

ESW-C



Client CROMPTON GREAVES Ltd. Switchgear Division

Address of the client A-3 MIDC – Ambad, IN-422010 NASIK
INDIA

Manufacturer CROMPTON GREAVES Ltd. Switchgear Division

Tested samples/items Three-pole 145 kV gas-insulated Live Tank circuit-breaker

Tests carried out Operation at the temperature limits (+55 °C)

Standards/Specifications IEC 62271-1 (2007-10), IEC 62271-100 (2008-04)

Tests date from February 21, 2012 to February 25, 2012

The results reported in this document relate only to the tested samples/items.
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1 SPECIFIC INFORMATION

Test witnessed by

Mr. Amit Shere (CROMPTON GREAVES Ltd. Switchgear Division)
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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 B2006139 no. 1 is annexed to this document.

Test evaluation

With reference to the Standards/Specifications listed in the first page and the characteristics of the tested sample assigned by the manufacturer, the test object passed the tests SUCCESSFULLY.

Measurement uncertainties

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

voltage: $\pm 5 \%$
 current: $\pm 5 \%$
 time: $\pm 5 \%$
 temperature: $\pm 2\%$ up to 100°C ; $\pm 2\%$ above 100°C up to 500°C ; $\pm 3\%$ above 500°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 about 95 %) and have to be considered as maximum values.

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

Laboratory information

Test location CESI – Via Rubattino 54 – Milan
 CESI testing team Mr. Claudio Carniel, Mr. Alessandro Cremona, Mr. Paolo Sironi
 Test laboratory P443
 Activity code AE12PMI010

2 RATED CHARACTERISTICS OF THE TESTED OBJECT ASSIGNED BY THE MANUFACTURER

Tested object	Three-pole 145 kV gas-insulated Live Tank circuit-breaker
Manufacturer	CROMPTON GREAVES Ltd. Switchgear Division
Type	120 – SFM – 32B
Serial number	X304942
Rated voltage	145 kV
Normal current	3150 A
Frequency	50/60 Hz
Lightning impulse withstand voltage	650 kV peak
Power frequency withstand voltage	275 kV rms
Short-circuit making current	104 kA peak
Short-circuit breaking current	40 kA rms
Time constant	45 ms
First-pole-to-clear-factor	1,5
Surge impedance	<2,3 p.u.
Out-of-phase breaking current (voltage factor 2,5)	10 kA
Duration of short-circuit	3 s
Short-time withstand current	40 kA
Peak withstand current	104 kA
Operating sequence	O – 0,3 s – CO – 3 min. – CO
Class	M2, C2
Number of poles	3
Breaking unit per phase	1
Pressure of SF ₆ for insulation (referred to 20° C)	
rated	0,8 MPa abs
minimum	0,7 MPa abs
Operating mechanism	
type	spring-spring
Supply voltage	
closing device	110/125 V _{DC}
tripping device	110/125 V _{DC}
motor	110/125 V _{AC/DC}

3 LIST OF INSTRUMENTS USED FOR THE TEST

- Microohmmeter MOH 600 A CESI number 014204;
- Multimeter FLUKE 77 CESI number 011043;
- KOCOS ACTAS P14 CESI number 039098;
- Control supply unit CESI number 024567;
- Control supply unit CESI number 029844.

4 MISCELLANEOUS INFORMATION FOR THE TEST

The tested object has been set up in the 750 m³ climatic cell, and fixed on a platform and filled with SF₆ at rated pressure of 0,80 MPa (abs.) measured by the densimeter (compensated pressure transducer) mounted on the tested object. The pressure values are referred to the ambient temperature of 20°C.

In figure no. 1 is showed the diagram of the test sequence and identification of the application points as described in the item 6.101.3.4 of the Standard.

In figure no. 2 is given the behaviour of the ambient air temperature during the tests.

The drawing with the layout of the tested object is showed in figure no. 3.

4.1 Modality of measurement of quantities during tests

For the measurement of the quantities during the tests, the following rules have been applied:

- the current in the motor of the operating mechanism is measured as follows:
 - peak current as the starting current;
 - steady state current as the mean value measured after the peak current;
- the two voltage probes used for calculation of the resistance, were connected to the two terminals of the circuit-breaker and connected to the nearest reachable point with respect to main contacts.

4.2 Identification of the traces contained in the Oscillograms

Trace no. (from top to bottom)	Signal
1	coil current
2	motor current
3	main contact A
4	main contact B
5	main contact C
6	travel main contact A
7	auxiliary contact normally open (N.O.)
8	auxiliary contact normally close (N.C.)

4.3 Test sequences

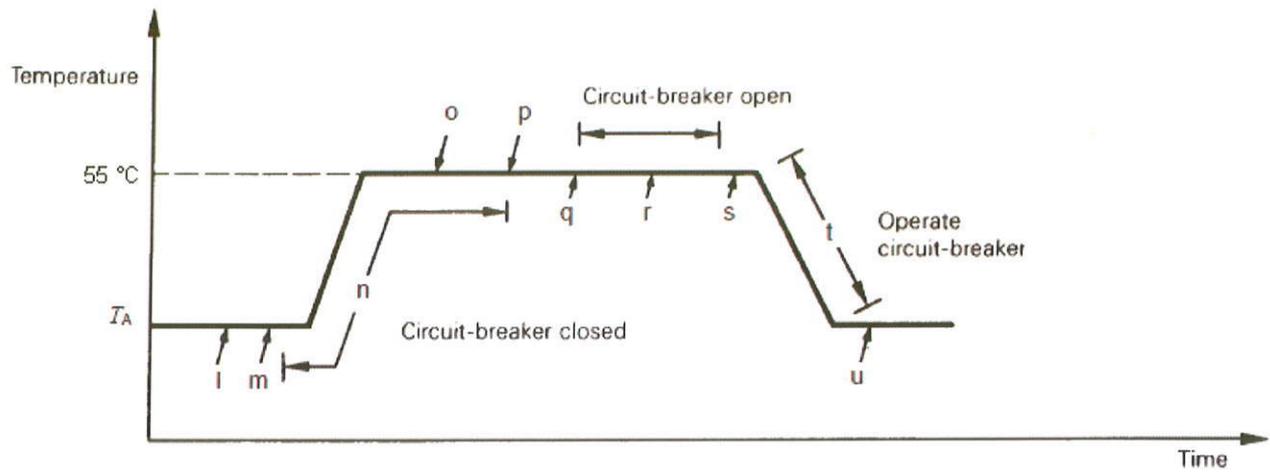


Figure no. 1 – High temperature test sequence.

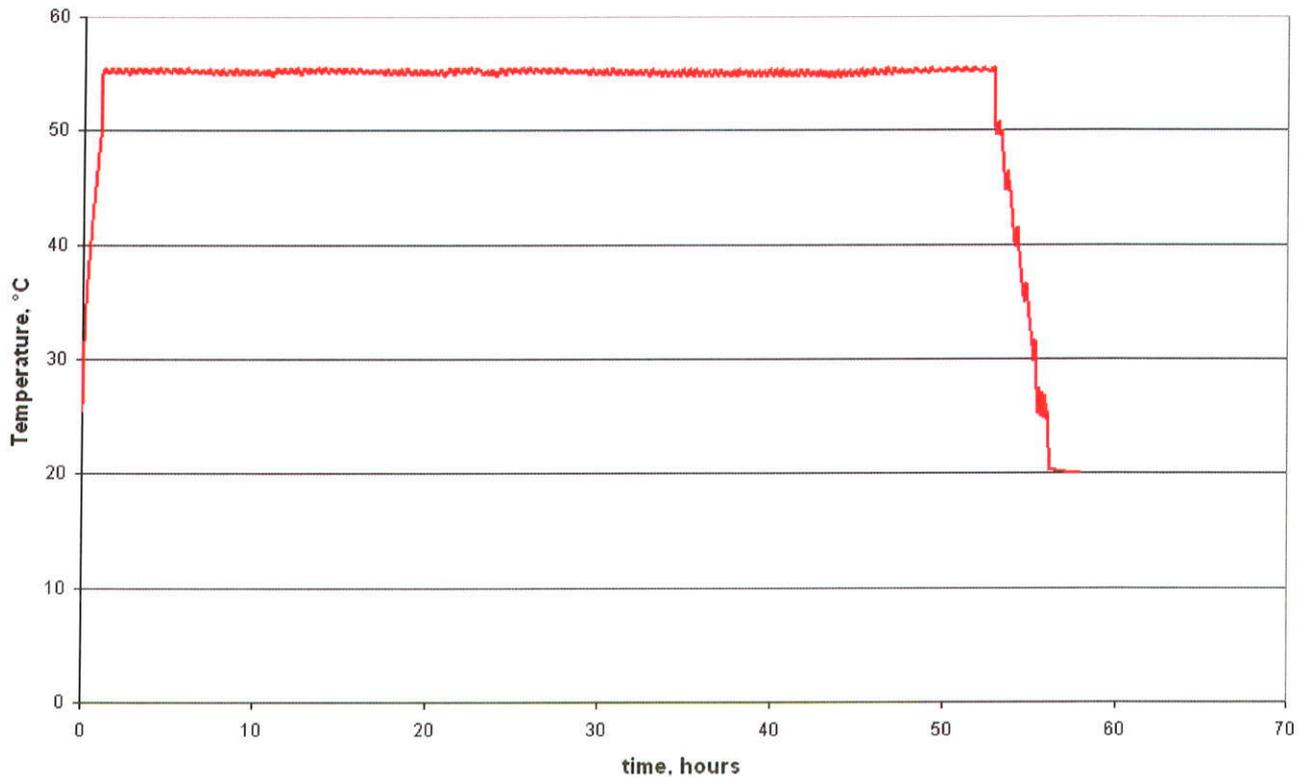


Figure no. 2 – Behaviour of the ambient air temperature during the tests.

