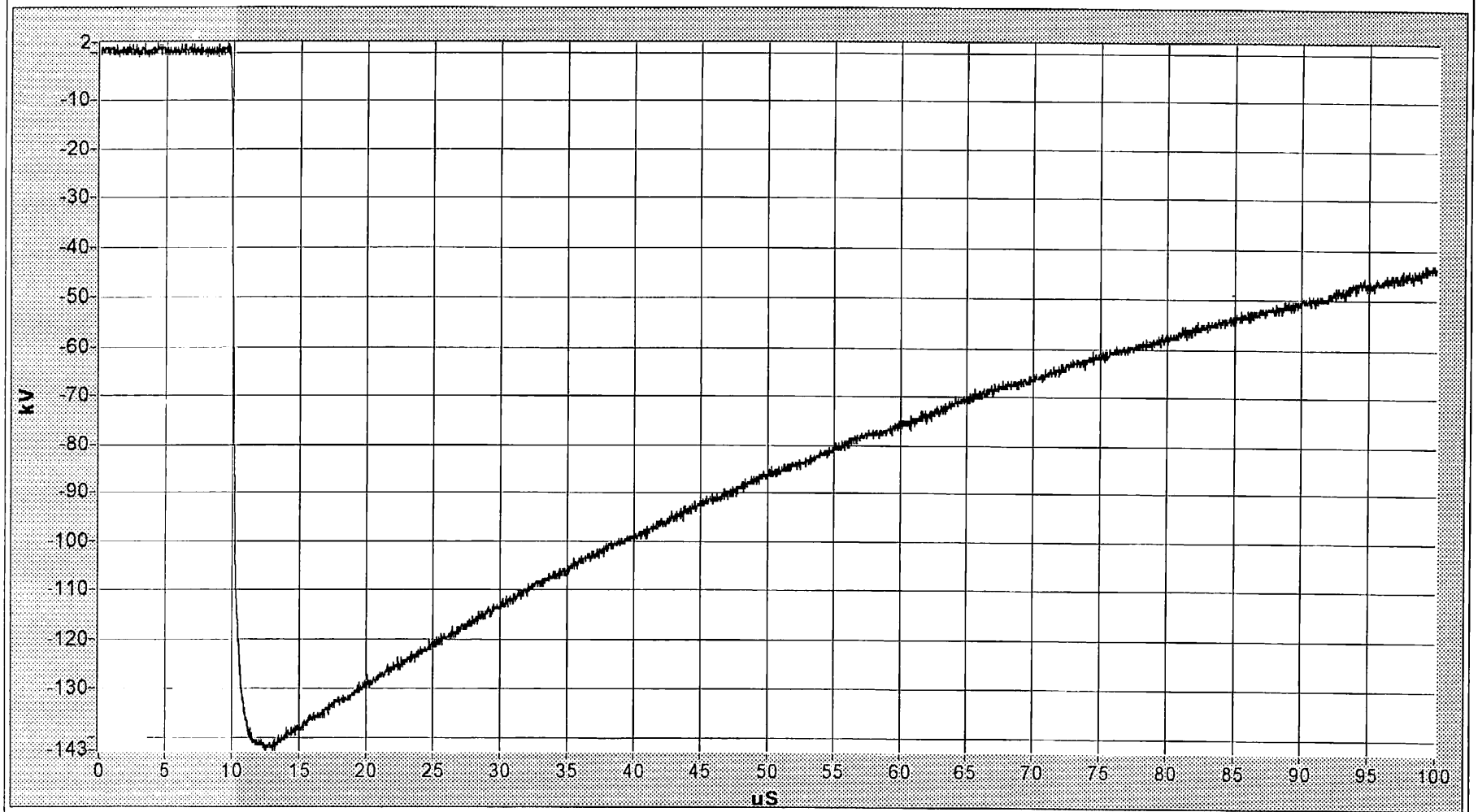
Vp[kV]	T1/Tp[us]	T2/Tc[us]
-114.460	1.055	54.641



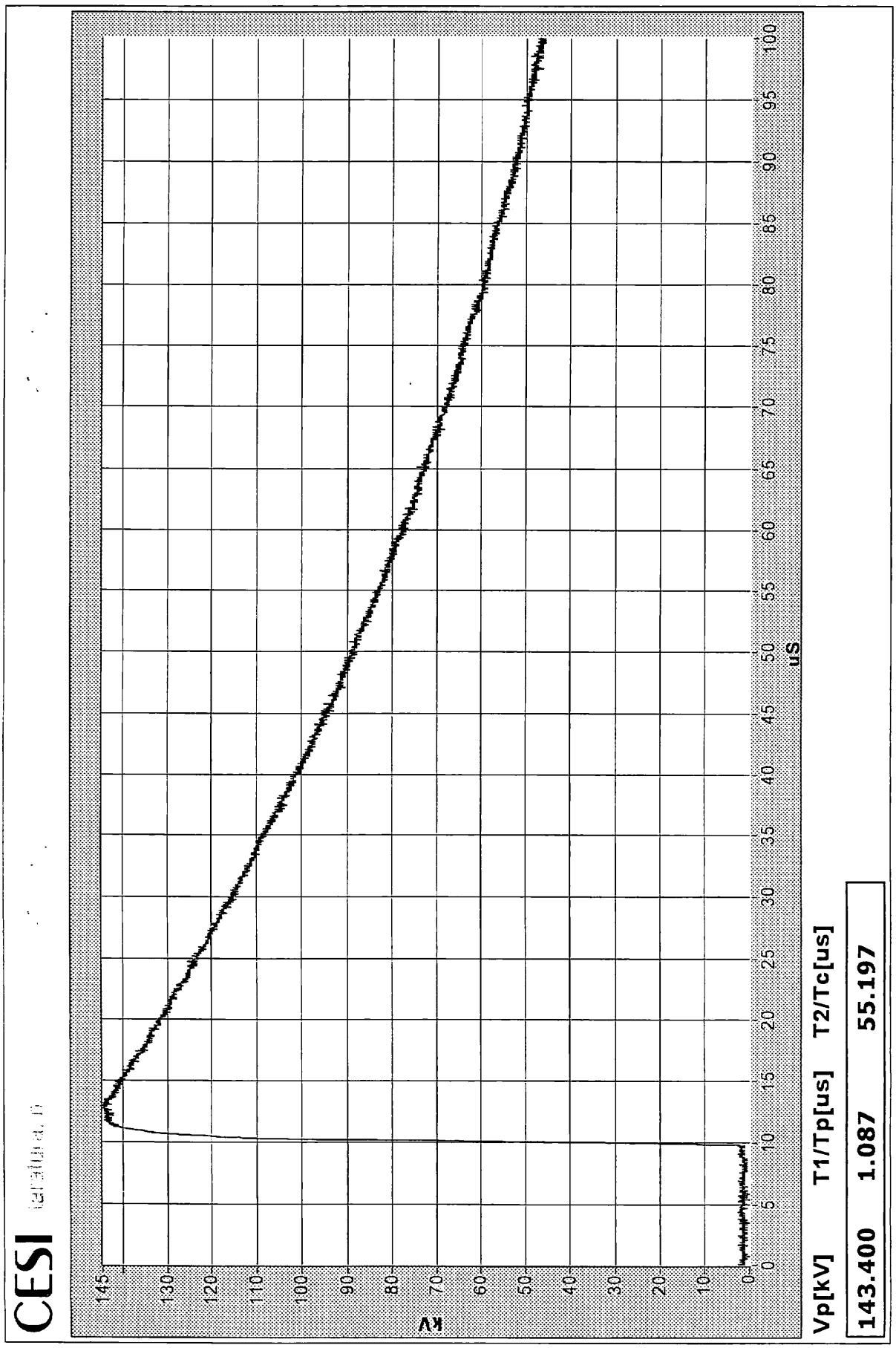
CESI PeC A5003349 oscillogram n. 2

CESI PeC A5003349 oscillogram n. 3

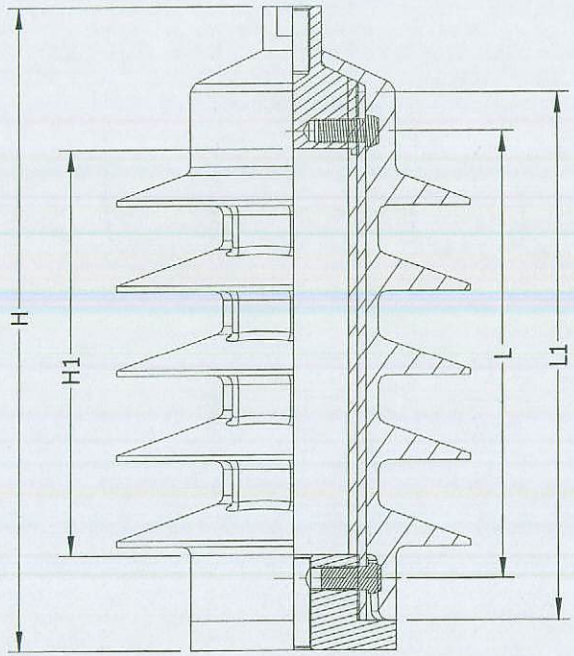
CESI



Vp[kV]	T1/Tp[us]	T2/Tc[us]
-143.105	1.050	54.500



CESI PeC A5003349 oscillogram n. 4



Code	Ur (kV)	Arrester heigh H (mm)	Number of ribs (pcs)	Area for ZnO bloks Hl (mm)	Lenght of strips L1 (mm)	Lenght L (mm)
21-48-01	3,75	147	3	67	107	81
21-48-02	5	147	3	67	107	81
21-48-03	7,50	147	3	67	107	81
21-48-04	10	193	5	113	153	127
21-48-05	12,5	193	5	113	153	127
21-48-06	15	193	5	113	153	127
21-48-07	17,5	243	6	163	203	177
21-48-08	20	243	6	163	203	177
21-48-09	22,5	243	6	163	203	177
21-48-10	25	270	7	190	230	204
21-48-11	26,25	270	7	190	230	204
21-48-12	27,5	270	7	190	230	204
21-48-13	30	317	8	237	277	251
21-48-14	32,5	317	8	237	277	251
21-48-15	35	317	8	237	277	251
21-48-16	37,5	370	11	290	330	304
21-48-17	40	370	11	290	330	304
21-48-18	42,5	404	12	324	364	338
21-48-19	45	404	12	324	364	338

CESI
PROTOCOLLO DATA
A 5/ 0 0 6 7 07 n.1 23 FEB. 2005
Firma Marco Gregori

	Date:	Name:	Signature:
Izdelal:	27.8.03	R. Kurnik	
Pregledal:	1.9.03	P. Pungercar	
Odobril:	1.9.03	P. Pungercar	

ZO ELEKTRO... ISO2768 -
Measure: 7:10 Weight:
Material:
Type: SURGE ARRESTER 2SS15N
Code: 21-48-00 Sheet: 1/1
Izdelek: Prip.:
Opombe:

Test Report

CESI Sinal n° 0030 Approved

Client	IZOELEKTRO d.o.o. – Pesnica Pri Mariboru (Slovenia)
Tested equipment	Polymer housed metal-oxide surge arrester type 2SS15N
Tests carried out	Partial discharge test
Standards/Specifications	IEC 60099-4 (2004-05)
Test date	**from** January 26, 2005 **to** January 26, 2005

No. of pages	11	**No. of pages annexed**	4
Issue date	February 23, 2005		
Prepared	BU PeC - M. Gregori Marco Gregori		
Verified	BU PeC - A. Sironi All. S.		
Approved	BU PeC - M. de Nigris		

CESI
CENTRO ELETTROTECNICO SPERIMENTALE ITALIANO
Business Unit
Prove e Componenti
Il Responsabile del Laboratorio

CESI
Centro Elettrotecnico
Sperimentale Italiano
Giacinto Motta spa

Via R. Rubattino 54
20134 Milano - Italia
Telefono +39 022125.1
Fax +39 0221255440
http://www.cesi.it

Capitale sociale 8 550 000 Euro
interamente versato
Codice fiscale e numero
iscrizione CCIAA 00793580150

Registro Imprese di Milano
Sezione Ordinaria
N. R.E.A. 429222
P.I. IT00793580150

Tests witnessed by:-----

Identification of the object:

The Manufacturer guarantees that the tested object is manufactured according to the submitted drawing.
CESI checked that this drawing adequately represents in shape and dimensions the essential details and the parts of the tested object.
This drawing, identified by CESI and numbered A5006707 No. 1, is annexed to this document.

The data necessary to permit repetition of the tests are contained in the document marked: ---

- dielectric tests with impulse voltage	: **peak voltage: ± 3 %; time parameters: ± 10 %**
- dielectric tests with impulse current	: **peak value: ± 3 %; time parameters: ± 10 %**
- dielectric tests with alternating voltage	: **voltage (rms): ± 3 %**
dielectric tests with direct voltage	: **voltage: ± 3 %**

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

Laboratory information

Receipt date of the sample	November 26, 2004
Test location	CESI – Via Rubattino 54 – Milan
CESI testing team	Mr L. Podavitte
Test laboratory	P177
Activity code	19774B

Rated characteristics of the tested object assigned by the Client

Metal-oxide surge arrester	
Manufacturer	IZOELEKTRO d.o.o. – Pesnica Pri Mariboru (Slovenia).
Year of manufacture	2004
Electrical characteristics	
Nominal discharge current (I_r)	10 kA
Line discharge class	1
Rated voltage (U_r)	45 kV
Continuous operating voltage (U_c)	36 kV
Rated frequency	50-60 Hz
Geometrical characteristics	
Total height	405 mm
Number of sheds	12
Shed diameter	116 mm
Shed spacing	29 mm
Other characteristics	
Housing material	silicone
Housing color	grey

Name and signature of Client's witness:

Photograph of the test object

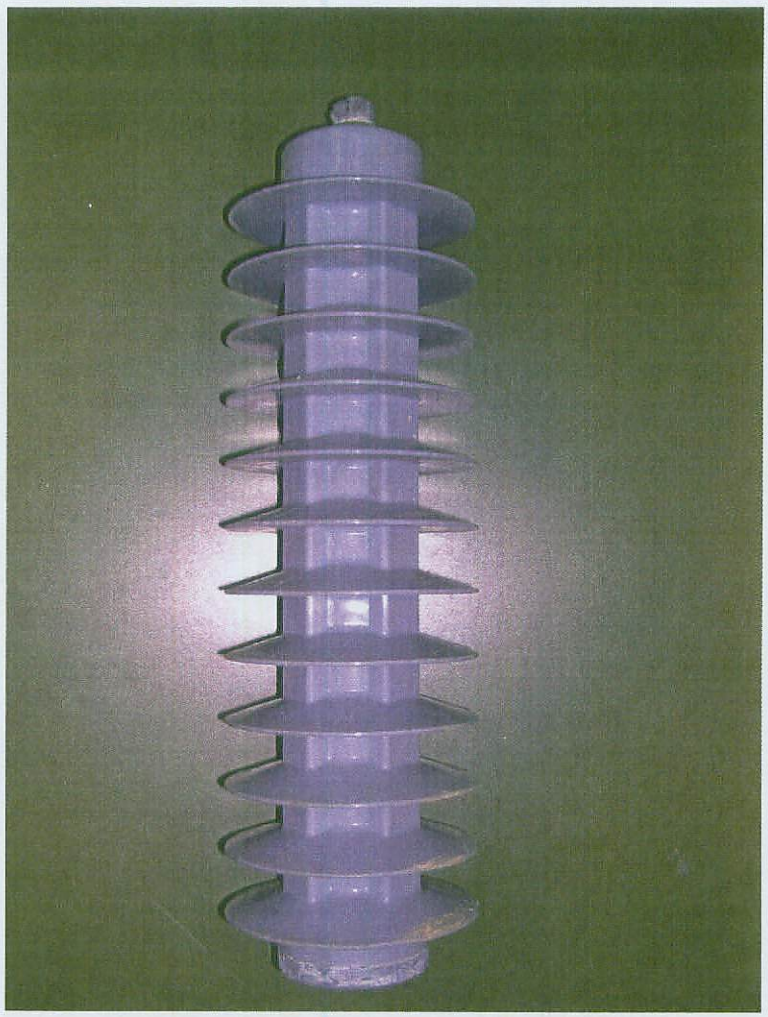


Photo no. 1

Reference Standard

IEC 60099-4 (2004-05): "Metal-oxide surge arrester without gaps for a.c. system", clause 10.8.8.,

Test carried out and identification of the test objects

Test carried out	Number of test objects	Test object identification
Partial discharge test	1	PD1

Test procedure

The application voltage has been increased up to rated voltage (U_r) and maintained for 10 sec.
The voltage has been decreased to 1.05 times the continuous operating voltage (U_c) and the partial discharge level has been measured according to the reference standard (IEC 60270).

Summary of test results

The partial discharge level found was less than 1 pC (background noise).
The test result is to be considered positive.

Test setting for the test

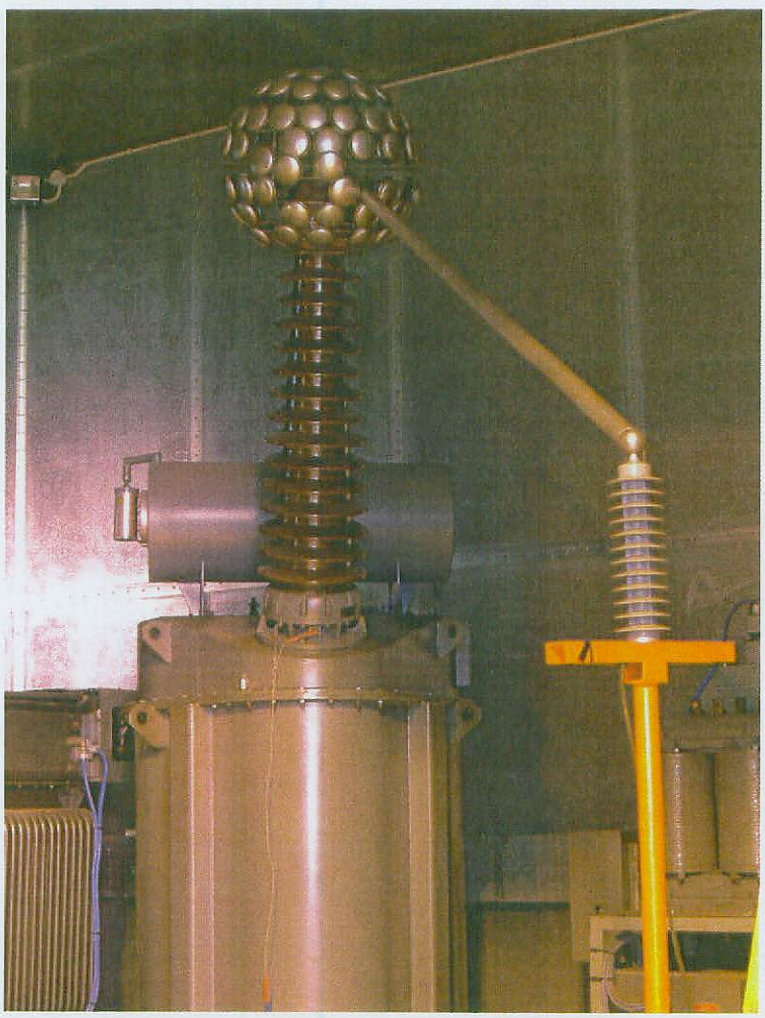


Photo no. 2

Measurement of partial discharges

Test circuit: A0127
Measurement circuit: A0022 "direct" calibration:55 pC/mV see oscillogram. no.01 – background noise ≤ 1 pC see oscillogram no.02
Arrangement: see pag. 8

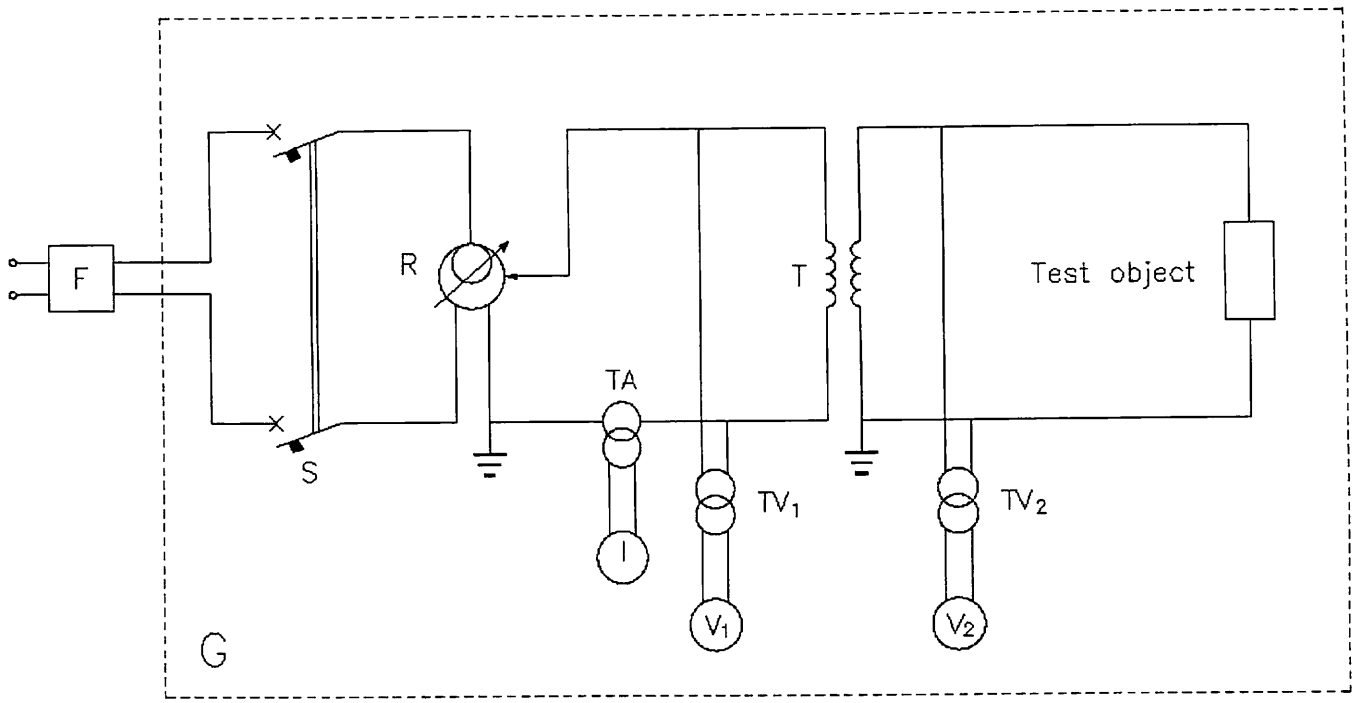
Atmospheric conditions and correction factor			
b	t_d/t_w	h	Relative umidity
kPa	°C	g / m^3	%
99,83	18 (13)	8,60	56,1

Date: January 26, 2005

Test sample	Applied voltage	Duration of voltage application	Temperature of the test object	Partial discharge measurement		Oscillogram	Notes
				voltage increase Q max	voltage decrease Q max		
	kV_{rms}	s	°C	pC	pC	No.	
MI	45,0	2-10	18	---	----	----	
MI	37,8	60	18		≤ 1	03	

continued

Circuit A0127

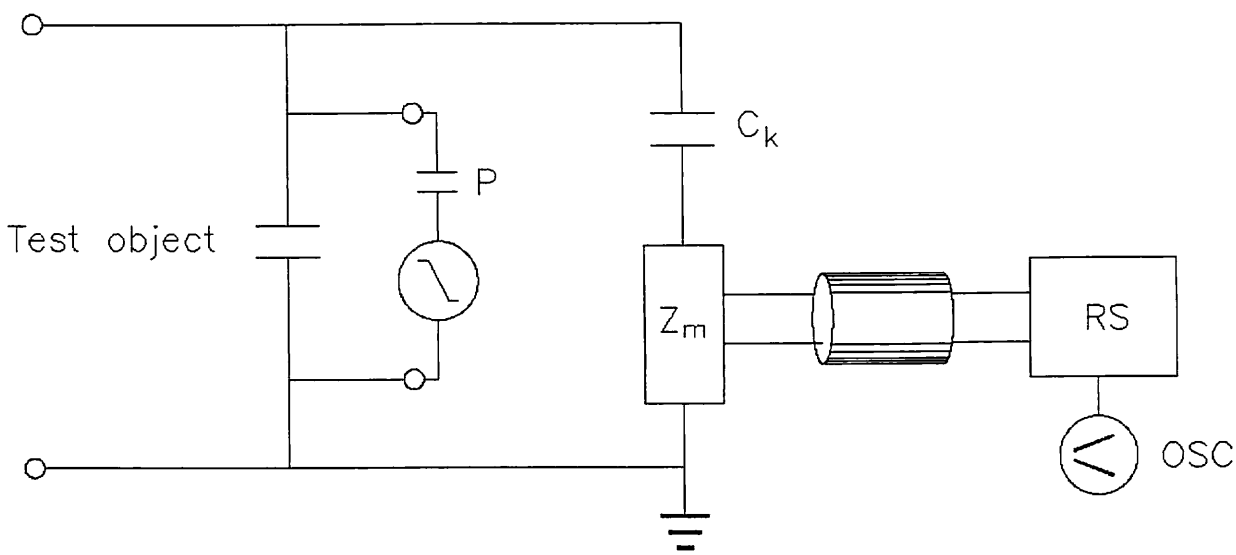


Power-frequency high voltage circuit.

F	- wide band rejection filter TELEC; 380 V; 100 A
G	- Faraday cage
S	- single phase circuit breaker SACE; 600 V; 800 A
R	- regulator CORMES; power 66 kVA; voltage 380 V/0÷220 V
TA	- current transformer CGS, ratio 150-300 A/5 A
I	- analogic amperometer
TV_1	- voltage transformer; ratio 440 V/ 100 V
V_1	- analogic voltmeter
T	- booster transformer PIVI; power 250 kVA; voltage 200-400 V/250 kV
TV_2	- voltage transformer PIVI; ratio 250 kV/ 100 V
V_2	- direct reading digital voltmeter FLUKE; CESI No. 06393

Circuit A0022

Partial discharges measurement
Direct circuit - Scheme 1a



P	- calibrator CESI; CESI No. 346
C_k	- coupling capacitor 0,3 nF
Z_m	- coupling impedance
RS	- partial discharge detector HAEFELY TRENCH type TE 571; CESI No. 13281
OSC	- (not used)

HAEFELY TRENCH TETTEX

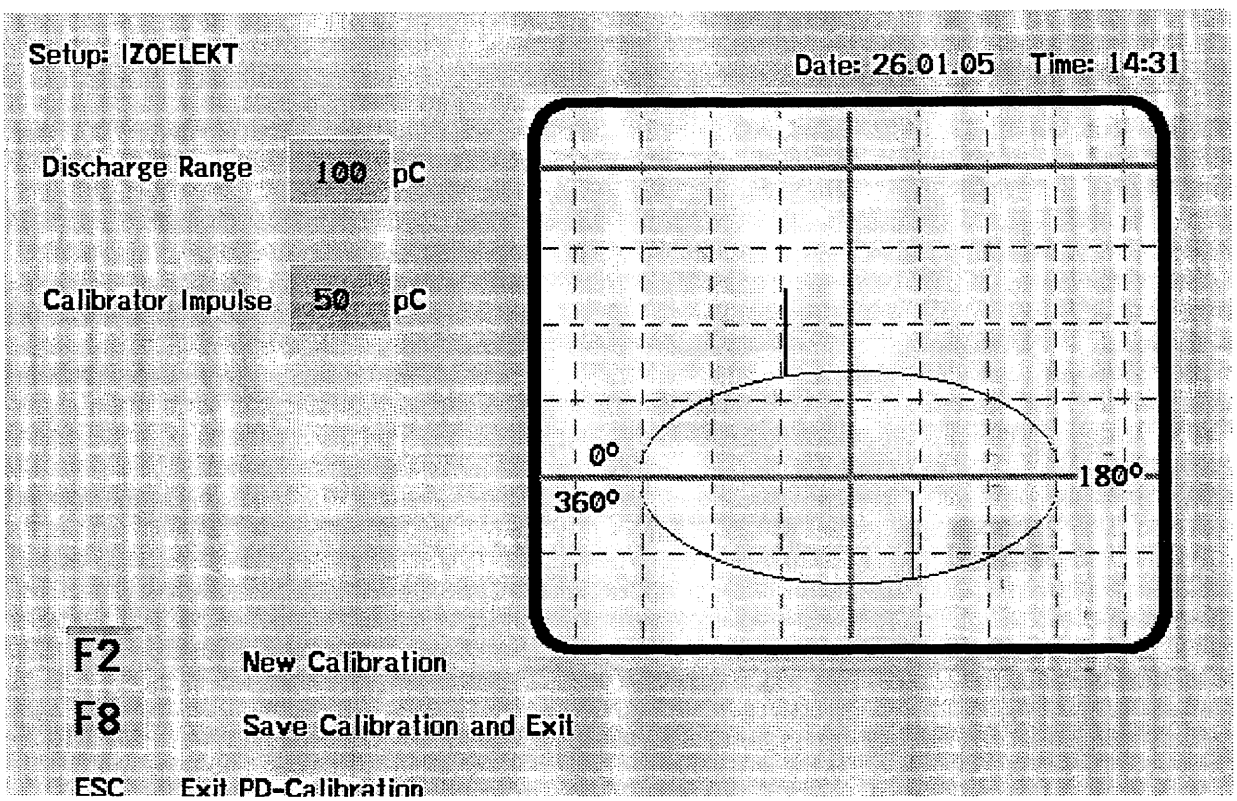
PD-DETECTOR

Info: 1
Measurement name:
Comment:
1st PD Range: 100 pC
Noise Suppression: 5 %
Test Measuring Time: 15 s

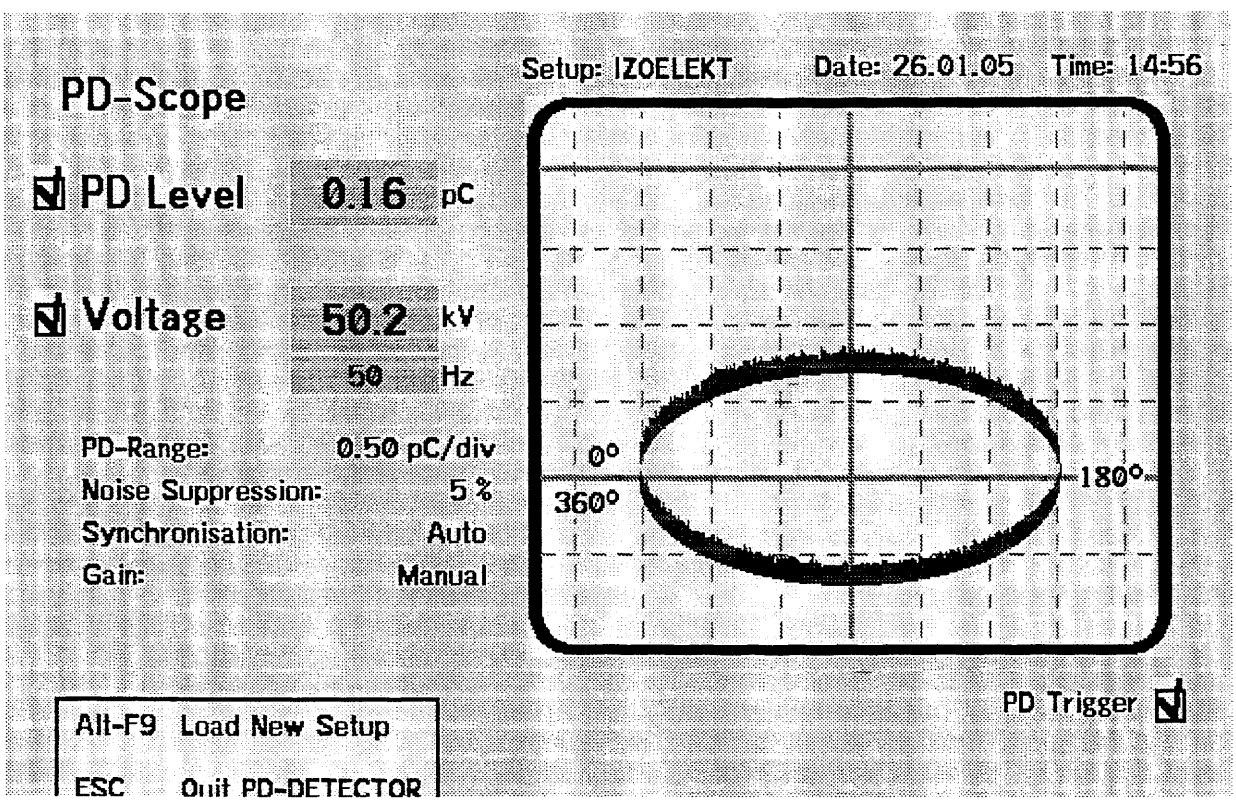
Start date: 00.00.00
Start time: 00:00

2nd PD Range: Not applied
Lockout Time: 7.3 usec
Voltage Range: 36 kV

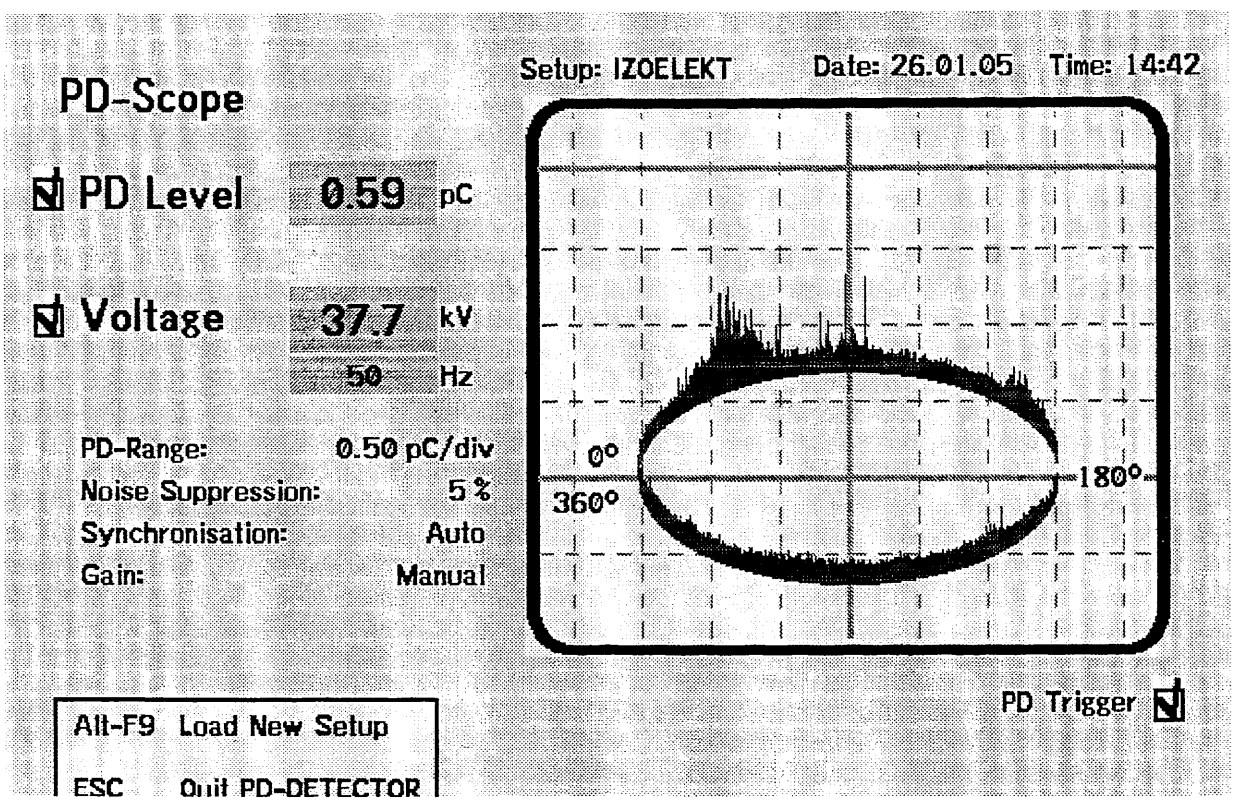
Remarks:



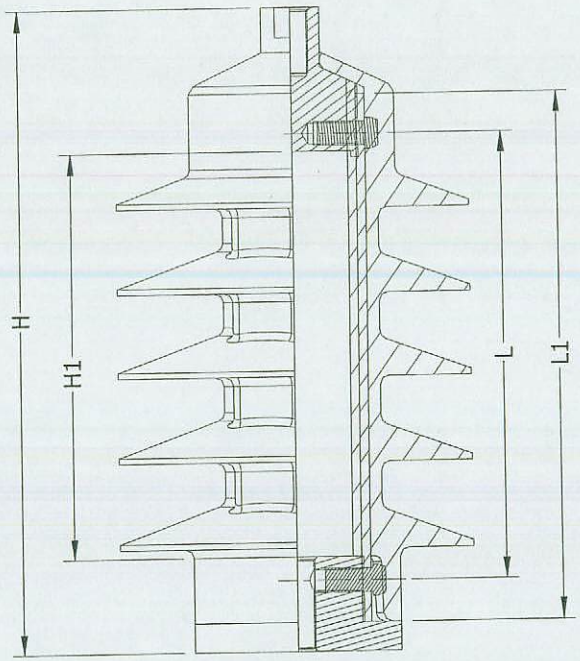
CESI PeC A5002464 oscillogram n. 1



CESI PeC A5002464 oscillogram n. 2



CESI PeC A5002464 oscillogram n. 3



Code	Ur (kV)	Arrester heigh H (mm)	Number of ribs (pcs)	Area for ZnO bloks H1 (mm)	Lenght of strips L1 (mm)	Lenght L (mm)
21-48-01	3,75	147	3	67	107	81
21-48-02	5	147	3	67	107	81
21-48-03	7,50	147	3	67	107	81
21-48-04	10	193	5	113	153	127
21-48-05	12,5	193	5	113	153	127
21-48-06	15	193	5	113	153	127
21-48-07	17,5	243	6	163	203	177
21-48-08	20	243	6	163	203	177
21-48-09	22,5	243	6	163	203	177
21-48-10	25	270	7	190	230	204
21-48-11	26,25	270	7	190	230	204
21-48-12	27,5	270	7	190	230	204
21-48-13	30	317	8	237	277	251
21-48-14	32,5	317	8	237	277	251
21-48-15	35	317	8	237	277	251
21-48-16	37,5	370	11	290	330	304
21-48-17	40	370	11	290	330	304
21-48-18	42,5	404	12	324	364	338
21-48-19	45	404	12	324	364	338

CESI
PROTOCOLLO A 5/0 0 0 7 0 7 n.1
DATA 23 FEB. 2005
Firma Marco Gopo

IZO ELEKTRO... ISO2768 -

	Date:	Name:	Signature:
Izdelal:	27.8.03	R. Kurnik	
Pregledal:	1.9.03	P. Pungercar	
Odobril:	1.9.03	P. Pungercar	

Opombe:

Measure: 2:10 Weight:
Material:
Type: SURGE ARRESTER 2SS15N
Code: 21-48-00 Sheet: 1/1
Izdelek: Prip.:

Test Report

CESI Sinal n° 0030 Approved

Client	IZOELEKTRO d.o.o. – Pesnica Pri Mariboru (Slovenia)
Tested equipment	Polymer housed metal-oxide surge arrester type 2SS15N
Tests carried out	Residual voltage tests
Standards/Specifications	IEC 60099-4 (2004-05)
Test date	**from** December 10, 2004 **to** December 14, 2004

No. of pages	16	**No. of pages annexed**	20
Issue date	February 23, 2005		
Prepared	BU PeC - M. Gregori		
Verified	BU PeC - A. Sironi		
Approved	BU PeC - M. de Nigris		

CESI
CENTRO ELETTROTECNICO SPERIMENTALE ITALIANO
Business Unit
Prove e Componenti
Il Responsabile del Laboratorio

Tests witnessed by: —

Identification of the object:

The Manufacturer guarantees that the tested object is manufactured according to the submitted drawing.
CESI checked that this drawing adequately represents in shape and dimensions the essential details and the parts of the tested object.
This drawing, identified by CESI and numbered A5006707 No. 1, is annexed to this document.

The data necessary to permit repetition of the tests are contained in the document marked: ---

- dielectric tests with impulse voltage	: **peak voltage: ± 3 %; time parameters: ± 10 %**
- dielectric tests with impulse current	: **peak value: ± 3 %; time parameters: ± 10 %**
- dielectric tests with alternating voltage	: **voltage (rms): ± 3 %**
dielectric tests with direct voltage	: **voltage: ± 3 %**

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

Laboratory information

Receipt date of the sample	November 28, 2004
Test location	CESI – Via Rubattino 54 – Milan
CESI testing team	Mr L. Podavitte – Mr I. Guacci
Test laboratory	P177
Activity code	19774B

Test object characteristics

type: Polymer housed metal-oxide surge arrester section

electrical characteristics (assigned by the client)

Manufacturer's name	IZOELEKTRO d.o.o. – Pesnica Pri Mariboru (Slovenia)
Nominal discharge current - I_N [kA]	10,0
Rated voltage - U_n [kV]	0,9912 x Uref.
Continuous operating voltage - U_c [kV]	0,7930 x Uref.
Reference current - $I_{ref.}$ [mA]	1,4
Line discharge class	1
Rated frequency - [Hz]	50 – 60
year of manufacture	2004

geometrical characteristics (measured on the test sample)

Height [mm]	215
Number of sheds	5
Shed diameter [mm]	117

other characteristics

Housing material	silicone
Housing color	grey

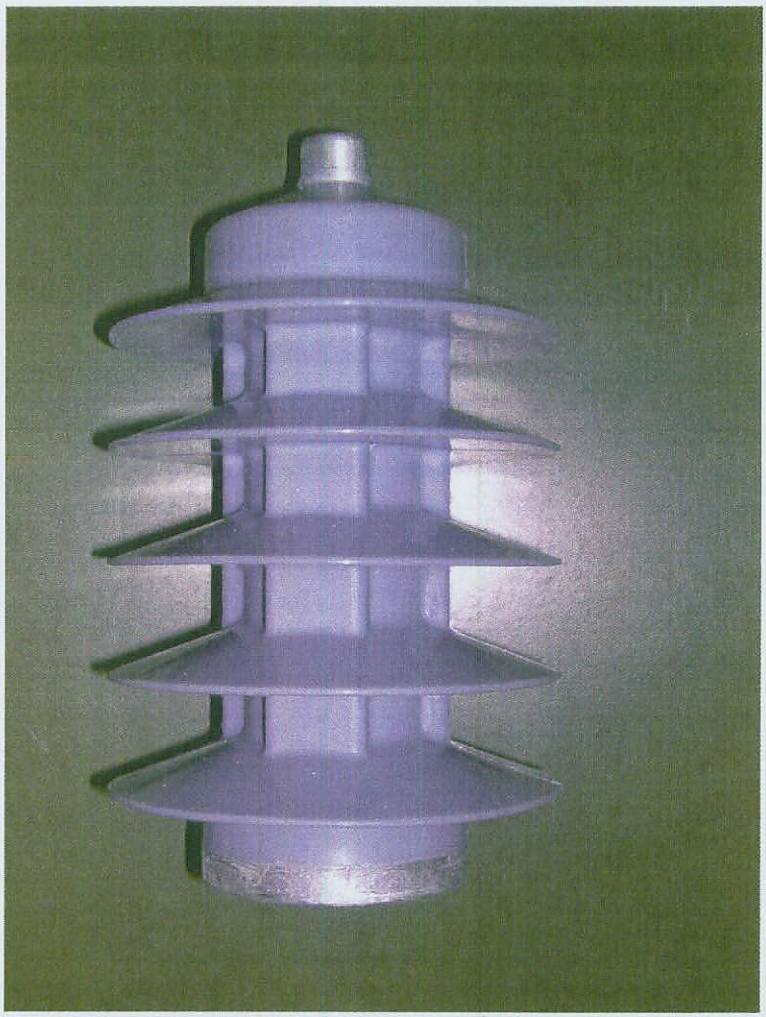


Photo no. 1
Panoramic view of the test object

Reference Standard

IEC 60099-4 (2004-05) Clause 10.8.3
"Metal-oxide surge arrester without gaps for a.c. system"

Test carried out	Number of sample tested
Lightning impulse residual voltage test	3
Switching impulse residual voltage test	
Steep current impulse residual voltage test	

Test object identification

Test object name	Identification of test sample (given by Cesi)
polymer housed metal-oxide surge arresters section	RV1-RV2-RV3

Test procedure

- The lightning impulse residual voltage with current waveshape having front time equal to 8 μs and time to half value equal to 20 μs at the following values has been measured at following current levels:

  I_N = 10 kA
  0,5 I_N = 5 kA
  2 I_N = 20 kA

- The switching impulse residual voltage with current waveshape having front time greater then to 30 μs but less than 100 μs and time to half value roughly twice has been measured according to table 3 of the reference standard at following current levels:

  I = 125 A
  I = 500 A

- The steep current residual voltage at I_N with current waveshape having front time equal to 1 μs and time to half value not longer than 20 μs has been measured.
  The inductive error was measured replacing the surge arrester section with a metal blocks having the same dimensions. The inductive correction was applied by substracting the impulse shape measured on the surge arrester and the impulse shape on the metal block.

Lightning impulse residual voltage test. IEC 60099-4 Standard

Test circuit: A0120

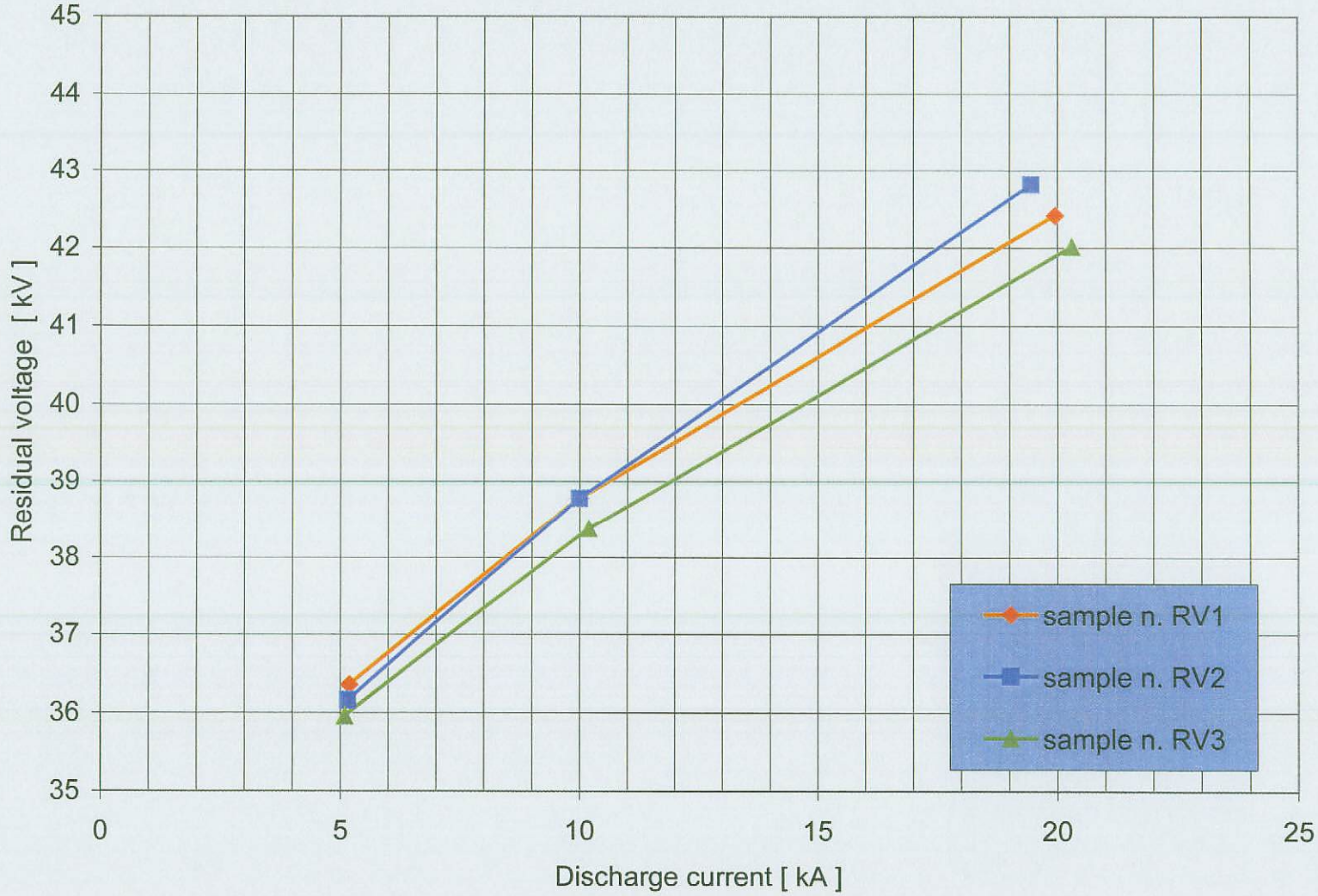
Date: December 13, 2004

Sample	Requested current	Charging voltage	Oscillogram	Current waveshape	Discharge current	Residual voltage	Lightning impulse protection level
No.		kV	No.	µs	kA	kV	kV
RV1	0,5 × I_N	43,0	10	7,9/20,0	5,20	36,36	see relevant curve in the following page 9
	I_N	52,0	4	8,0/19,4	10,00	38,78	
	2,0 × I_N	68,8	7	8,4/19,1	19,95	42,42	
RV2	0,5 × I_N	43,0	11	7,9/20,0	5,16	36,16	
	I_N	52,0	5	8,0/19,4	10,00	38,78	
	2,0 × I_N	68,8	8	8,4/19,1	19,45	42,82	
RV3	0,5 × I_N	43,0	12	7,9/20,0	5,10	35,96	
	I_N	52,0	6	8,0/19,4	10,20	38,38	
	2,0 × I_N	69,0	9	8,4/19,1	20,30	42,02	

		Oscilloscope settings		
		sampling division	input	attenuation
		µs	V_{div}	
Current	0,5 I_N	5	0,5	20:5
	I_N		0,5	50:5
	2 I_N		1,0	50:5
Voltage	0,5 I_N	5	1,0	50:5
	I_N		1,0	50:5
	2 I_N		1,0	50:5

Notes:

Lightning impulse protection level



Switching impulse residual voltage test. IEC 60099-4 Standard

Test circuit: A0122

Date: December 14, 2004

Sample	Requested current	Charging voltage	Oscillogram	Current waveshape	Discharge current	Residual voltage	Switching impulse protection level
No.	A	kV	No.	µs	A	kV	kV
RV1	125	29,1	13	31/86	130	28,89	30,50
	500	35,2	16	32/73	504	30,50	
RV2	125	29,3	14	31/86	130	28,08	
	500	35,2	17	32/73	500	29,90	
RV3	125	29,3	15	31/86	131	28,08	
	500	35,2	18	32/73	518	30,10	

	Oscilloscope settings		
	sampling division	input	attenuation
	µs	V_{div}	
Current	20	0,5	5:5
Voltage	20	1,0	50:5

Notes:

Steep current impulse residual voltage test. IEC 60099-4 Standard

Measurement of the inductive error

Test circuit: A0121B

Date: December 14, 2004

Sample	Charging voltage	Oscillogram	Current waveshape	Discharge current	Peak voltage	Inductive error
No.	kV	No.	μs	kA	kV	%
aluminium block	59,0	19	0,95/2,2	10,2	1,2	2÷20 (1)

	Oscilloscope settings		
	sampling division	input	attenuation
	ns	V_{div}	
Current	500	2	x 10
Voltage		0,5	---