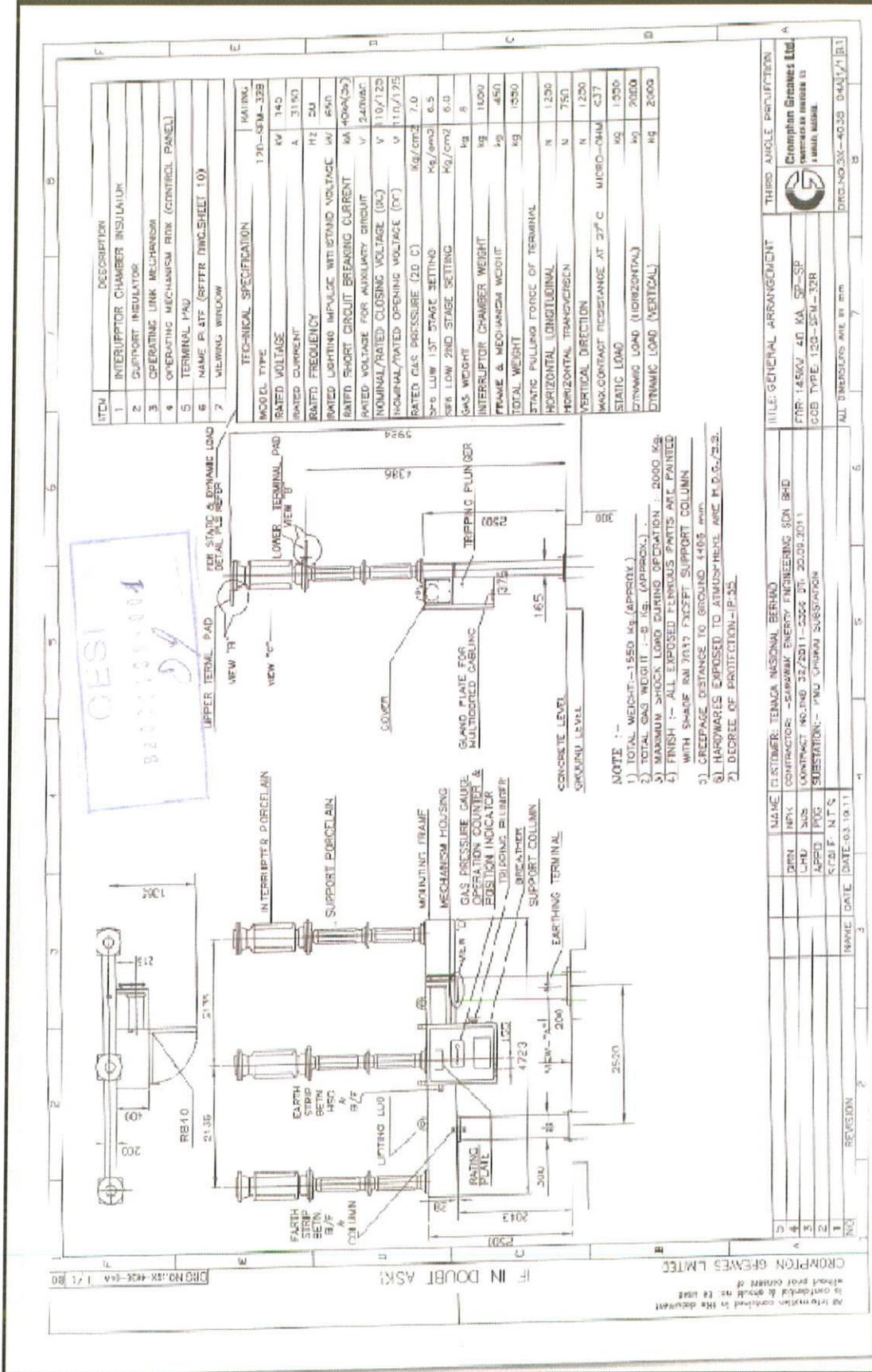


Figure no. 3 – Layout of the tested object.

5 OPERATION AT THE TEMPERATURE LIMITS (+55 °C)

Type of operation: check of the characteristics of the tested object before the operation at the temperature limits

Ambient air temperature: +20 °C

Date: February 21, 2012

Oscillogram no.	Type of operation	Voltage of operating devices and control circuit		Coil		Motor			Operation time of main contact			Operation time of auxiliary contacts	
		coil [V _{bcd}]	motor [V _{bcd}]	current [A]	duration of impulse command [ms]	current peak [A]	current steady state [A]	duration of operation [s]	A [ms]	B [ms]	C [ms]	N.O. [ms]	N.C. [ms]
1A/B	C	125	125	5,67	82	25,03	6,77	8,6	90,7	91,1	89,9	85,9	73,5
2	O	125	125	5,27	37	-	-	-	25,4	24,4	25,7	28,7	35,7
3A/B	C	137,5	137,5	6,21	83	30,25	6,80	7,7	89,7	90,3	89,1	84,6	72,5
4	O	137,5	137,5	5,96	38	-	-	-	25,0	24,2	25,3	28,3	35,0
5A/B	C	106,25	106,25	5,34	85	21,25	6,63	9,0	94,8	95,6	94,3	89,7	78,0
6	O	87,5	106,25	3,49	37	-	-	-	27,1	26,1	27,6	29,8	37,1

C = closing operation O = opening operation

The temperature has been increased to 55 °C: the circuit-breaker has been closed and left close.

Type of test: 50 closing and 50 opening operations in accordance with 6.101.3.3 item "s" of the Standard: below are reported the first closing operation and the first opening operation

Ambient air temperature: +55 °C

Operating sequence : C – 90 s – O – 90 s

Date: February 24, 2012

Oscillogram no.	Type of operation	Voltage of operating devices and control circuit		Coil		Motor			Operation time of main contact			Operation time of auxiliary contacts	
		coil [V _{bdc}]	motor [V _{bdc}]	current [A]	duration of impulse command [ms]	current peak [A]	current steady state [A]	duration of operation [s]	A [ms]	B [ms]	C [ms]	N.O. [ms]	N.C. [ms]
9	C	125	125	5,08	86	26,61	6,94	8,7	94,7	95,0	93,4	89,0	75,6
10	O	125	125	4,77	37	-	-	-	25,7	25,1	26,7	28,7	36,1

C = closing operation O = opening operation

After the above operations has been completed the operations in accordance with 6.101.3.3 item "t" of the Standard.

Type of operation: recheck of the characteristics of the tested object as prescribed in the item "u" of the Standard.

Ambient air temperature: +20 °C

Date: February 25, 2012

Oscillogram no.	Type of operation	Voltage of operating devices and control circuit		Coil		Motor			Operation time of main contact			Operation time of auxiliary contacts	
		coil [V _{bc}]	motor [V _{bc}]	current [A]	duration of impulse command [ms]	peak current [A]	steady state current [A]	duration of operation [s]	A [ms]	B [ms]	C [ms]	N.O. [ms]	N.C. [ms]
11A/B	C	125	125	5,77	84	24,20	6,58	8,6	91,5	92,4	91,1	86,5	73,4
12	O	125	125	5,34	37	-	-	-	25,4	24,3	25,5	27,9	35,0
13A/B	C	137,5	137,5	6,32	84	27,55	6,85	7,8	90,0	90,8	89,6	85,0	72,2
14	O	137,5	137,5	6,09	38	-	-	-	23,0	22,0	23,1	25,5	32,6
15A/B	C	106,25	106,25	5,05	83	24,89	6,58	9,9	92,6	93,3	92,2	87,7	74,7
16	O	87,5	106,25	4,41	37	-	-	-	25,4	24,3	25,4	28,0	35,2

C = closing operation

O = opening operation

6 TIGHTNESS TESTS

The tested object has been set up in the test laboratory, fixed on a floor, filled with SF₆ at rated pressure of 0,8 MPa (abs.) and wrapped up in a polythene enclosure in order to measure the possible SF₆ leakages.

The measurements have been carried out by means of SF₆ GASCHECK P1 leak detector.

The leak rate R for a specimen is calculated by the formula (as per IEC 60068-2-17 Method Q_m):

$$R = \frac{V_m(C_1 - C_0)}{t_1 - t_0} 10^{-6} P_e$$

where:

R is the leak rate expressed in Pa * m³/s

$V_m^{(*)}$ is the capacity of the volume of measurement expressed in cubic meters

$t_1 - t_0$ is the time interval expressed in seconds

$C_1 - C_0$ are the tracer gas concentrations expressed in cm³/m³

P_e is the pressure at the outer surface of the specimen, equivalent to 10⁵ Pa

(*) equal to the total volume inside to the wrapping

To get the free volume inside the wrapping, it is necessary to subtract from the total volume herewith reported the external volume of the equipment under test declared by the Manufacturer.

The permissible leakage rate F_p declared by the Manufacturer is 0,1 % per year.

6.1 Tests results

Measurement conditions	Leak rate R as per Method Qm (according to IEC 60068-2-17)	Relative Leakage Rate Frel (according to IEC 62271-1)
	[Pa*m ³ /s]	[% per year]
Before the tests (+20 °C)	0	0
After 24 h in closed position (+55 °C)	0	0
After 24 h in open position (+55 °C)	0	0
After the High Temperature test (+20 °C)	0	0

7 VERIFICATIONS AFTER THE TESTS

7.1 Measurement of the resistance of main current path

The main circuit resistance measurement has been performed with 100 A_{d.c.}

Conditions	Ambient air temperature [°C]	Resistance		
		Pole A [μΩ]	Pole B [μΩ]	Pole C [μΩ]
Before the tests	20	35,4	34,6	35,7
After the tests	20	36,5	35,3	36,6

7.2 Conditions of the tested object after the tests

At the end of the tests the conditions stated in the items 6.101.1.4 and 6.101.1.5 of the Standard have been fulfilled.

8 TESTED OBJECT PICTURES



Photo no. 1



Photo no. 2

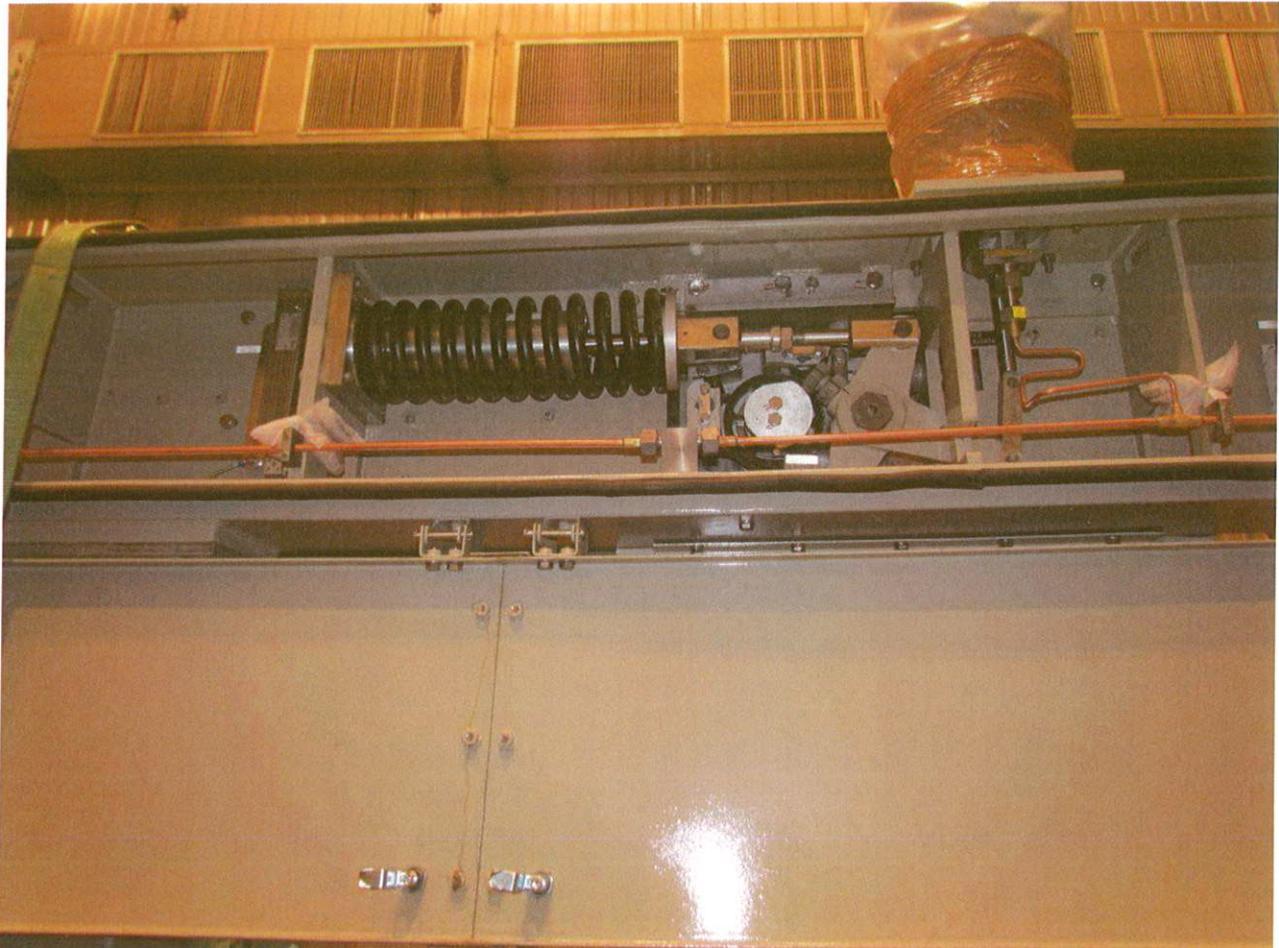


Photo no. 3

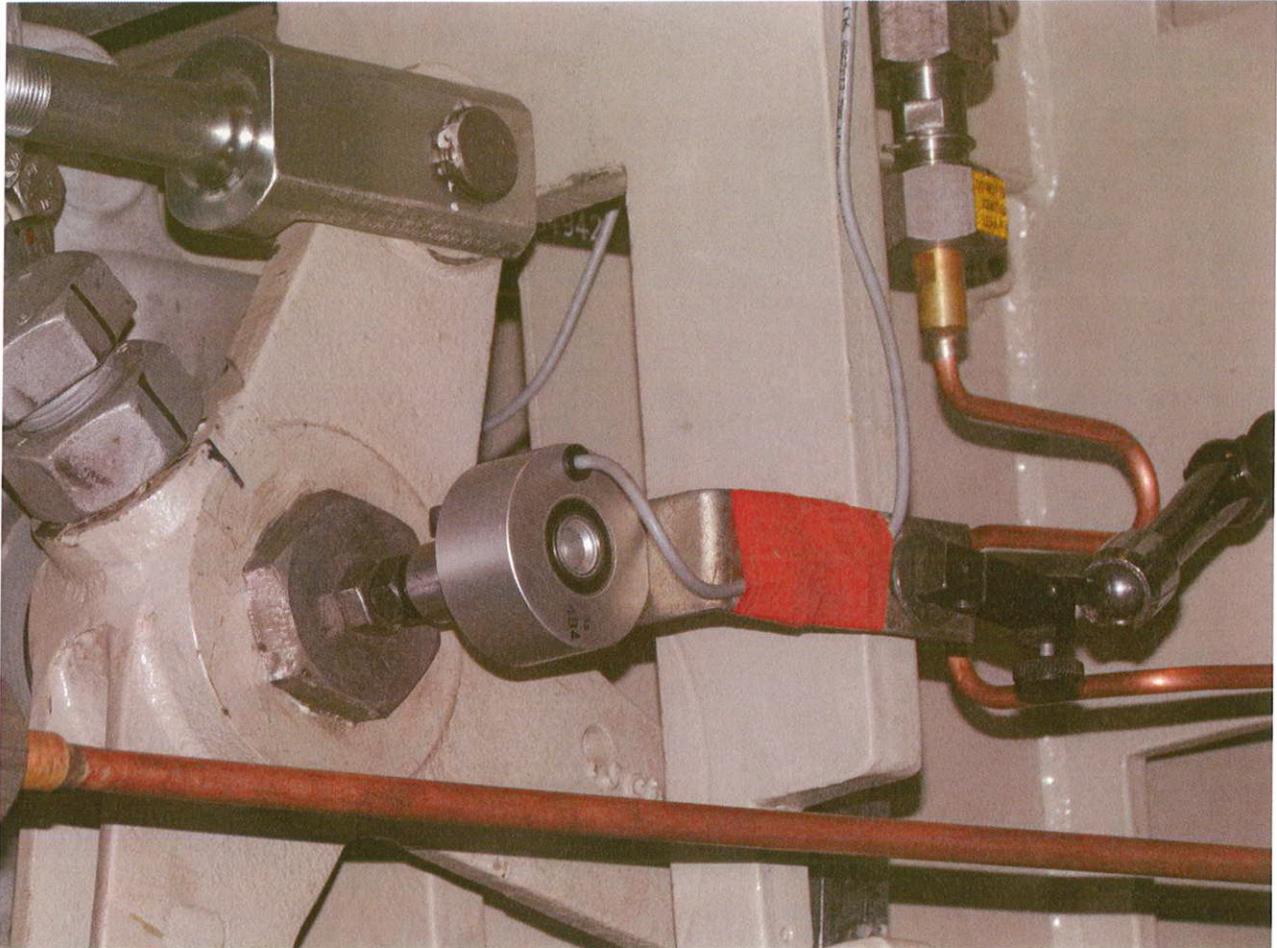
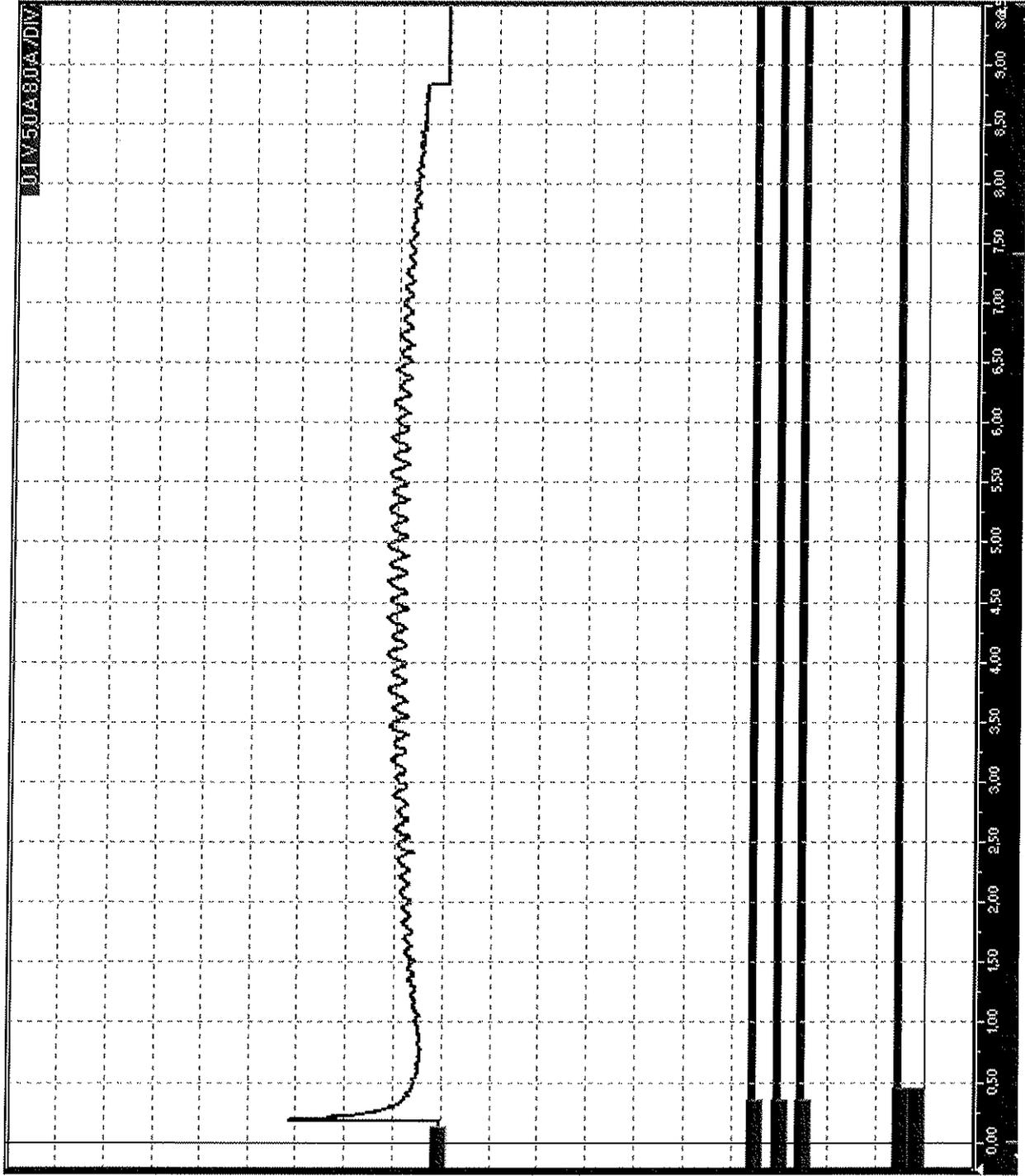
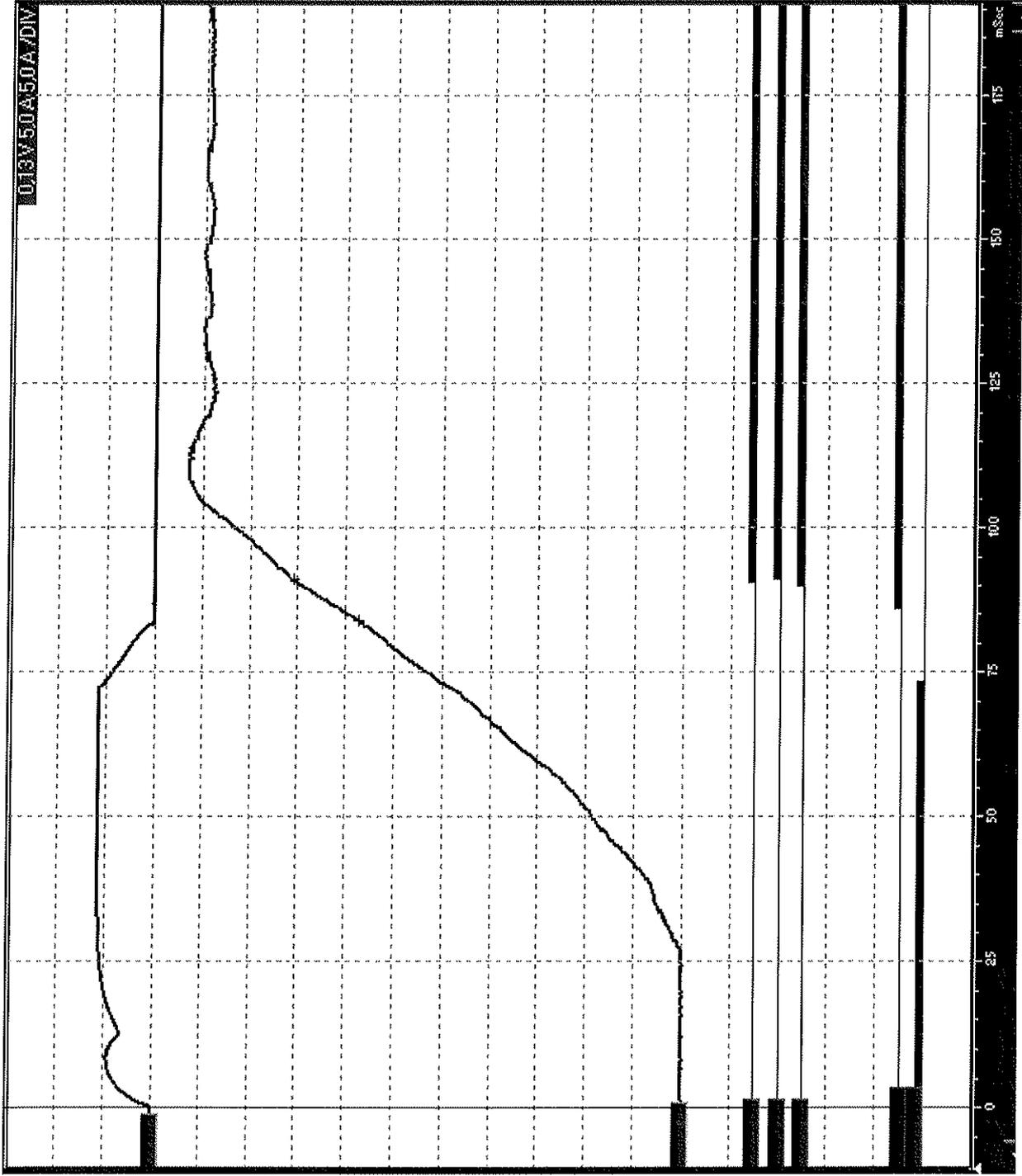