Notes: (1) correction is required

Steep current impulse residual voltage test. IEC 60099-4 Standard

Test circuit: A0121B

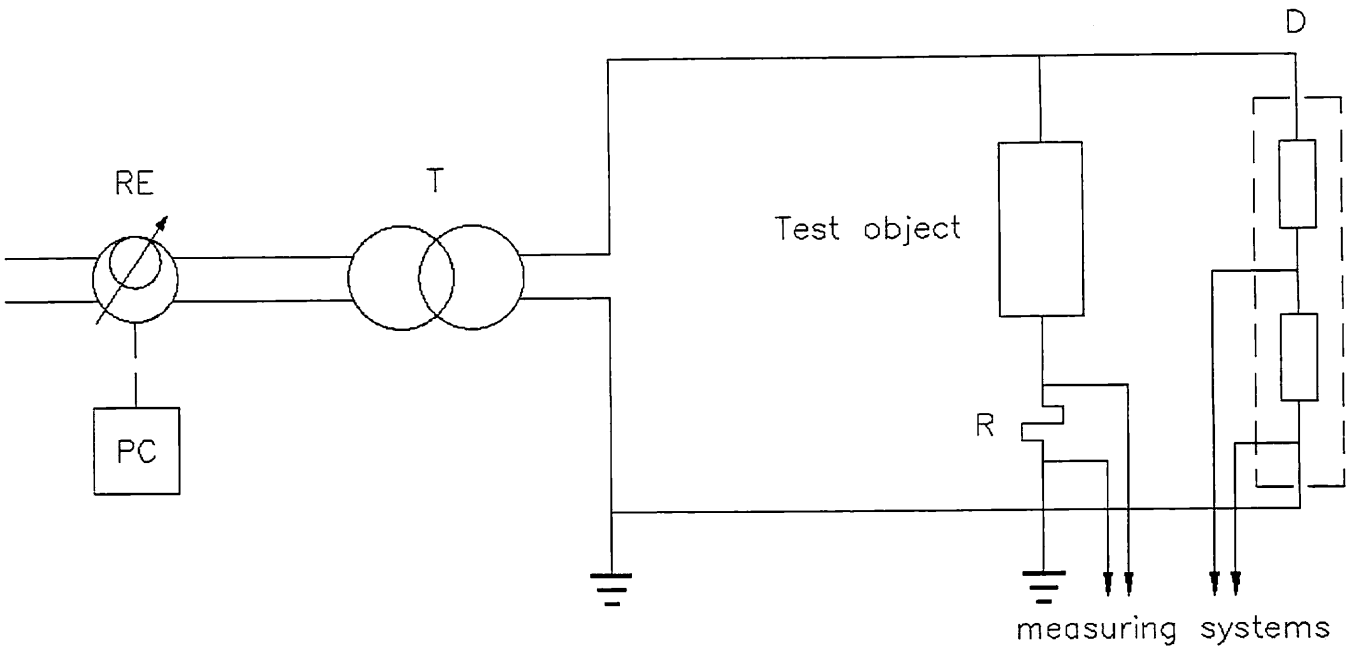
Date: December 14, 2004

Sample	Charging voltage	Oscillogram	Current waveshape	Discharge current	Residual voltage	Steep current impulse protection level
No.	kV	No.	µs	kA	kV	kV
RV1	59,0	20	0,95/2,2	10,1	42,1	42,6
RV2	59,1	21		9,95	42,6	
RV3	59,2	22		10,1	42,0	

	Oscilloscope settings		
	sampling division	input	attenuation
	ns	V_{div}	
Current	500	2	x10
Voltage		10	---

Notes: wave channel 1 : discharge current
wave channel 2 : residual voltage
wave channel M1 : corrected residual voltage

Circuit A0019



Power frequency supply

RE - programmable supply type LARCET A.C. Power Source 5000 P.S.; CESI no. 23702-32191
PC - personal computer
T - voltage transformer type SPECIALTRASFO; power 30 kVA; voltage 200 V/15-30 kV

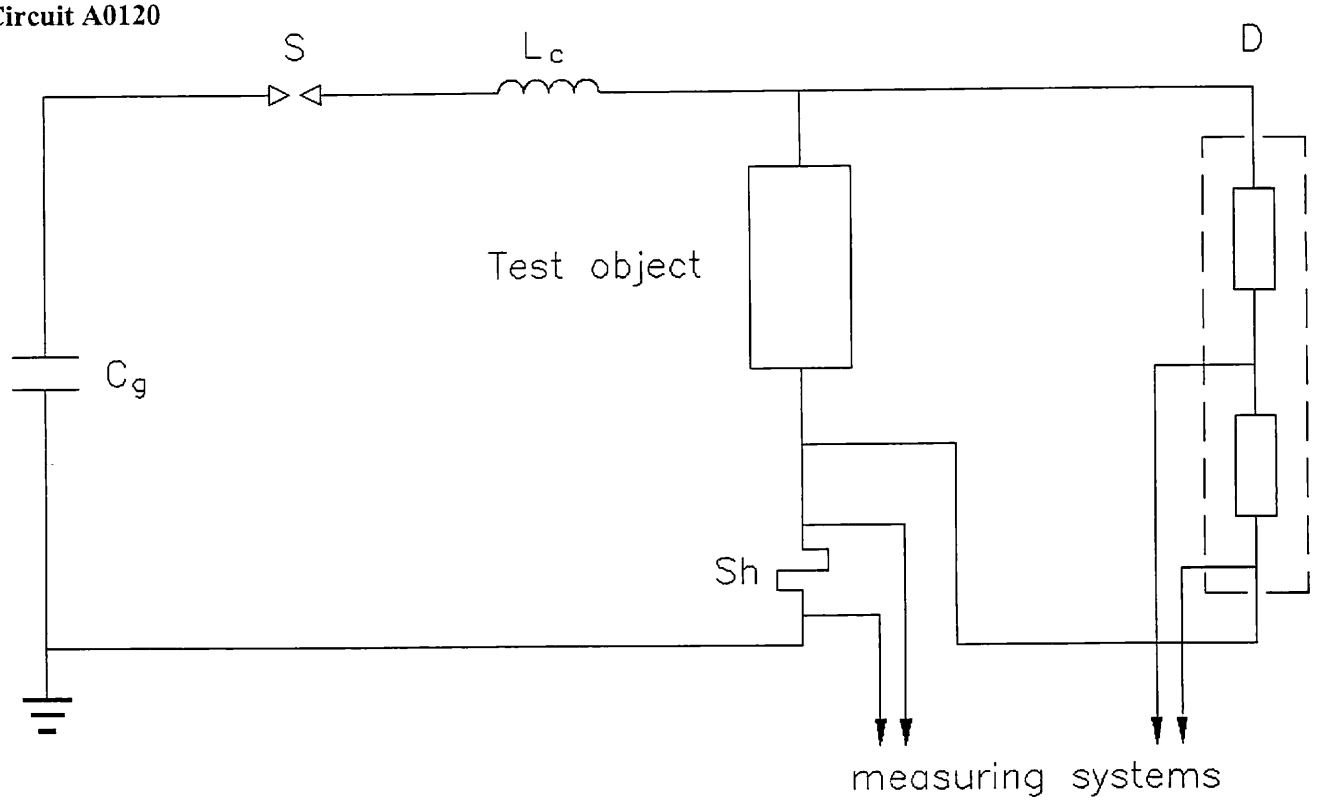
Current measuring system

R - Current shunt CESI No.31120; R= 941,4 Ω
- Electro optical system CESI No.11517/518; attenuation 5:5
OSC - Oscilloscope type SONY TEKTRONIX RTD 710A; CESI No.9090

Voltage measuring system

D - Voltage divider SAGI; CESI No.11120
- Electro optical system CESI No.11521/522; attenuation 50:5
OSC - Oscilloscope type SONY TEKTRONIX RTD 710A; CESI No.9090

Circuit A0120



Impulse generator

No. of stages	2
Cg	4,98 µF
Lc	10 µH
S	- Spark-gap

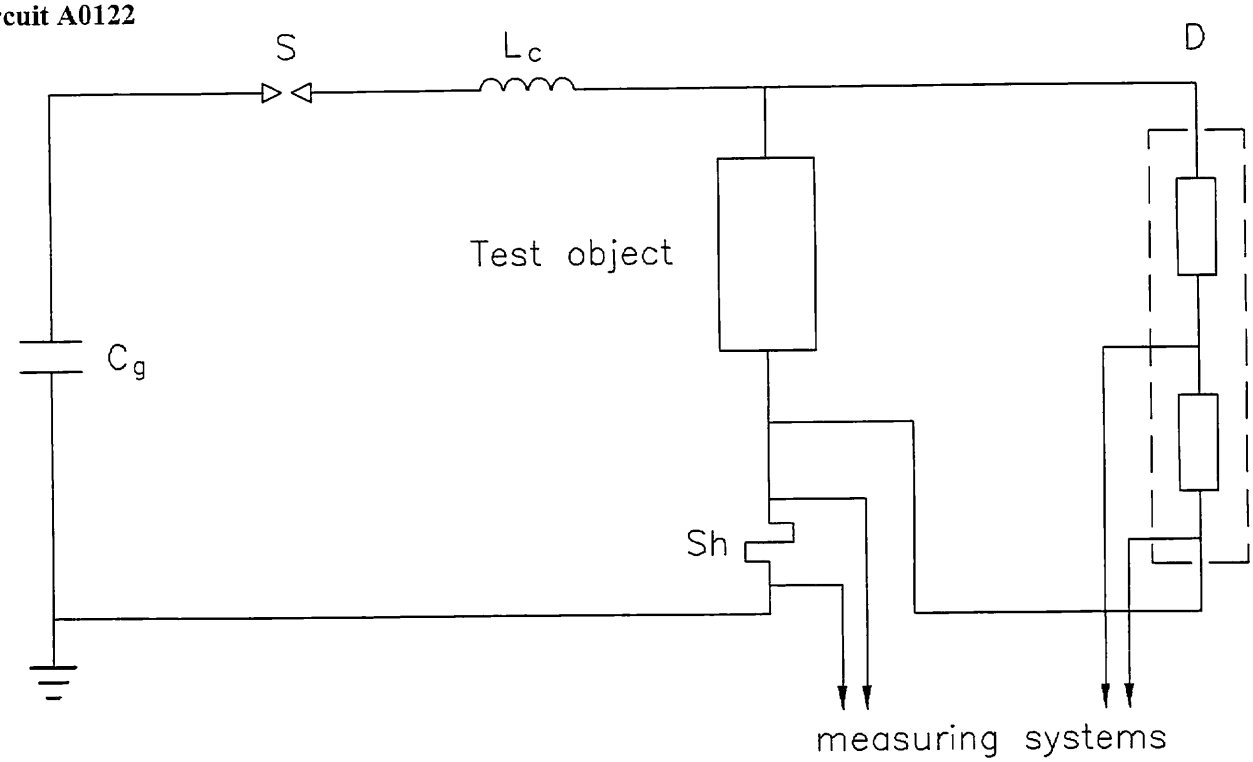
Voltage measuring system.

D	- Voltage divider SAGI; CESI No.11120
	- Electro optical system CESI No.11521/522;
OSC	- Oscilloscope type TEKTRONIX TDS 540A; CESI No.13217 (on channel No.2)

Current measuring system

Sh	- Current shunt CESI No.6042; R= 2 mΩ; peak current= 250 kA
	- Electro optical system CESI No.11517/518;
OSC	- Oscilloscope type TEKTRONIX TDS 540A; CESI No.13217 (on channel No.1)

Circuit A0122



Impulse generator

No. of stages	1
Cg	2,49 µF
Lc	150 µH
S	- Spark-gap

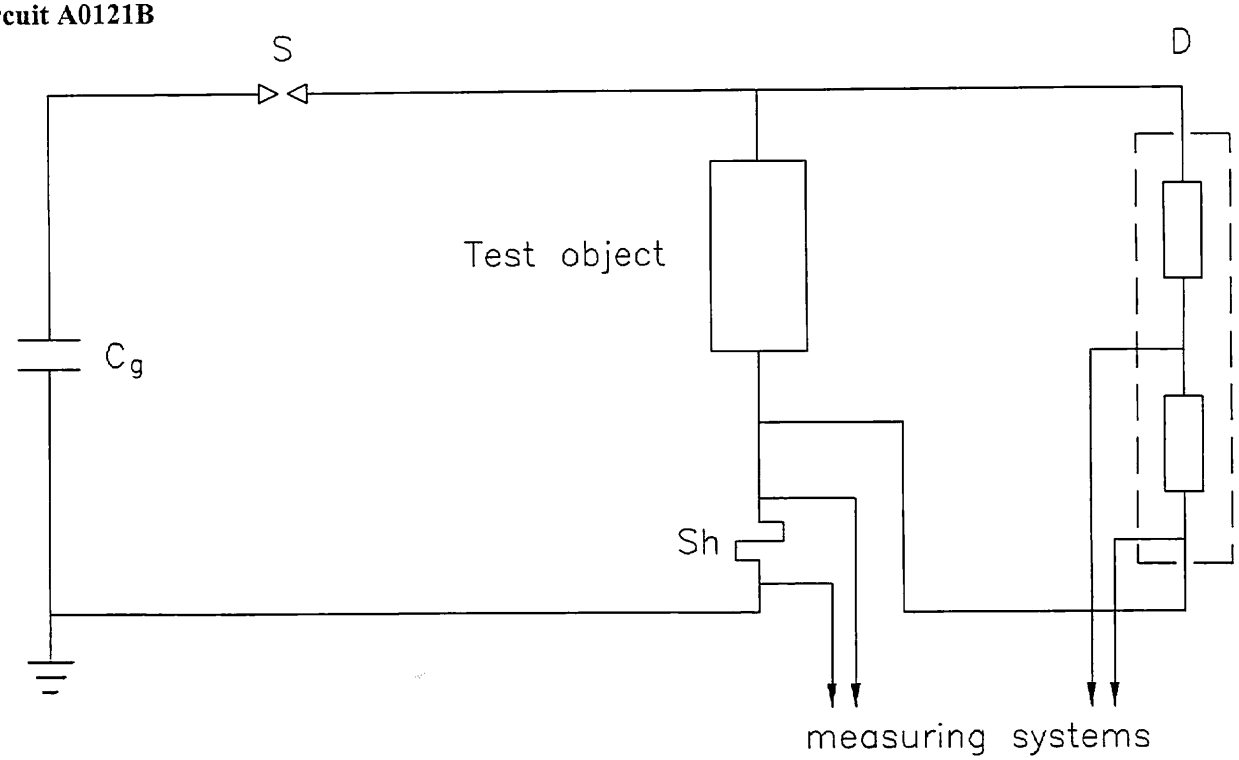
Voltage measuring system.

D	- Voltage divider SAGI; CESI No.11120
	- Electro optical system CESI No 11521/522
OSC	- Oscilloscope type TEKTRONIX TDS 540A; CESI No.13217 (on channel No.2)

Current measuring system

Sh	- Current shunt CESI No.6037; R= 20 mΩ ; peak current= 250 kA
	- Electro optical system CESI No11517/518
OSC	- Oscilloscope type TEKTRONIX TDS 540A; CESI No.13217 (on channel No.1)

Circuit A0121B



Impulse generator

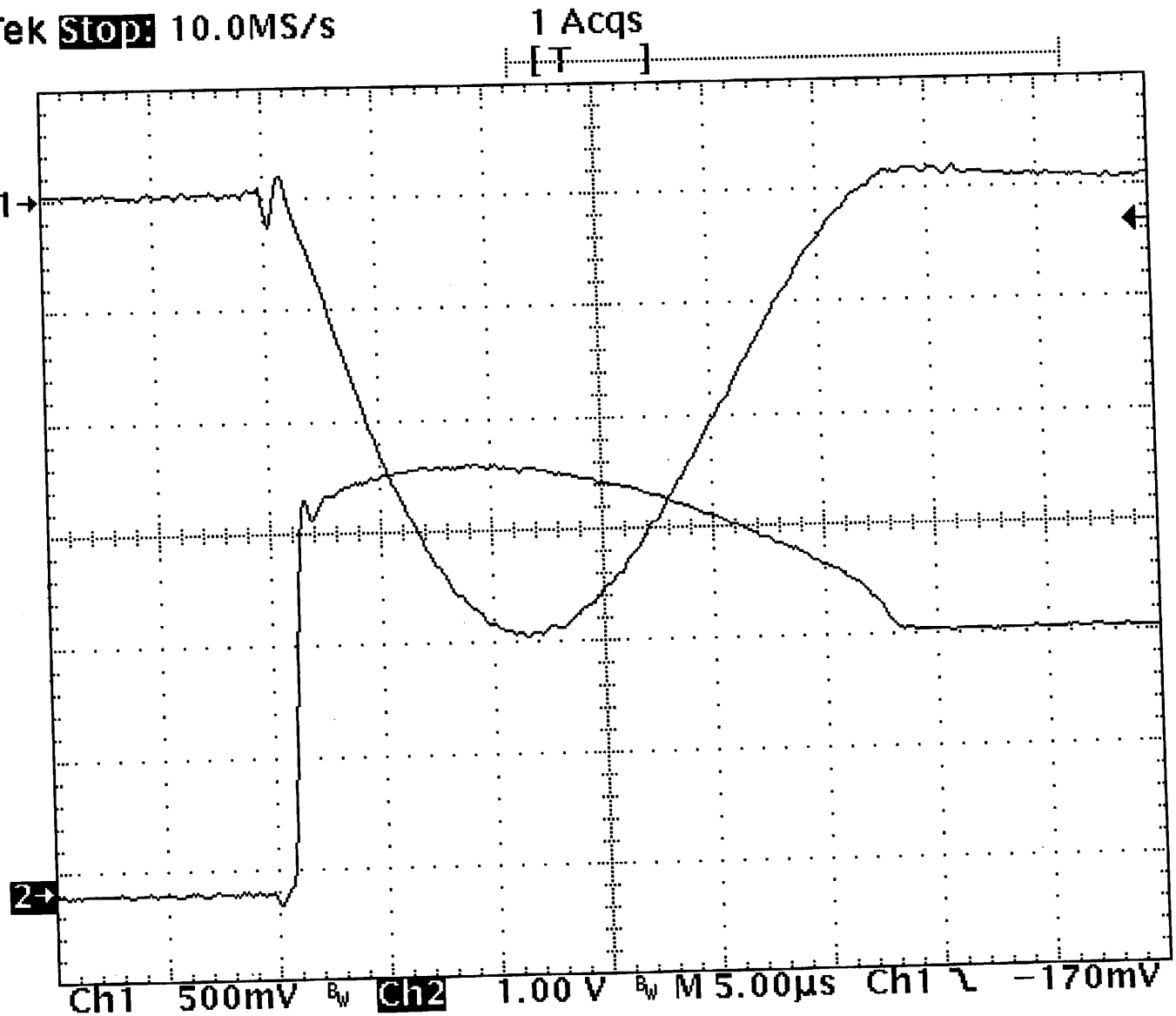
No. of stages	1
Cg	0,25 µF
S	- Spark-gap

Voltage measuring system.