Photo no. 4



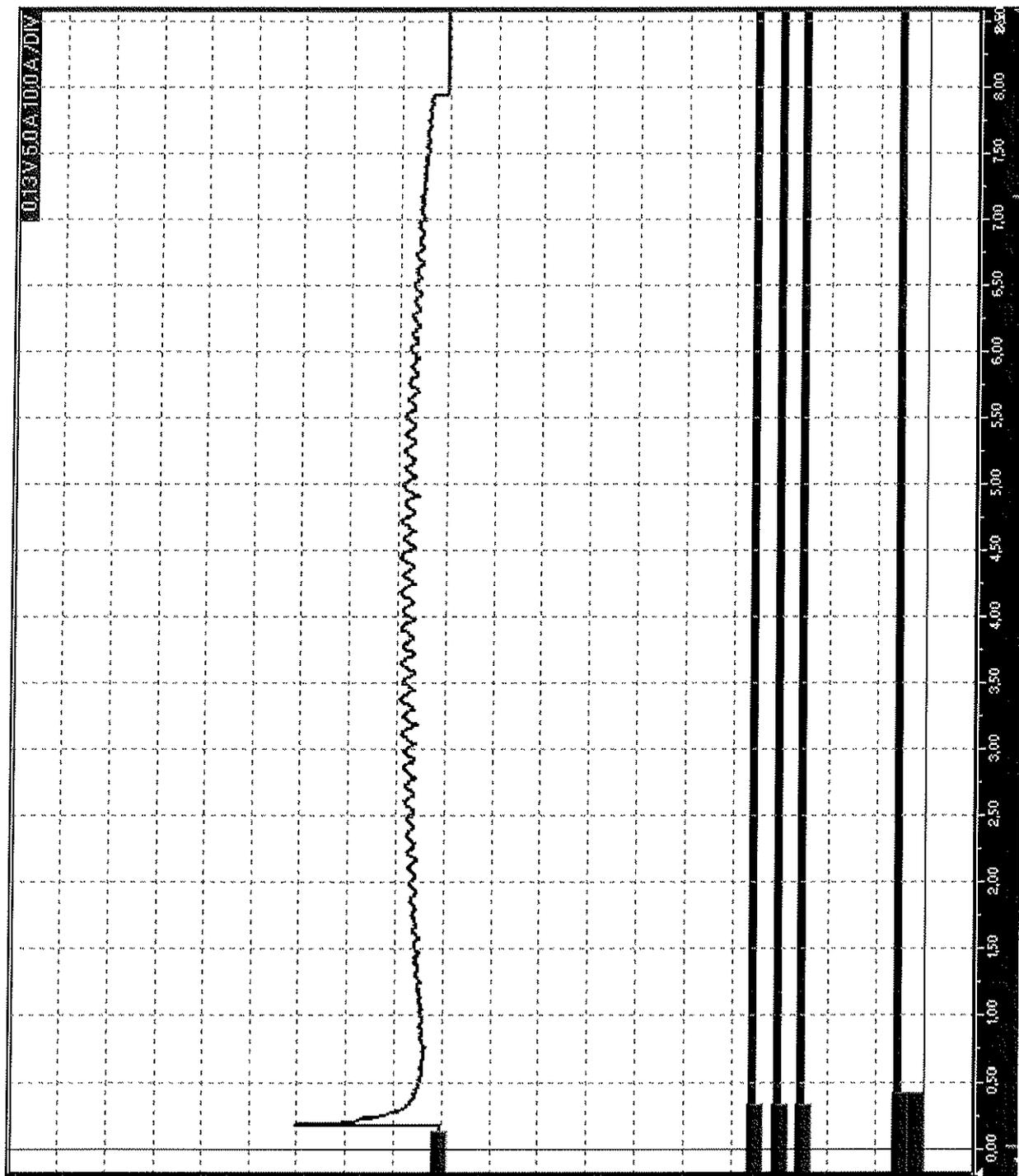
CESI B2005352 - Oscillogram 1A



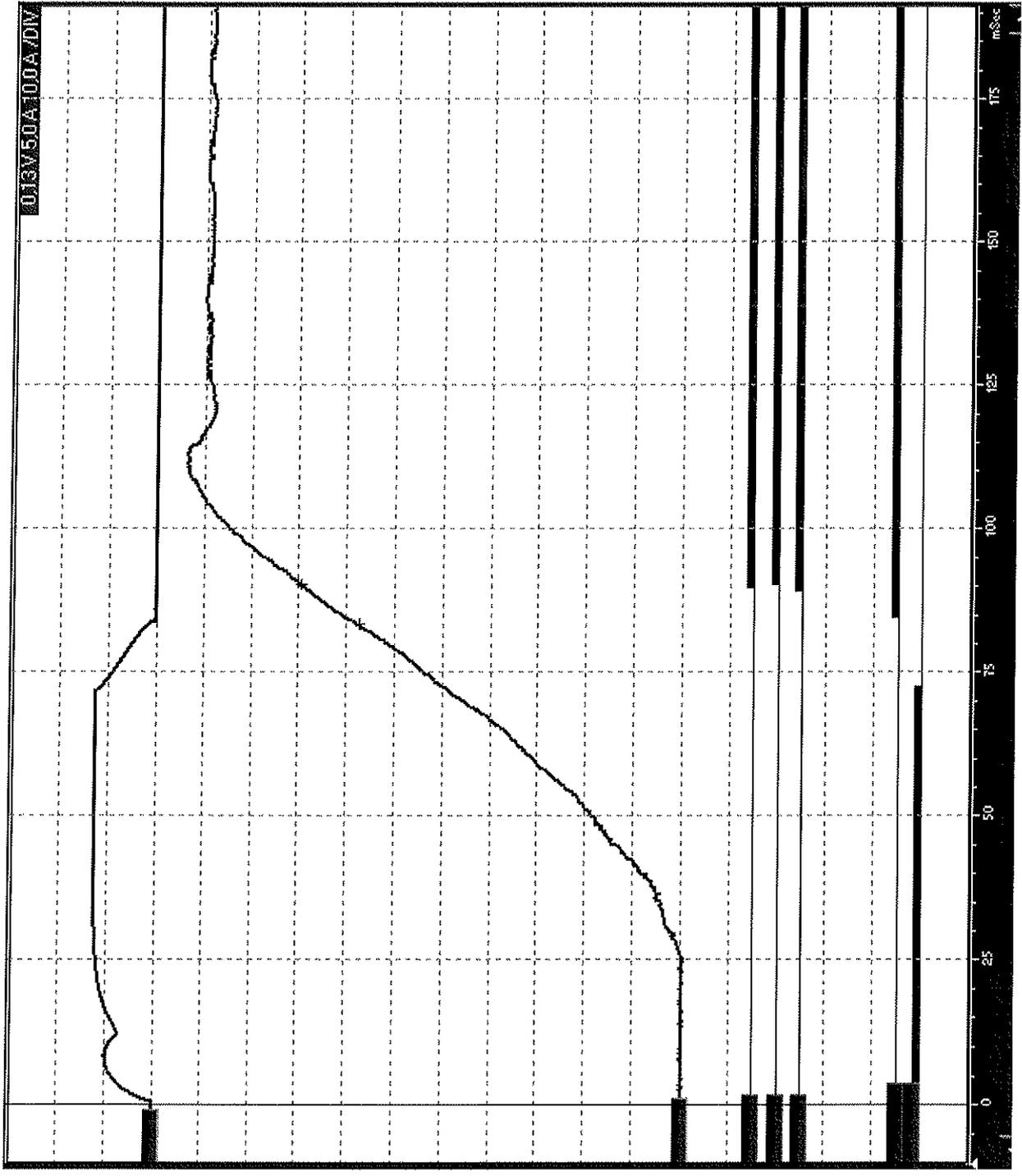
CESI B2005352 - Oscillogram 1B



CESI B2005352 - Oscillogram 2



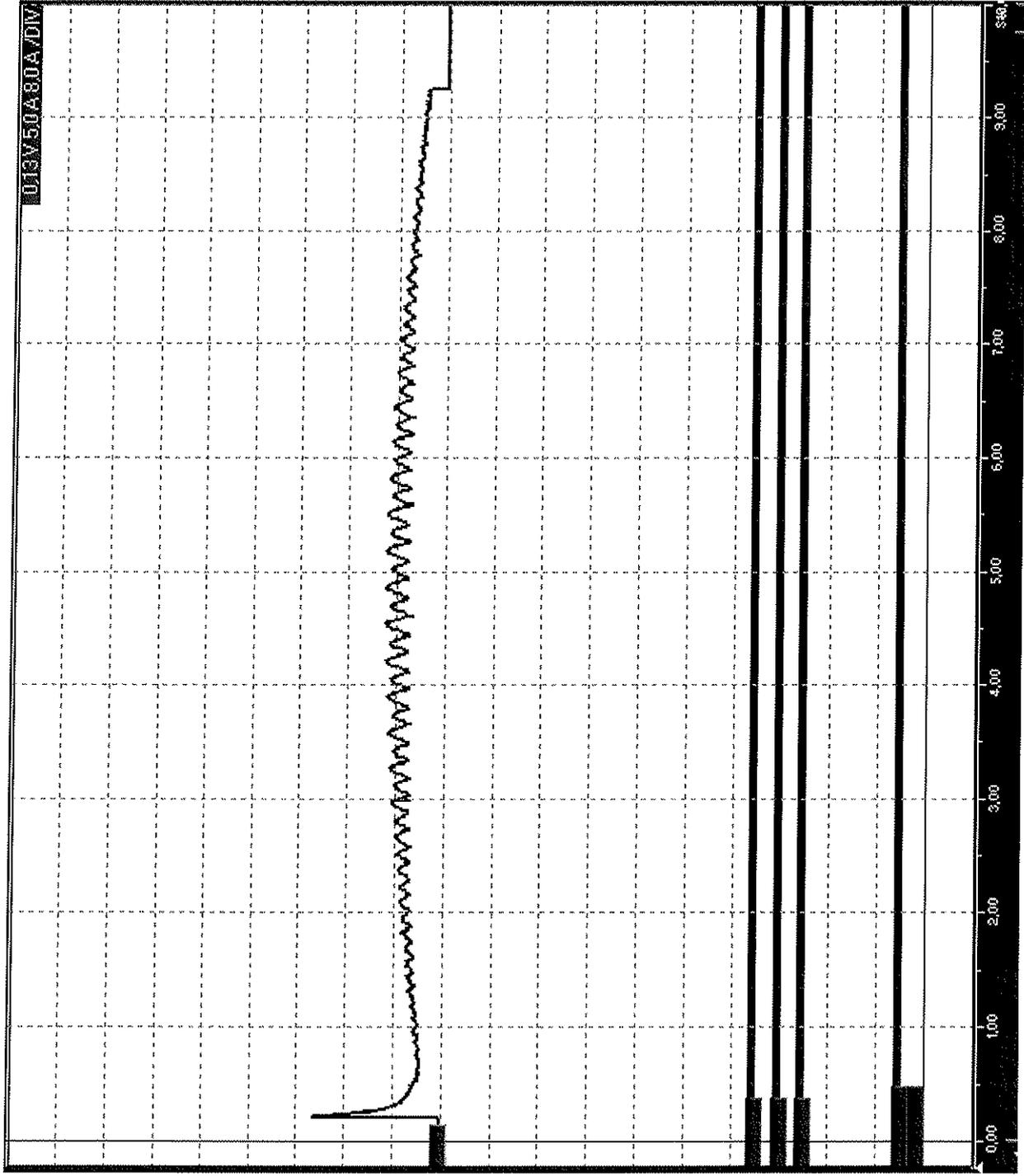
CESI B2005352 - Oscillogram 3A



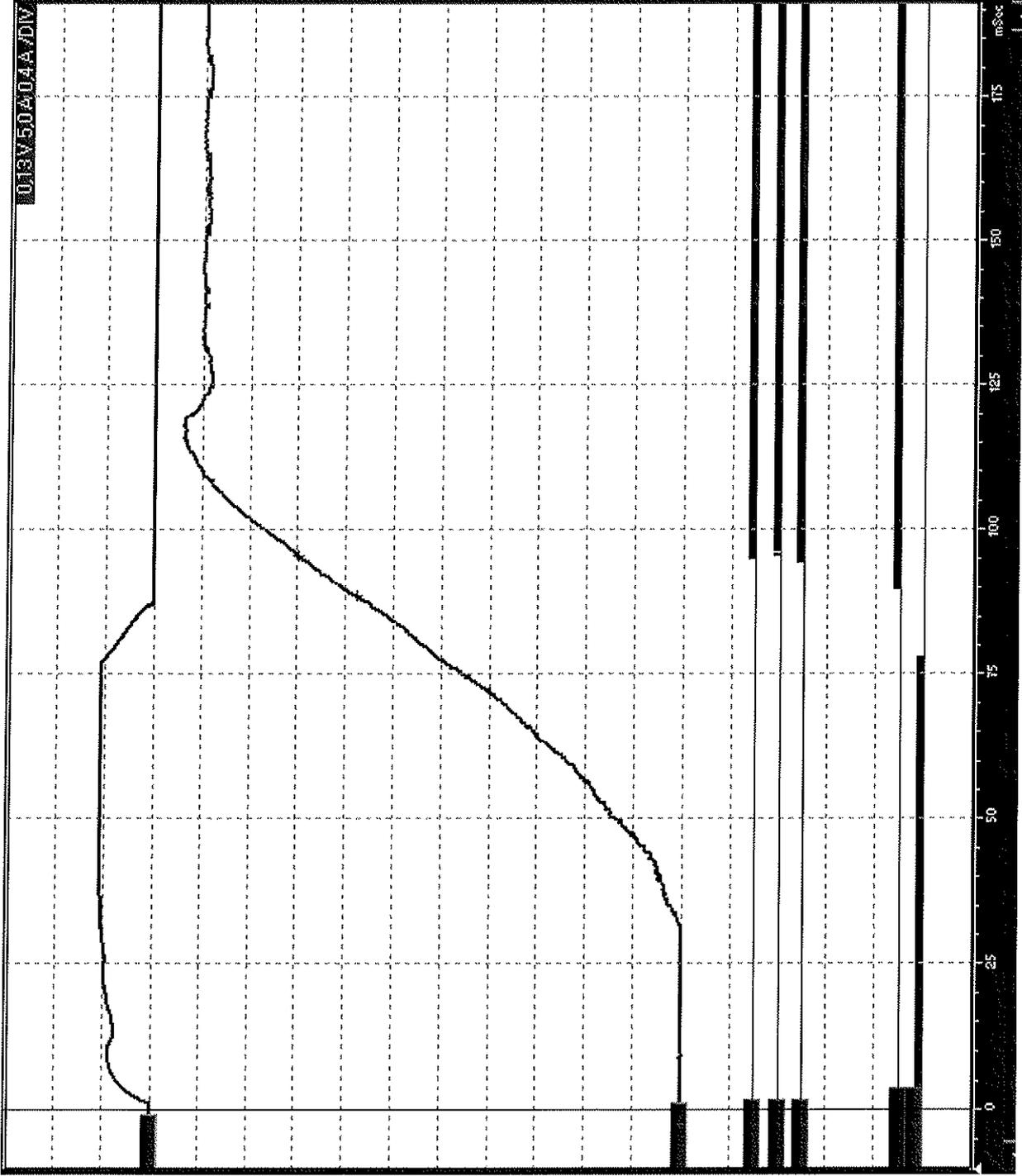
CESI B2005352 - Oscillogram 3B



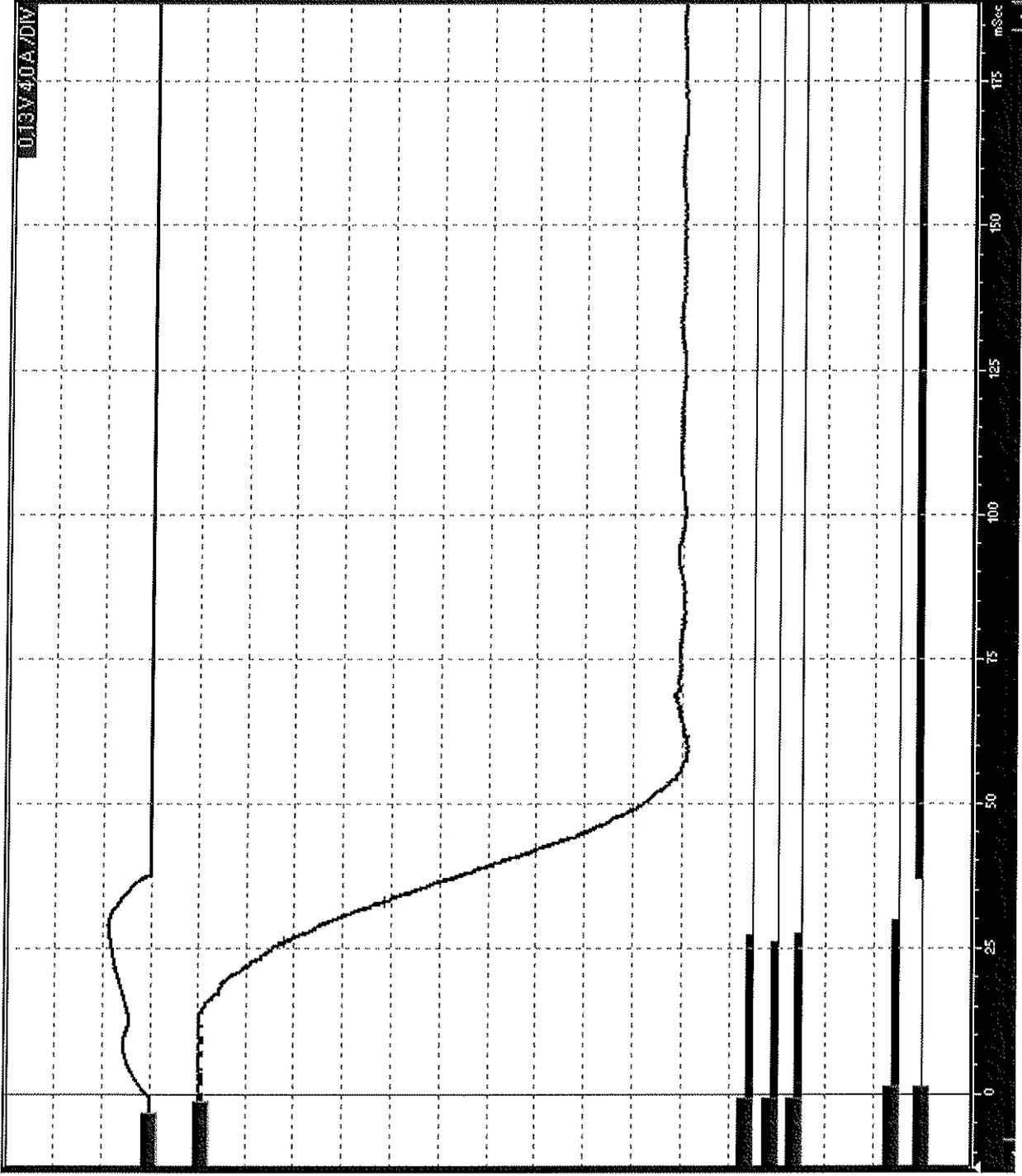
CESI B2005352 - Oscillogram 4



CESI B2005352 - Oscillogram 5A



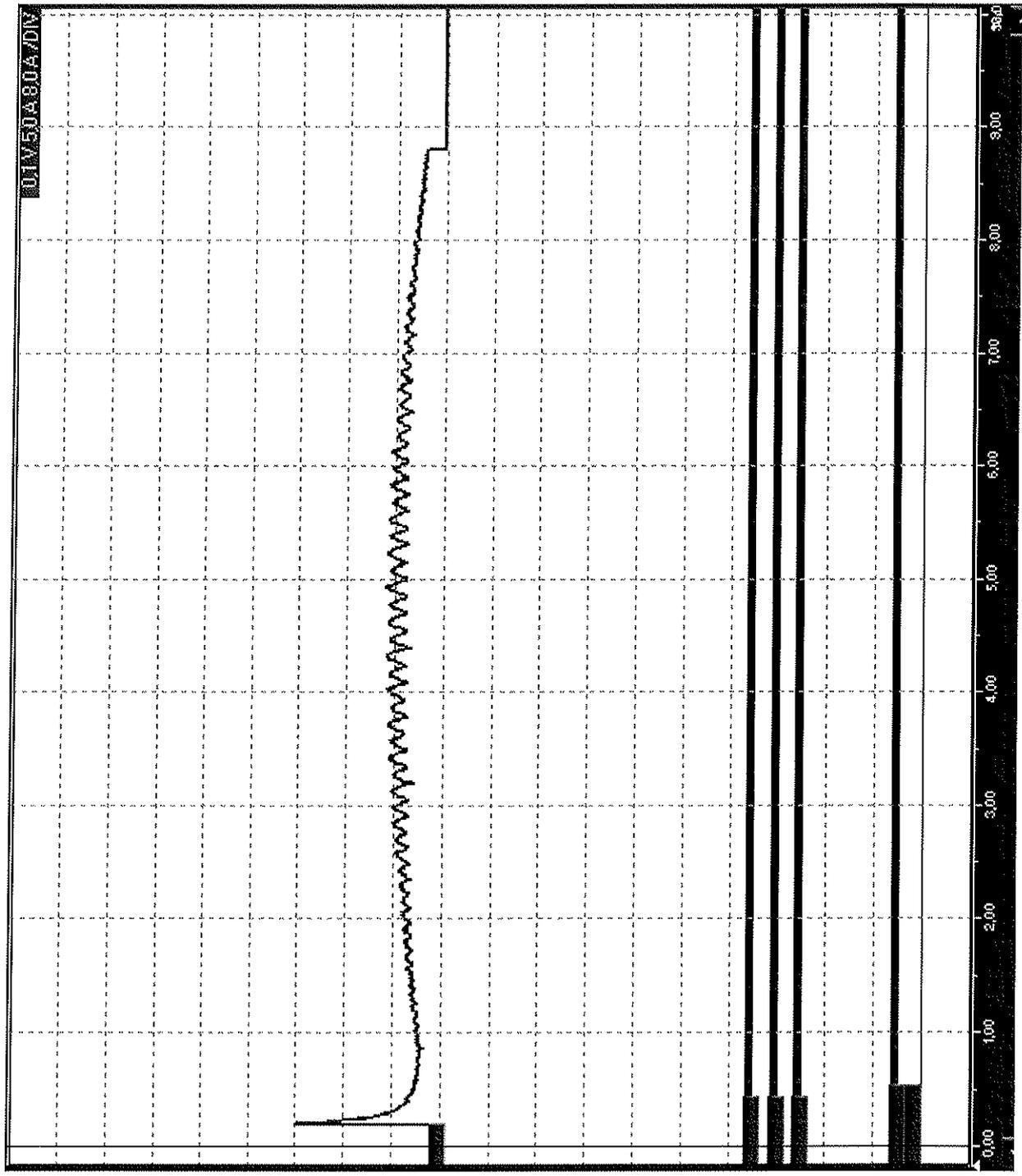
CESI B2005352 - Oscillogram 5B



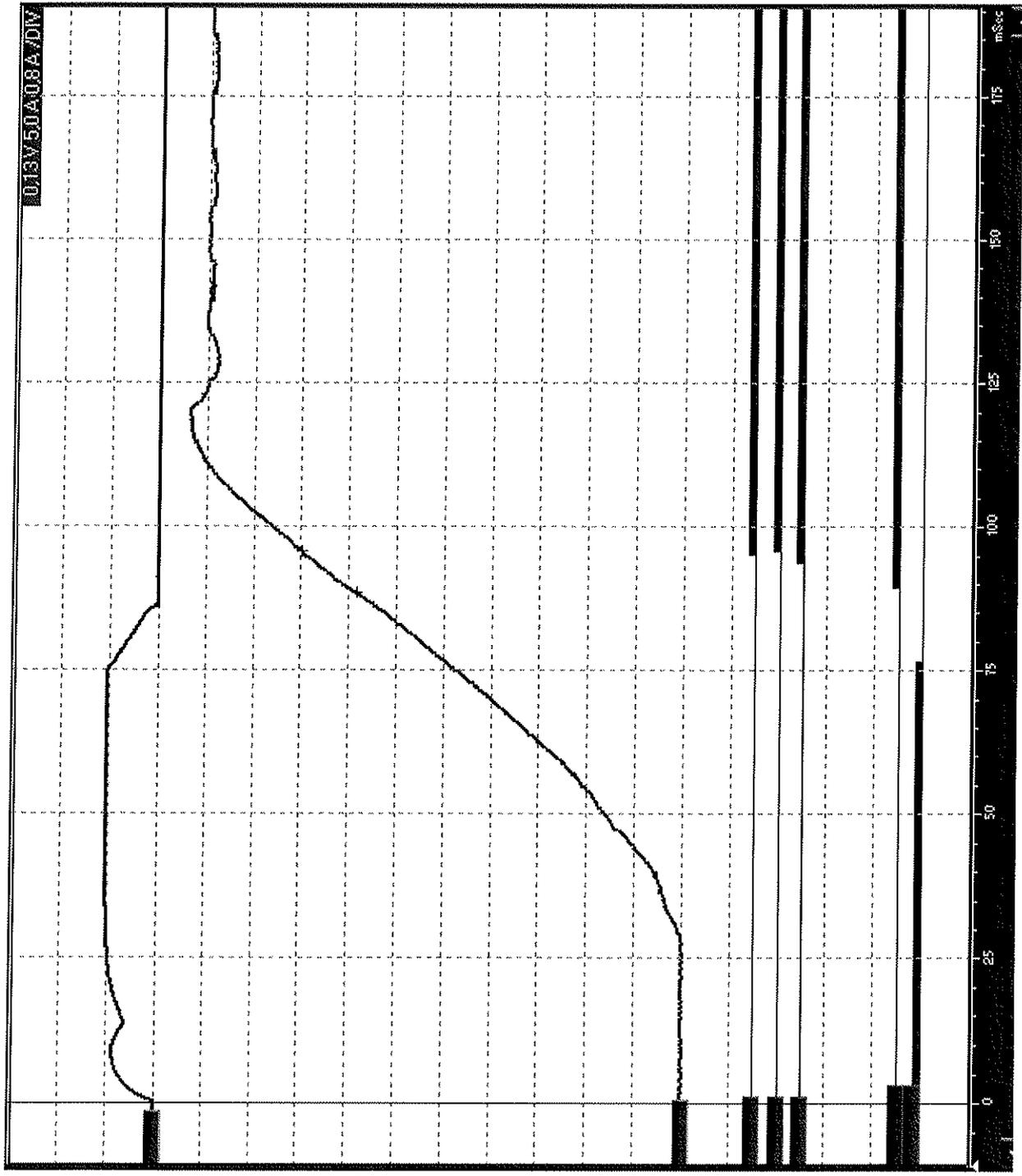