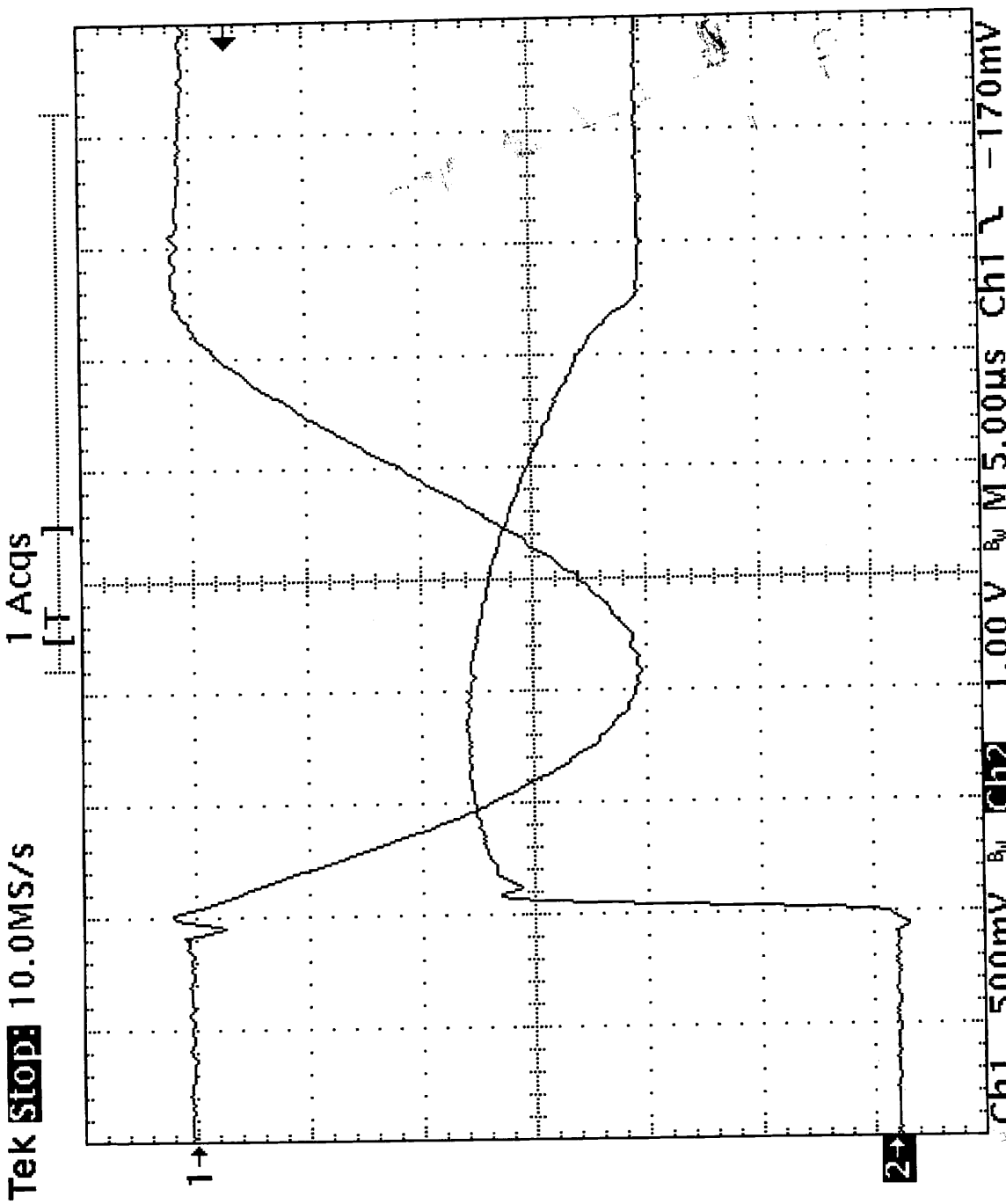
D	- Voltage divider SAGI; CESI No.11120
OSC	- Oscilloscope type TEKTRONIX TDS 540A; CESI No.13217 (on channel No.2)

Current measuring system

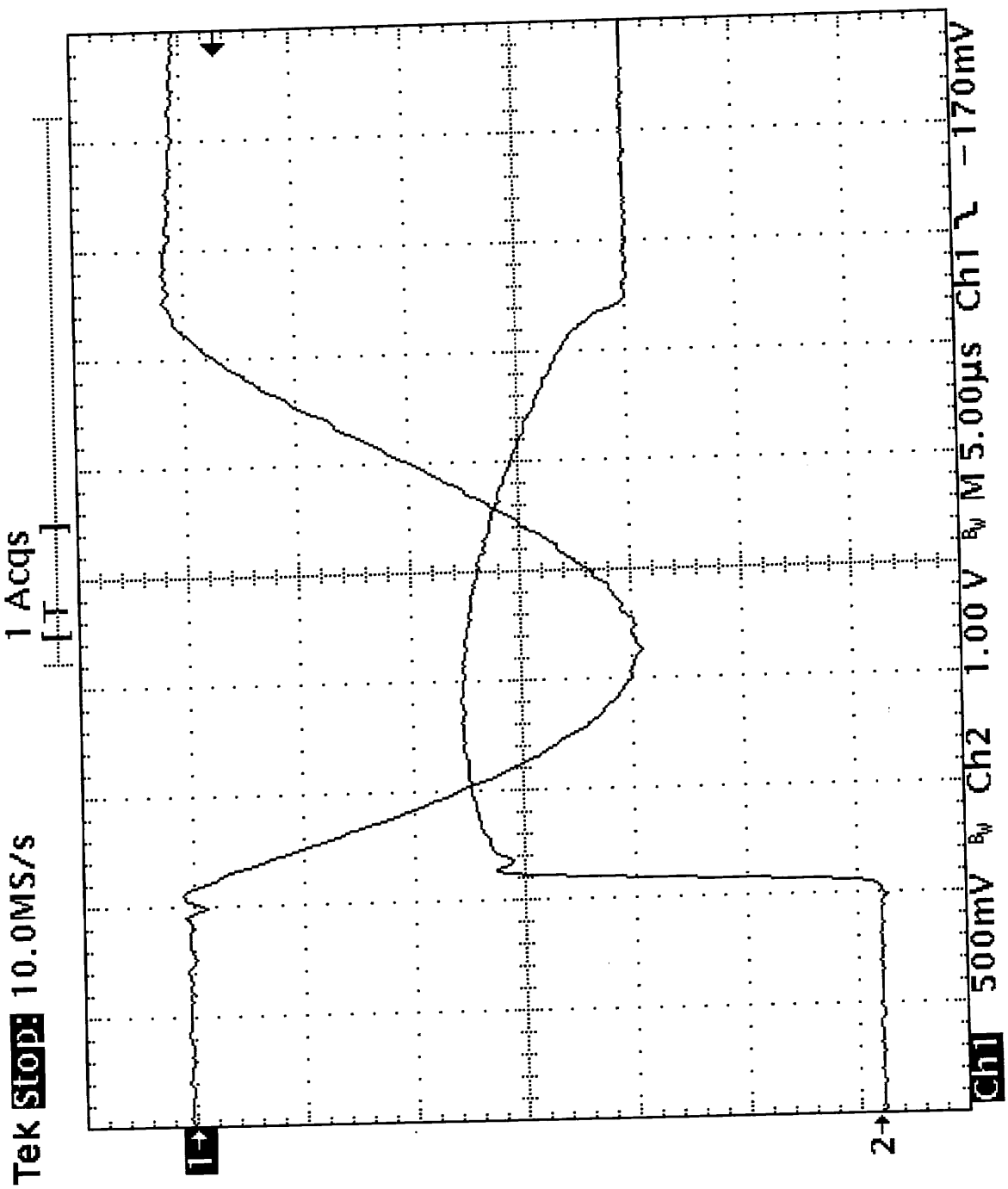
Sh	- Current Pearson CESI No.6042; o,o1 V xA
OSC	- Oscilloscope type TEKTRONIX TDS 540A; CESI No.13217 (on channel No.1)