CESI B2005352 - Oscillogram 6



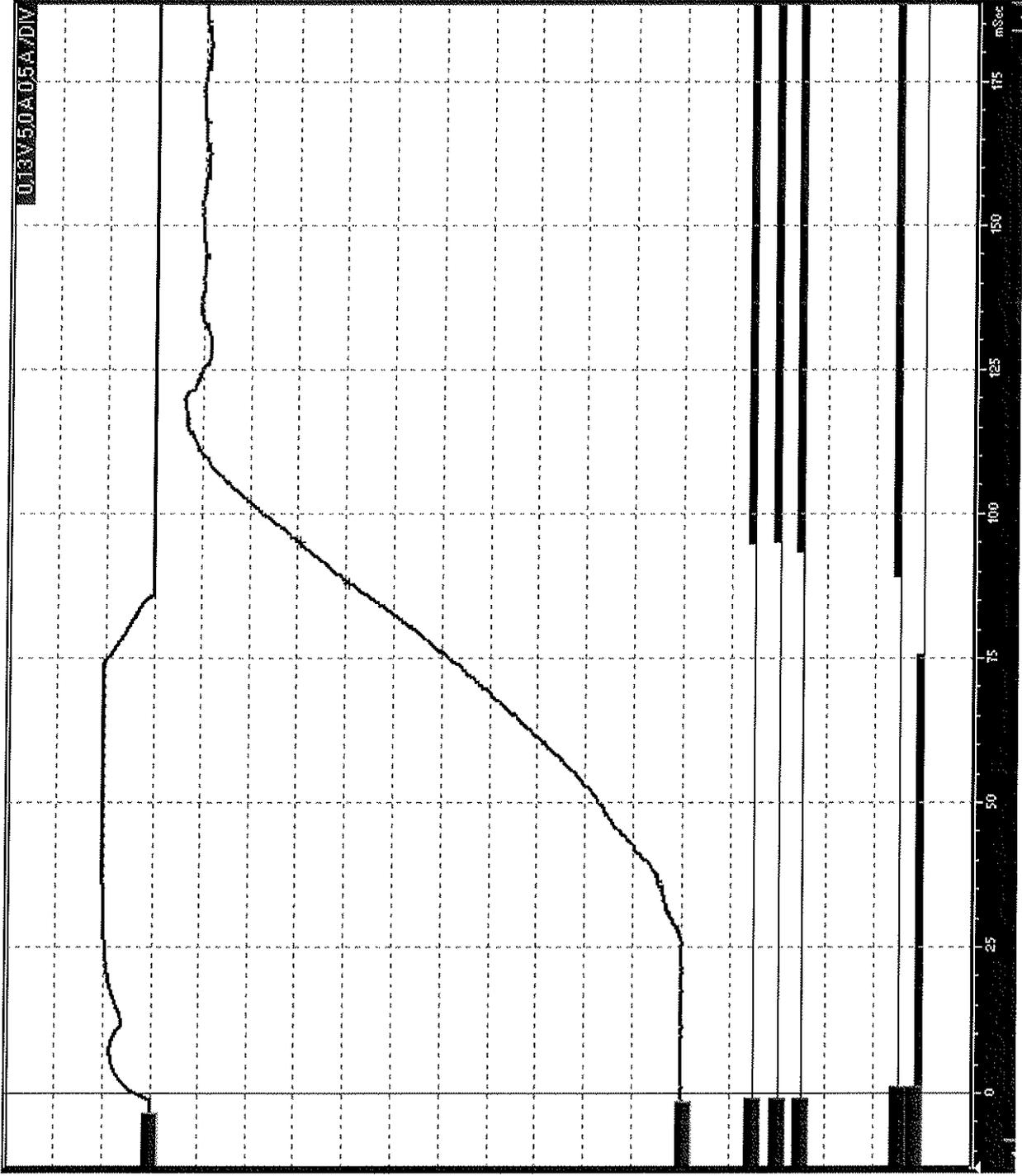
CESI B2005352 - Oscillogram 7



CESI B2005352 - Oscillogram 8A



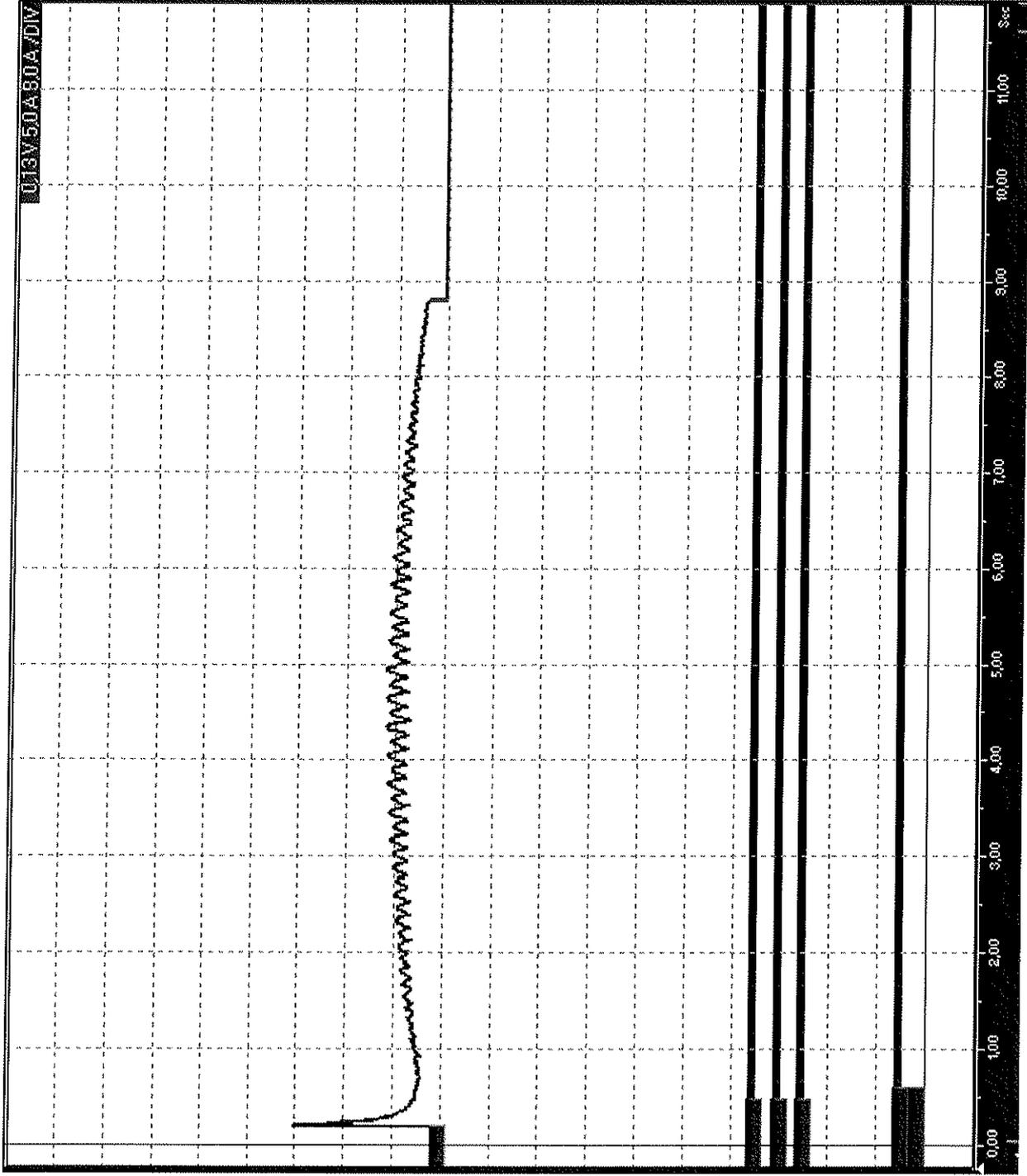
CESI B2005352 - Oscillogram 8B



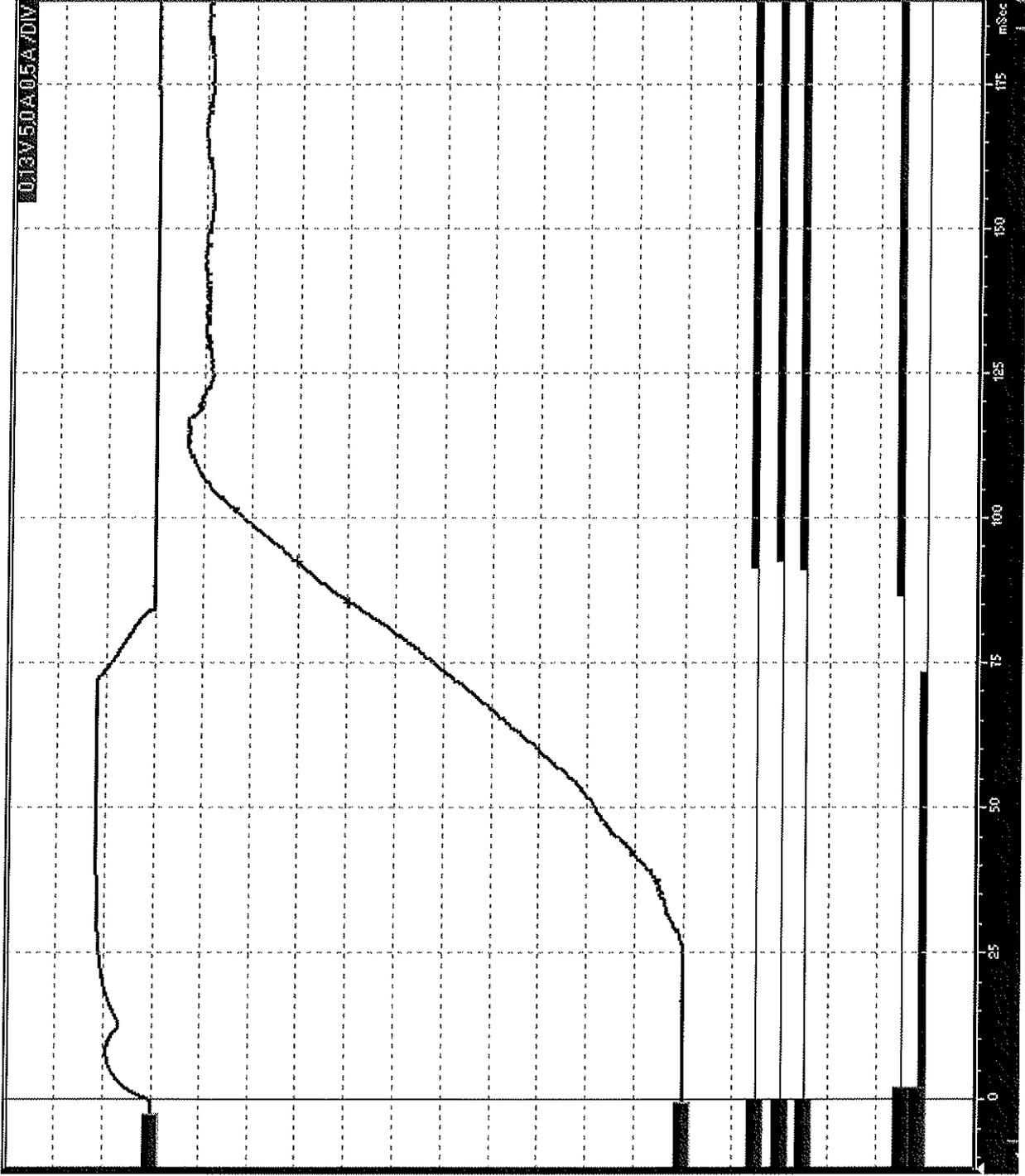
CESI B2005352 - Oscillogram 9