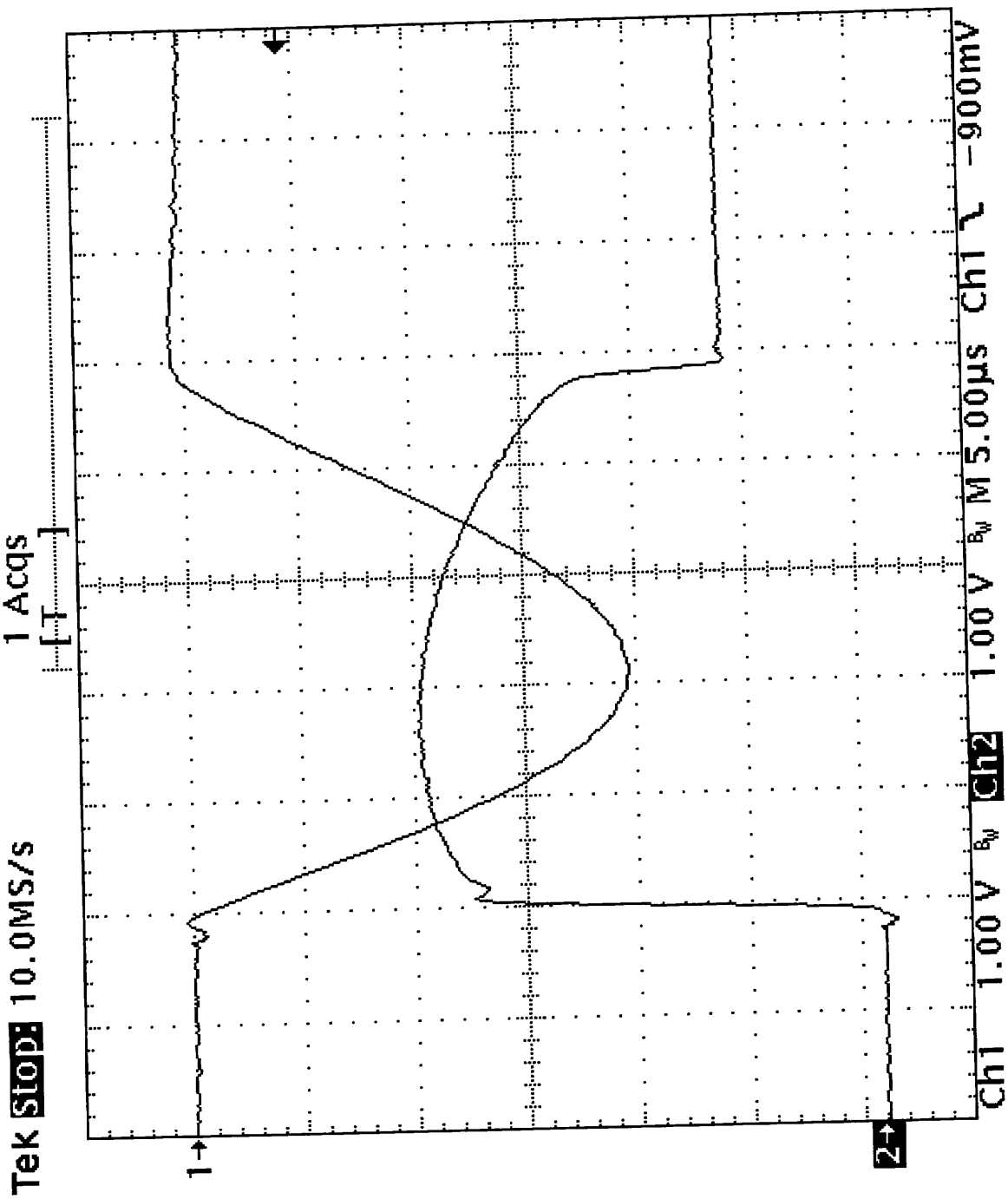
CESI PeC A4522503 oscillogram n. 4



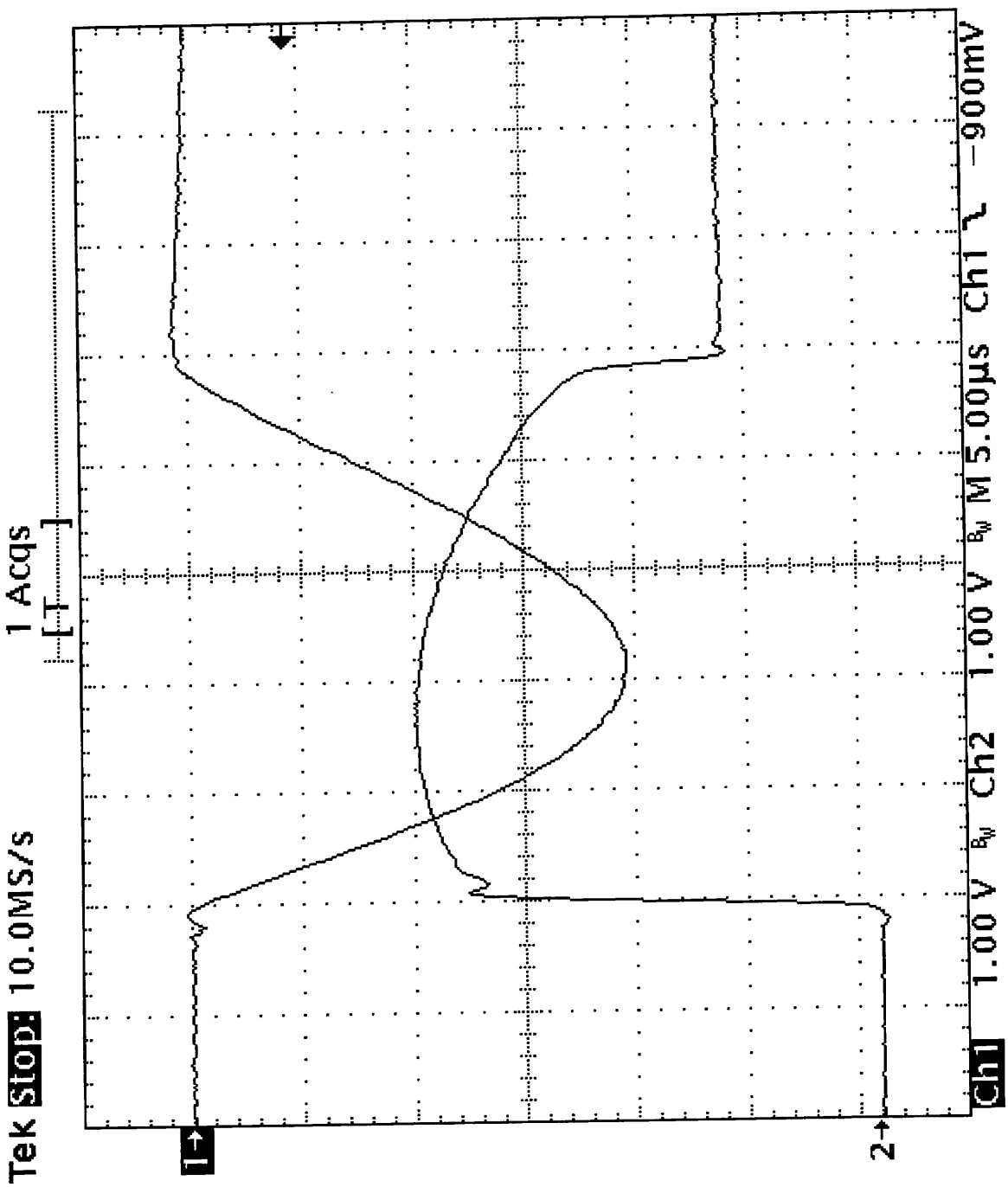
CESI PeC A4522503 oscillogram n. 5



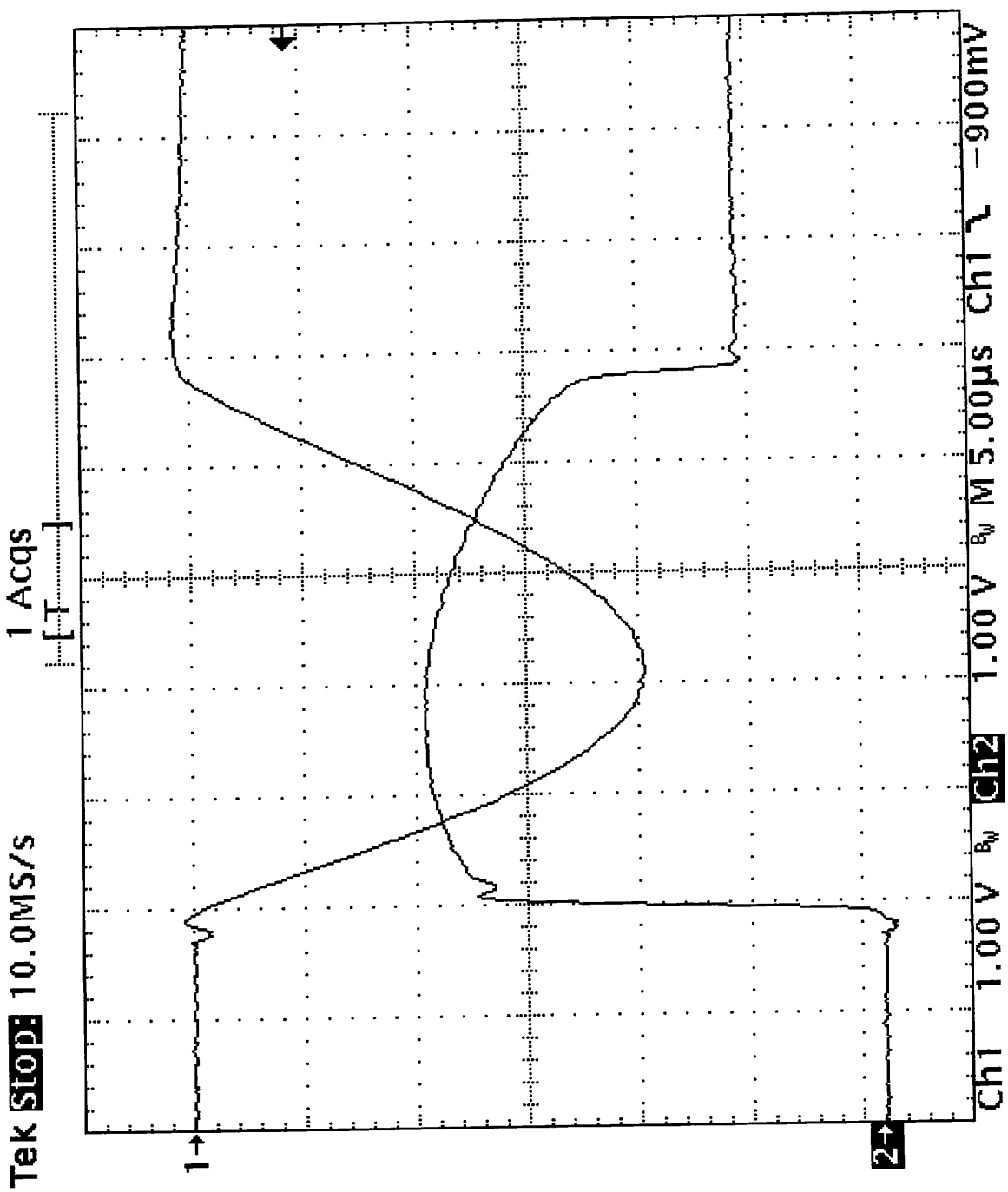
CESI PeC A4522503 oscillogram n. 6



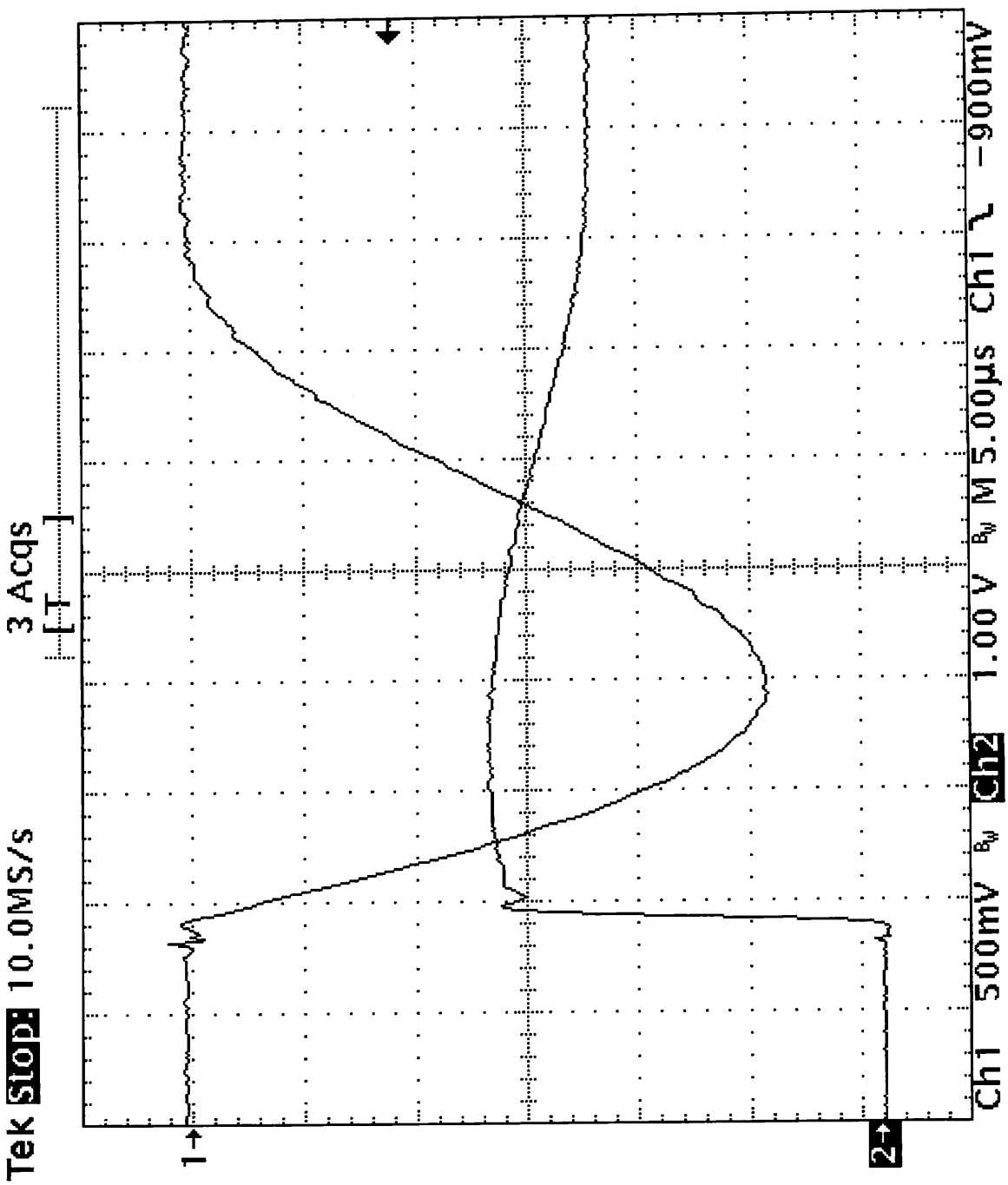
CESI PeC A4522503 oscillogram n. 7



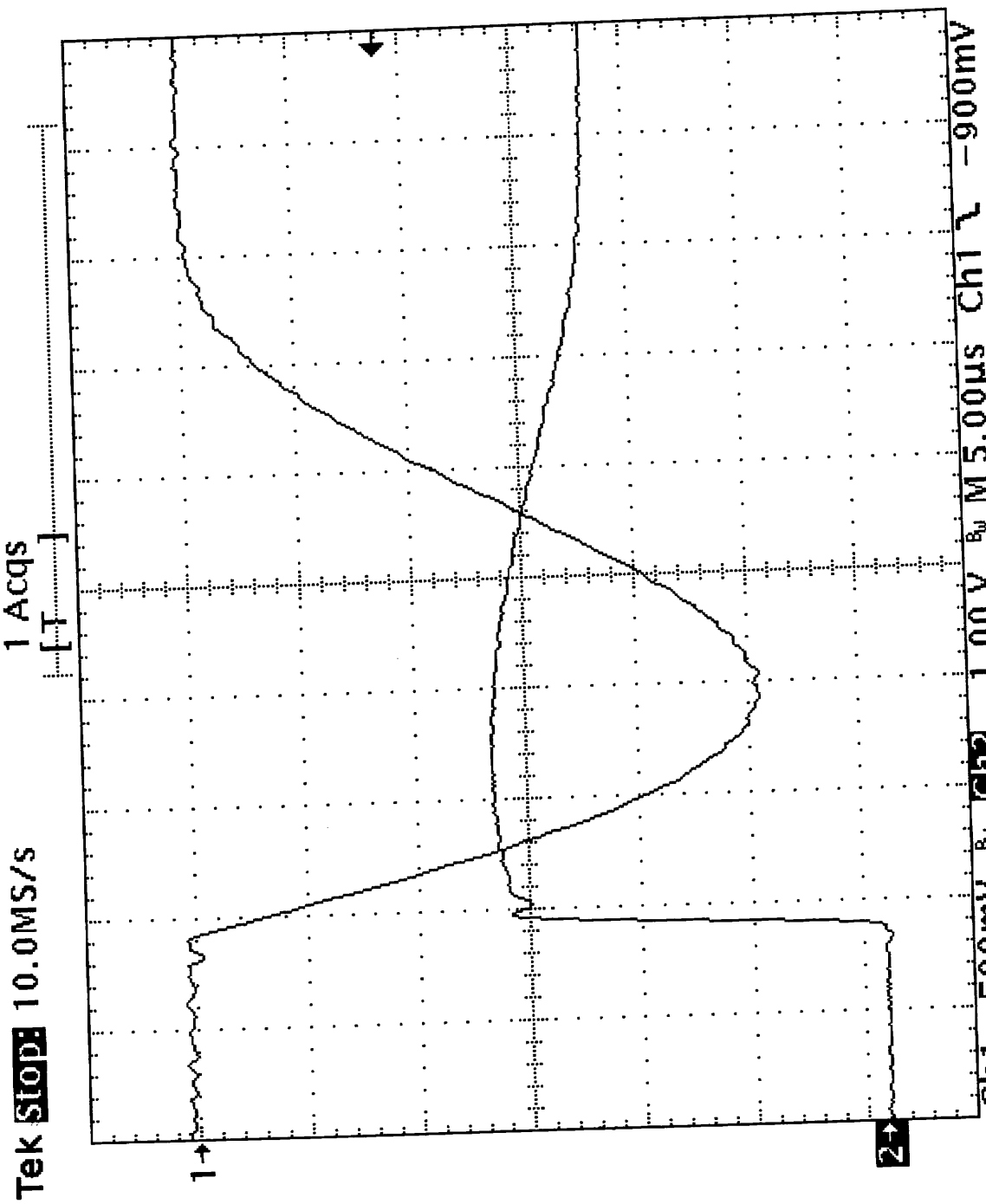
CESI PeC A4522503 oscillogram n. 8



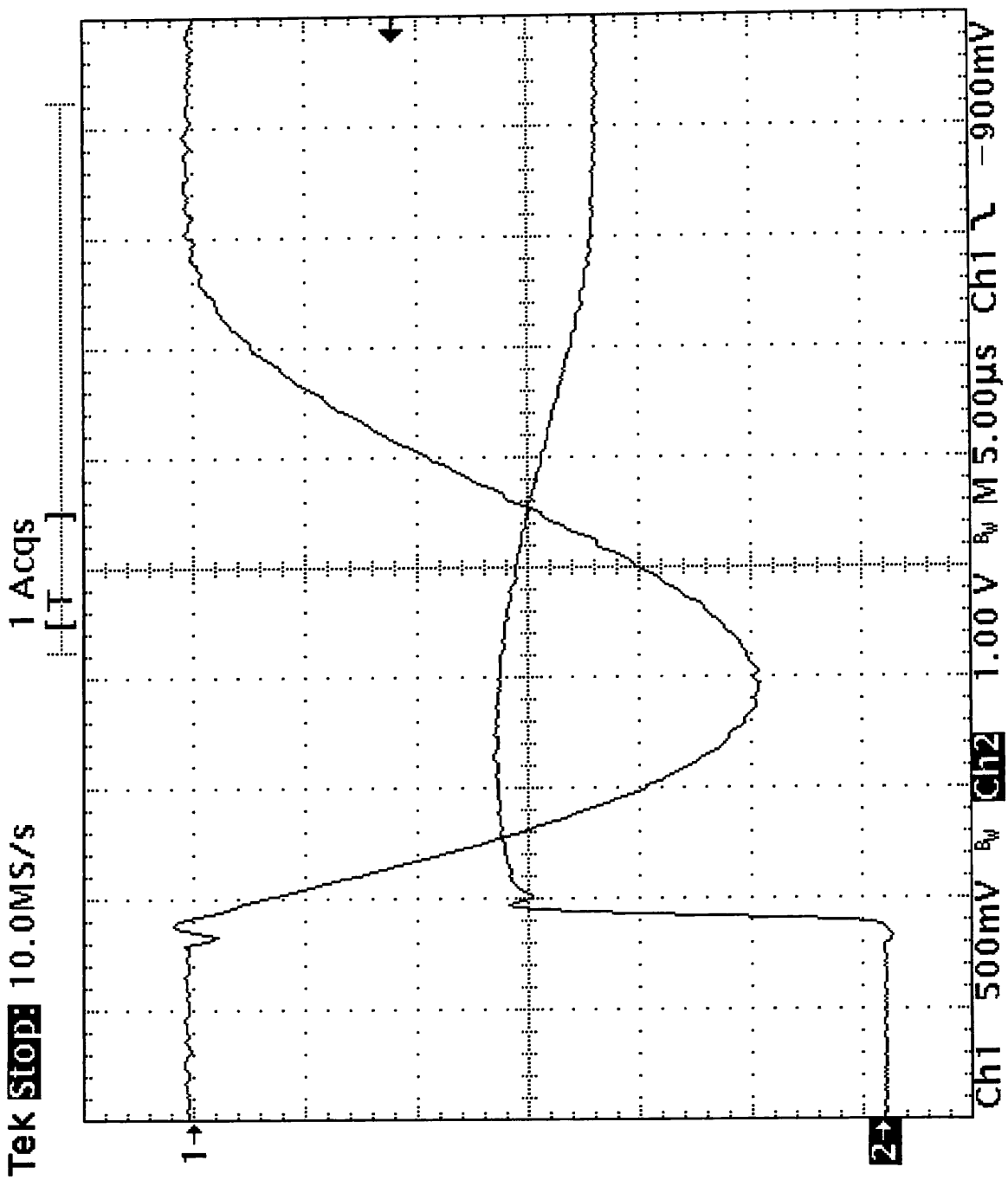
CESI PeC A4522503 oscillogram n. 9



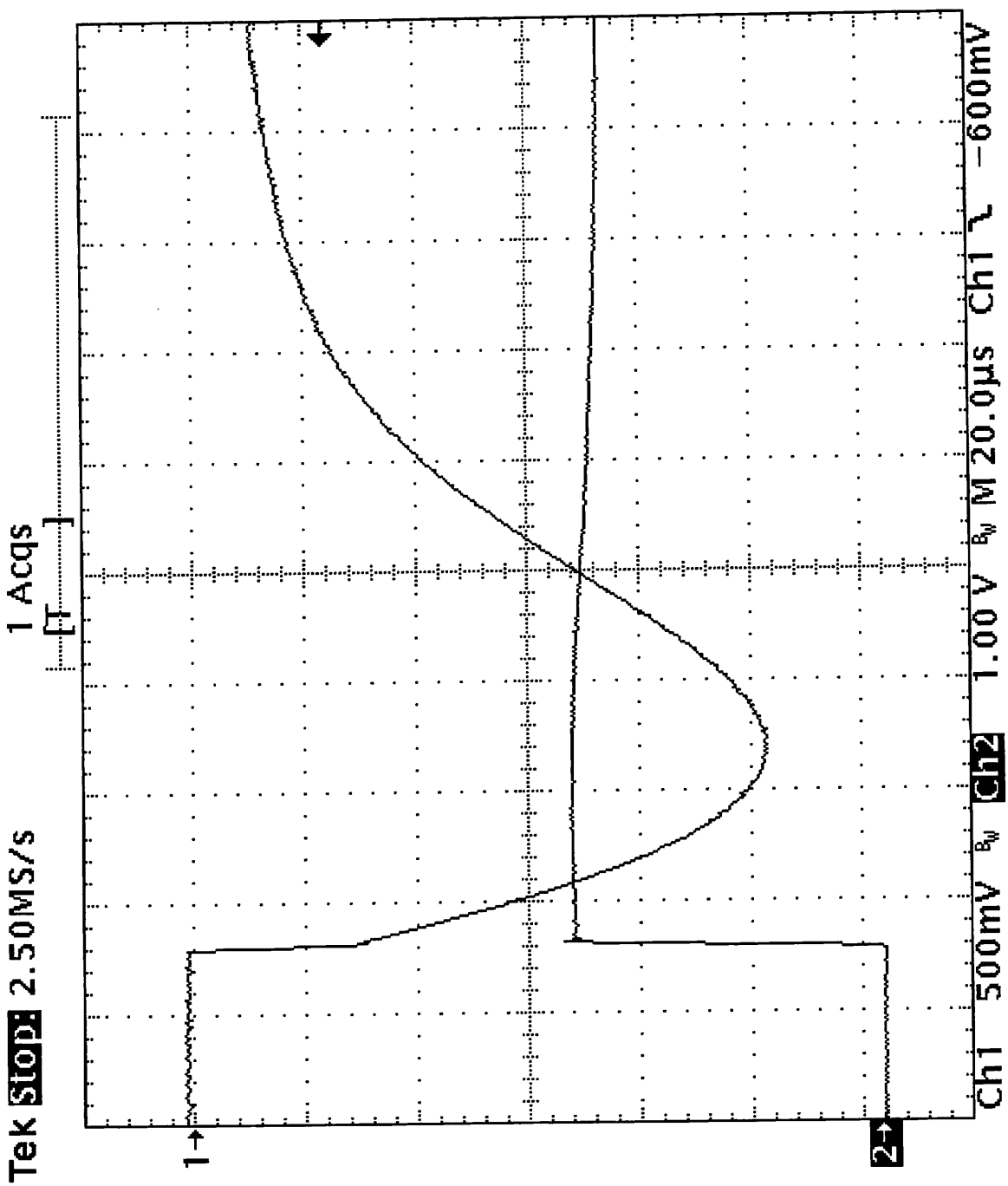
CESI PeC A4522503 oscillogram n. 10



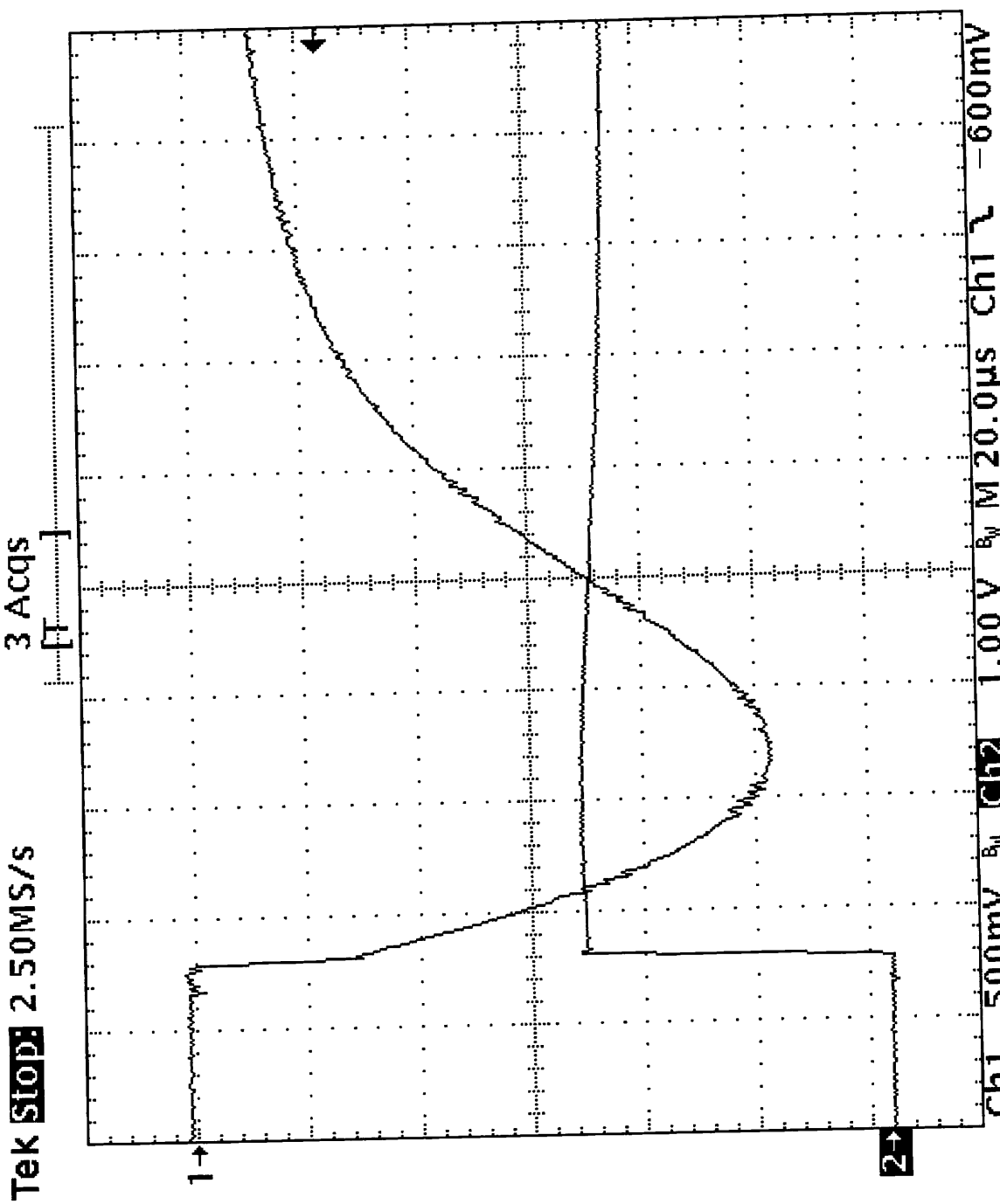
CESI PeC A4522503 oscillogram n. 11



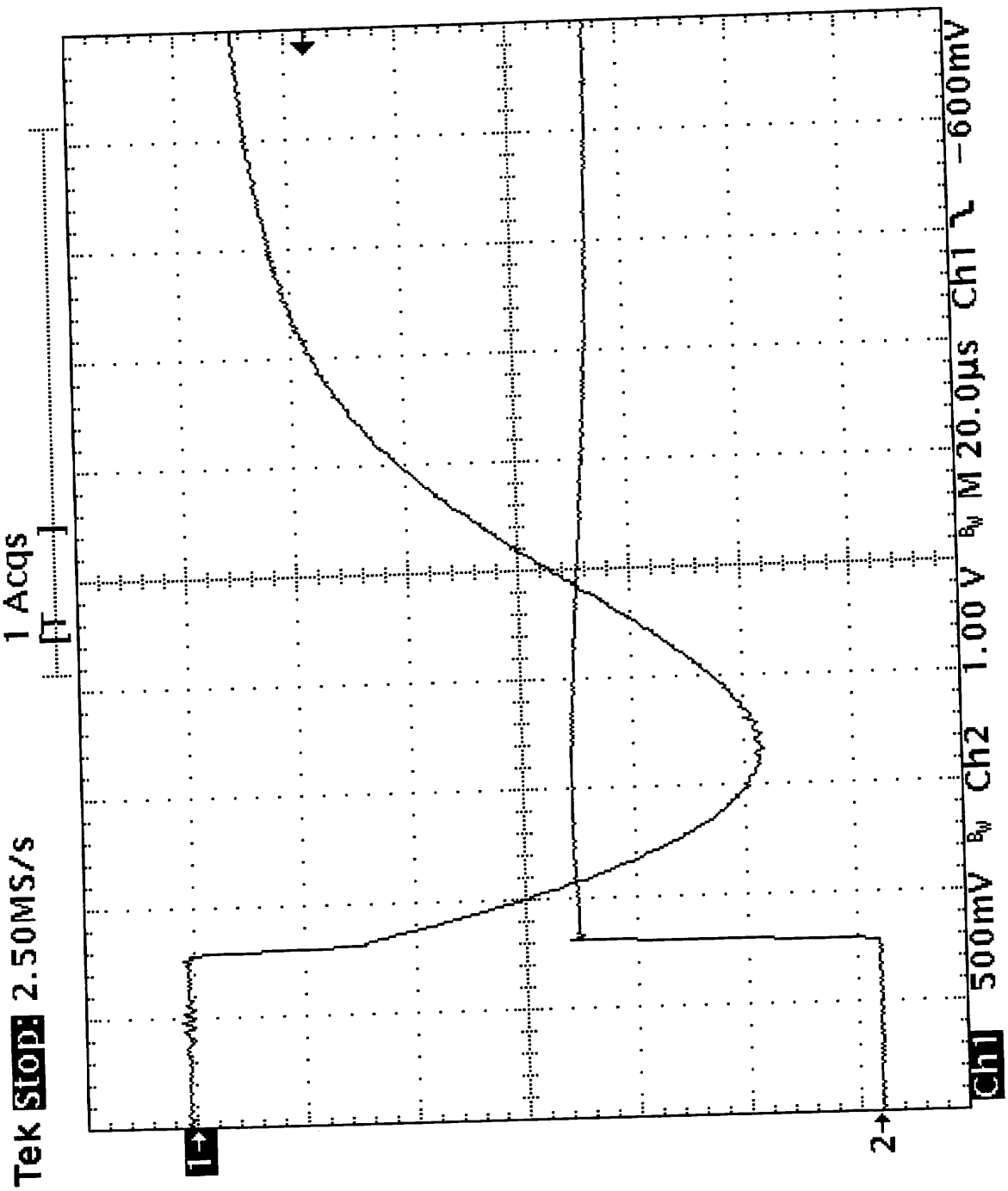
CESI PeC A4522503 oscillogram n. 12



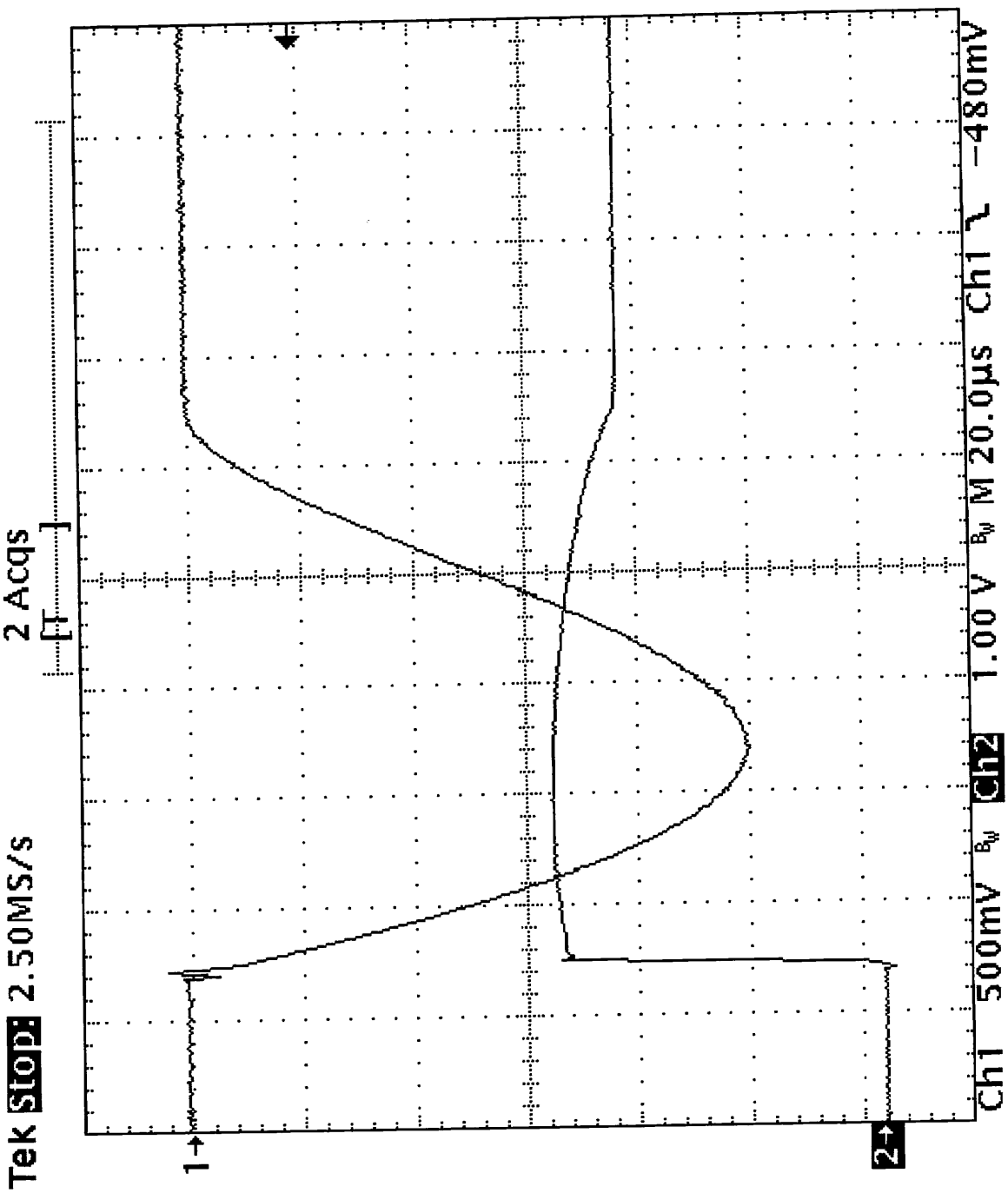
CESI PeC A4522503 oscillogram n. 13