CESI B2005352 - Oscillogram 10



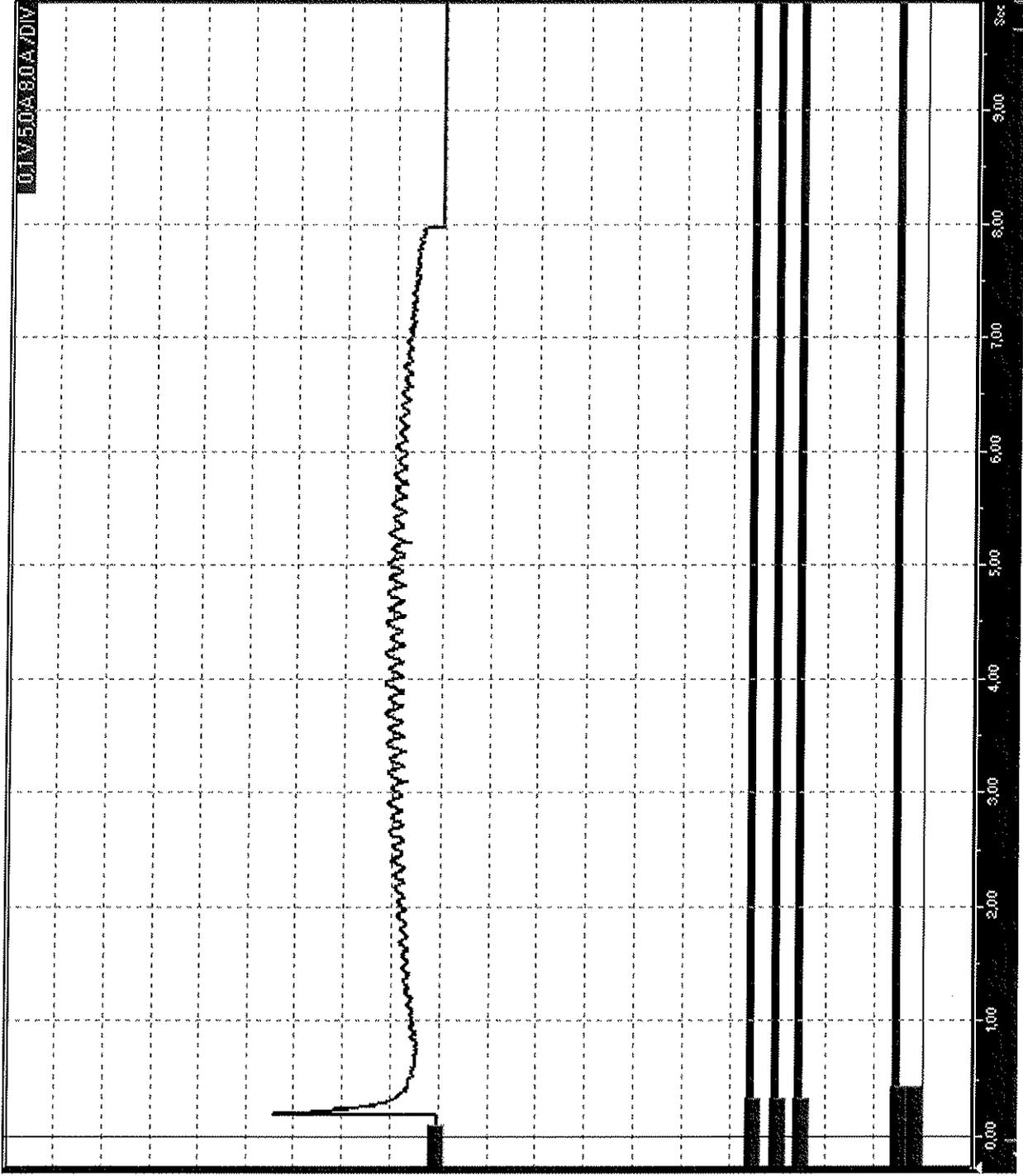
CESI B2005352 - Oscillogram 11A



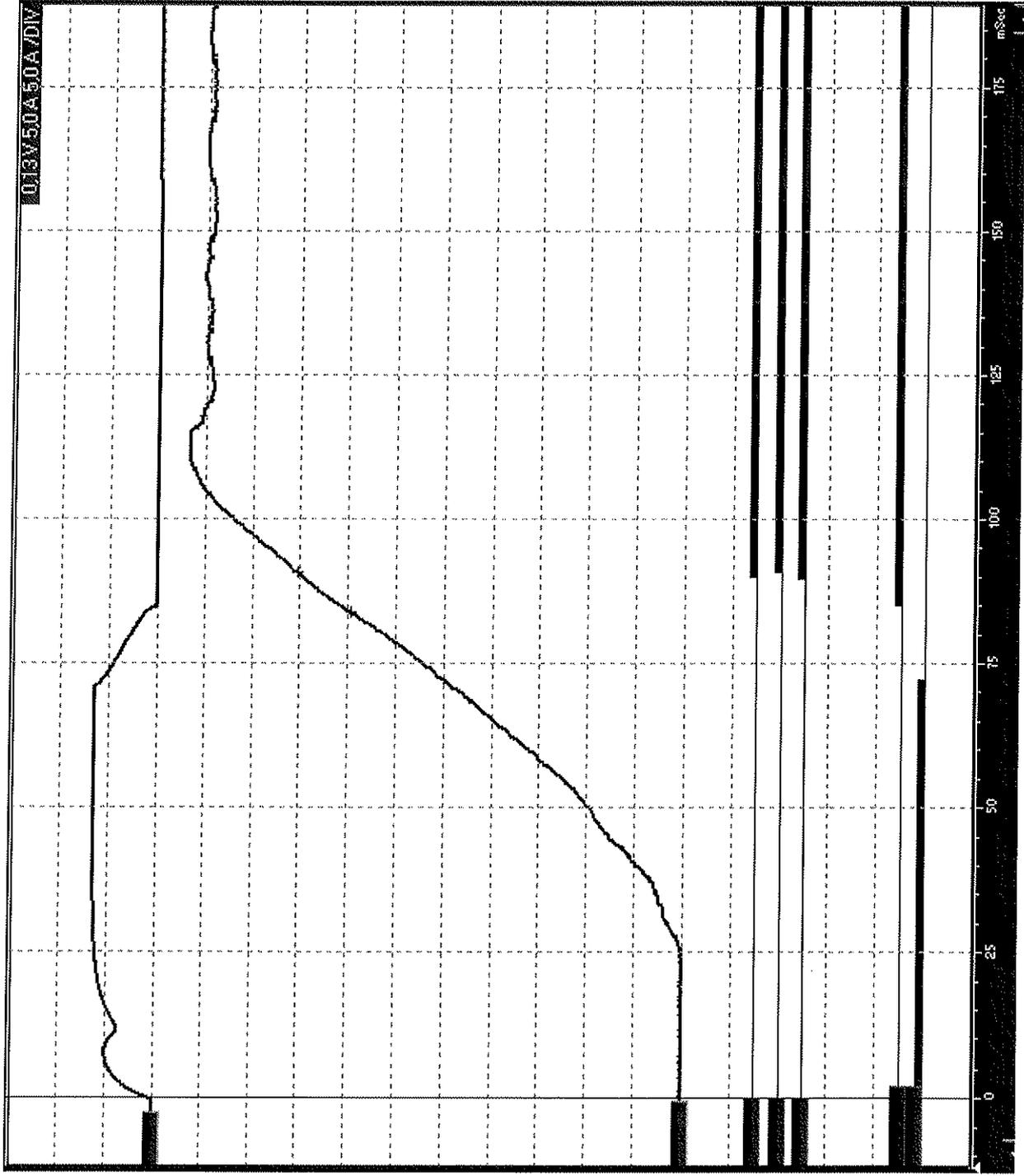
CESI B2005352 - Oscillogram 11B



CESI B2005352 - Oscillogram 12



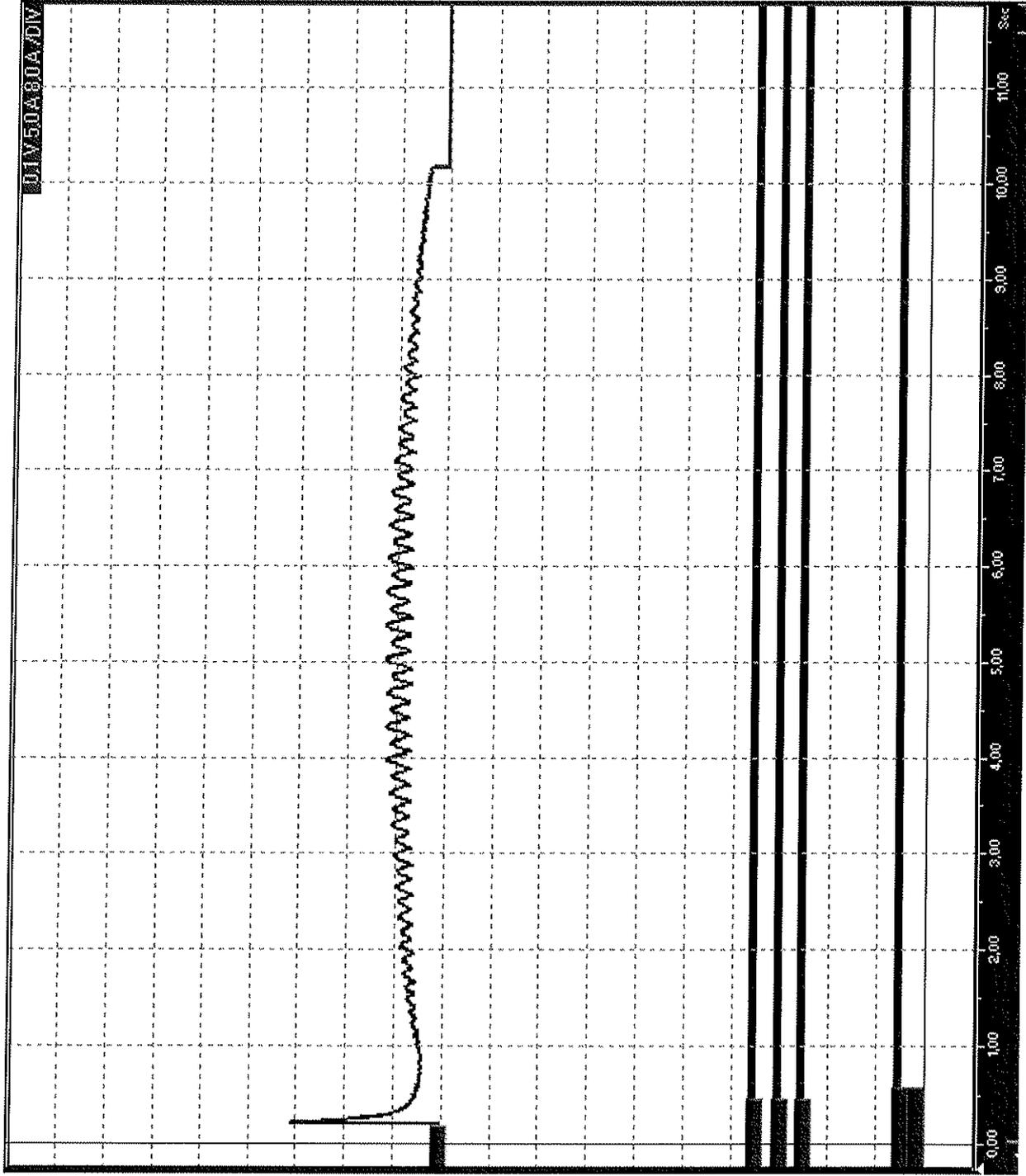
CESI B2005352 - Oscillogram 13A



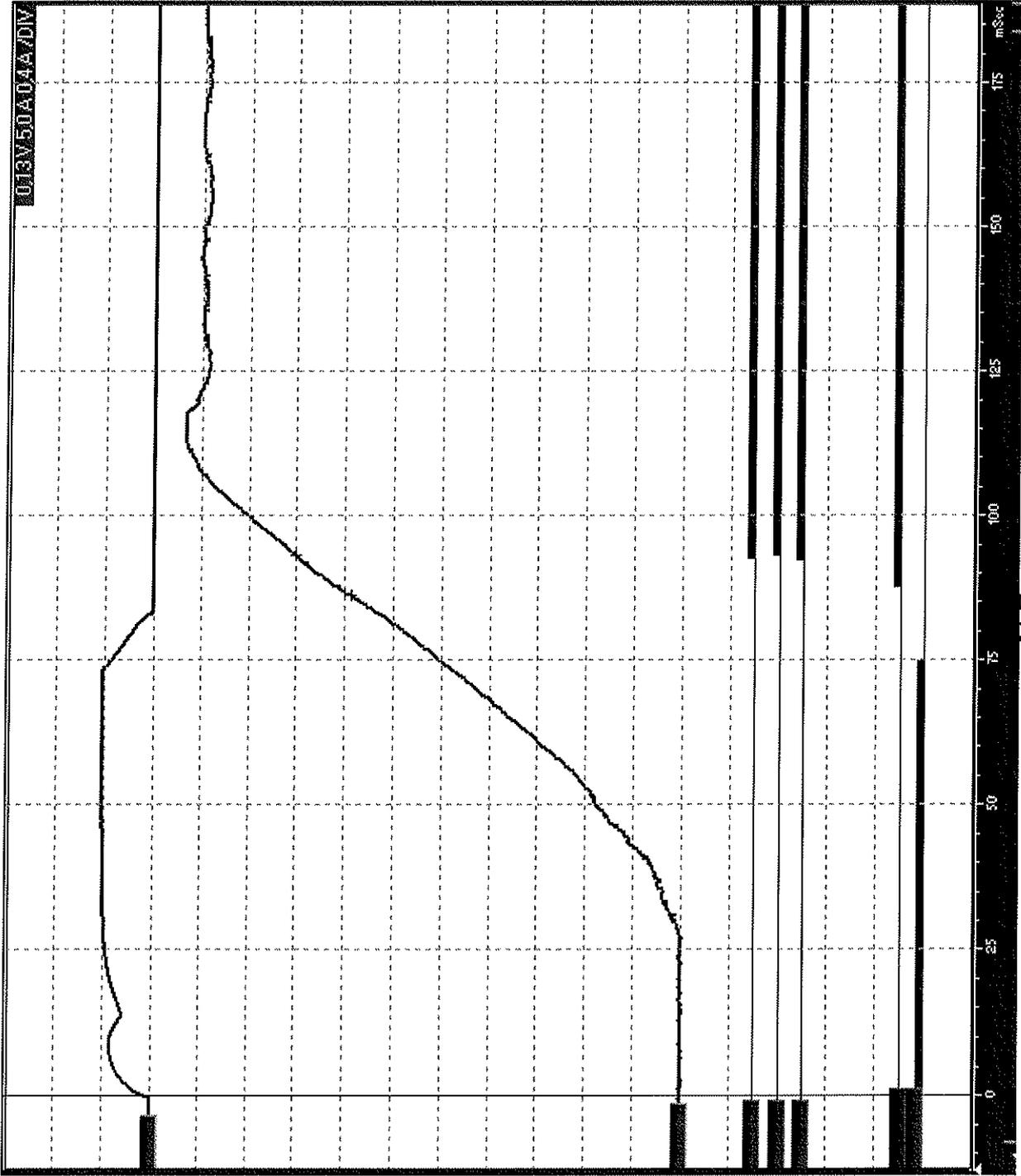
CESI B2005352 - Oscillogram 13B



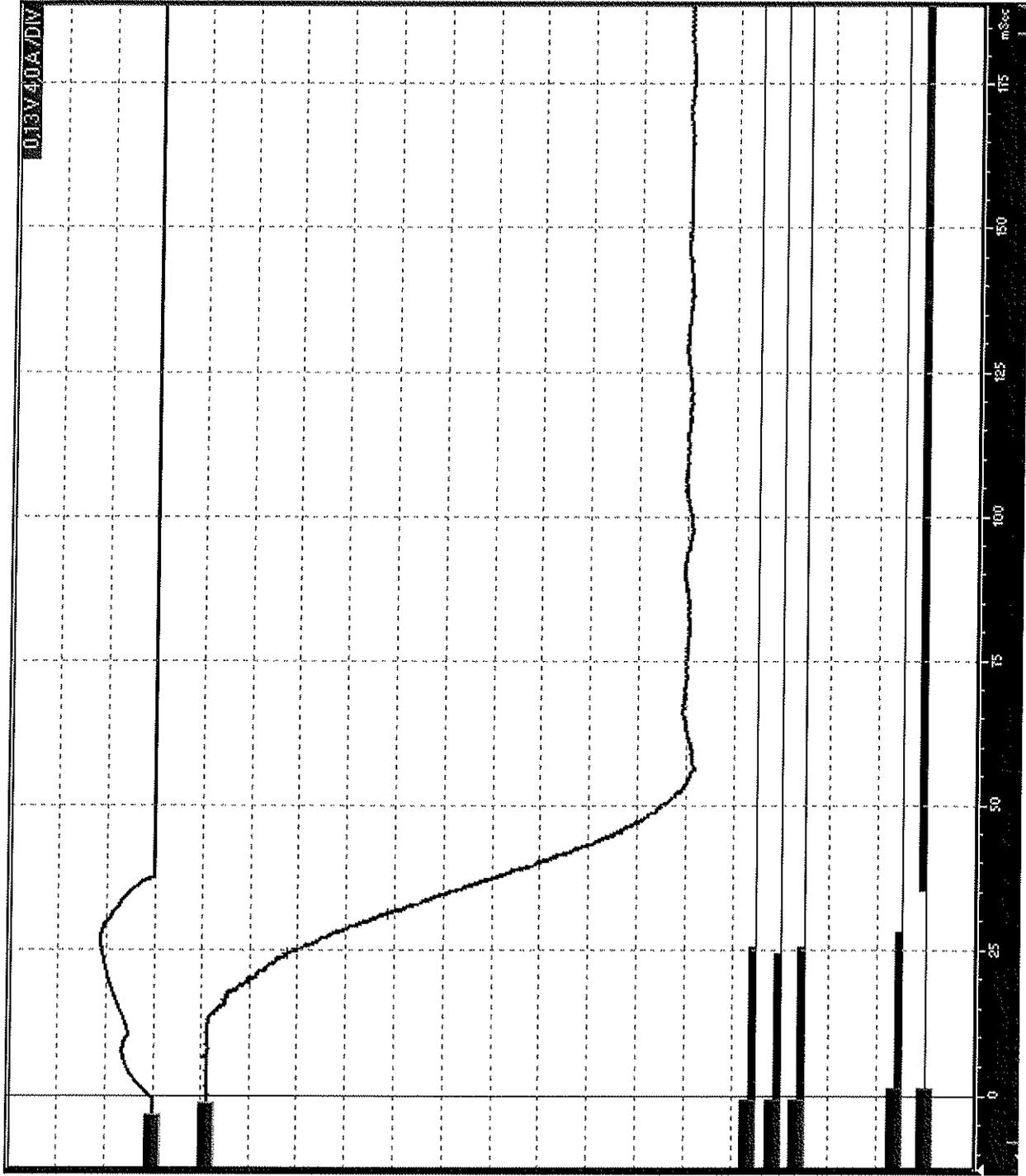
CESI B2005352 - Oscillogram 14



CESI B2005352 - Oscillogram 15A



15B
CESI B2005352 - Oscilloscope 15B



CESI B2005352 - Oscillogram 16