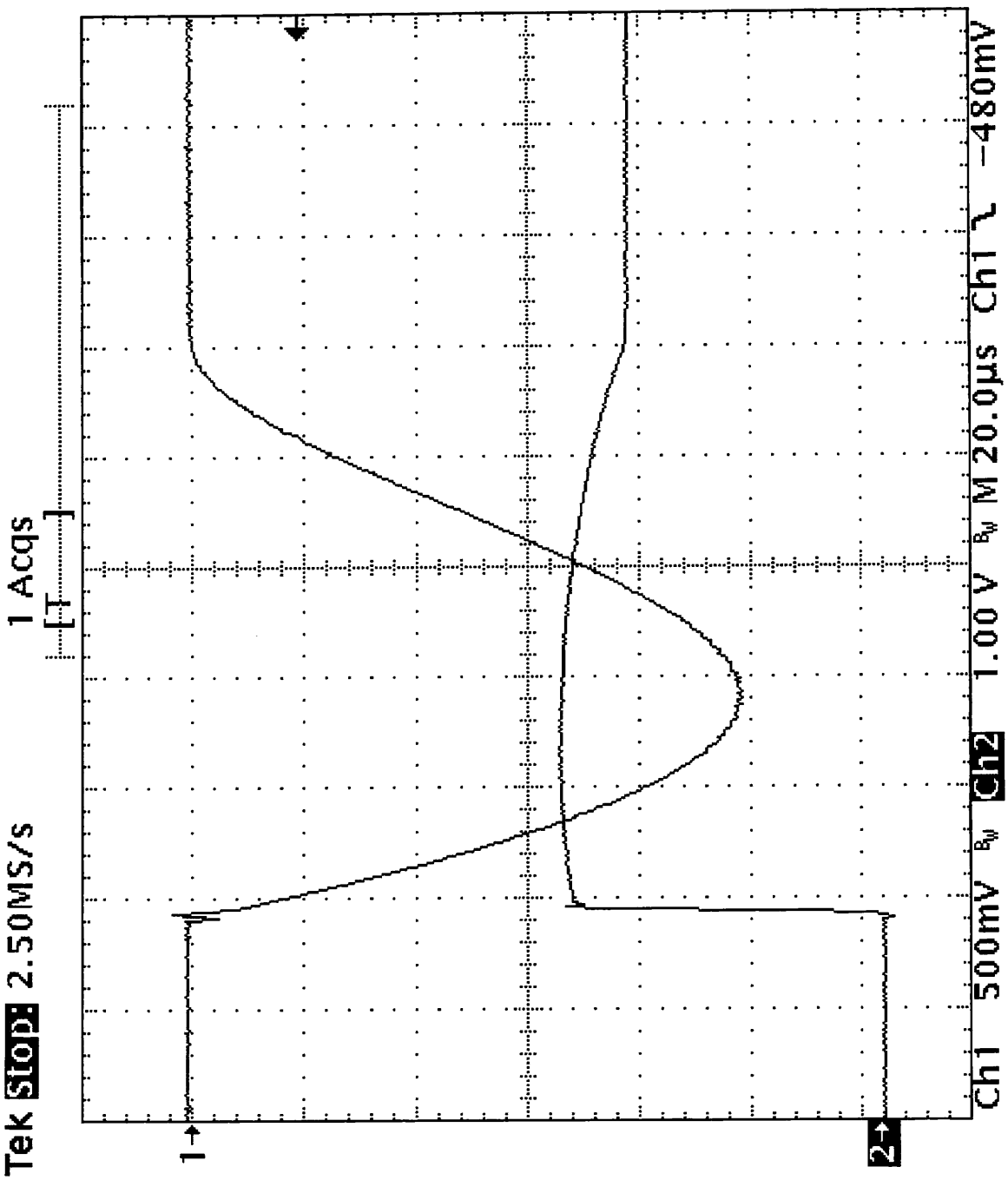
CESI PeC A4522503 oscillogram n. 14



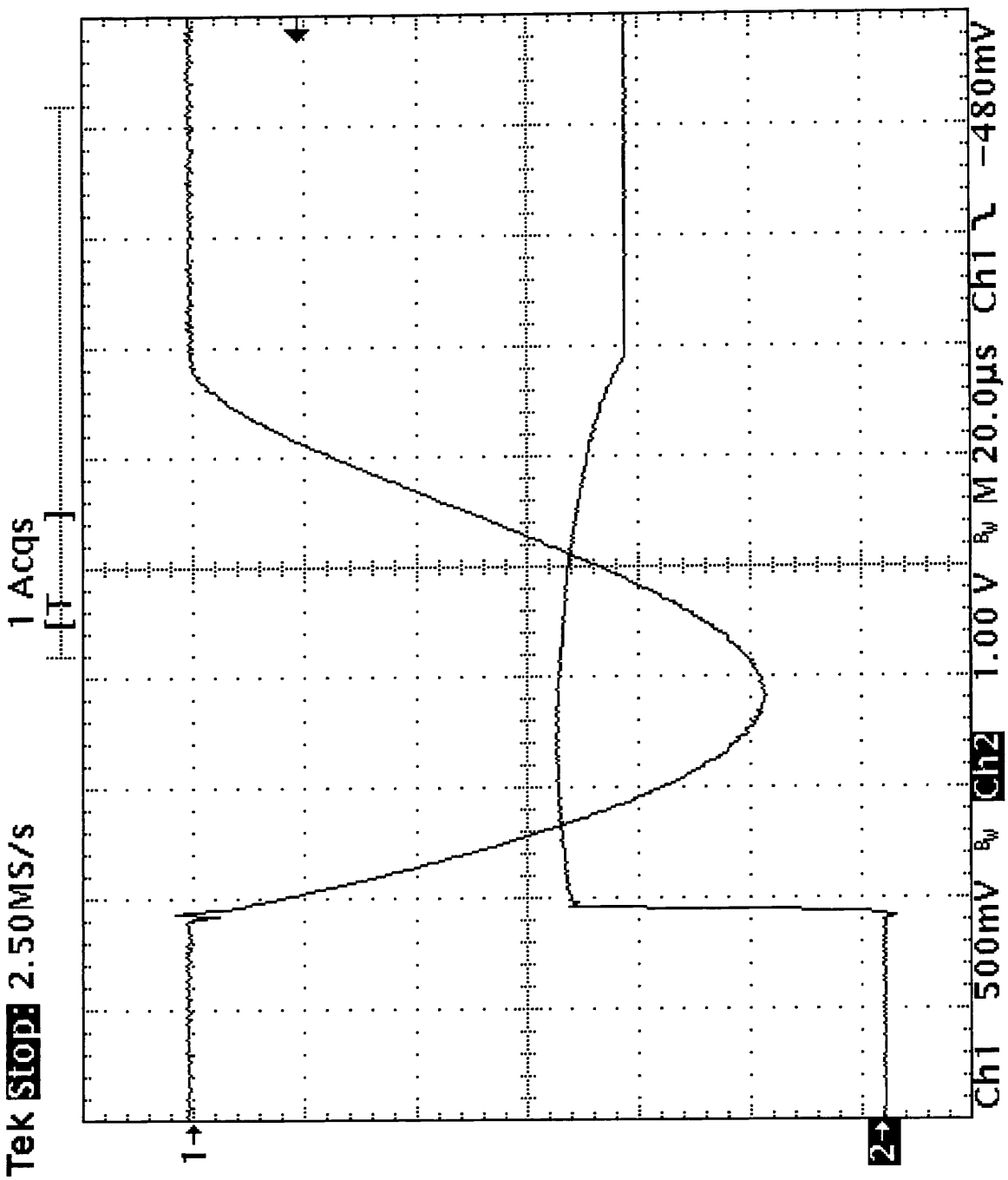
CESI PeC A4522503 oscillogram n. 15



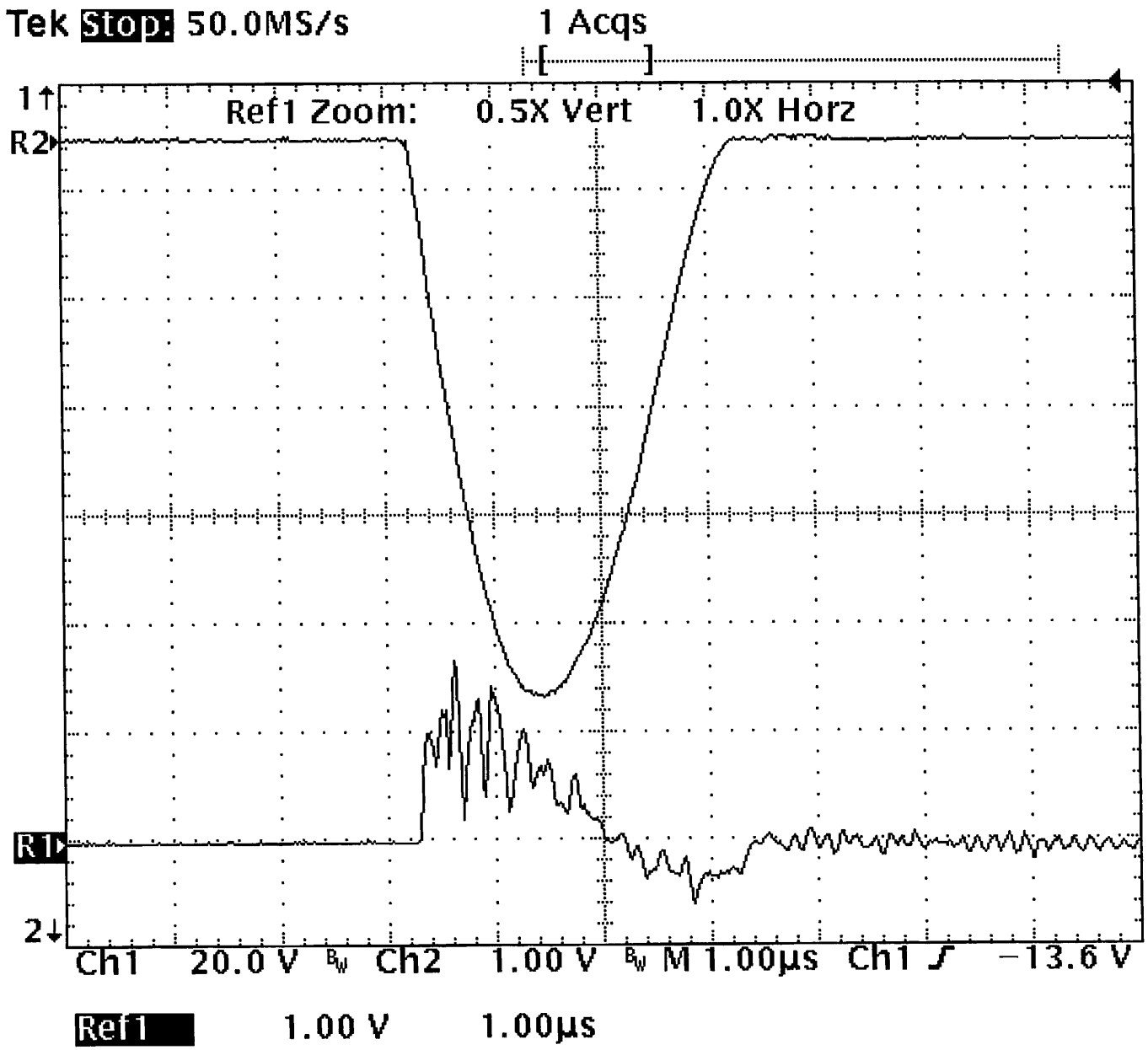
CESI PeC A4522503 oscillogram n. 16



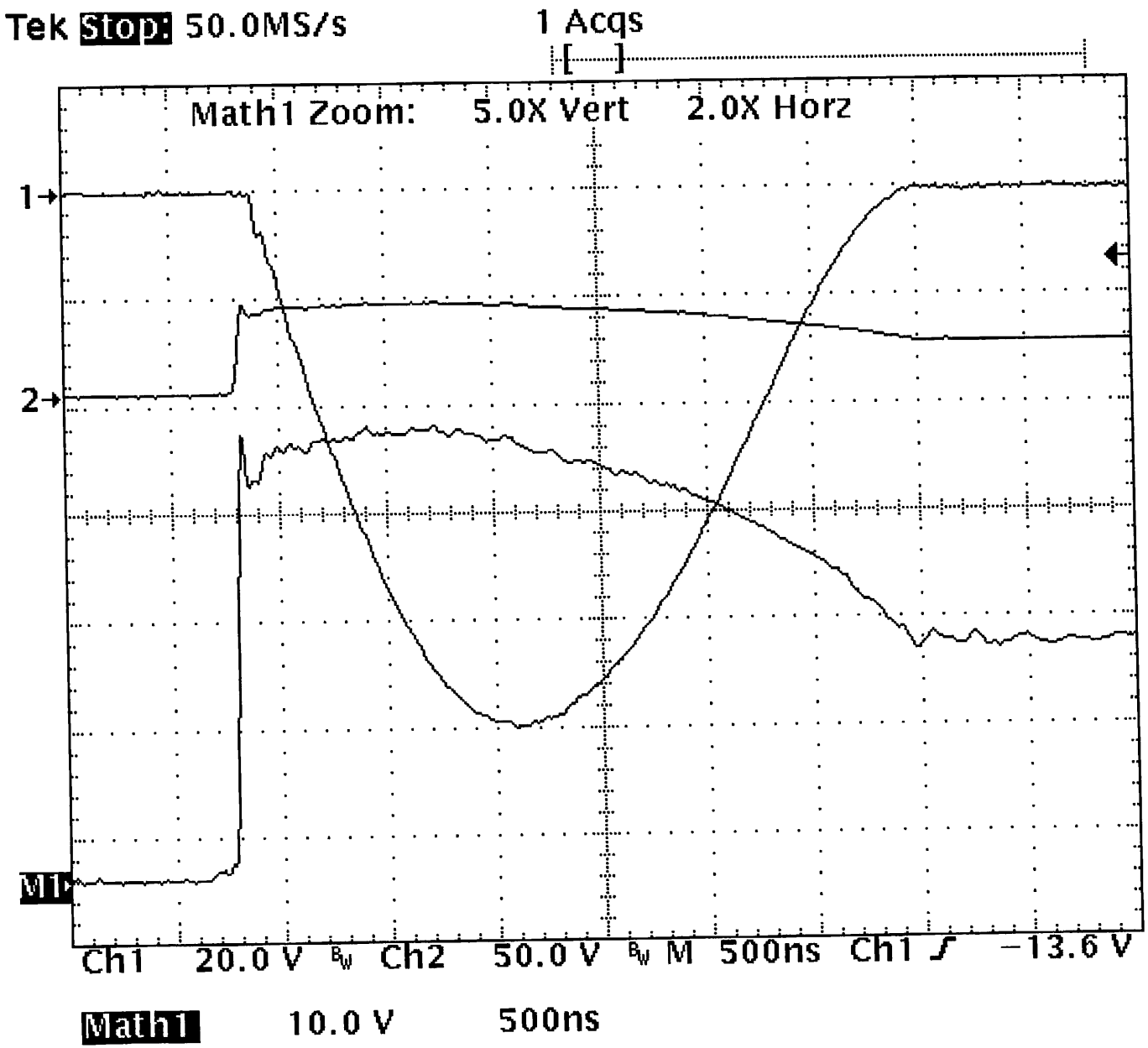
CESI PeC A4522503 oscillogram n. 17



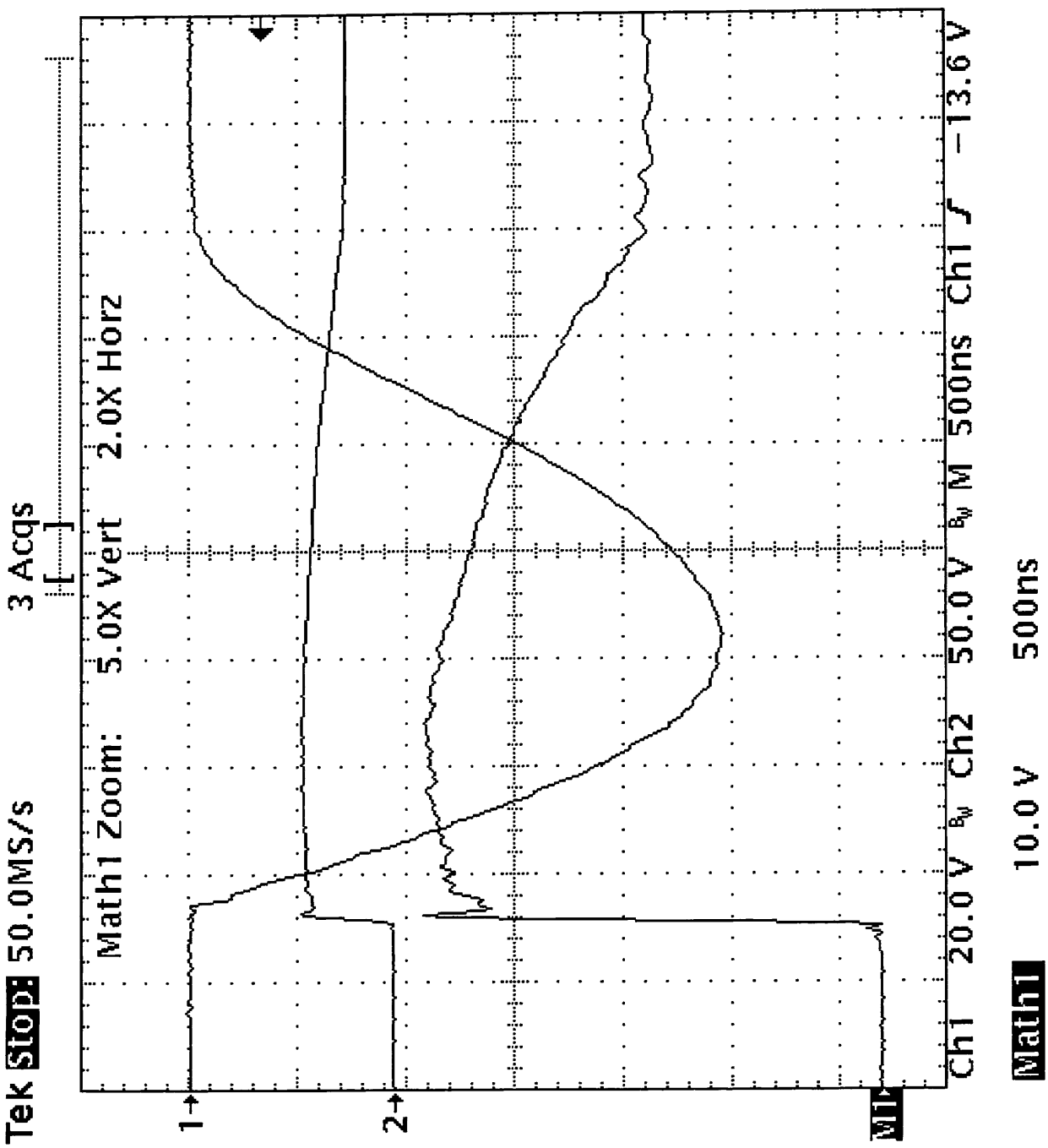
CESI PeC A4522503 oscillogram n. 18



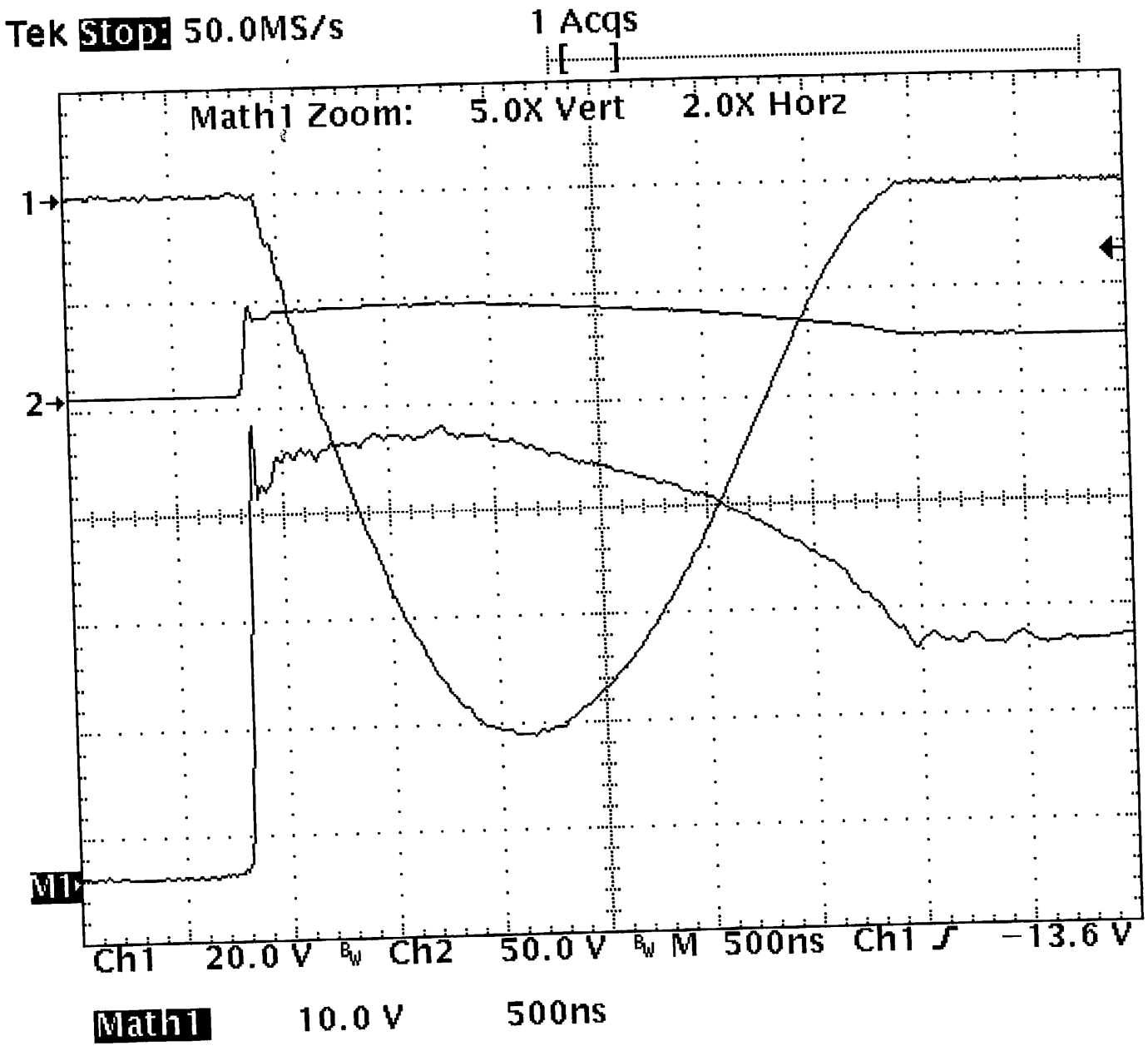
CESI PeC A4522503 oscillogram n. 19



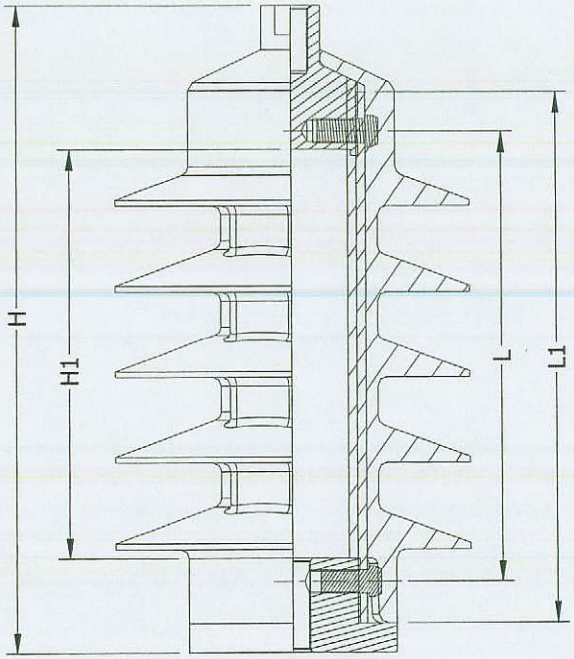
CESI PeC A4522503 oscillogram n. 20



CESI PeC A4522503 oscillogram n. 21



CESI PeC A4522503 oscillogram n. 22



Code	Ur (kV)	Arrester heigh H (mm)	Number of ribs (pcs)	Area for ZnO bloks H1 (mm)	Lenght of strips L1 (mm)	Lenght L (mm)
21-48-01	3,75	147	3	67	107	81
21-48-02	5	147	3	67	107	81
21-48-03	7,50	147	3	67	107	81
21-48-04	10	193	5	113	153	127
21-48-05	12,5	193	5	113	153	127
21-48-06	15	193	5	113	153	127
21-48-07	17,5	243	6	163	203	177
21-48-08	20	243	6	163	203	177
21-48-09	22,5	243	6	163	203	177
21-48-10	25	270	7	190	230	204
21-48-11	26,25	270	7	190	230	204
21-48-12	27,5	270	7	190	230	204
21-48-13	30	317	8	237	277	251
21-48-14	32,5	317	8	237	277	251
21-48-15	35	317	8	237	277	251
21-48-16	37,5	370	11	290	330	304
21-48-17	40	370	11	290	330	304
21-48-18	42,5	404	12	324	364	338
21-48-19	45	404	12	324	364	338

IZO ELEKTRO...	ISO2768 -		Measure: 7:10	Weight:
			Materiali:	
	Date:	Name:	Signature:	Type: SURGE ARRESTER 2SS15N
Izdelali:	27.8.03	R. Kurnik		
Pregledal:	1.9.03	P. Pungercar		
Odobril:	1.9.03	P. Pungercar		
Opombe:				Code: 21-48-00
				Sheet: 1/1
				Izdelek: Prip.: