DIRECTION
DES ÉTUDES ET RECHERCHES
LES LABORATOIRES DE GÉNIE ÉLECTRIQUE
LES RENARDIÈRES

EDF
Electricité de France

cofrac
ACCREDITATION
N° 1-0120
PORTÉE
COMMUNIQUÉE
SUR DEMANDE
ESSAIS

TEST REPORT HM22/ 21-901/2

Equipment : Capacitor Voltage Transformer CCV 245

Désignation : rated primary voltage 220 / √3 kV
rated frequency 50 Hz

Manufacturer : ALSTOM BALTEAU

Purpose of the tests : Type test

Applicant for the tests : EDF / CNIR / DMHT

Date(s) and place of the tests : From March 17th to April 30th, 1999, 420 kV, 100 kV testing areas.
Les Renardières - LGE
High Voltage Testing Station.

The tests were carried out according to : CSCT ME 83 J (Dec./87)

The performance of the equipment tested and the results obtained are recorded in the enclosed tables of results, oscillograms and photographs.

The report comprises the following documents:

Characteristics of the equipment	page : 3	List of tests performed	page : 4
Test conditions	pages : 5 à 29	Tables of test results	pages : 5 à 29
Photograph	page : 31	Oscillograms	n° : 1 to 50, appendix 2

The report includes 29 pages & 2 appendixes

Reproduction of this test report is authorized only in the form of a complete photographic facsimile with the written authorization of laboratory and the applicant.

Executive responsible for the tests

S. SURIER

Laboratory Manager
High Voltage Testing Station

Philippe MONPERT

Les Renardières, the 23/7/99

Indice E RAP.dot 020197

REFERENCE DOCUMENTS

Identification file of apparatus

Reference: n° 83545556 dated on 15/1/99

Standard documents

CSCT ME 83 J (Dec./87)

Test request

Type test demand : letter from EDF Production & Transport ref. D5730-MH1198/FL98469 dated on December 17,98.
Test proposition : Fax from EDF/LGE ref. M22/JDF/17/12/98 (17 : 44) dated on December 17,98.
Alstom order R2F.R09393G dated on March 8,99.

Test program

Dated on March 9,1999, reference : HM 22 / 21- 901 / 2

EXTERNAL CONTACTS WITH THE LABORATORY

Responsible for co-ordination of tests for the applicant : M.LEMAITRE (CNIR-DMHT)

Present for the tests :

- Applicant's representatives :

- Other person present :

LABORATORY STAFFS

Tests responsible : S. SURIER

Technicians for tests : JR BOUSQUET

Name and adress of engineer responsible for co-ordination of tests :

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DIFFUSION

Original : Chef Adjoint du LGE puis Responsable d'Essais
(1) Chef de Service Adjoint puis archives LGE
(2) Demandeur : M.LEMAITRE (CNIR-DMHT)
(2) Chargé d'Affaires
(2) Constructeur : M. DESPINEY
(1) Ingénieur produit: C. MOREAU (LGE)

1. APPARATUS CHARACTERISTICS

- Name	: Capacitor Voltage Transformer	
- Type	: CCV 245	
- Serial number	: 98-XE 71100-01/001	
- Construction year	:1998	
- Terminals	: P1-P2	S1-S2
- Rated primary voltage	: 220 / √3 kV	100 /√3 V
- Power and accuracy class	: 80 VA - Cl. 0.5 & 160 VA - cl 3P	
- Temperature-rise burden	: 1200 VA	
- Rated voltage factor	: 1.9 Un - 2 h	
- Insulation level	: 245 / 460 / 1050 kV	
- Rated capacitance	: 4000 pF	
- Intermediate voltage	: 20kV	
- Standard documents	: CSCT ME 83 J	
- Rated frequency	: 50 Hz	
- Weight	: 500 Kg	
- Manufacturer	: ALSTOM BALTEAU - Montrouge	

2. APPARATUS IDENTIFICATION

- A visual identification was made (see page 29).
- Verification of principal sizes mentionned on drawing referenced : 8162847 given in appendix 1 (see page 32).

The measured values different than those given by the manufacturer are mentionned on the drawing.

CHRONOLOGICAL LIST OF TESTS PERFORMED

REFERENCES	TYPE OF TESTS	DATE AND PLACE OF TESTS (1)	PAGE n°	OBSERVATIONS
NFC 42 501 § 49, 57 & Ann. XI § 1-2-10	ferro-resonance test	420 kV testing area 17/03/99	5 à 8	With electromagnetic unit
NFC 42 501 § 56 Ann. XI § 3.1.1 NFC 54 110 § 9.2.5	Lightning impulse test of voltage capacitor divider	420 kV testing area 18/03/99	9	Without electromagnetic unit
NFC 54 110 § 9.2.2 & NFC 42-501 § 61	Wet power frequency withstand test of voltage capacitor divider	420 kV testing area 19/03/99	10, 11	Without electromagnetic unit
NFC 54 110 § 9.2.1 & NFC 42-501 § 61.1	Dry power frequency withstand test of voltage capacitor divider	420 kV testing area 23/03/99	12	Without electromagnetic unit
CEI 44-4 Ann. XI § 1-2-18	Partial discharge measurement	420 kV testing area 23/03/99	12; 13	Without electromagnetic unit
NFC 42 501 § 56 et 19	Lightning impulse test of electromagnetic unit	100 kV testing area 06/04/99	14; 15	electromagnetic unit only
NFC 42 501 § 61	Dry power frequency withstand test of electromagnetic unit	100 kV testing area 06/04/99	16	electromagnetic unit only
Ann. XI § 1-2-25	Interference overvoltage transmission control	100 kV testing area 08/04/99	17	With
NFC 54 110 § 12.1 & Ann. XI § 1-2-27	High frequency capacitance and equivalent series resistance (ambient temperature, -25°C & +40°C)	Tdm testing area 09 et 10/04/99	18	With
Ann. XI § 1-2-28	Measurement of input impedance	Tdm testing area 15/04/99	19	With
Ann. XI § 1-2-29	Measurement of composite attenuation	Tdm testing area 15/04/99	20	With
CSCT ME 83 § 3.2 NFC 54 110 § 7 & 8	Measurement of capacitance and dielectric dissipation factor (ambient temperature)	Tdm testing area 19/04/99	21	Without electromagnetic unit
Ann. XI § 1-2-32 A	Measurement of dielectric dissipation factor at -25, +20°C & +50°C.	Tdm testing area 20 au 22/04/99	22	Without electromagnetic unit
Ann. XI § 1-2-34 & 35 NFC 42 501 § 27, 33, 48	Test for accuracy	Tdm testing area 27/04/99	23 à 26	With
NFC 42 501 § 59	secondary wave shape	Tdm testing area 28/04/99	27	With
Ann. XI § 3.1.9	Measurement of impedance viewed from secondary windings	Tdm testing area 29/04/99	28	With
NFC 42 501 § 22; 23	terminal markings	Tdm testing area 30/04/99	29	With

measurement accuracy :

Except where otherwise stated, the measurements are guaranteed with widened accuracy (k=2) to ± 5 %.

For dielectric tests

widened accuracy (k=2) on peak values measurement of lightning impulses is estimated to ± 3 %.
widened accuracy (k=2) on 50 Hz Rms voltages is estimated to ± 2 %.

For climatic tests

widened accuracy (k=2) on ambient temperature measurement for climatic tests is estimated to ± 2 °C.
(1) Tdm testing area : Measurement Transformers testing area

FERRO-RESONANCE TEST
(NFC 42 501 § 57 & CSCT ME 83 appendix 11 § 1-2-10)

1 - Test conditions

The test is performed on whole transformer. It is made by short-circuiting the secondary terminals for at least 0.1 s the short-circuit being opened by a protective device (silver fuse calibrated 10 A).

At 1,2 U1n **(152 kV),** the thirty tests are realized continually without break.

At 1,9 U1n **(241 kV),** the ten tests are realized in groups of two consecutivly tests separated by 10 minutes of rest time.

The secondary terminals short-circuiting is made with a making switch , switched off on the period 2 ms by 2 ms.

If a moment seems to be favourable for appearance of ferro-resonance, the other tests are realized in this area.

2 - Measurement

During the short-circuit, the voltage of the power source mustn't differ by more than 10% from the voltage before short-circuit and must remain substantially sinusoïdal.

After sudden suppression of short-circuit, we check that :

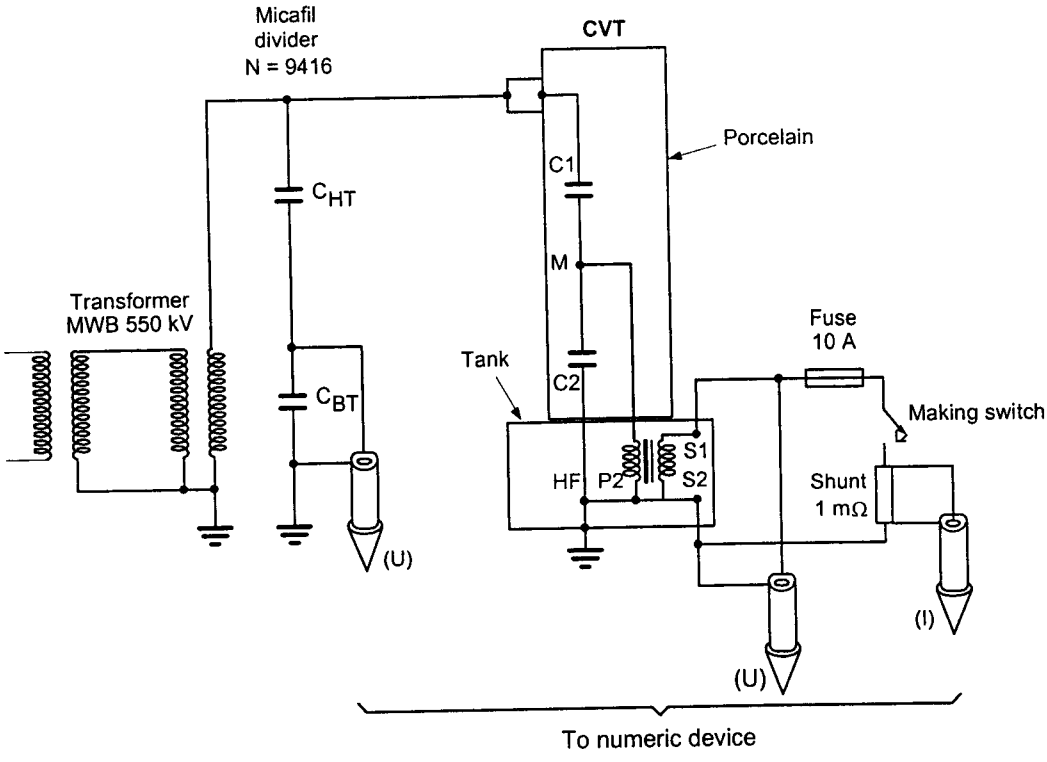
- at 1,2 U1n the secondary peak voltage comes back, after the tenth cycle of rated frequency, to a value which doesn't differ by more than 10% from its normal value.

- at 1,9 U1n the ferro-resonance doesn't maintain more than 2 s.

- With (U1n = 220 / √3 kV)

FERRO-RESONANCE TEST
(NFC 42 501 § 57 & CSCT ME 83 appendix 11 § 1-2-10)

3 - Test circuit diagram



Other information about connections between the making switch and the apparatus:

- Total tength of the loop : 3,10 meters.
- Wire section : 35 mm^2 copper braid

4- Result

The tables of tests results are given in pages : 7, 8.

The oscillograms are given in appendix 2

FERRO-RESONANCE TEST (1.2 U_{1n})
(NFC 42 501 § 57 & CSCT ME 83 appendix 11 § 1-2-10)

Result

Time	U(S1-S2) (just after Short-circuit) (Peak volts)	I(S1-S2) (During Short-circuit) (Peak Ampere)	Test voltage (k.Volt Rms)	Short-circuit position on the period * (ms)	Ferro-resonance duration (ms)	Oscillograms (see Appendix 2)
16:59	130	97,5		0+	105	1
08:59	144	98		19,7	125	2
09:04	146	103		0+	125	3
09:07	148	104		0.6	125	4
09:12	154	106		1,3	103	5
09:15	153	107		3,8	121	6
09:19	168	107		4,7	121	7
09:21	157	103		M+	107	8
09:24	145	99		6,5	112	9
09:26	153	102		7,8	118	10
09:28	149	103		8,5	115	11
09:31	140	104		9,6	114	12
09:33	150	103		10,5	114	13
09:35	155	102		12	112	14
09:37	141	106		13	112	15
09:41	156	107	152	13,7	112	16
09:44	161	107		14,2	112	17
09:46	185	110		M-	110	18
09:49	172	80		16,8	88	19
09:51	178	102		17,2	127	20
09:57	166	108		4,1	111	21
10:01	183	108		4,9	110	22
10:10	144	103		O+	130	23
10:16	140	105		1,1	105	24
10:33	157	99		1,4	105	25
10:39	148	100		19,7	110	26
10:45	149	99		O+	110	27
16:16	155	100		O+	104	28
16:19	150	100		1	125	29
16:23	158	101		1,5	103	30

* With regard to O^+

FERRO-RESONANCE TEST (1.9 U_{1n})
(NFC 42 501 § 57 & CSCT ME 83 appendix 11 § 1-2-10)

Result

Time	U(S1-S2) (just after Short-circuit) (Peak volts)	I(S1-S2) (During Short-circuit) (Peak Ampere)	Test voltage (k.Volt Rms)	Short-circuit position on the period * (ms)	Ferro-resonance duration (ms)	Oscillograms (see Appendix 2)
16:31	221	131		O+	84	31
16:43	240	130		1,5	113	32
16:46	276	123		3,5	91	33
16:57	254	120		4,3	72	34
17:05	208	131	241	6,5	99	35
17:11	230	130		9,4	96	36
17:14	225	131		10,7	95	37
17:23	255	128		13,9	91	38
17:28	208	121		15,2	100	39
17:37	206	130		17,3	77	40

* With regard to O^+

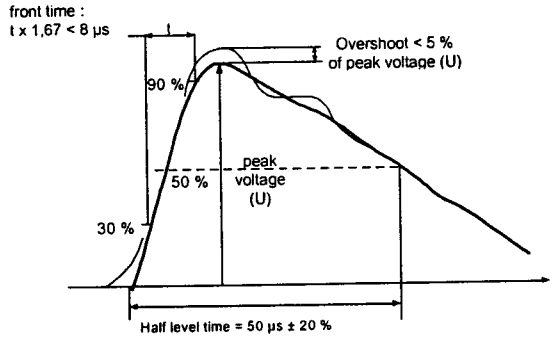
LIGHTNING IMPULSE TEST OF VOLTAGE CAPACITOR DIVIDER
(CSCT ME 83 J § 3.1.1, NFC 42 501 § 56 & NFC 54 110 § 9.2.5)

1 - Test conditions

The apparatus under test is installed on a 2 meters high frame . A full oil tank is placed instead the electromagnetic unit tank.
The tank and HF terminal are earthed together.

The impulses are applied between P1 terminal and the earth.
Test voltage : **1050 kV ± 3%** (CVT 245 kV)

Tolerance on the full waveform (according to IEC 60-1, 2nd édition Nov. 1989 & CFN 54-110 June 1992 § 9.2.5) :

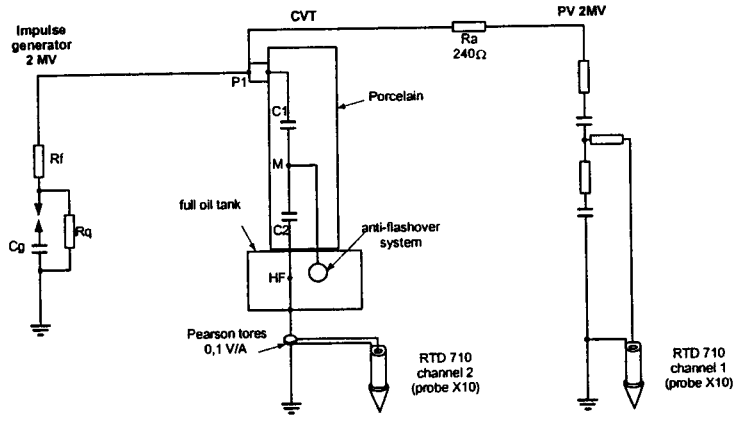


2 - Test procedure

1°/ One 80 % full impulse.

2°/ Fifteen 100% full impulses in each polarity. see oscillograms n°41à 44 (appendix 2)

3 - Test circuit diagram



4 - Specification

No more than 2 flashovers per polarity and no internal perforation are allowed.

5 - Result

No waveform variation was noticed between first and last recording.
No internal or external flashover happened during the test.

WET POWER FREQUENCY WITHSTAND TEST OF VOLTAGE CAPACITOR DIVIDER (CSCT ME 83 J § 3.1.1, NFC 54 110 § 9.2.2 & NFC 42-501 § 61)

1 - Test conditions.

The apparatus under tests is installed on a 2 meters high frame. A full oil tank is placed instead the electromagnetic unit tank.

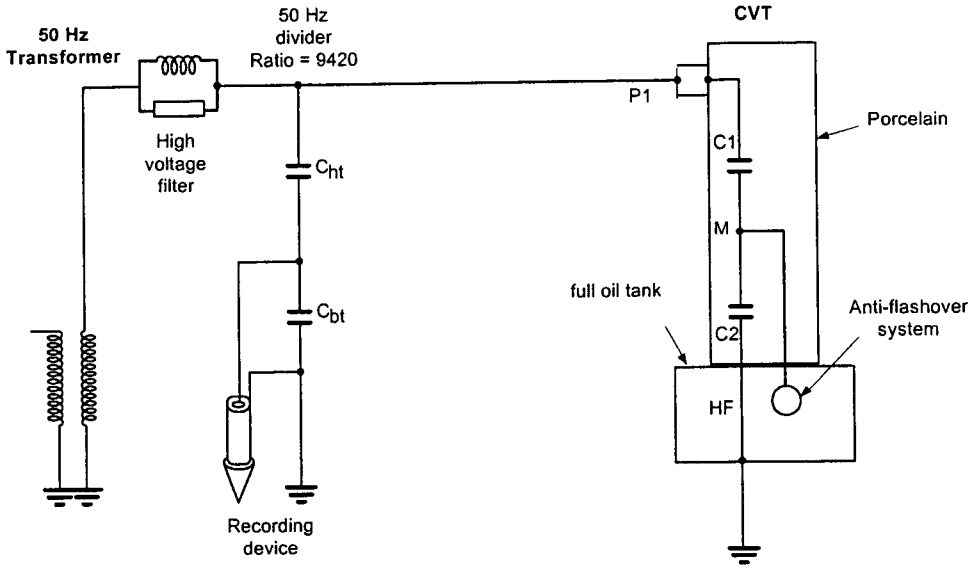
2 - Test procedure

2.1 - Rain conditions (see next page)

2.2 - A power frequency test voltage of **460 kV** (CVT 245 kV) is applied during **1 minute** between P1 terminal and the earth. The tank and HF terminal are earthed together.

Applied voltage is recorded during the whole test.

3 - Test circuit diagram



4 - Result

No disruptive discharge was detected during this test .

WET POWER FREQUENCY WITHSTAND TEST OF VOLTAGE CAPACITOR DIVIDER (CSCT ME 83 J § 3.1.1, NFC 54 110 § 9.2.2 & NFC 42-501 § 61)

The tests were performed according to IEC publication 60.1, article 9.1.

Measurements consisted of vertical movements (max. length : 1m) on the apparatus under test.

Ambient temperature :21°C

Rain conditions :

PARAMETERS NOTE	MEASURED VALUES		SPECIFIED VALUES
	high part	Low part	
Average precipitation rate (mm/mn)			
- Horizontal components	1,2	1,4	1,0 à 2
- Verticale components	1,1	1,6	1,0 à 2
Limit values (mm/mn) for any individual measurement			
- Horizontal component	0,2		± 0,5 from average
- Verticale component	0,5		± 0,5 from average
Temperature of water (°C)	17		Ambient temperature ± 15
Resistivity of water at 20°C	104 µS / cm		100 ± 15 (Ω.m) or 100 $^{+18}_{-13}$ (µS / cm)

DRY POWER FREQUENCY WITHSTAND TEST OF VOLTAGE CAPACITOR DIVIDER (CSCT ME 83 J § 3.1.1, NFC 54 110 § 9.2.1 & NFC 42-501 § 61.1)

1 - Test conditions.

This test is combined with partial discharge measurement discribed on next page.

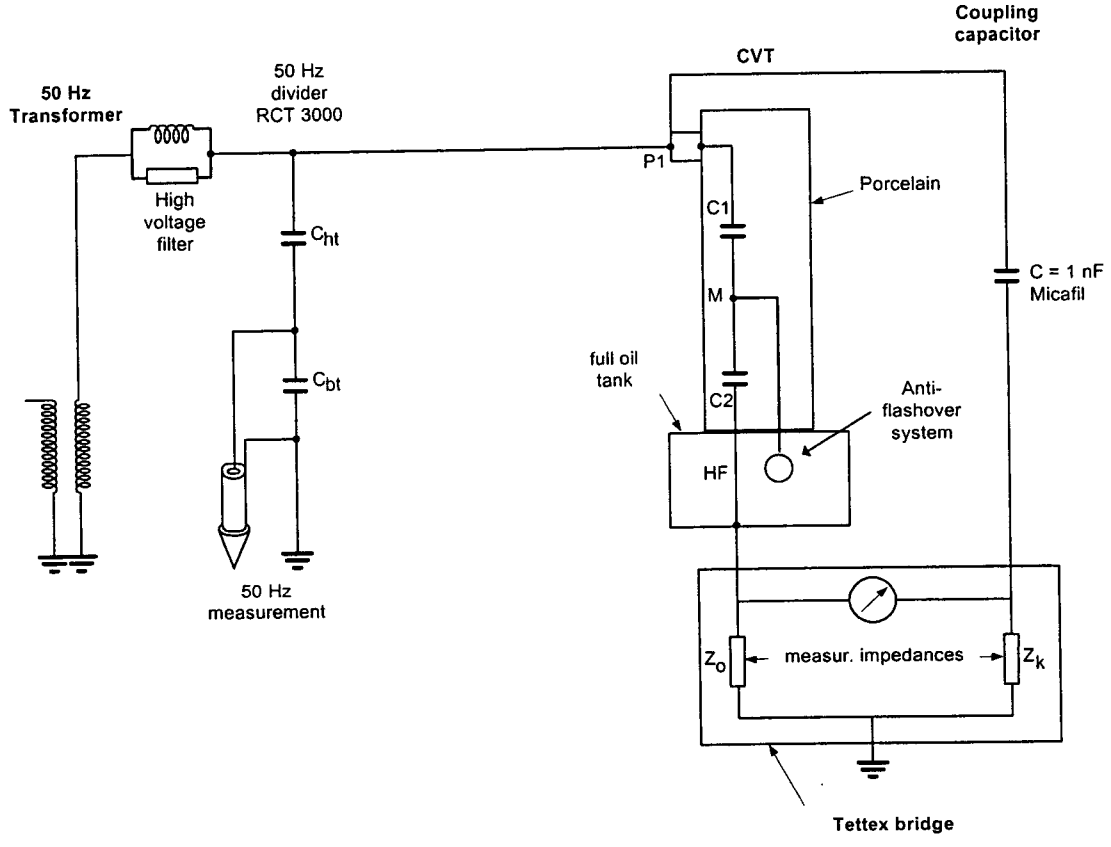
The apparatus under test is installed on a 2 meters high frame. A full oil tank is placed instead the electromagnetic unit tank.

2 - Test procedure

A power frequency test voltage of **460 kV** (CVT 245 kV) is applied during **1 minute** between P1 terminal and the earth. The low voltage terminal (HF) and the tank are earthed together through the partial discharge Tettex bridge.

The applied voltage is recorded during the whole test.

3 - Test circuit diagram



4 - Result

No disruptive discharge was detected during this test .

PARTIAL DISCHARGE MEASUREMENT
(IEC 44-4 & CSCT ME 83 J appendix 2 § 1.2.18)

1 - Test conditions

This test carries out after power frequency withstand test of voltage capacitor divider (see previous page).

The measurement carries out a bridge method, using a wide band amplifier.

2 - Test circuit diagram

(see previous page)

3 - Test procedure

3-1 Balancing of the bridge

A calibration signal of 1000 pC is applied between the earth and the high voltage terminal. Bridge elements are adjusted so as to get a maximum rejection level of this common mode signal.

The corresponding rejection level is measured by short-circuiting successively measure impedances of each bridge branch.

- Short-circuited object branch: τ = 100/900
- Short-circuited CK branch: τ = 100/600

3-2 Calibration of the system

A calibration signal of 10 pC with a 100 Hz repeating frequency, is applied to the apparatus under test terminals.

Measurer gain is adjusted so as to get a direct reading of DP peak level.

3-3 Background noise measurement

Power transformer connected with voltage at 0 kV level, we read the background noise (see table, column n° 3).

3-4 Partial discharges measurement of the apparatus under test

Um = 245 kV

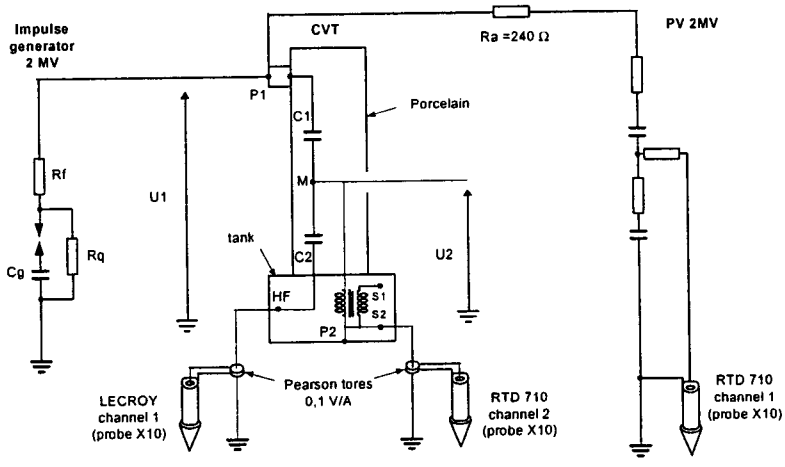
After 50 Hz dielectric test at Ue (**460 kV**) during 60 s, we respectively measure at following voltage levels 1,2 Um (**294 kV**), 0.7Um (**171.5 kV**) and 1,2 Um/√ 3 (**170 kV**), the corresponding partial discharges level.

4 - Result

	voltage (kV rms)	0 Um (Background noise)	Ue	1.2 Um	0.7 Um	1.2 Um/v3
Level applied with calibrator (pC)	discharge level (pC)	1	6	4	1	1
10	accuracy (+/-pC)	<0.53	0.61	0.53	<0.53	<0.53
Specification			not specified	≤ 10 pC	≤ 10 pC	≤ 10 pC

LIGHTNING IMPULSE TEST OF ELECTROMAGNETIC UNIT (NFC 42 501 § 56 et 19)

1 - Determination at low voltage (about 100 kV) of ratio U1 / U2 (ratio k).



Note : at 50 Hz, U1 = 220 kV / √3, U2 = 20 kV / √3

2 - Test procedure (1 st part) see oscillograms n° 45

Determination at low voltage (about 100 kV) of ratio U1 / U2, see circuit diagram above. The voltage capacitor divider is lightly removed (≈ 1 cm) from the tank in order to slide a 20 kV withstand wire which allows to measure the voltage at the intermediary point (M).

The measured ratio K is = 10,94

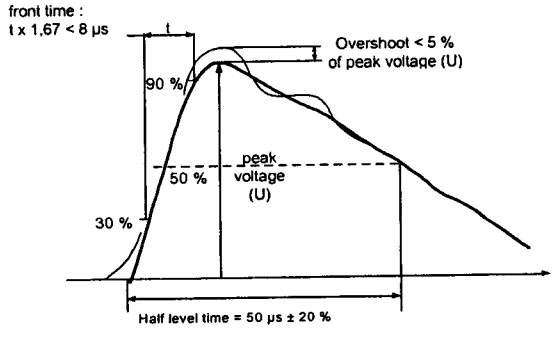
3 - Test procedure (2nd part)

Tests realized only on electromagnetic unit.
P2 terminal and the tank are earthed together.

The impulse voltage is determinated by dividing the impulse withstand voltage value (**1050 kV**, CVT 245 kV) of high voltage terminal by the ratio K of impulse voltage determinated previously at low voltage (value determinated in the first part)
If the ratio of impulse voltage is notably less than 50 Hz voltage ratio, it is necessary to make lightning impulse test of voltage of intermediate capacitor divider which must be tested at the same lightning voltage as electromagnetic unit.

Test voltage : **1050 / 10,94 = 96 kV** (CVT 245 kV)

Tolerance on the full waveform (according to IEC 60-1, 2nd édition Nov. 1989 & CFN 54-110 June 1992 § 9.2.5) :



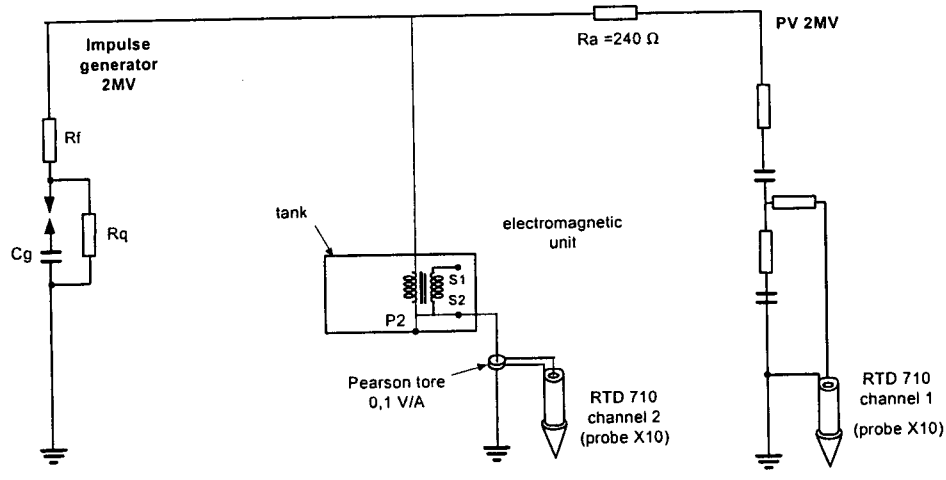
LIGHTNING IMPULSE TEST OF ELECTROMAGNETIC UNIT (NFC 42 501 § 56 et 19)

4- Test procedure

1°/ One 50 % full impulse. see oscillograms n°46 à 48 (appendix 2).

2°/ Five 100% full impulses in each polarities. see oscillograms n°47 à 49 (appendix 2).

5 - Test circuit diagram



6 - Result

No waveform variation was noticed between first and last recording.
No internal or external flashover happened during the test.

DRY POWER FREQUENCY WITHSTAND TEST OF ELECTROMAGNETIC UNIT (NFC 42 501 § 61)

1 - Test conditions

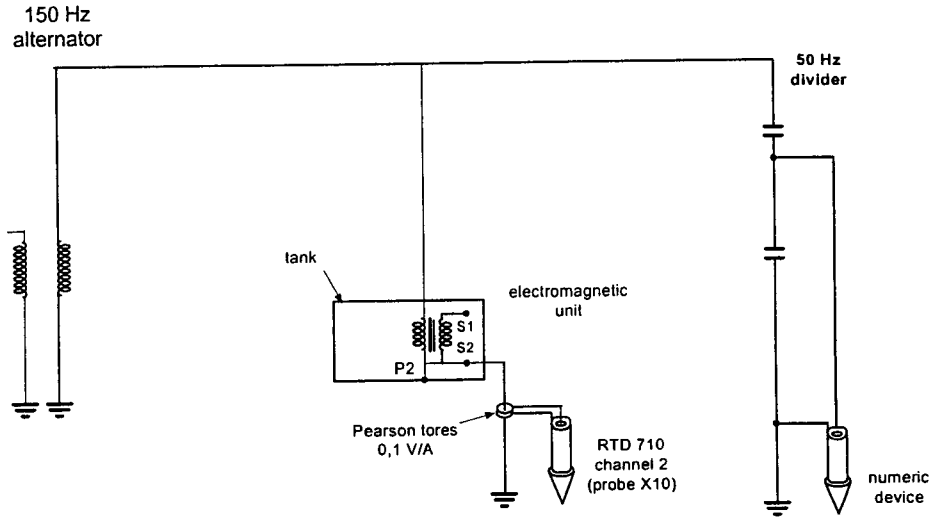
Tests realized only on electromagnetic unit.
P2 terminal and the tank are earthed together.

A **150 Hz** rms voltage equal to the ratio of complet CVT test voltage value (**460 kV** CVT 245 kV) by the divider ratio : **42 kV** is applied during 40 seconds between P1 terminal and earth.

The damping circuit and external spark gap are disconnected.

Applied voltage is recorded during the whole test.

2 - Test circuit diagram



3 - Result

No disruptive discharge was detected during this test .

INTERFERENCE OVERVOLTAGE TRANSMISSION CONTROL (CSCT ME 83 J appendix 11 § 1-2-25)

1 - Test conditions

This test is performed on whole transformer.

A reduced step voltage (about 100 V) delivered by a step generator (type Gary) is applied on CVT P1 primary terminal. This connection is made with copper braid (see test circuit diagram).

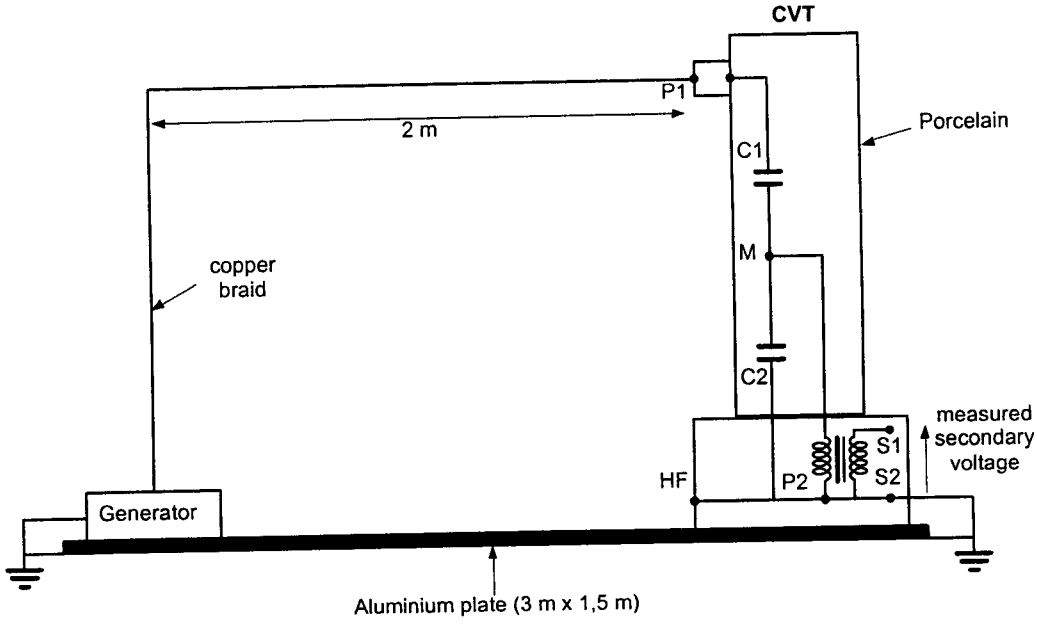
Waveshape characteristics :
- Peak voltage value ≈ **100 V**
- Front time = **200 ns ± 10% entre 10 et 90%** of peak voltage.
- Half level time at least **50 µs.**

2 - Measurement

- Waveshape characteristics control.
- Voltage measurement to S1 - S2 terminals.

Signal recordings is realized with a numeric oscilloscope type TEKTRO (350 MHz) supplied with insulation transformer.

3 - Test circuit diagram



4 - Specification

measured ratio ≤ 0,5 / 650 (CVT 245 kV)

5 - Result: see oscillogram n° 50 (appendix 2).

measured ratio = 0,156 / 650

HIGH FREQUENCY CAPACITANCE AND EQUIVALENT SERIES RESISTANCE (AMBIENT TEMPERATURE, -25°C & +40°C) (NFC 54 110 § 12.1 & CSCT ME 83 J appendix 11 § 1-2-27)

1 - Test conditions

This test is performed on whole transformer.

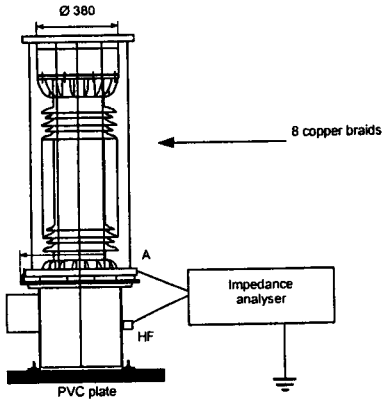
This test is performed at ambient temperature (between 15°C et 35°C) and at both extreme temperatures (-25°C et +40°C).

The apparatus is installed on an insulated frame. HF, P2, S2 terminals are connected to the apparatus tank.

S1 - S2 secondary is opened. The measurement is realized according to IEC 358 (05-1990) method :

The voltage is applied between HF terminal and a cage, made of 8 copper braids which are hold in position in narrow contact with porcelain and connected to the apparatus head. An impedance analyser type : HP 4192 A, is used (see test circuit diagram).

2 - Test circuit diagram



3 - Result

Test temperature (°C)	Frequency (kHz)	40	100	200	300	350	400	450	measurement accuracy
Ambient temp.: 19° C	Rs (Ω)	5	18	17,3	17,3	17,3	17,2	16,6	± 1 % à 1 kHz
Ambient temp.: 19° C	Cs (pF)	4104	4163	4158	4247	4280	4311	4382	± 1 % à 1 kHz
-25° C	Rs (Ω)	13	16,2	15	14,7	14,6	14,5	14,4	± 1 % à 1 kHz
-25° C	Cs (pF)	4102	4137	4164	4225	4268	4321	4383	± 1 % à 1 kHz
40° C	Rs (Ω)	10	18,2	18,4	18,5	18,5	18,5	18,5	± 1 % à 1 kHz
40° C	Cs (pF)	4093	4143	4170	4182	4200	4221	4245	± 1 % à 1 kHz

Specification : - *For 40 kHz ≤ F ≤ 450 kHz we must have :*

$$Rs \leq 40\ \Omega$$
$$0{,}9\ Cn \leq Cs \leq 1{,}2\ Cn$$
$$(3600\ pF < Cs < 4800\ pF)$$

MEASUREMENT OF INPUT IMPEDANCE
(CSCT ME 83 J appendix 11 § 1-2-28)

1 - Test condition

This test is performed on whole transformer.

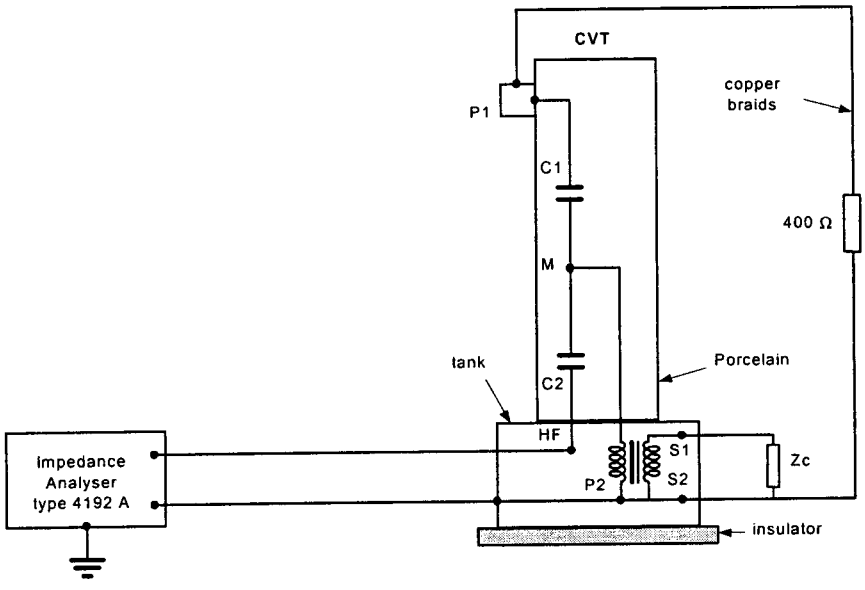
The apparatus is installed on an isolated frame. P2, S2 terminals are connected to the apparatus tank.

P1 terminal is connected to the earth, through a 400,2 Ω resistor (which figurate ligne impedance), with copper braid.

S1 - S2 secondary is closed on Zc burden (cos φ = 0,8), similar type of those used transient rating tests.

The impedance measurement Z = R + jX is realized with an impedance analyser type : HP 4192A between HF terminal and the apparatus tank.

2 - Test circuit diagram



3 - Result

Burden Zc (VA)	Frequency (kHz)	40	100	130	200	300	350	400	450	measurement accuracy
50	Rs (Ω)	504	405,7	403,9	400,5	398,1	397,5	396,7	396	± 1 % à 1 kHz
50	Cs (pF)	3951	4127	4059	3825	3441	3226	3029	2827	± 1 % à 1 kHz
80	Rs (Ω)	504	405,7	403,9	400,5	398,1	397,5	396,7	396	± 1 % à 1 kHz
80	Cs (pF)	3951	4127	4059	3825	3441	3226	3029	2827	± 1 % à 1 kHz
160	Rs (Ω)	504	405,7	403,9	400,5	398,1	397,5	396,7	396	± 1 % à 1 kHz
160	Cs (pF)	3951	4127	4059	3825	3441	3226	3029	2827	± 1 % à 1 kHz

Specification: *Rs ≥ 350 Ω from 40 kHz to 300 kHz for every burden*
Rs ≥ 315 Ω from 301 kHz to 450 kHz for every burden

MEASUREMENT OF COMPOSITE ATTENUATION
(CSCT ME 83 J appendix 11 § 1-2-29)

1 - Test condition

This test is performed on whole transformer.

The apparatus is installed on an isolated frame. P2, S2 terminals and the tank are grounded.

P1 terminal is connected to the earth,through a 400,2 Ω resistor (which figurate ligne impedance), with copper braid.

S1 - S2 secondary is closed on Zc burden (cos φ = 0,8).

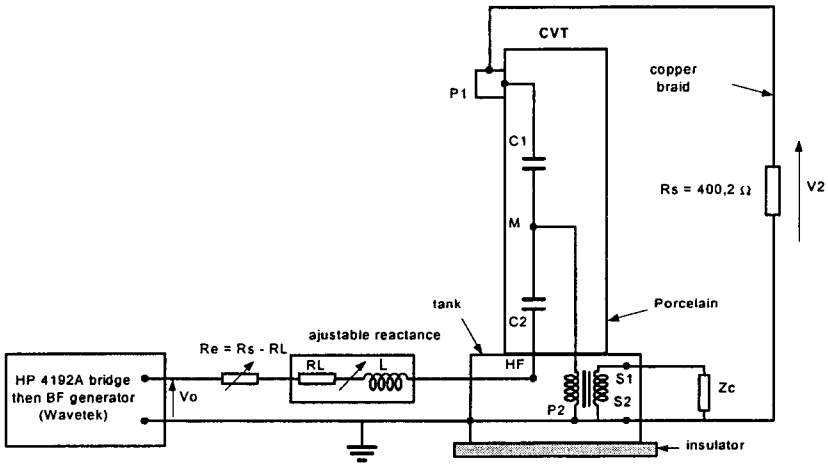
2 - Test procedure

1 - Utilisation of HP 4192 A bridge
2 - Insert in the circuit of the reactance decade block only and search of L value allowding the adjustment of the capacitive component of the CVT, in order to obtain an input impedance completely resistive (imaginary part equal to zero). This search is realized by successive adjustments of the reactance for each **test frequency**.
3 - Measurement of resistive part (RL) of the chosen reactance.
4 - Insert in the circuit of the resistor decade block adjusted on the value Re = Rs - RL; (Rs = 400,2 Ω).
5 - Replacement of HP 4192 A bridge by a BF generator allowing to reach higher voltage levels.
6 - Vo (to genérator terminals) and V2 voltage recordings (to Rs terminal).

In this conditions, composite attenuation, for a given frequency, is determinated by :

$$\alpha \text{ (dB)} = 20 \log (Vo/2V2)$$

3 - Test circuit diagram



4 - Result

Burden Zc (VA)	Frequency (kHz)	40	130	300	400	450	measurement accuracy
50	α (dB)	0,33	0,26	0,29	0,33	0,35	± 3 %
80	α (dB)	0,33	0,26	0,29	0,33	0,35	± 3 %
160	α (dB)	0,33	0,26	0,29	0,33	0,35	± 3 %

Specification: *α ≤ 0,5 dB de 40 kHz à 300 kHz for every burden.*
α ≤ 0,7 dB de 301 kHz à 450 kHz for every burden.

MEASUREMENT OF CAPACITANCE AND DIELECTRIC DISSIPATION FACTOR (AMBIENT TEMPERATURE) (CSCT ME 83 § 3.2 & NFC 54 110 § 7 et 8)

1 - Test conditions

The apparatus under test is installed on a 2 meters high frame. A full oil tank is placed instead the electromagnetic unit tank.

The low voltage terminal (HF) and the tank are earthed together through the Tettex bridge.

This test is performed at ambient temperature, after dielectric tests (lightning impulses and 50 Hz tests).

2 - Test procedure

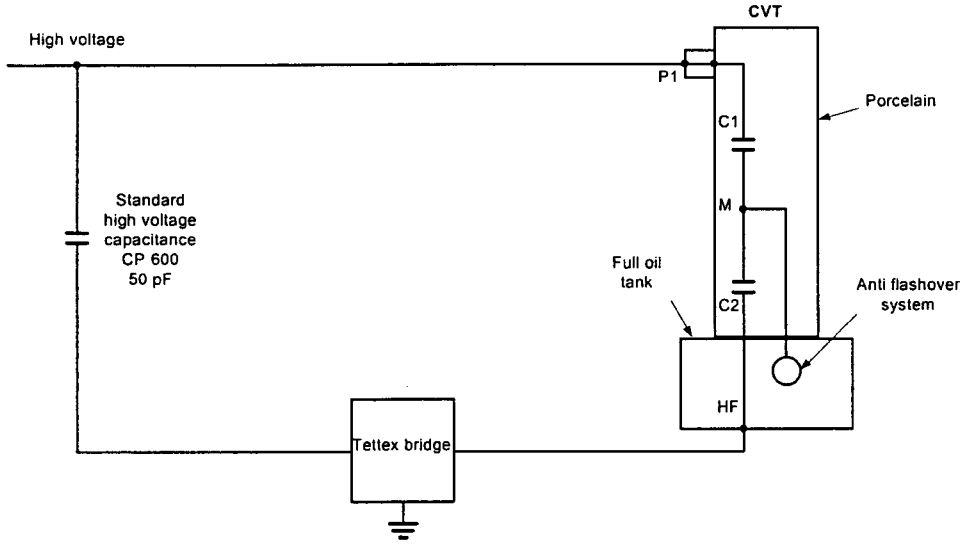
U1n= 220 kV / √ 3 (CVT 245 kV)

Tests are realised at nominal frequency and 0.1 U1n, U1n.

In this conditions, capacitance and dielectric dissipation factor are recorded

The capacitance measurement shall not differ from rated capacitance by more than - 5% or +10%.

3 - Test circuit diagram



4 - Result

Conditions	Voltage (kV)	Temperature	C (pF)	Tg δ	Date of test :
After dielectric test (50 Hz)	0.1 U1n	13,3	4146,3	$7,66.10^{-4}$	19/04/99
	U1n	13,3	4146,8	$7,93.10^{-4}$	19/04/99
	Measurement Accuracy	± 0,6°C	± 0,5 % de C mesured (Tettex bridge)	$\pm 0,5.10^{-4}$ (Tettex bridge)	

Spécification : 0,95 Cn ≤ C ≤ 1,1 Cn (3800 pF ≤ C ≤ 4400 pF)
Tg δ ≤ 0,005.

MEASUREMENT OF DIELECTRIC DISSIPATION FACTOR AT -25, +20°C & +50°C. (CSCT ME 83 J appendix 11 § 1-2-32 A)

1 - Test conditions

The apparatus under test is installed on a 2 meters high frame. A full oil tank is placed instead the electromagnetic unit tank.

The low voltage terminal (HF) and the tank are earthed together through a shunt.

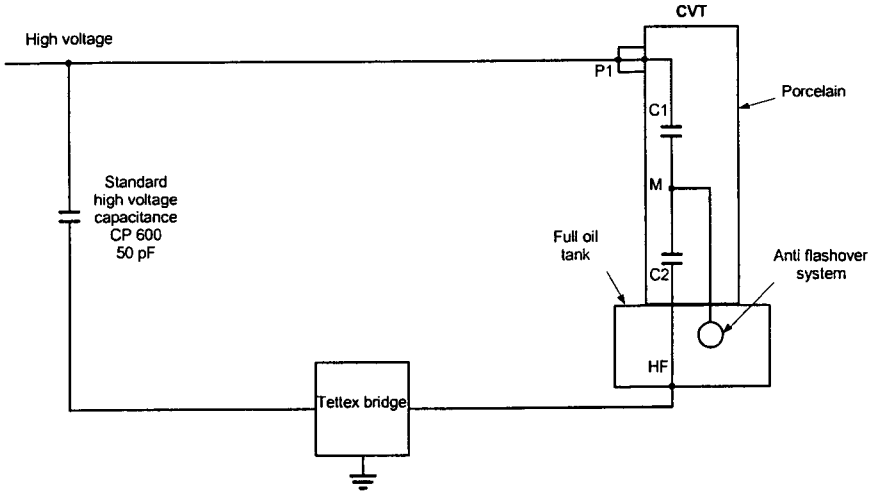
2 - Test procedure

Um= 245 kV

Tests are realized at -25, +20 et +50°C and **2.5 kV**, **0.6 Um**, **Um**.

In this conditions, the dielectric dissipation factor is recorded

3 - Test circuit diagram



4 - Result

Voltage (kV)	Temperature	Tg δ
2,5 kV	à - 25°C	$1,83.10^{-3}$
	à + 20°C	$1,35.10^{-3}$
	à + 50°C	$1,06.10^{-3}$
0,6 Um **(147 kV)**	à - 25°C	$1,43.10^{-3}$
	à + 20°C	$7,92.10^{-4}$
	à + 50°C	$7,58.10^{-4}$
Um **(245 kV)**	à - 25°C	$1,51.10^{-3}$
	à + 20°C	$8,47.10^{-4}$
	à + 50°C	$8,11.10^{-4}$
Measurement Accuracy	± 0,6°C	$\pm 1.10^{-3}$ (Haefely bridge)

Spécification : Tg δ < 0,005.

TEST FOR ACCURACY
(NFC 42 501 § 27, 33, 48 & CSCT ME 83 J appendix 11 §1-2-34 & 35)

1 - Test conditions

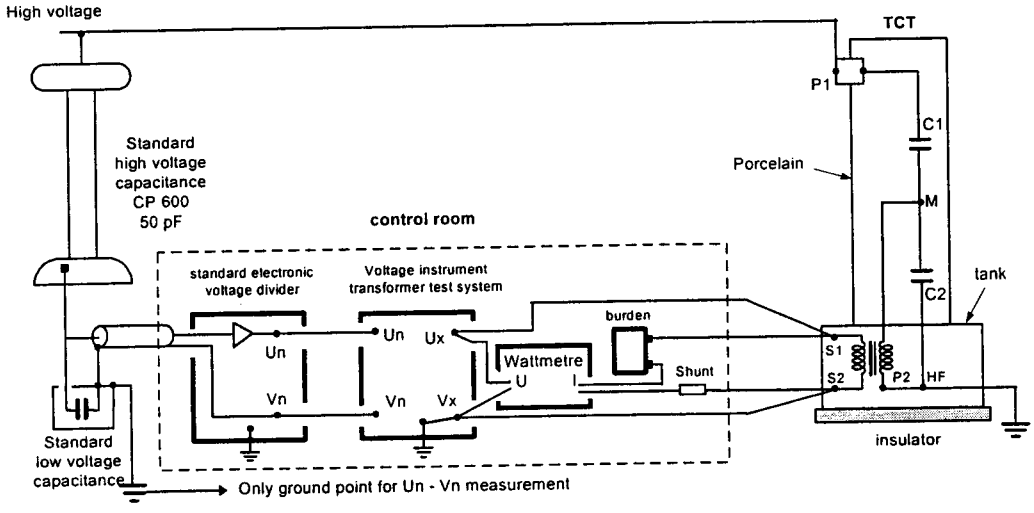
This test is performed on whole transformer at ambient temperature.

2 - Test procedure

Accuracy measurements are performed with an accuracy measuring instrument TETTEX associated with a standard capacitance 600 kV (CP 600) and accuracy burdens.

The measurements are performed as a function of frequency, voltage and secondary burden. (see next pages).

3 - Test circuit diagram



TEST FOR ACCURACY
(NFC 42 501 § 27, 33, 48 & CSCT ME 83 J appendix 11 §1-2-34 & 35)

4 - Result

MEASURE Fonction

N°	% Un	Burden (VA, cos φ=0,8)	Frequency (Hz)	Error on ratio	Error on phase	Error tolerance on ratio	Error tolerance on phase
1	80	20	48	0,13	85	± 2 %	± 120'
2			49,5	0,12	14		
3			50,5	0,1	-18		
4			51	0,09	-31		
5		80	48	0,12	65		
6			49,5	0,01	17		
7			50,5	-0,08	-19		
8			51	-0,11	-26		
9	100	20	48	0,13	53		
10			49,5	0,12	18		
11			50,5	0,11	-16		
12			51	0,1	-31		
13		80	48	0,12	66		
14			49,5	0,02	20		
15			50,5	-0,07	-14		
16			51	-0,12	-34		
17	120	20	48	0,14	59		
18			49,5	0,13	12		
19			50,5	0,12	-14		
20			51	0,1	-32		
21		80	48	0,13	66		
22			49,5	0,02	19		
23			50,5	-0,06	-12		
24			51	-0,11	-34		
25	80	20	49,7	0,12	6	± 0,5 %	± 30'
26			50,3	0,1	-10		
27		80	49,7	-0,007	10		
28			50,3	-0,006	-12		
29	100	20	49,7	0,12	9		
30			50,3	0,11	-10		
31		80	49,7	0,007	13		
32			50,3	-0,05	-10		
33	120	20	49,7	0,13	7		
34			50,3	0,12	-8		
35		80	49,7	0,008	8		
36			50,3	-0,04	-10		
37	80	20	50	0,11	-4	± 0,5 %	± 20'
38		80		-0,03	-0,6		
39	100	20		0,12	-4		
40		80		-0,02	0,5		
41	120	20		0,12	-5		
42		80		-0,02	-1		

TEST FOR ACCURACY
(NFC 42 501 § 27, 33, 48 & CSCT ME 83 J appendix 11 §1-2-34 & 35)

4-1 Result

PROTECTION Fonction

N°	% Un	Burden (VA, cos φ=0,8)	Frequency (Hz)	Error on ratio	Error on phase	Error tolerance on ratio	Error tolerance on phase
1	2	0	48	0,01	71	± 3 %	± 120'
2			50	0	12		
3			51	0	-14		
4		40	48	0,02	79		
5			50	-0,08	14		
6			51	-0,13	-15		
7		160	48	0,01	97		
8			50	-0,33	22		
9			51	-0,55	-16		
10	100	0	48	0,13	53		
11			50	0,16	-4		
12			51	0,17	-28		
13		40	48	0,12	61		
14			50	0,07	-1		
15			51	0,03	-34		
16		160	48	0,1	75		
17			50	-0,23	3		
18			51	-0,4	-32		
19	150	0	48	0,15	53		
20			50	0,18	-4		
21			51	0,19	-27		
22		40	48	0,14	60		
23			50	0,08	-4		
24			51	0,04	-32		
25		160	48	0,13	76		
26			50	-0,2	1		
27			51	-0,4	-38		
19	190	0	48	0,16	52		
20			50	0,2	-3		
21			51	0,21	-30		
22		40	48	0,16	57		
23			50	0,1	1		
24			51	0,07	-33		
25		160	48	0,14	75		
26			50	-0,17	4		
27			51	-0,37	-36		

TEST FOR ACCURACY
(NFC 42 501 § 27, 33, 48 & CSCT ME 83 J appendix 11 §1-2-34 & 35)

4-2 Result

PROTECTION Fonction

28	2	0	45	-0,02	167	± 6 %	± 360'
29			55	-0,08	-121		
30		40	45	0,12	182		
31			55	-0,4	-129		
32		160	45	0,47	220		
33			55	-1,33	-149		
34	100	0	45	0,05	146		
35			55	0,18	-135		
36		40	45	0,18	158		
37			55	-0,16	-145		
38		160	45	0,53	200		
39			55	-0,17	-170		
40	150	0	45	0,06	144		
41			55	0,2	-137		
42		40	45	0,19	160		
43			55	-0,14	-145		
44		160	45	0,55	203		
45			55	-1,16	-172		
40	190	0	45	0,08	142		
41			55	0,2	-138		
42		40	45	0,2	154		
43			55	-0,14	-146		
44		160	45	0,55	193		
45			55	-1,12	-168		

SECONDARY WAVE SHAPE
(UTE C 42501 § 59)

1 - Test conditions

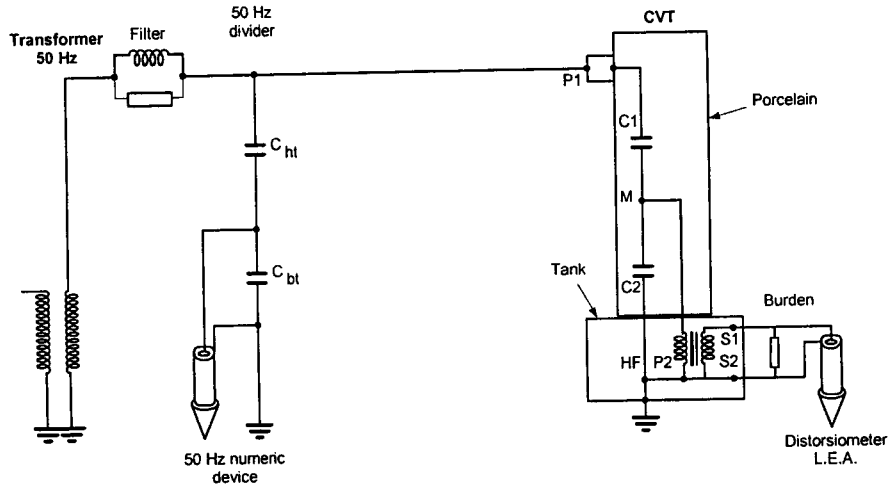
U1n = **220 kV/√ 3**

distortion factor (Fd) measurement to CVT secondary in the following conditions :

- Test voltage = 0,8 x U1n (101,6 kV), U1n (127 kV) and 1,2 x U1n (152,4 kV).
- Burdens (cos φ 0,8) = 0, 80 et 160 VA.
- Frequency = 45, 50, 55 Hz.

Measurements are made with a distorsiometer type L.E.A.

2 - Test circuit diagram



3 - Result

Voltage (kV)	Burden (VA)	distortion factor (Fd) at **45** Hz (%)			distortion factor (Fd) at **50** Hz (%)			distortion factor (Fd) at **55** Hz (%)		
		F.d. (%) primary	F.d. (%) second.	Δ F.d. (%)	F.d. (%) primary	F.d. (%) second.	Δ F.d. (%)	F.d. (%) primary	F.d. (%) second.	Δ F.d. (%)
102	0	0,64	0,6	-0,4	0,44	0,34	-1	0,4	0,3	-1
	80		0,58	-0,6		0,34	-1		0,3	-1
	160		0,57	-0,7		0,37	-0,7		0,34	-0,6
127	0	0,64	0,61	-0,3	0,44	0,34	-1	0,4	0,3	-1
	80		0,58	-0,6		0,36	-0,8		0,3	-1
	160		0,57	-0,7		0,37	-0,7		0,35	-0,5
152	0	0,64	0,61	-0,3	0,44	0,34	-1	0,4	0,3	-1
	80		0,58	-0,6		0,36	-0,8		0,3	-1
	160		0,58	-0,6		0,37	-0,7		0,36	-0,4

Specification : *secondary distortion factor ≤ ± 5 % of primary distortion factor:*
- 5% ≤ F.d second. (%) - F.d primaire (%) ≤ + 5%

MEASUREMENT OF IMPEDANCE VIEWED FROM SECONDARY WINDINGS (CSCT ME 83 J § 3.1.9)

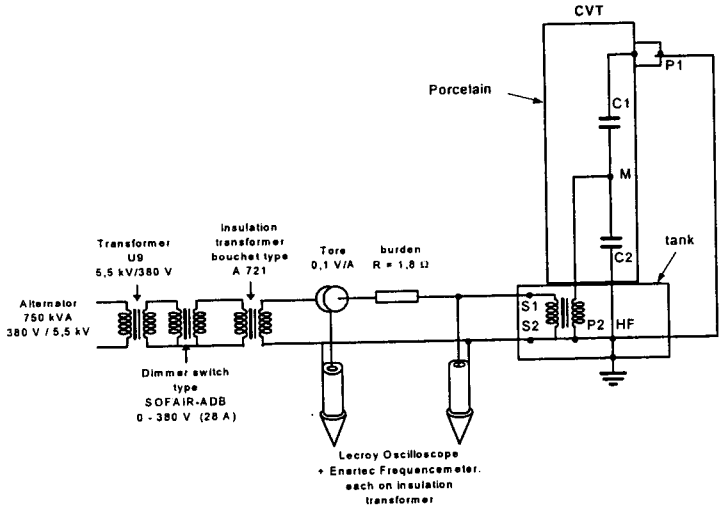
1 - Test conditions

CVT primary circuit terminals are short-circuited. HF, P2, S2 terminals and CVT tank are grounded.

2 - Measurements

The voltage is applied on S1 - S2 terminals.
This measurements are realized at 45, 50 et 55 Hz.

3 - Test circuit diagram



4 - Result

Frequency (Hz)	Current (A)	Us voltage (V)	Impedance (Ω)
45	1,38	0,46	0,33
50	1,37	0,14	0,10
55	1,38	0,50	0,36
45	2,78	0,94	0,34
50	2,77	0,28	0,10
55	2,76	1,02	0,37
45	5,02	1,65	0,33
50	5,00	0,50	0,10
55	5,00	1,82	0,36
45	10,03	3,34	0,33
50	10,07	1,01	0,10
55	10,01	3,65	0,36
45	15,06	5,00	0,33
50	15,03	1,51	0,10
55	15,07	5,63	0,37
45	21,03	7,09	0,34
50	21,01	2,06	0,10
55	20,99	7,77	0,37

Specification : The impedance must be ≤ 0,5 Ω for each frequency between 45 Hz and 55 Hz.

TERMINALS MARKING
(NF C 42-501 § 22 et 23)

This test consists in terminals marking verification (primaries & secondaries) and description plates marking.

Obligatory markings

	On ID	On apparatus
Manufacturer name	ALSTOM	ALSTOM
Type identification and serial number	CCV 245 - 4000 pF ± 10%	CCV 245 98 - XE 71100 - 01/001
Manufacturing year (possibly combined with serial number)	98	98
Approximate weight (if higher than 100 kg)	500	500
Rated primary & secondary voltages	220000/√3 - 100/√3	220000/√3 - 100/√3
Rated output & accuracy class	80 VA Cl 0,5 - 160 VA Cl 3P	80 VA Cl 0,5 - 160 VA Cl 3P
Highest voltage	245/460/1050 kV	245/460/1050 kV

Optional markings

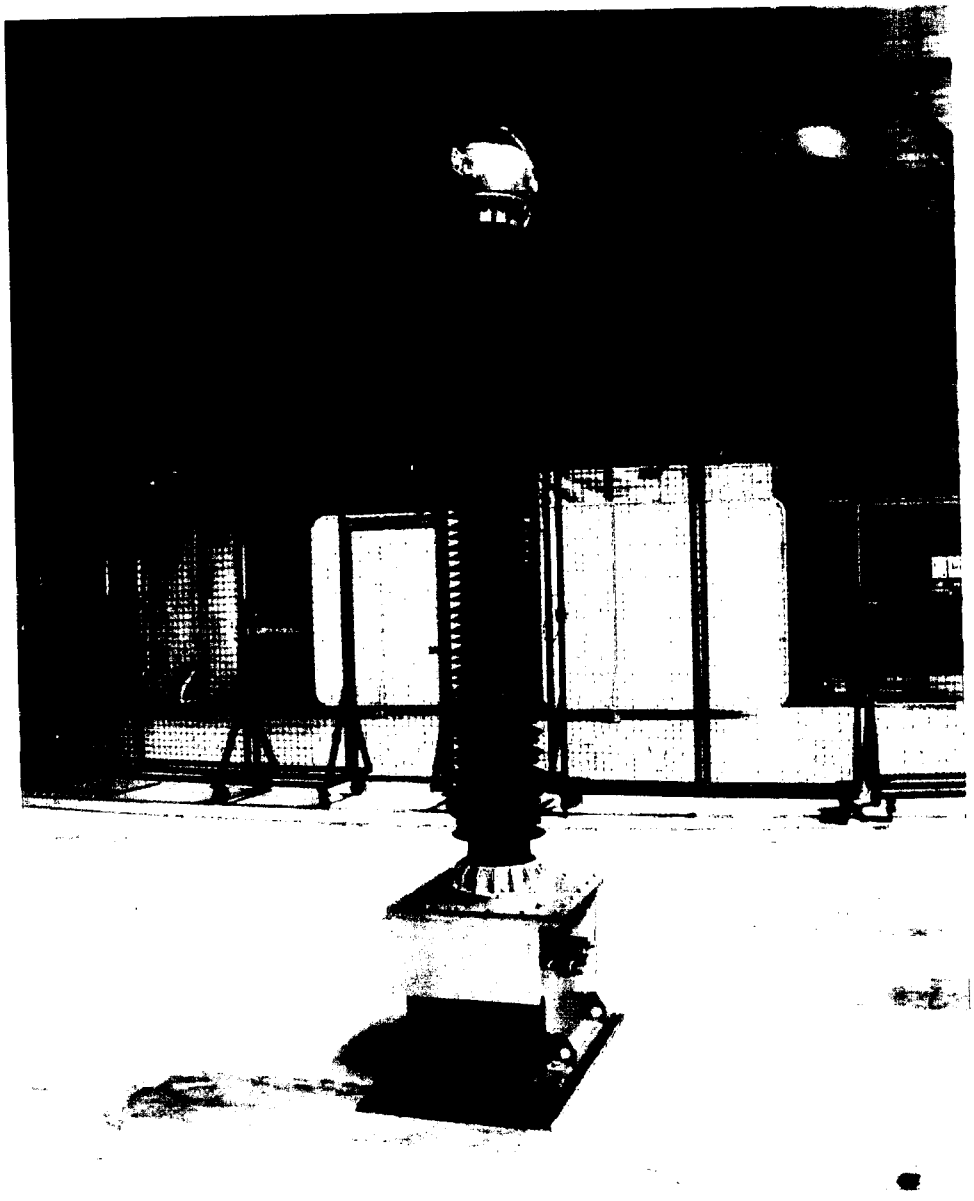
	On ID	On apparatus
Rated frequency	50 Hz	50 Hz
Rated insulation level	/	/
Rated voltage factor	1,9 Un - 2 hours	/
Insulated class (if different of A class)	/	/

Terminals markings

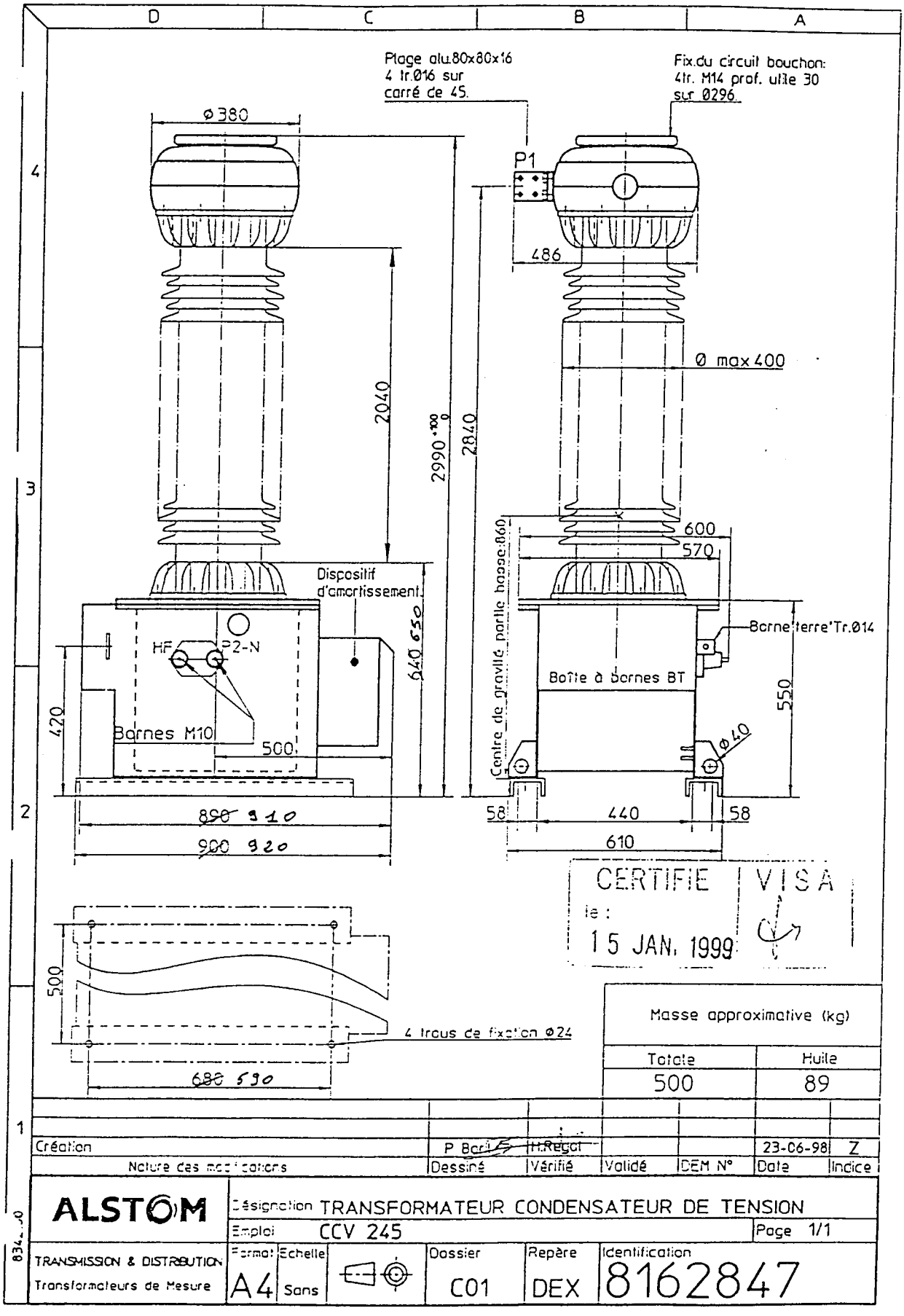
	On ID	On apparatus
Primaries terminals with polarities marking (P1 & P2)	Yes	Yes
Secondaries terminals with affectation marker for measurement and polarities marking (1S1 & 1S2)	Yes	Yes
ground terminal with grounding marker (⏚)	Yes	Yes

APPENDIX 1

PHOTOGRAPH OF THE APPARATUS UNDER TEST

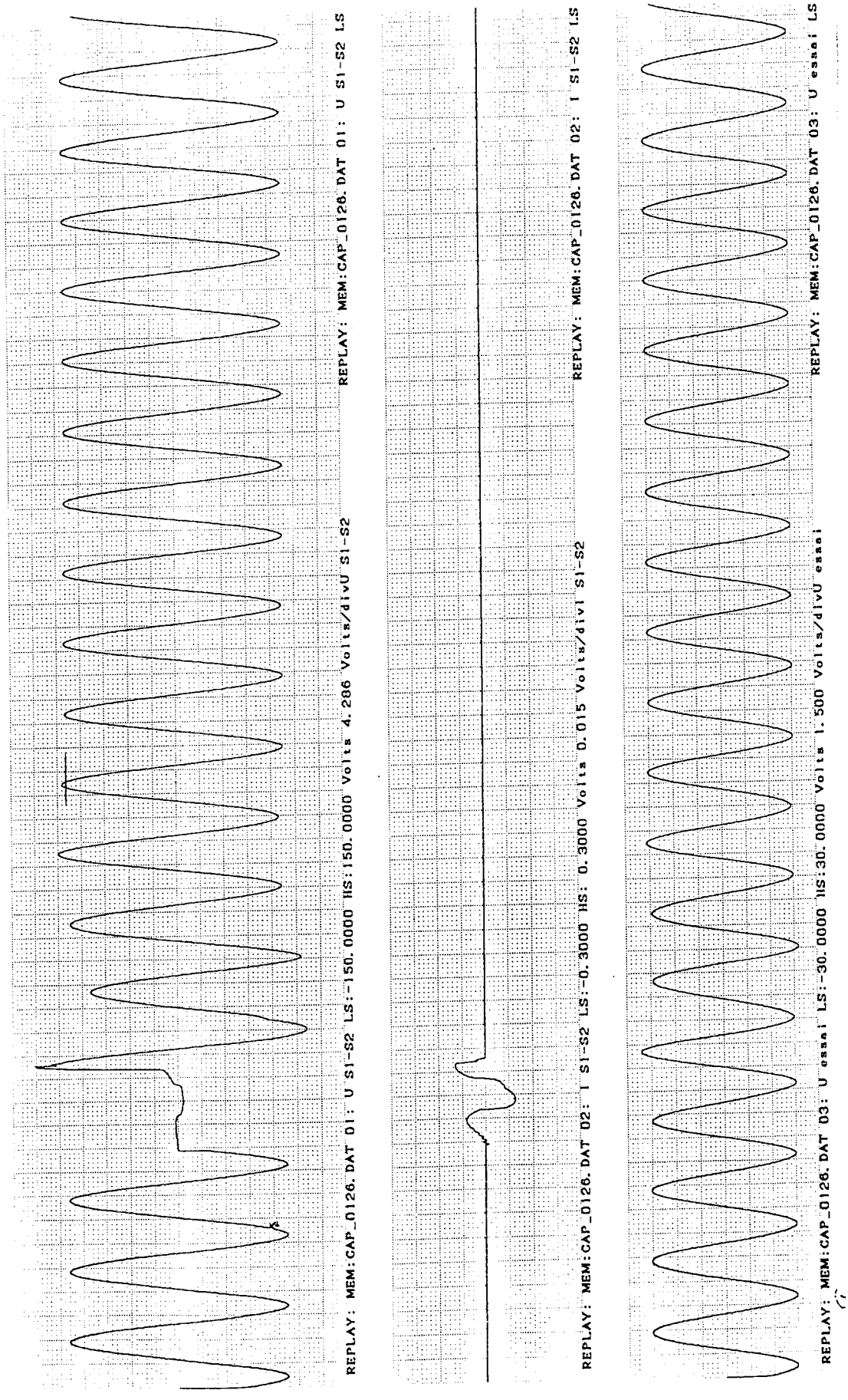


VERIFICATION OF APPARATUS PRINCIPAL SIZES

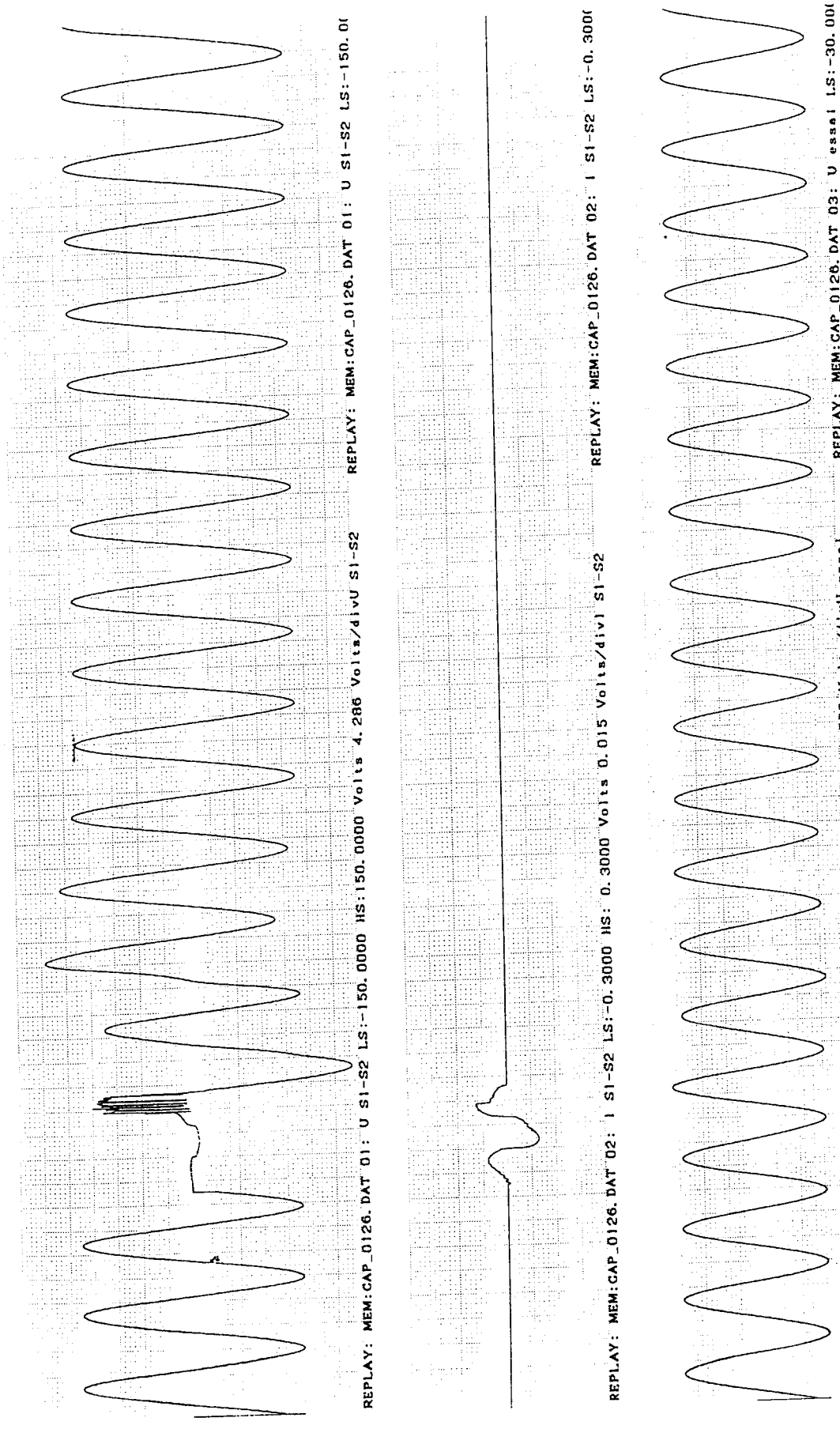


APPENDIX 2

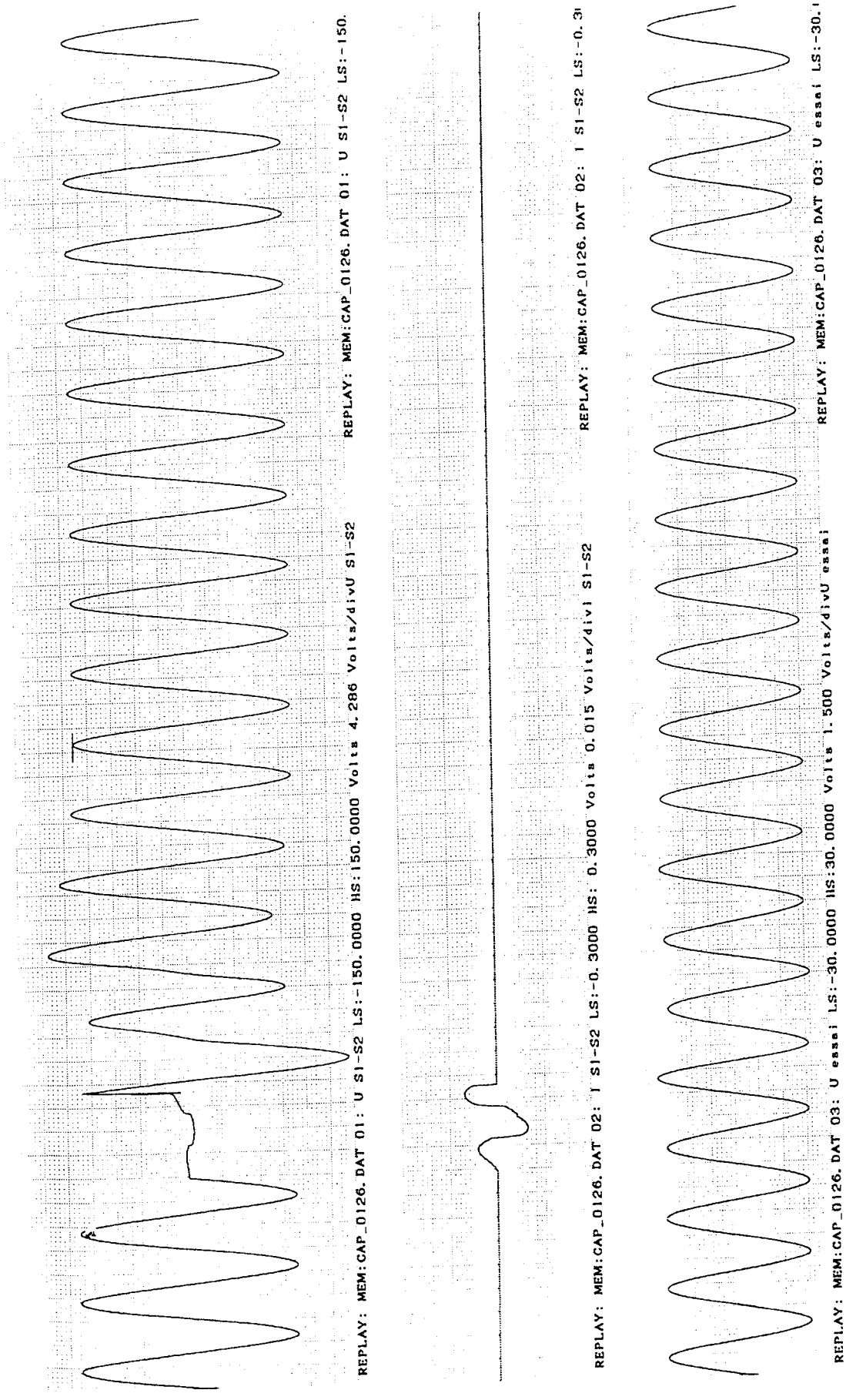
FERRO-RESONANCE a 1,2 U_{1n}



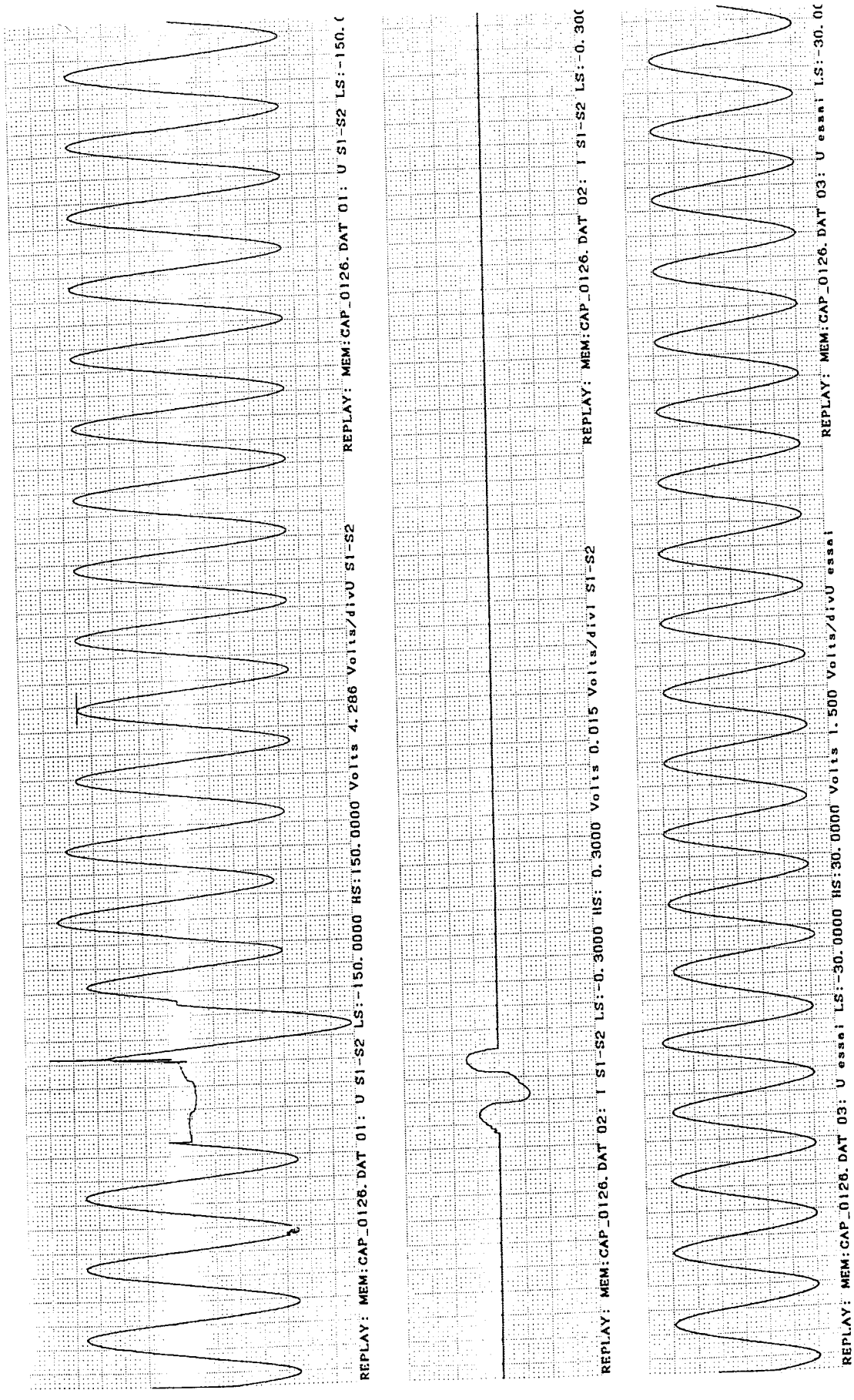
FERRO-RESONANCE a 1,2 U_{1n}



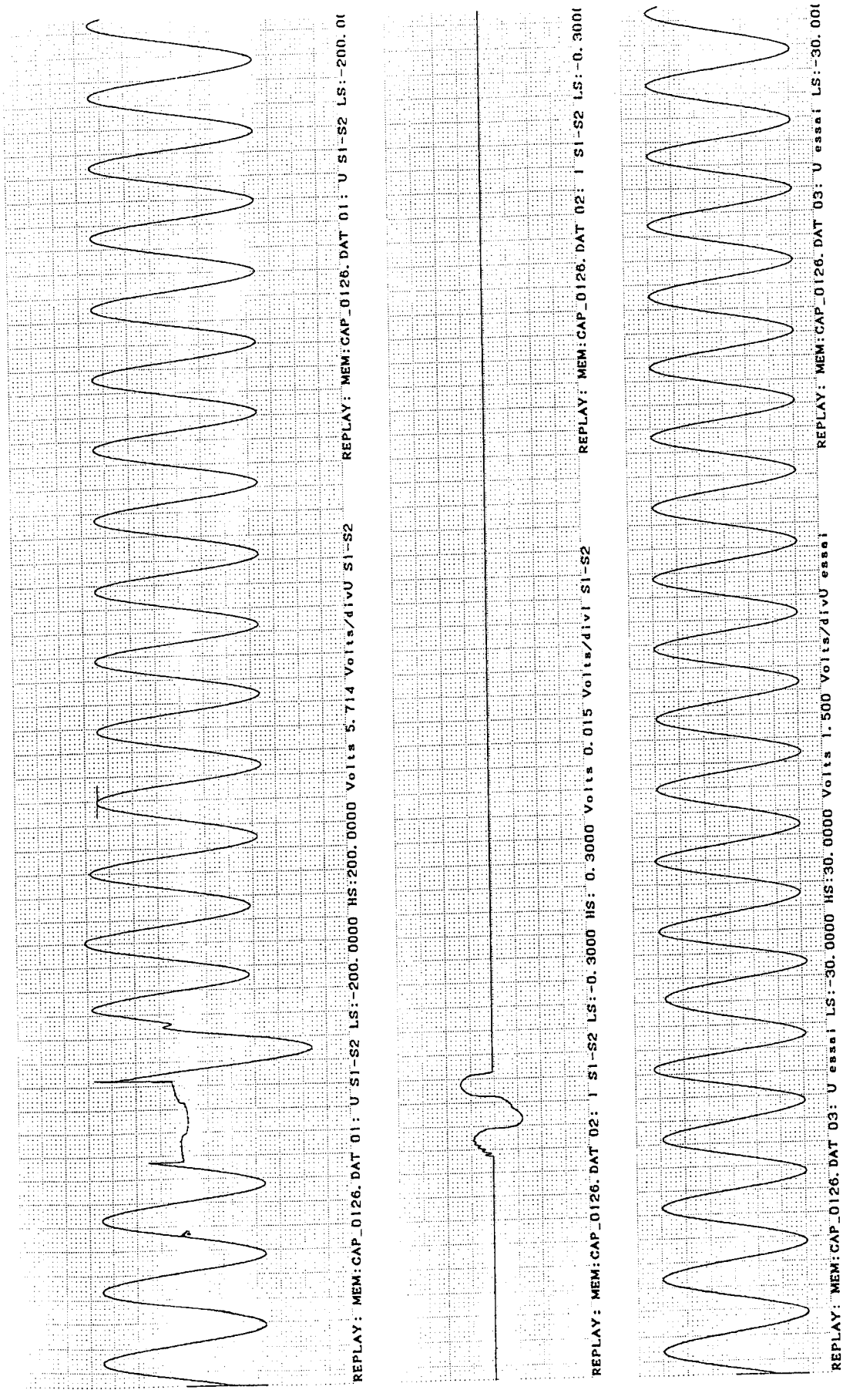
FERRO-RESONANCE a 1,2 U_{1n}



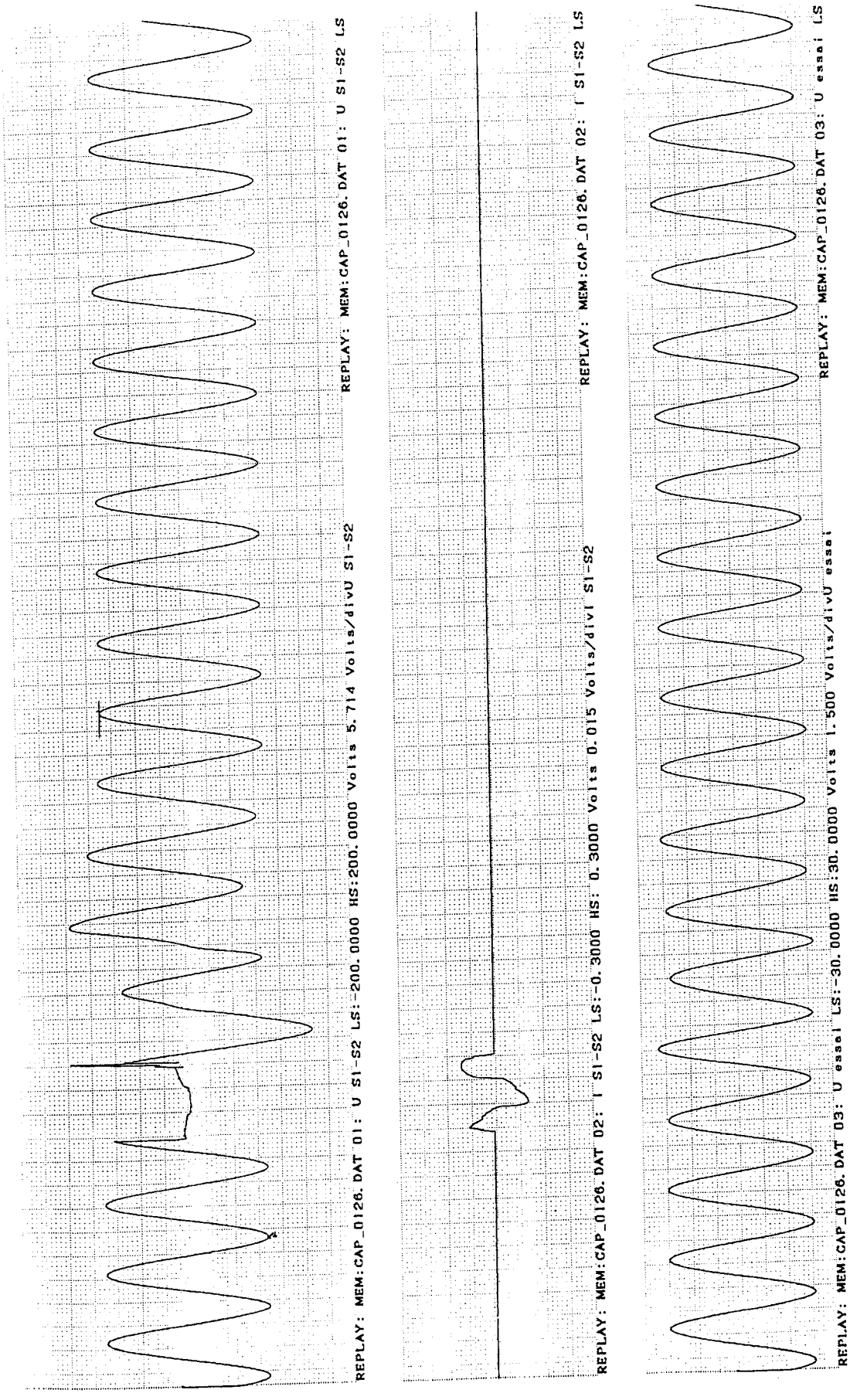
FERRO-RESONANCE a 1,2 U_{1n}



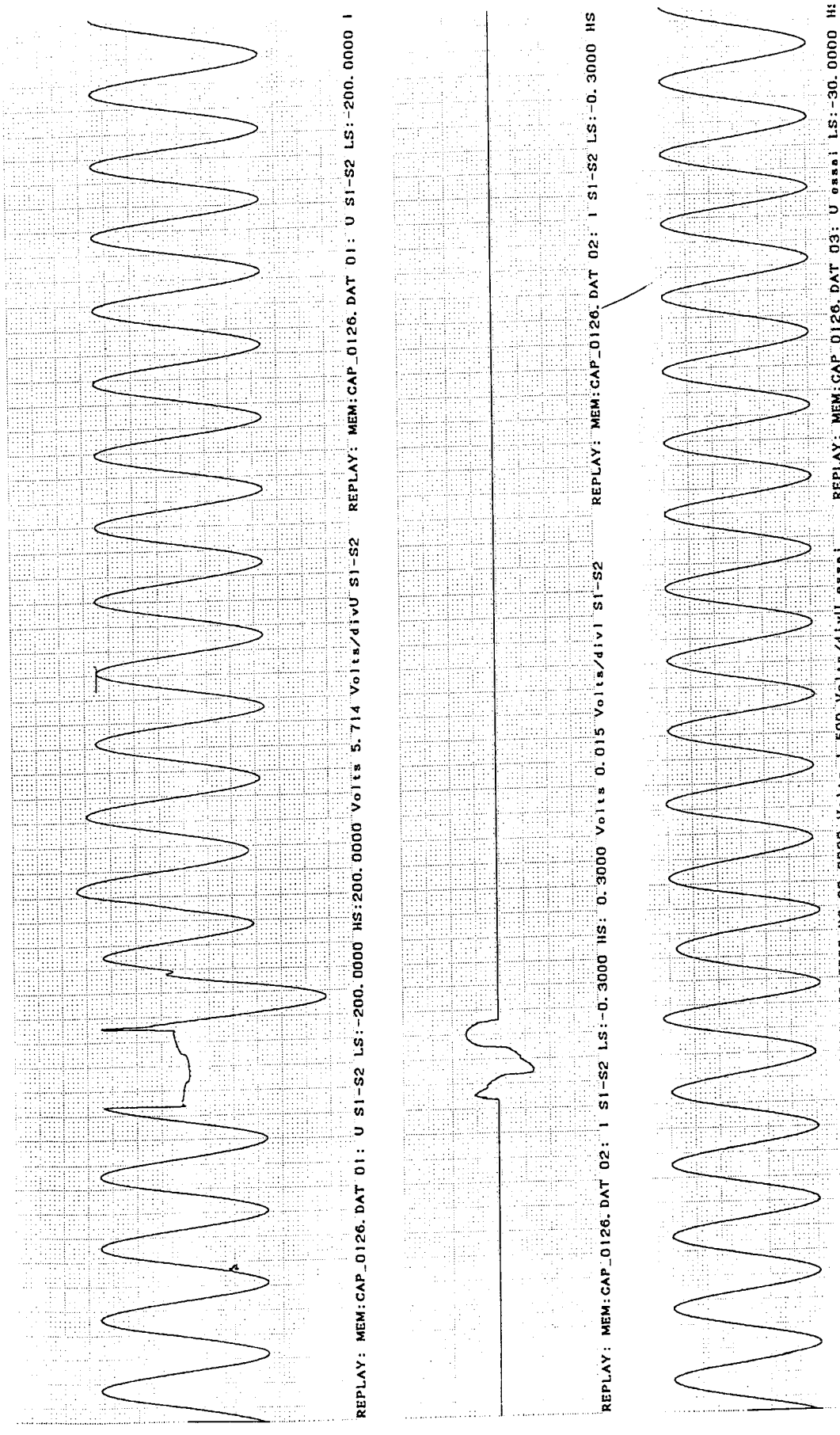
FERRO-RESONANCE a 1,2 U_{1n}



FERRO-RESONANCE a 1,2 U_{1n}



FERRO-RESONANCE a 1,2 U_{1n}



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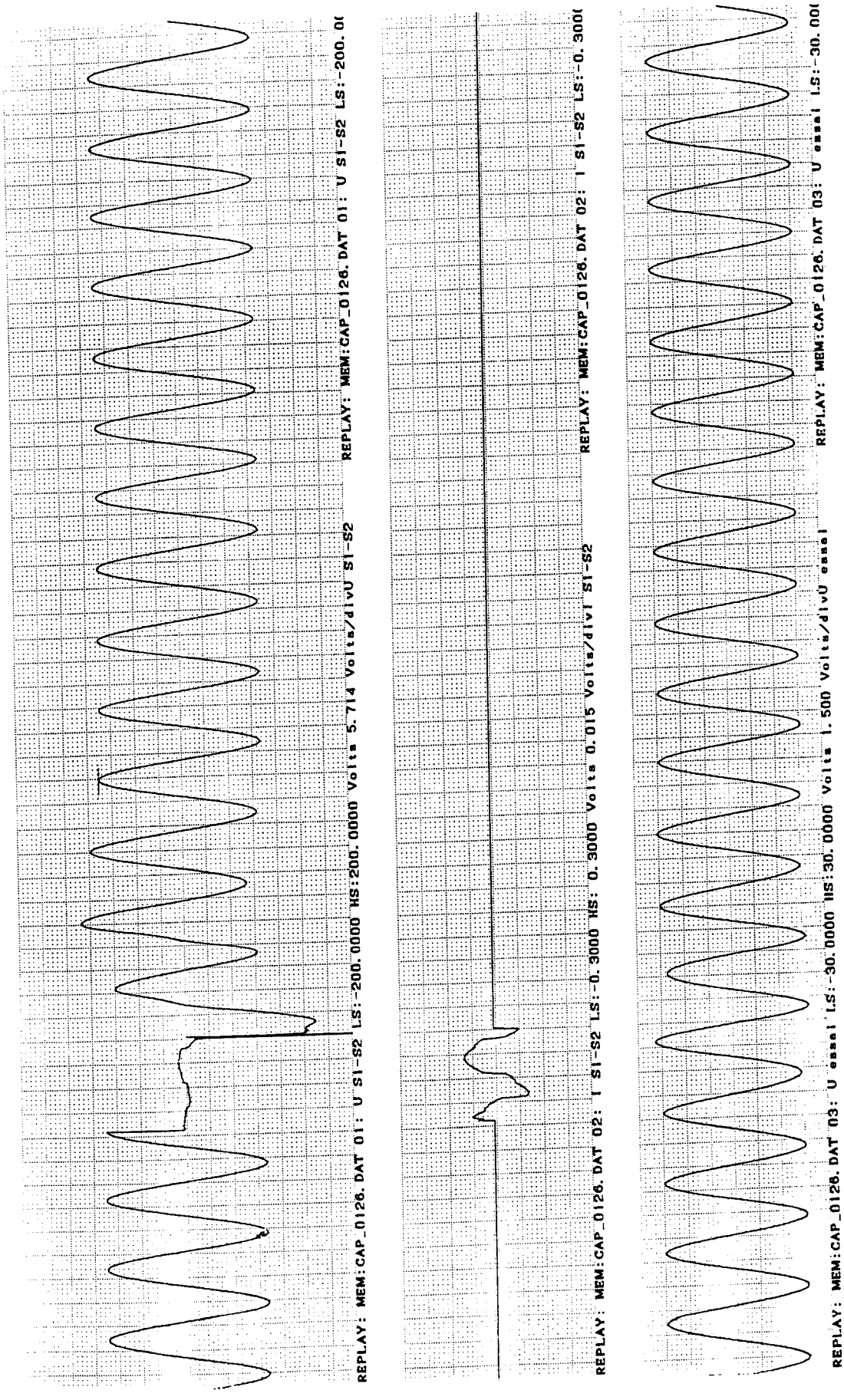
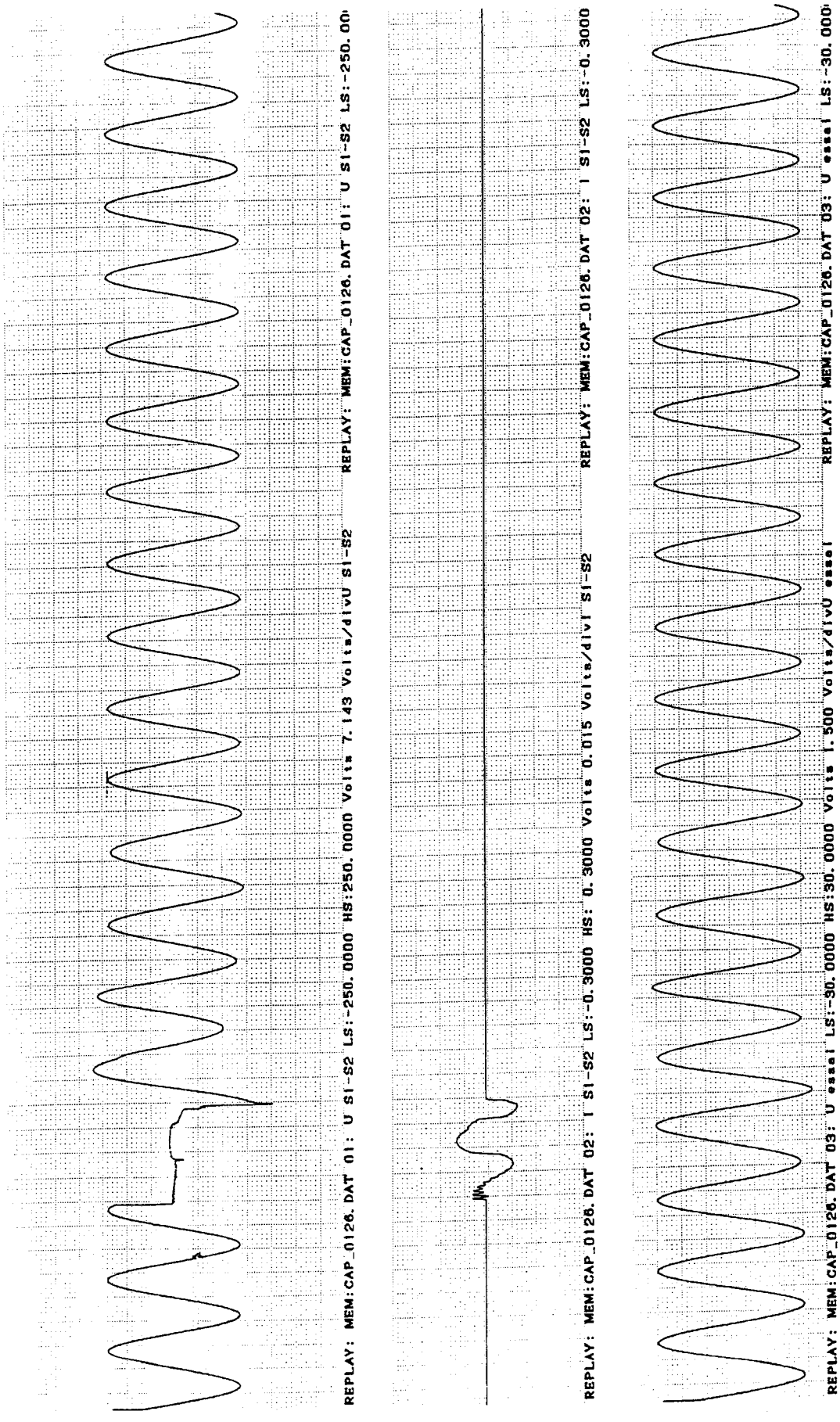
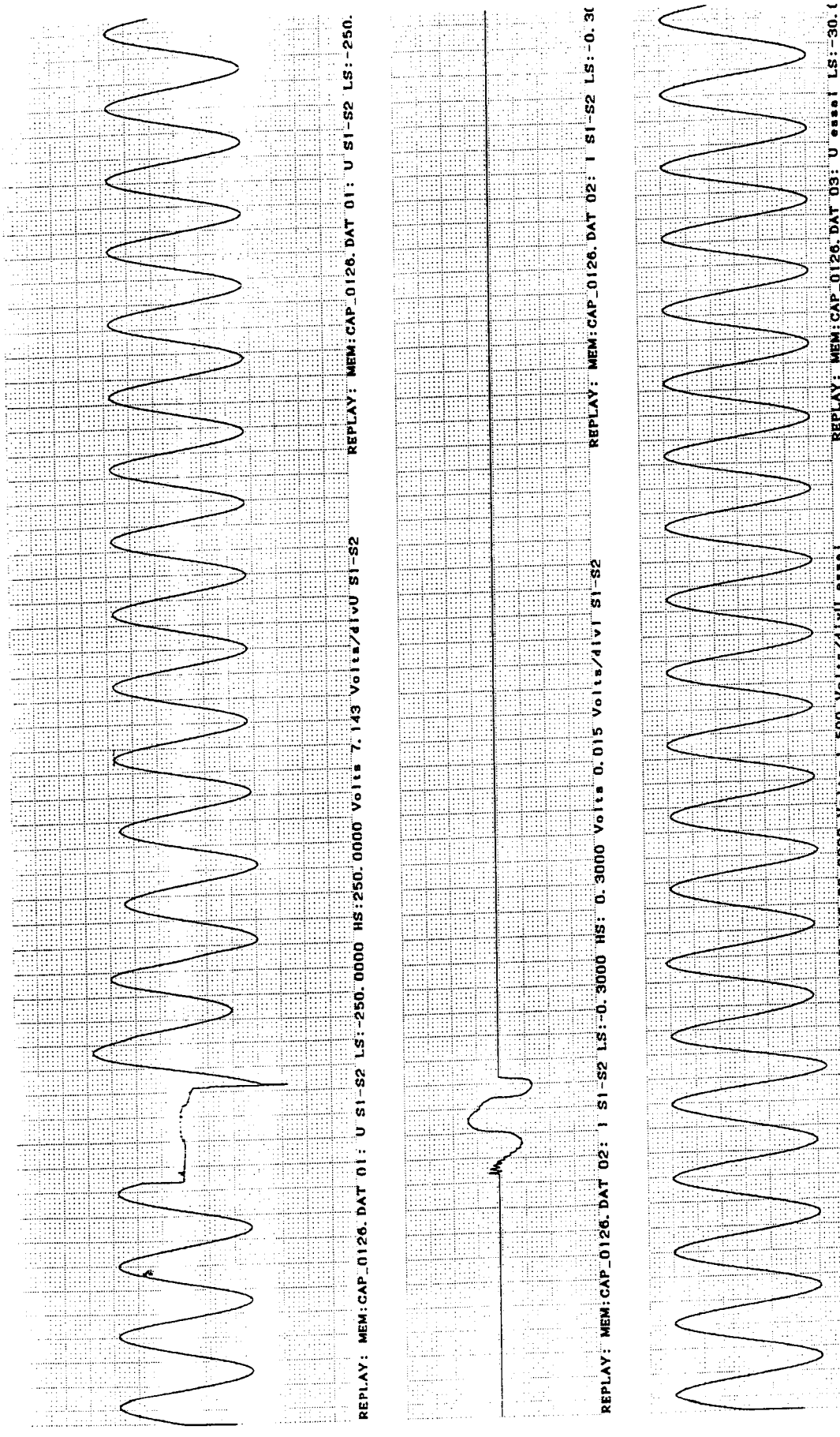


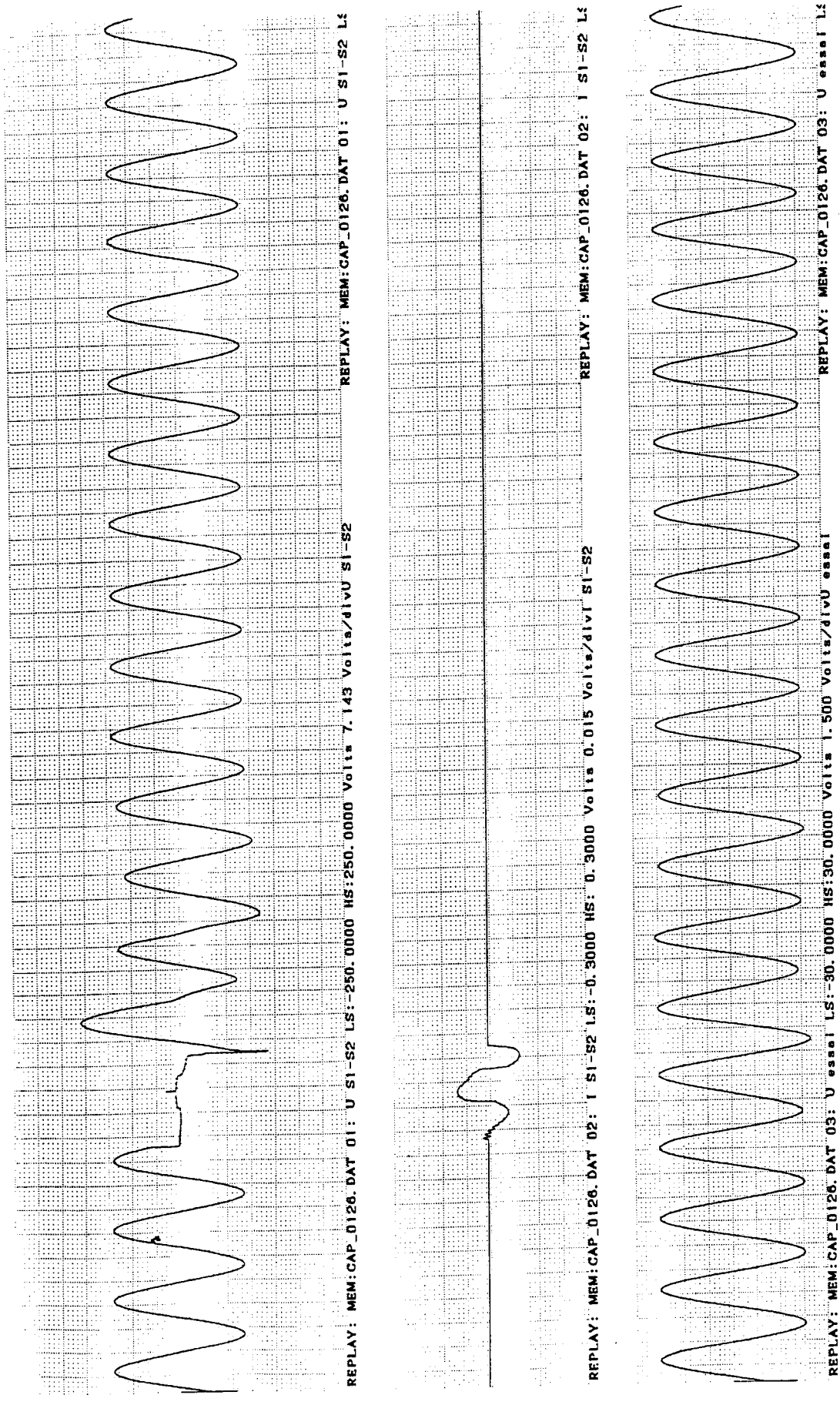
FERRO-RESONANCE a 1,2 U_{1n}



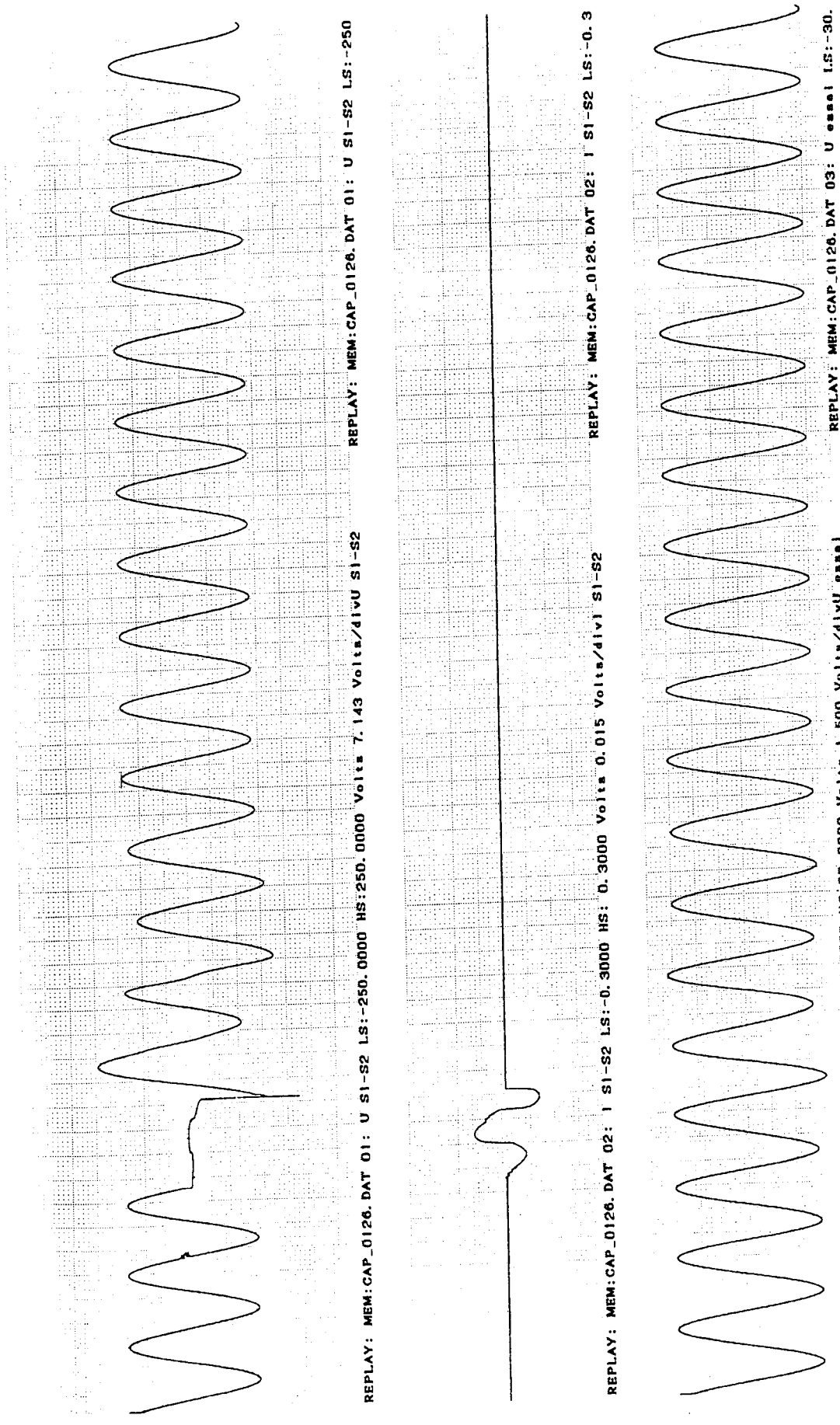
FERRO-RESONANCE a 1,2 U_{1n}



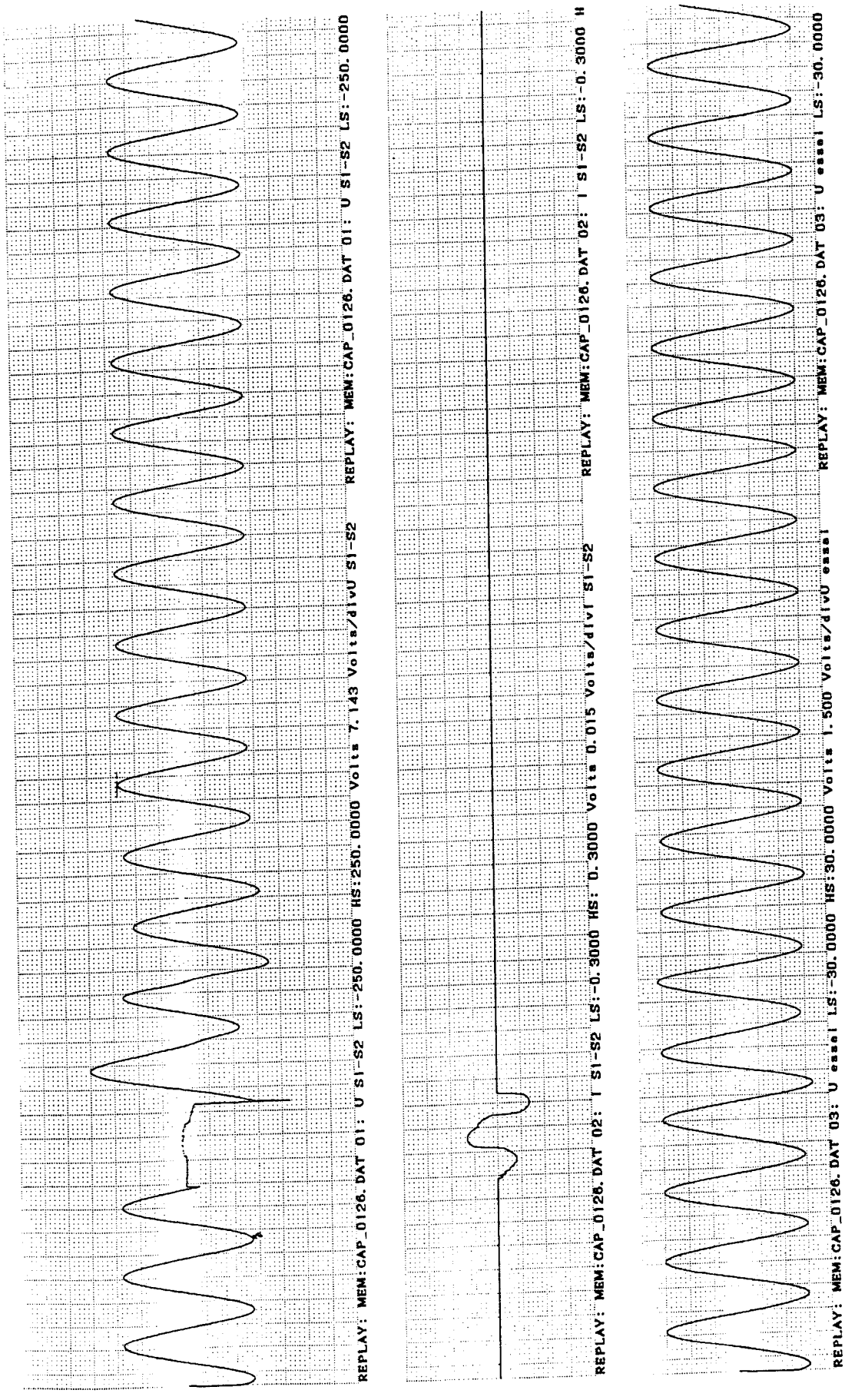
FERRO-RESONANCE a 1,2 U_{1n}



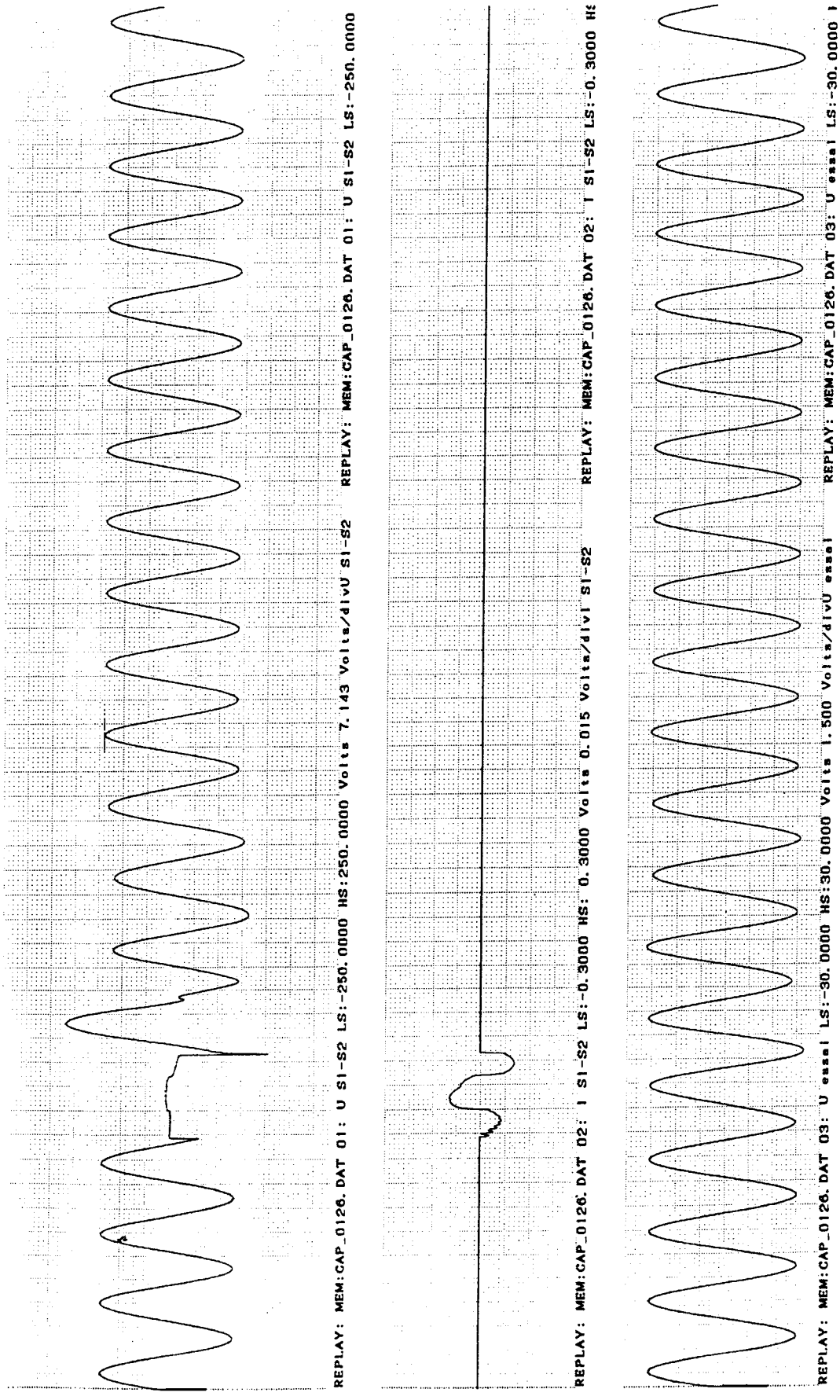
FERRO-RESONANCE a 1,2 U_{1n}



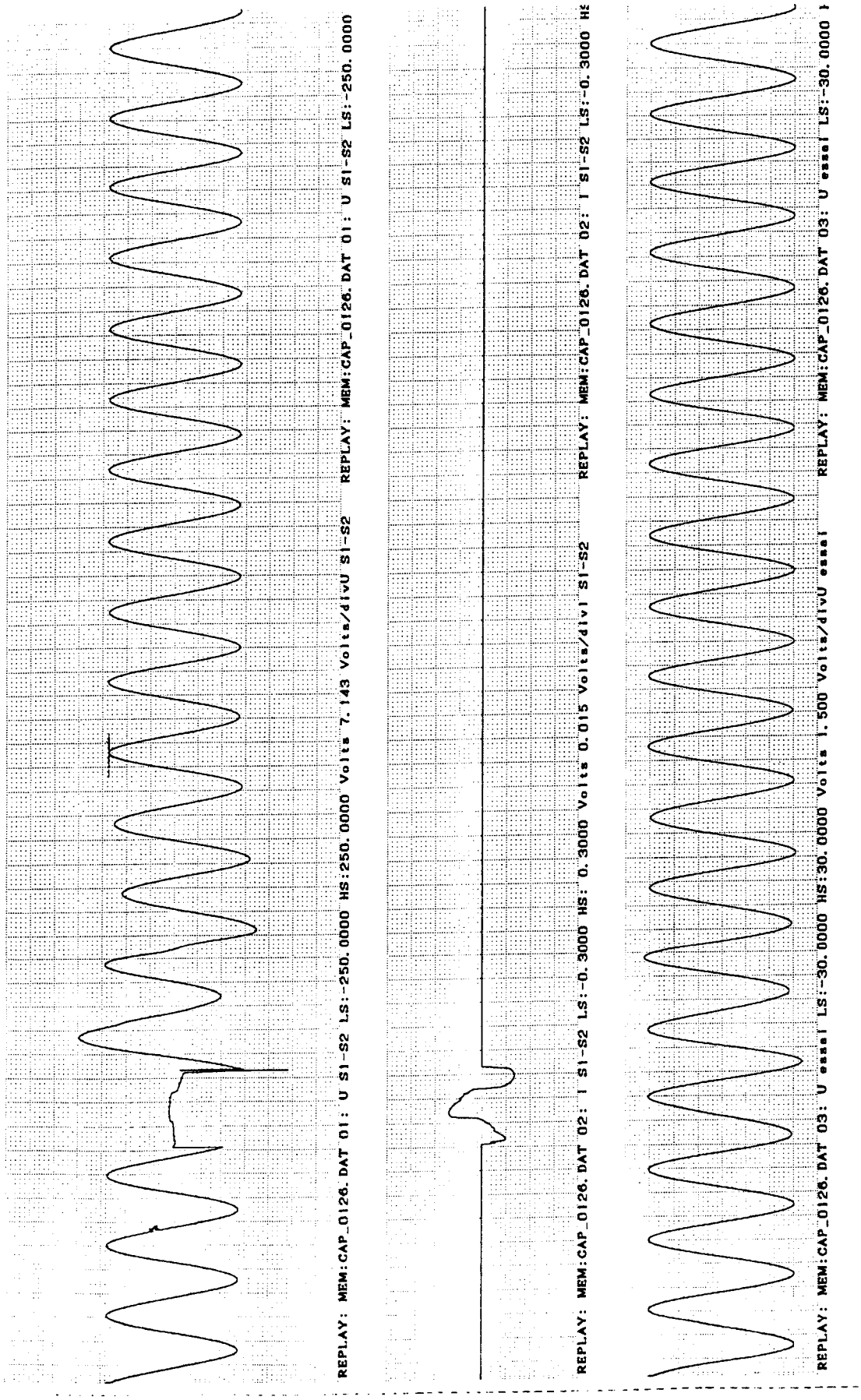
FERRO-RESONANCE a 1,2 U_{1n}



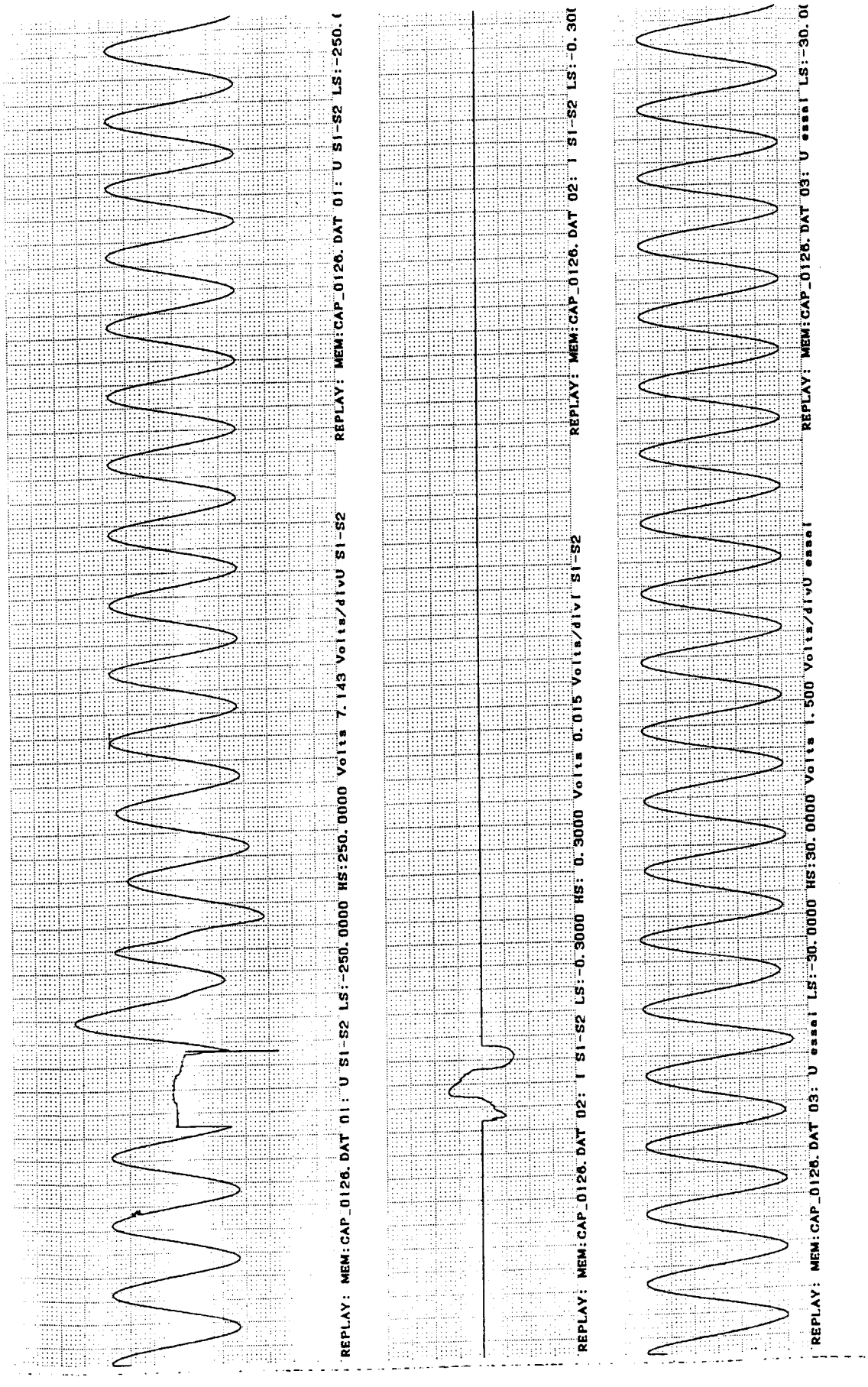
FERRO-RESONANCE a 1,2 U_{1n}



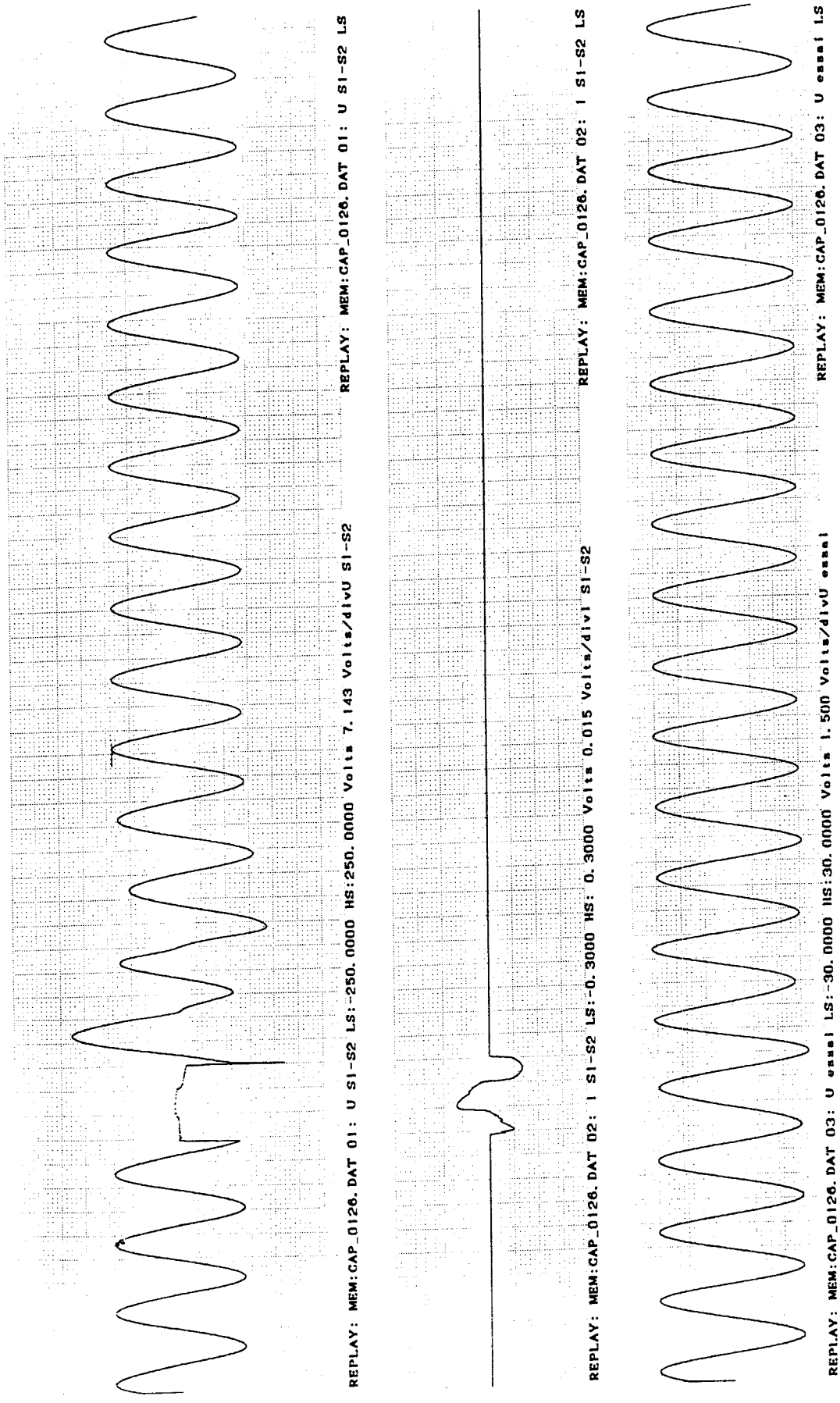
FERRO-RESONANCE a 1,2 U_{1n}



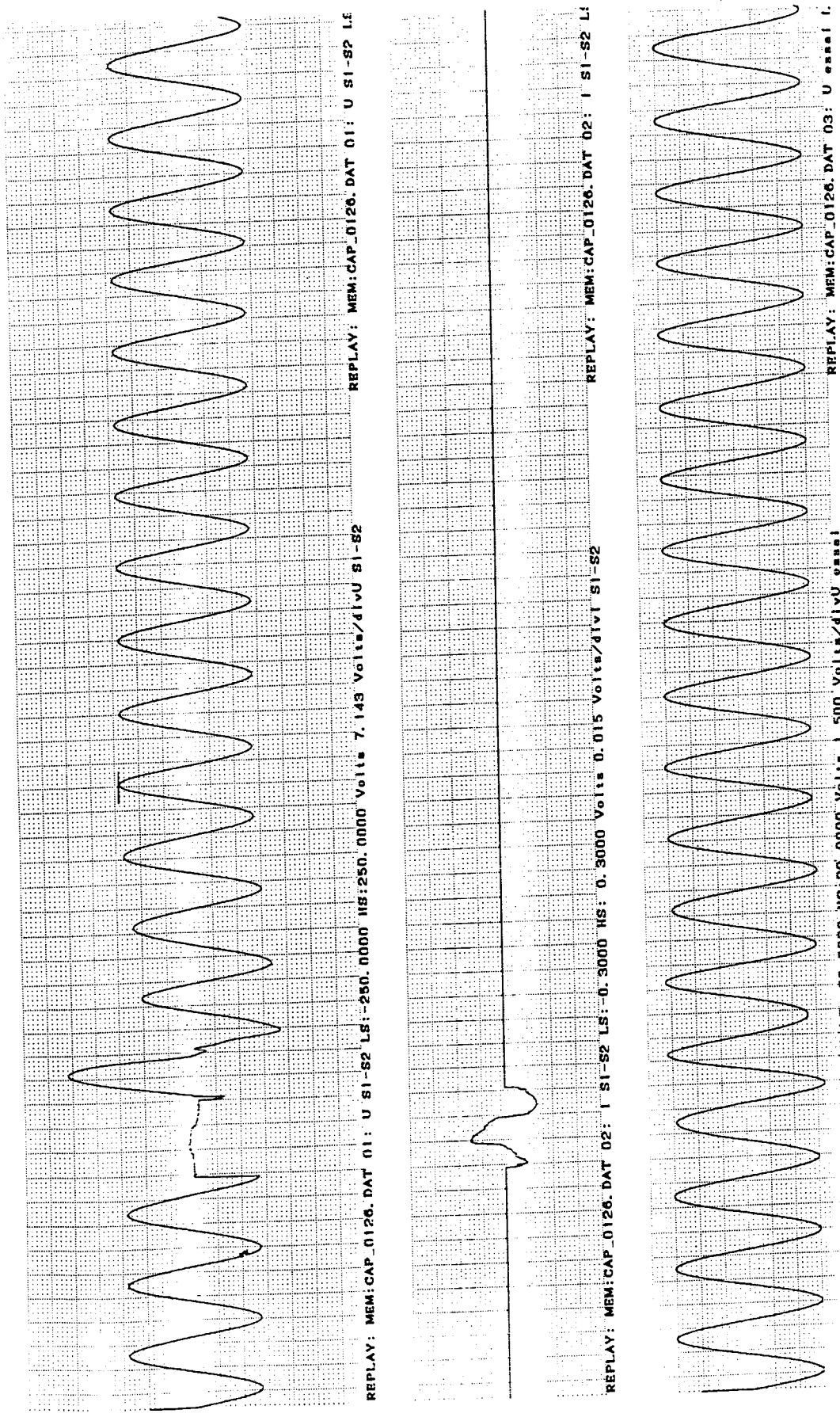
FERRO-RESONANCE a 1,2 U_{1n}



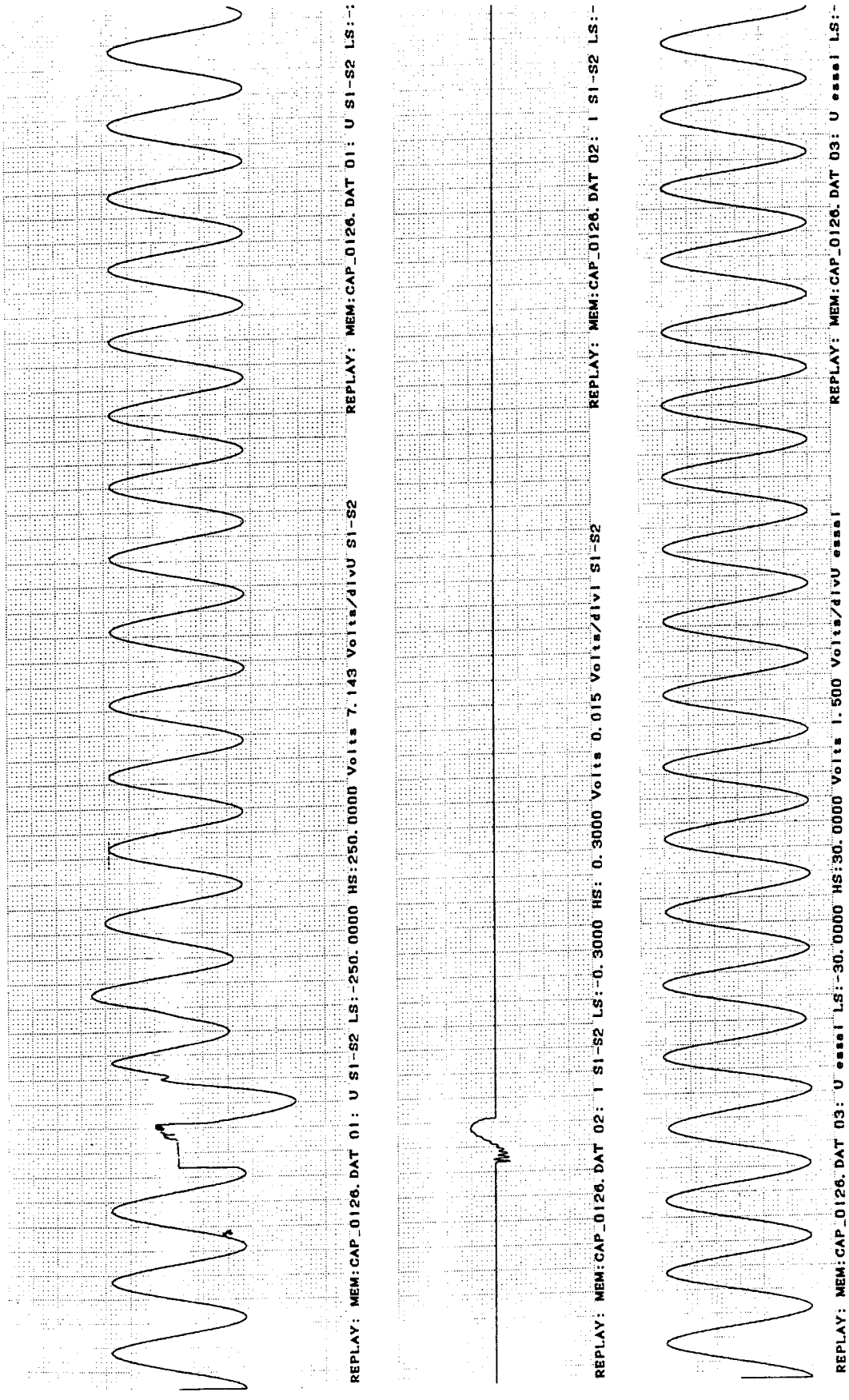
FERRO-RESONANCE a 1,2 U_{1n}



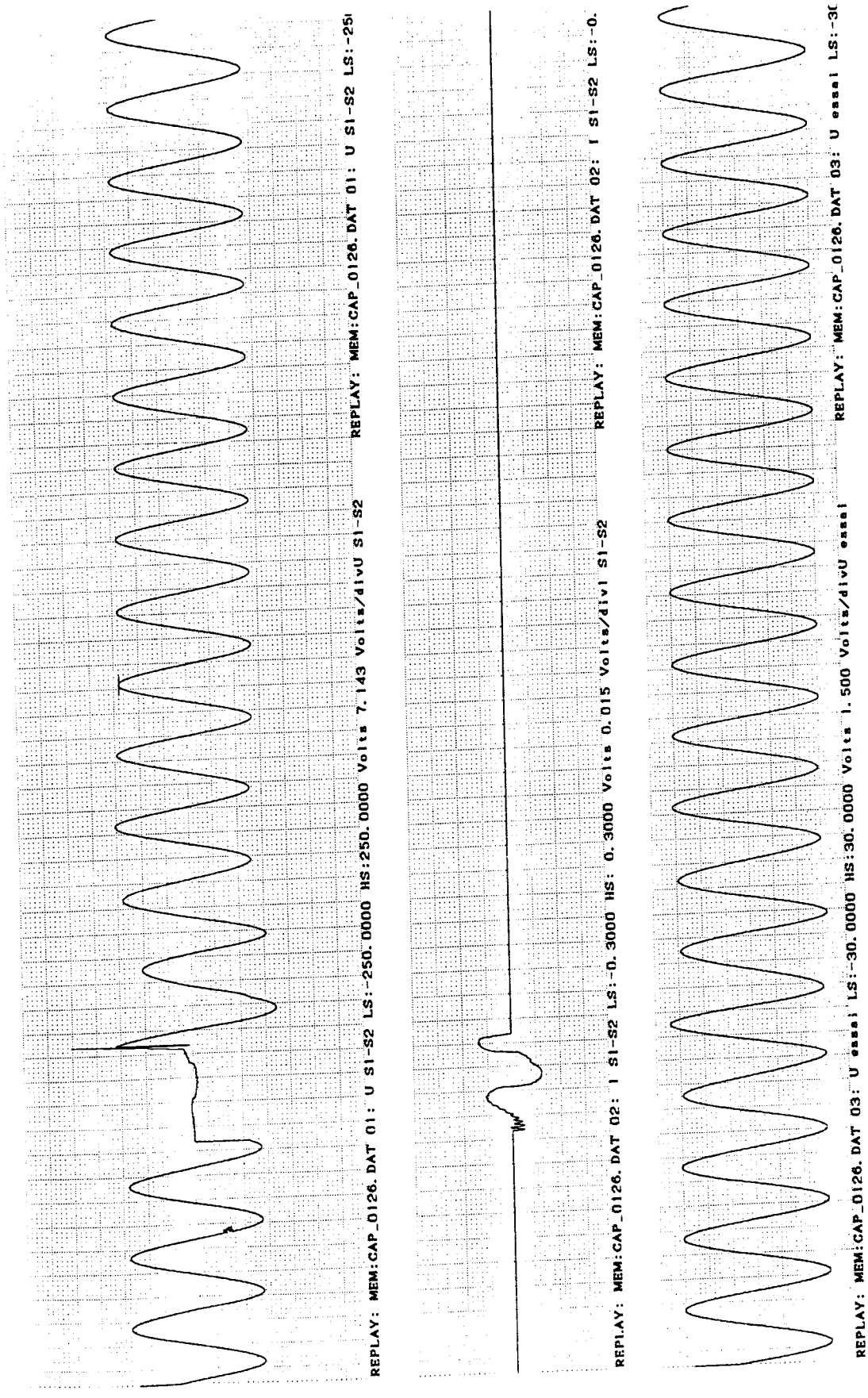
FERRO-RESONANCE a 1,2 U_{1n}



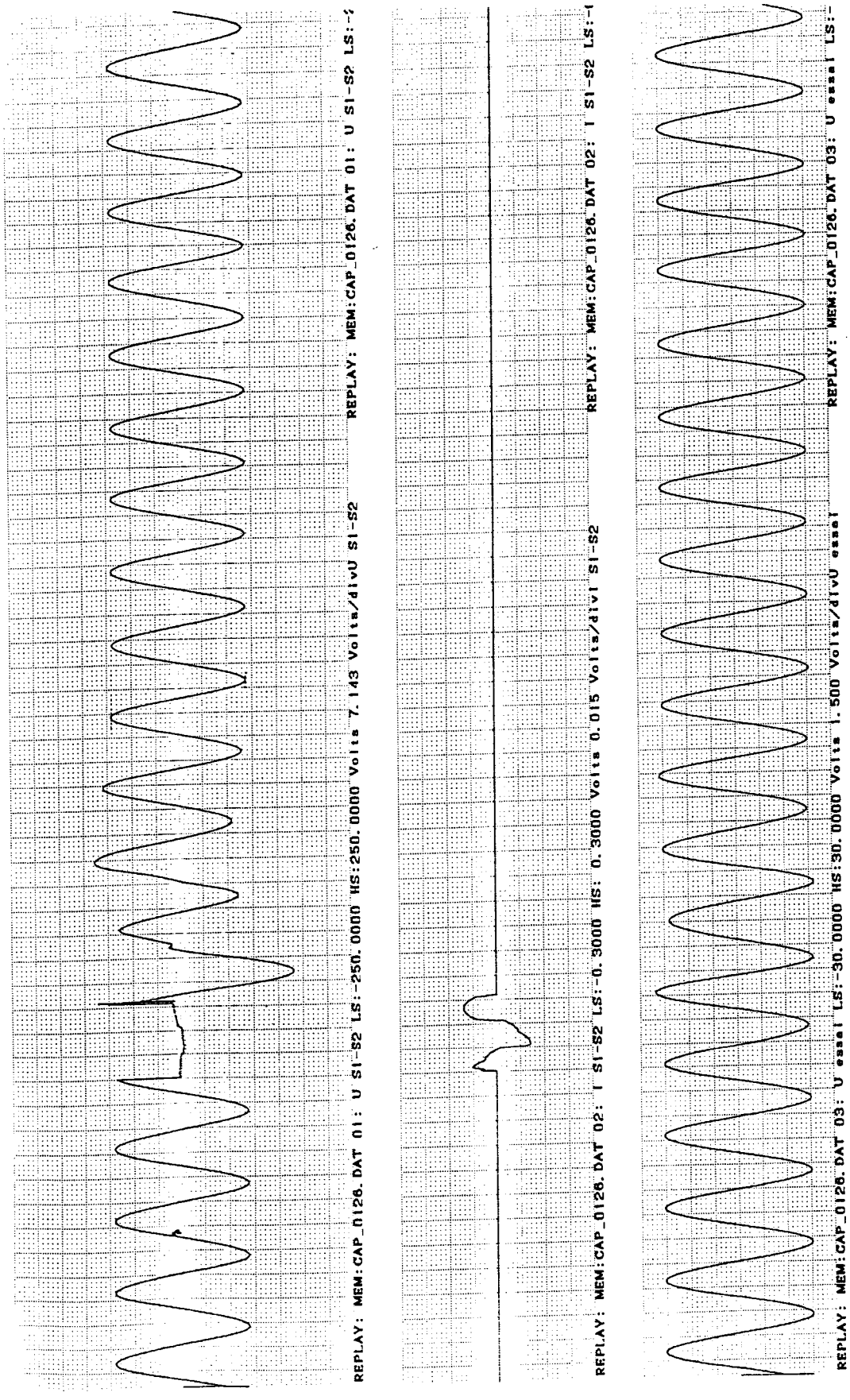
FERRO-RESONANCE a 1,2 U_{1n}



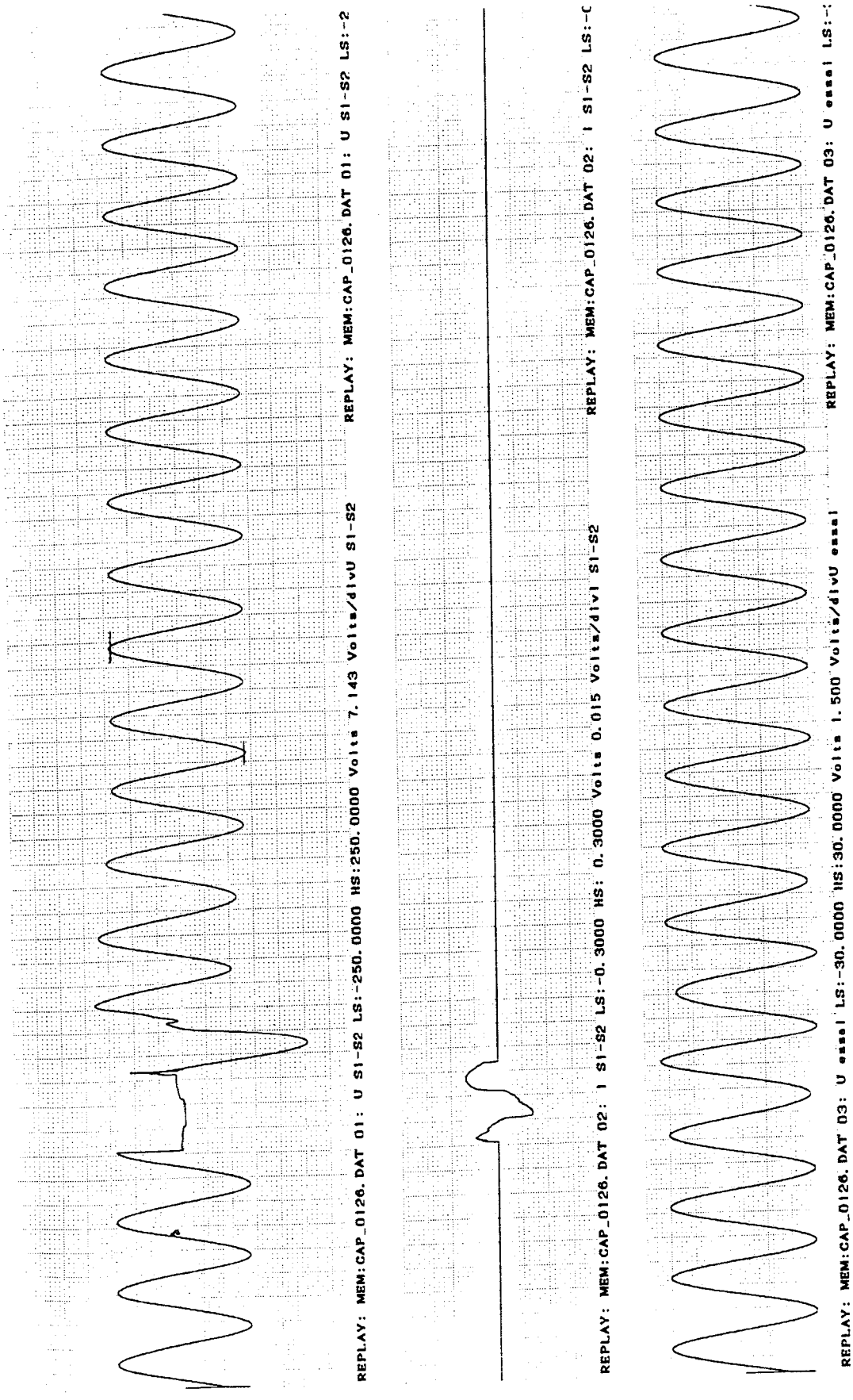
FERRO-RESONANCE a 1,2 U_{1n}



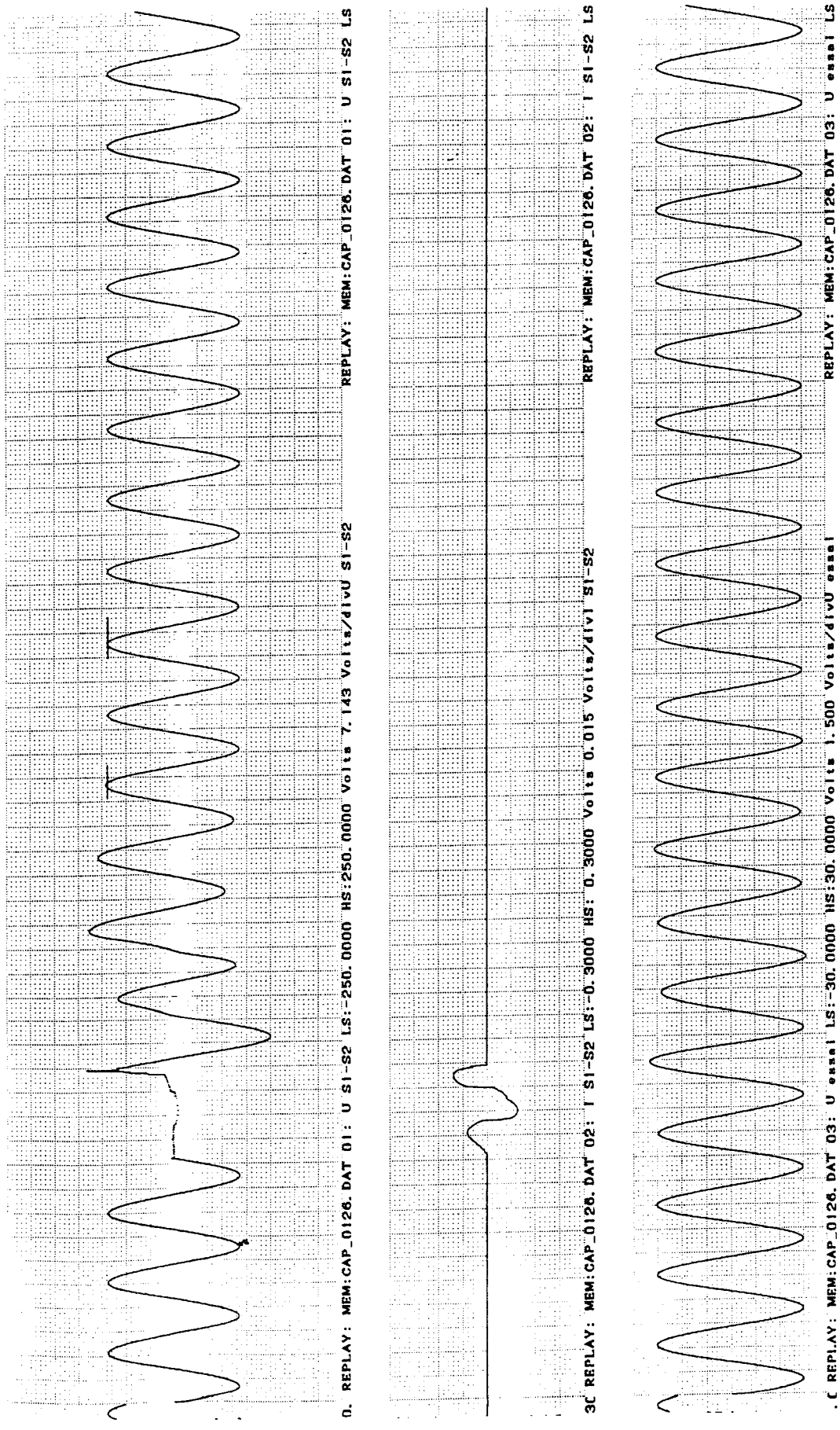
FERRO-RESONANCE a 1,2 U_{1n}



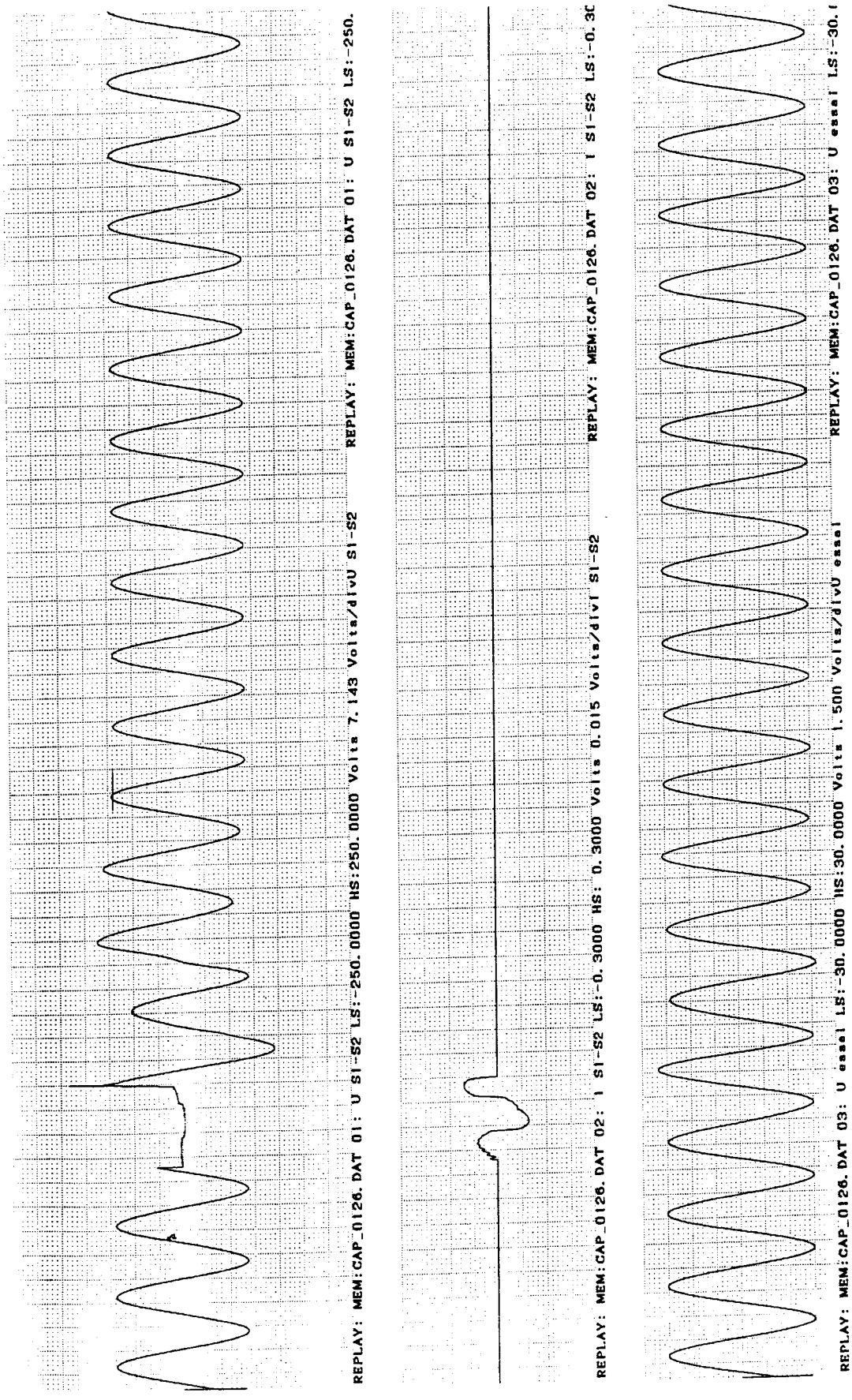
FERRO-RESONANCE a 1,2 U_{1n}



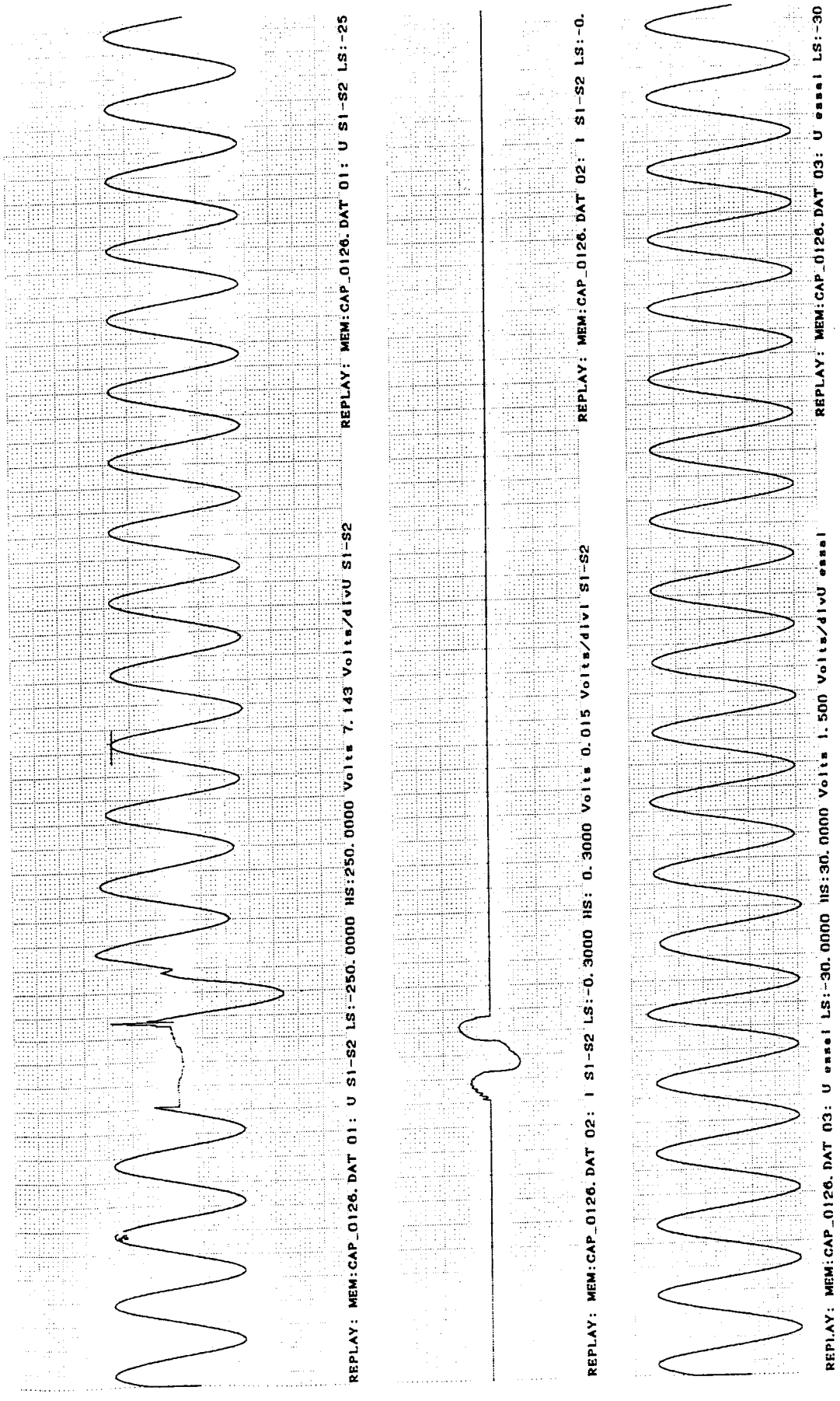
FERRO-RESONANCE a 1,2 U_{1n}



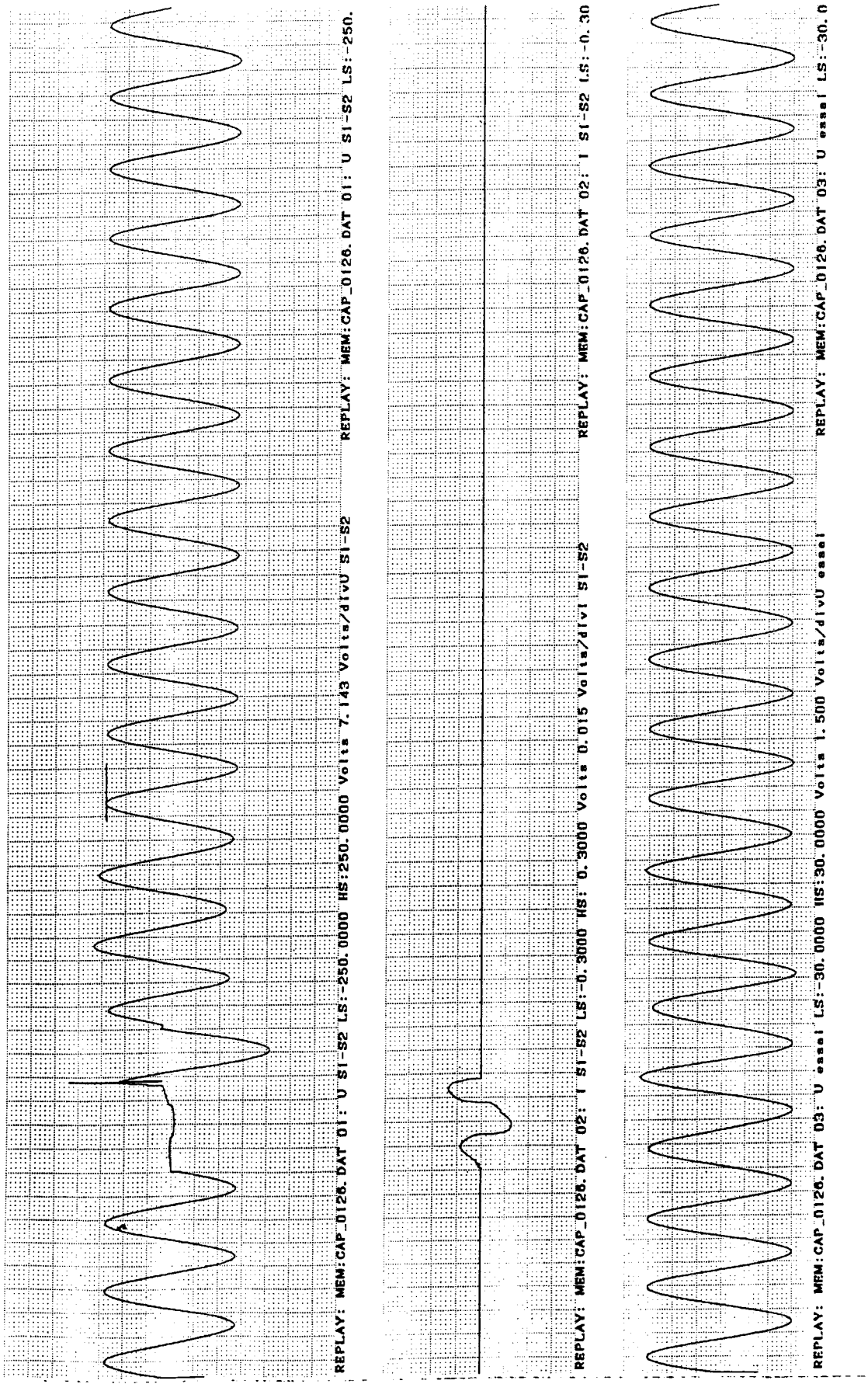
FERRO-RESONANCE a 1,2 U_{1n}



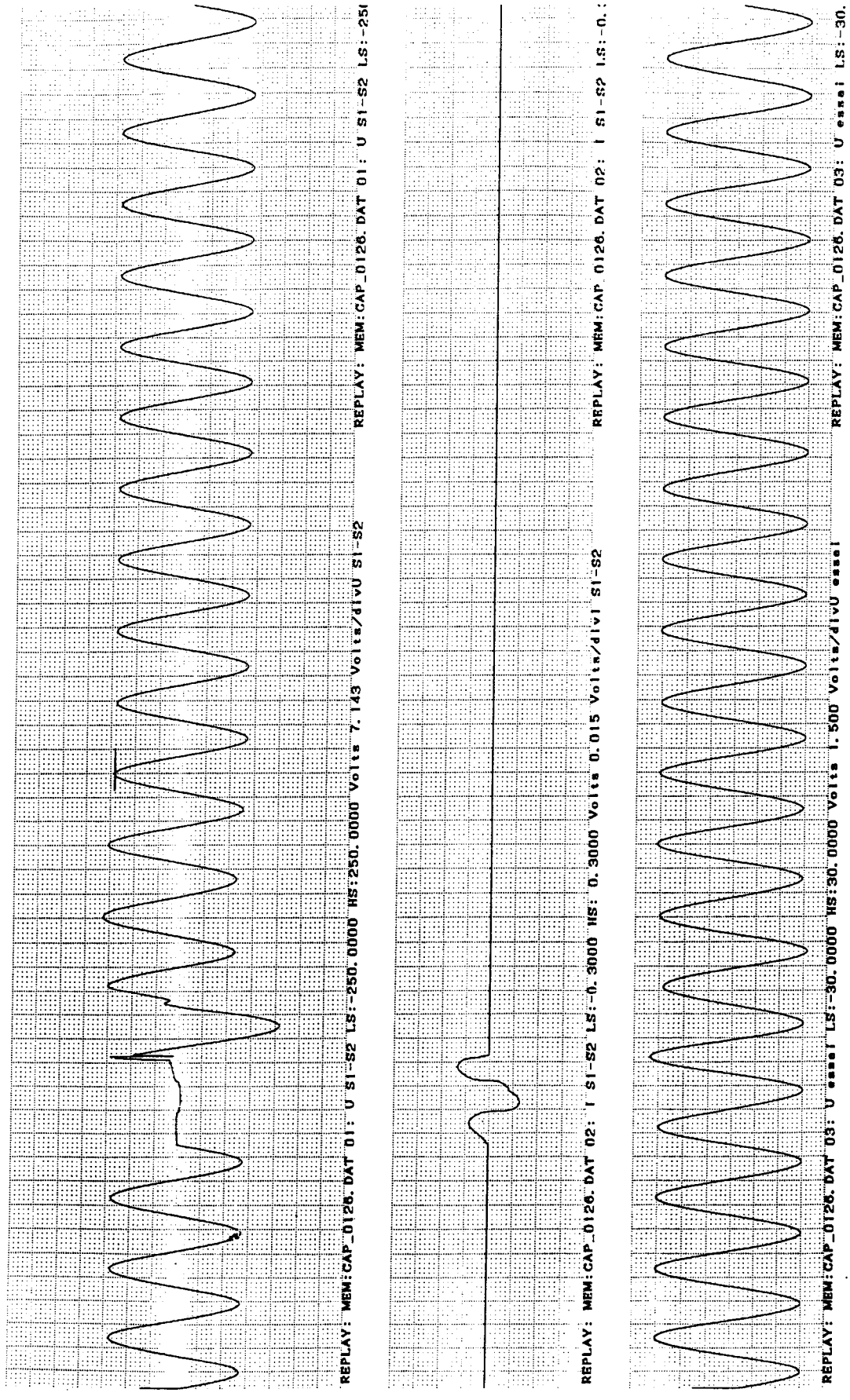
FERRO-RESONANCE à 1,2 U_{1n}



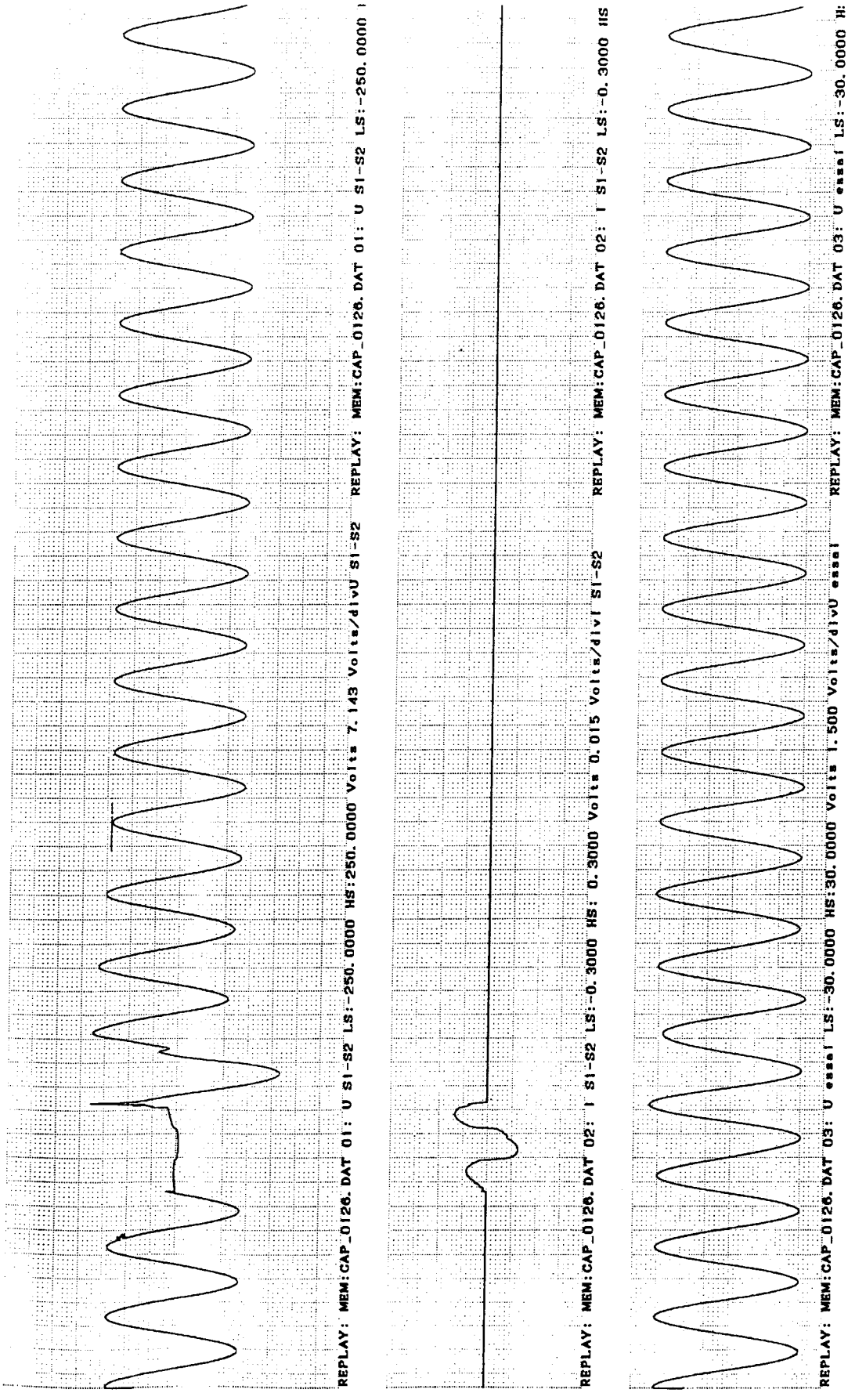
FERRO-RESONANCE a 1,2 U_{1n}



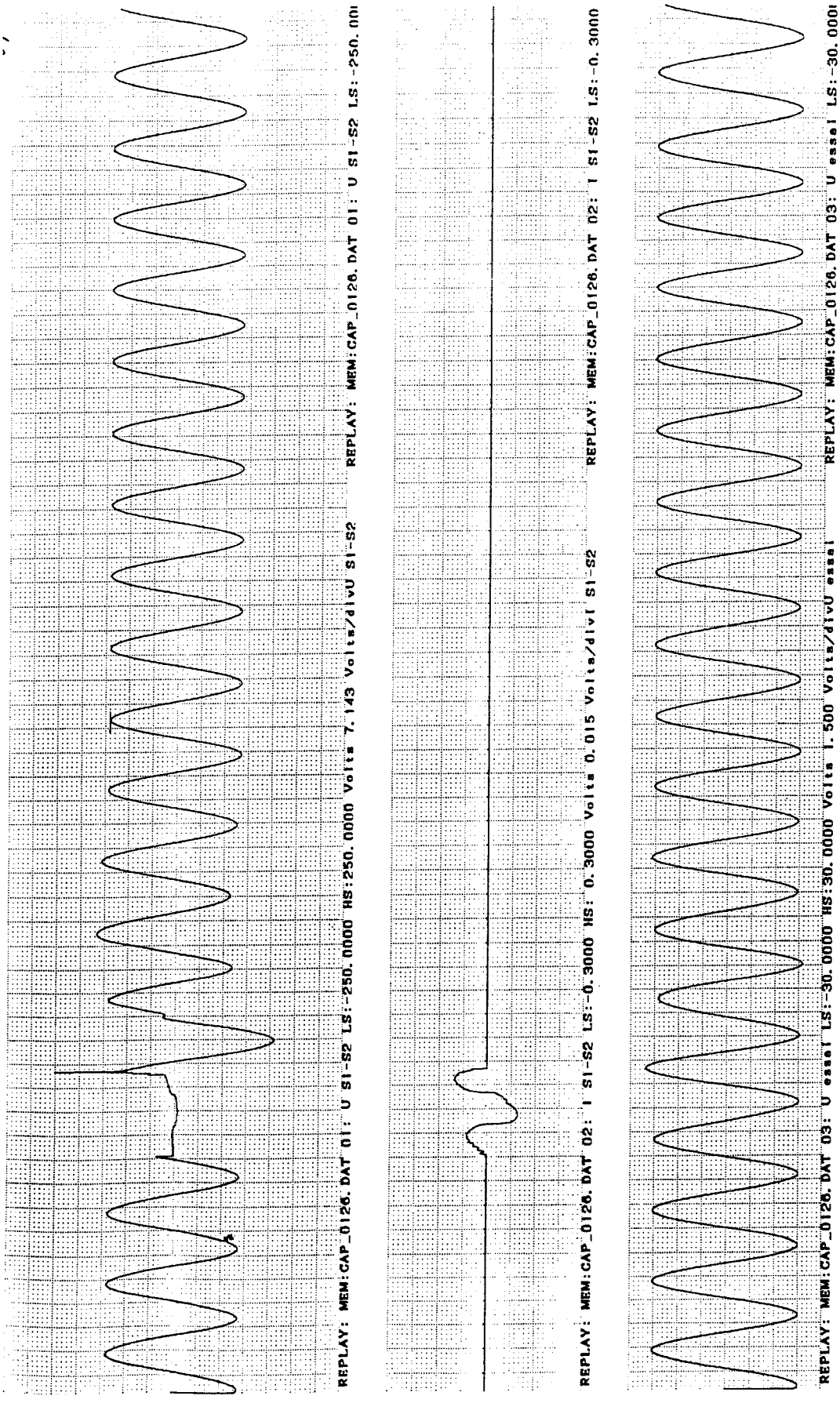
FERRO-RESONANCE a 1,2 U_{1n}



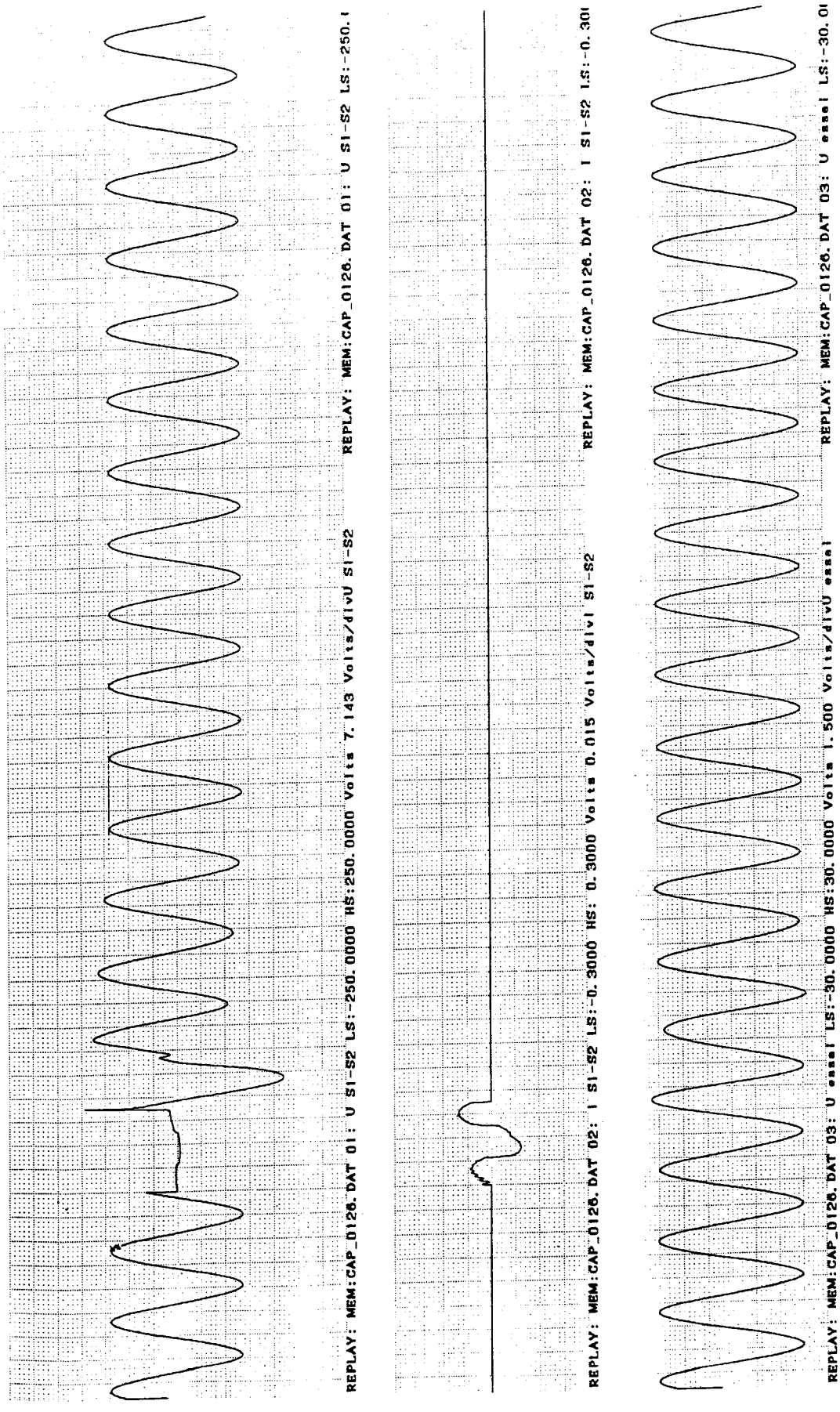
FERRO-RESONANCE a 1,2 U_{1n}



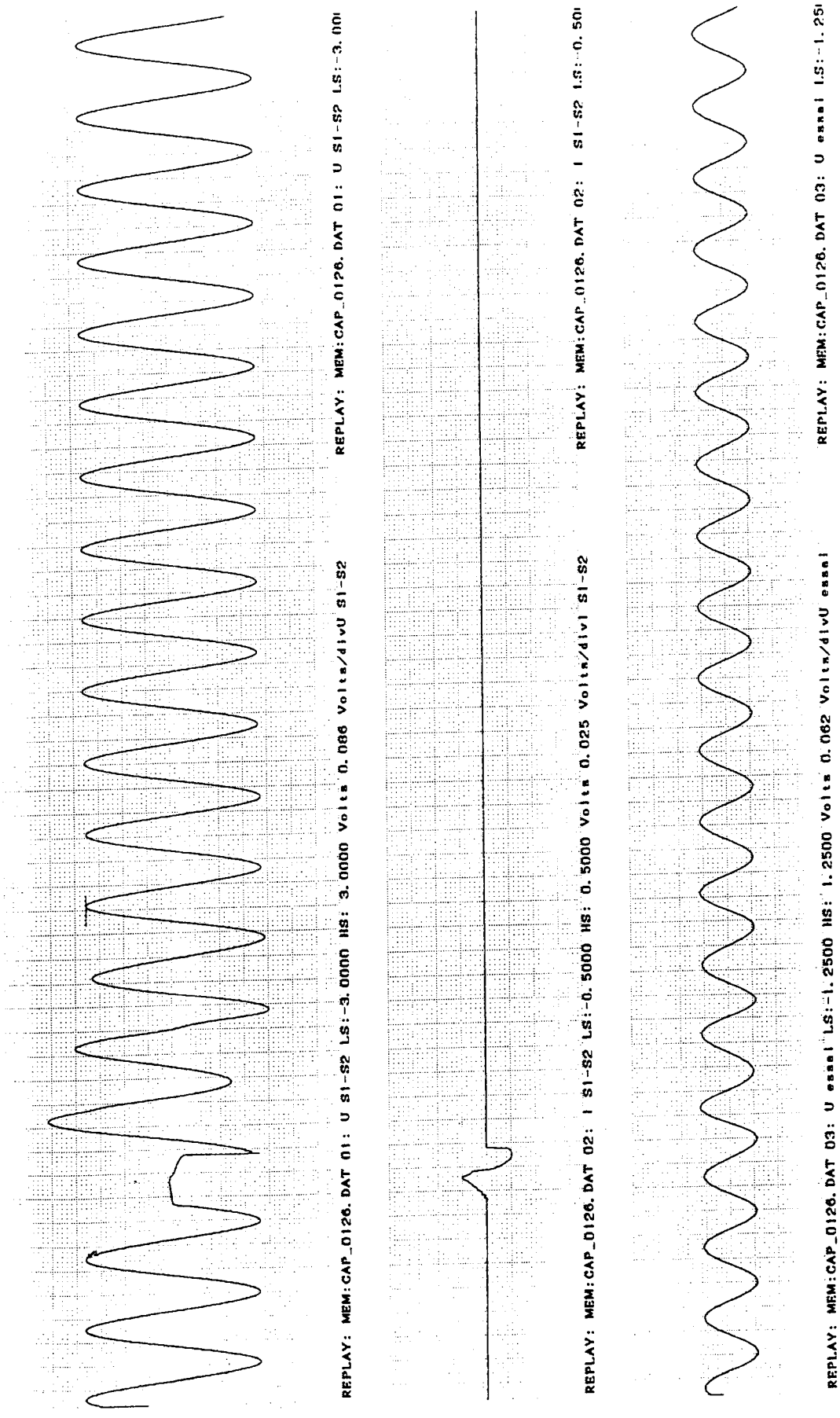
FERRO-RESONANCE a 1,2 U_{1n}



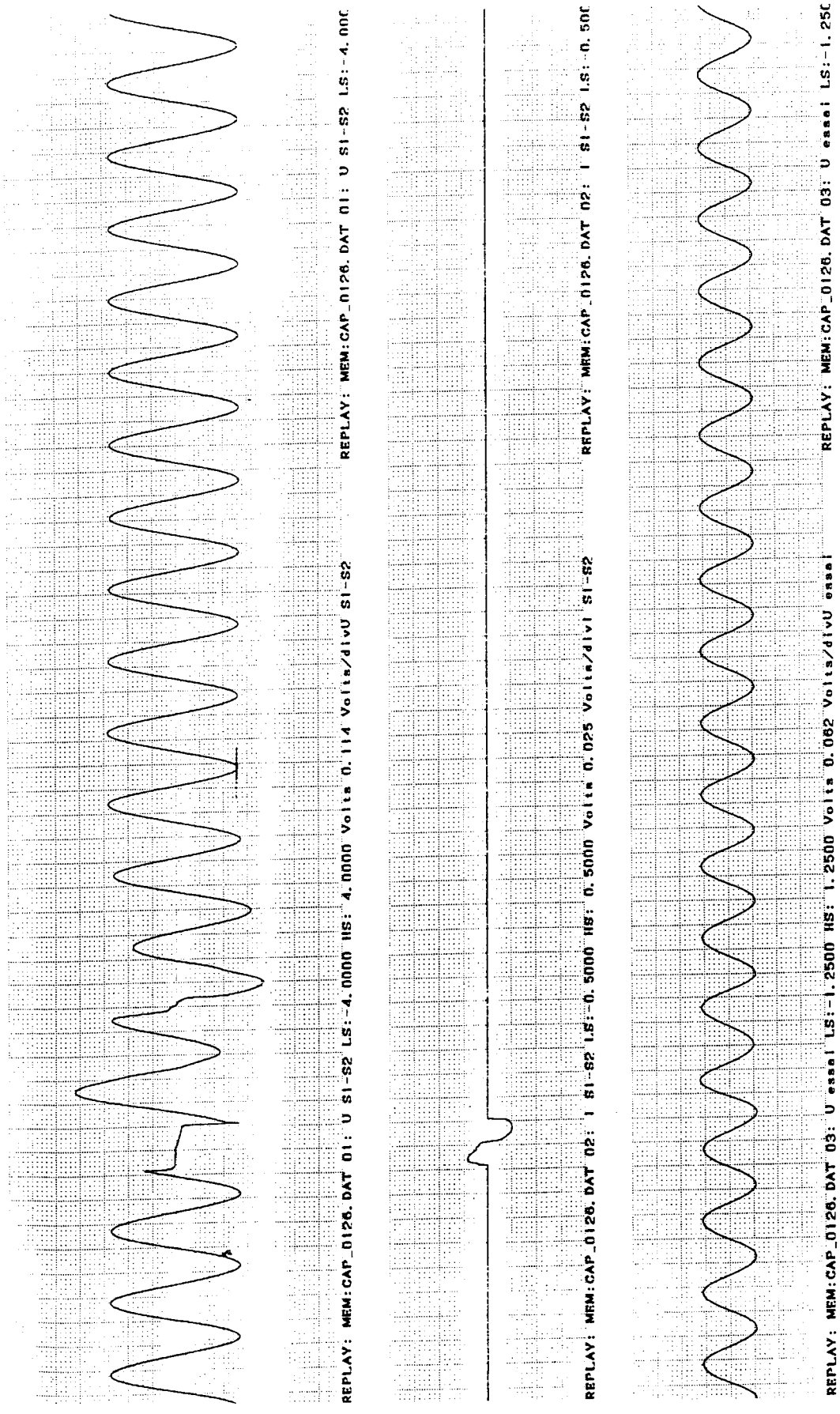
FERRO-RESONANCE a 1,2 U_{1n}



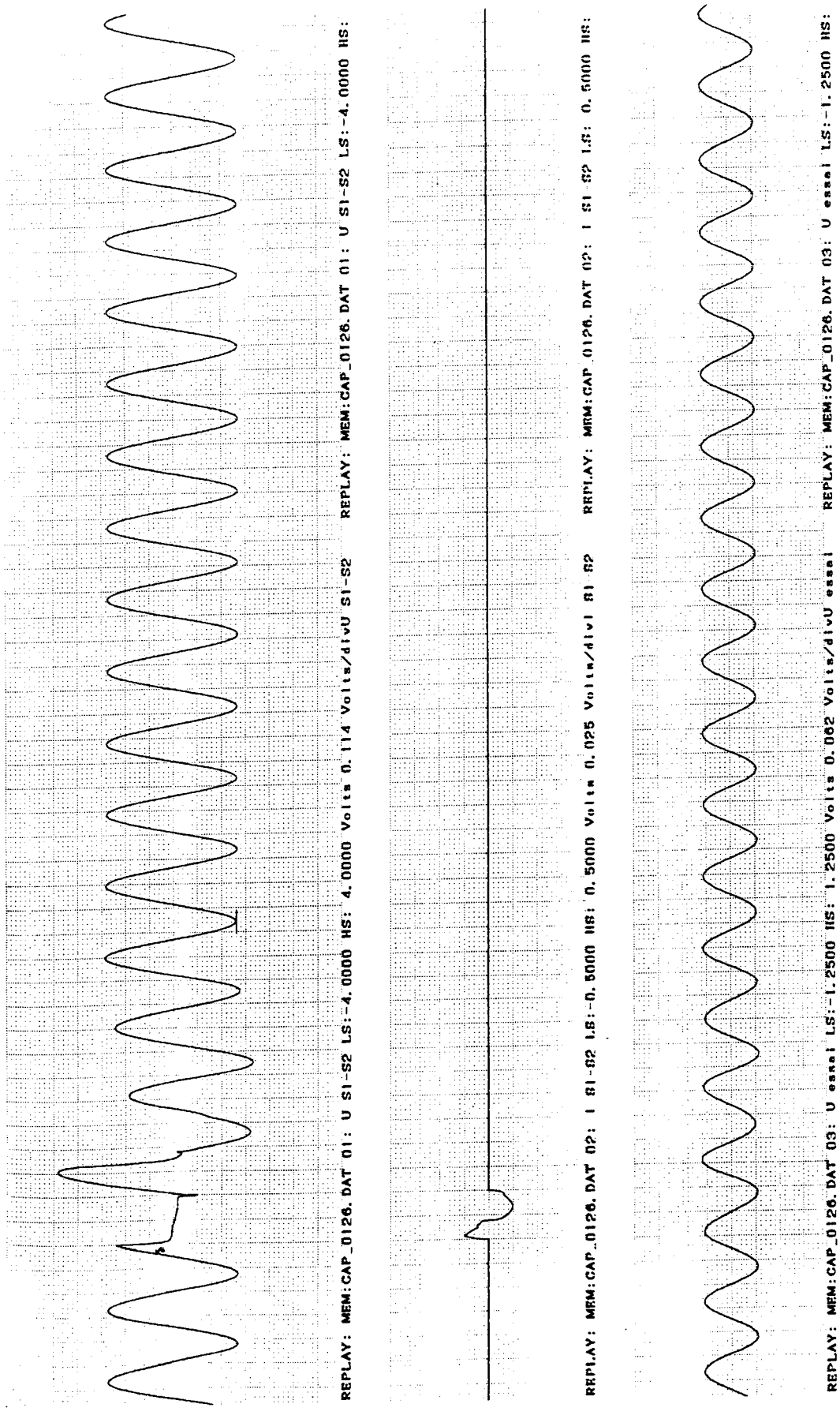
FERRO-RESONANCE a 1,9 U_{1n}



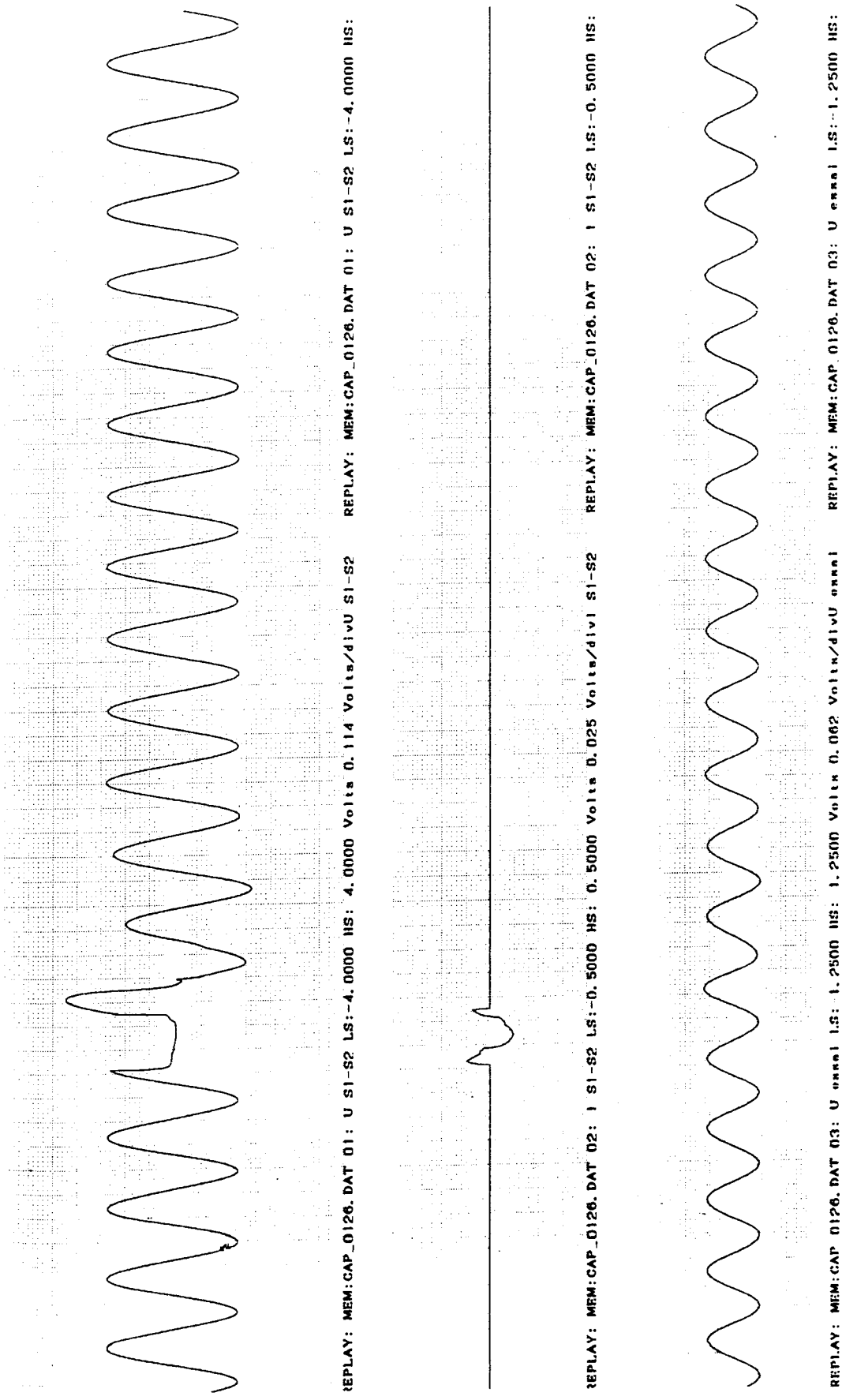
FERRO-RESONANCE a 1,9 U_{1n}



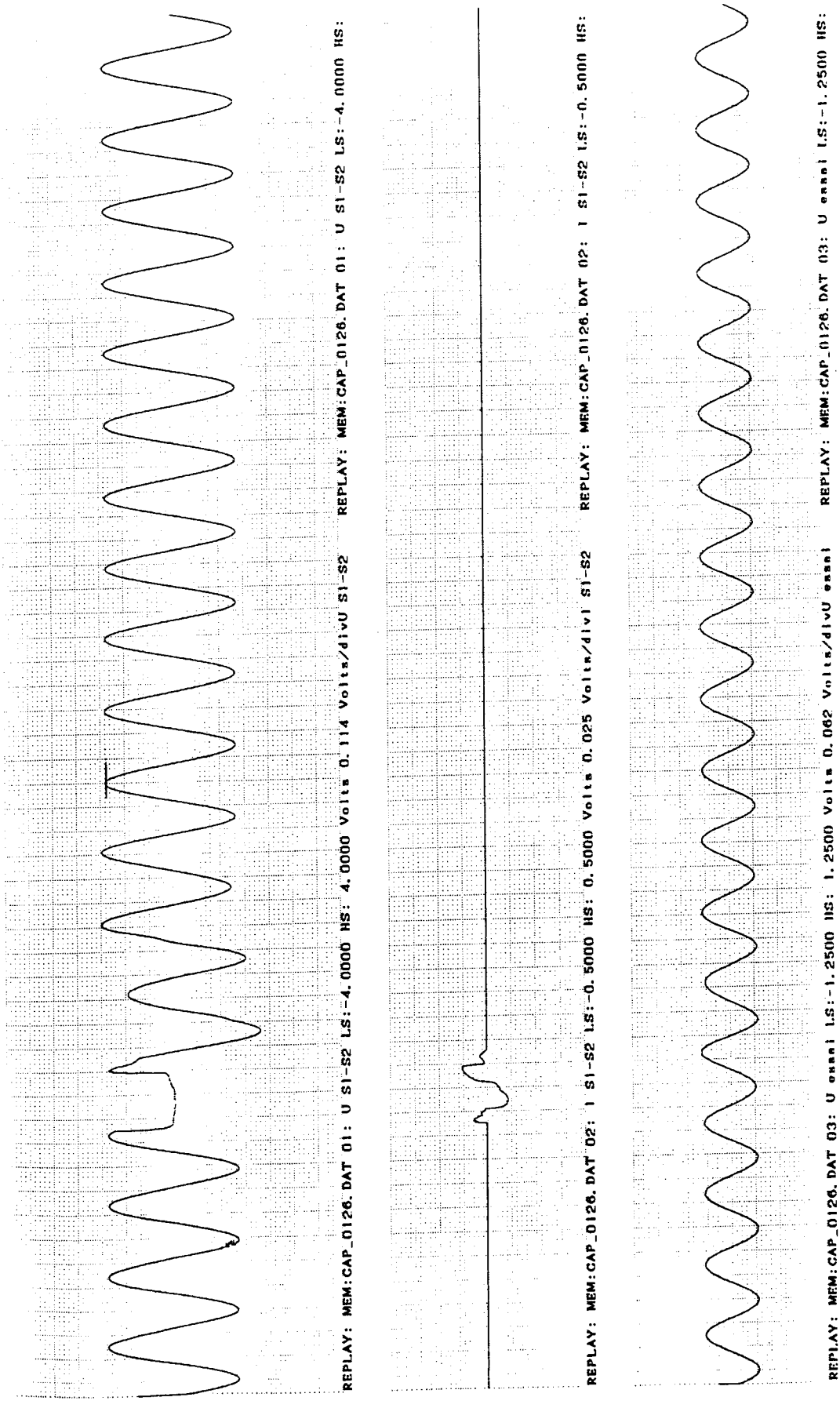
FERRO-RESONANCE a 1,9 U_{1n}



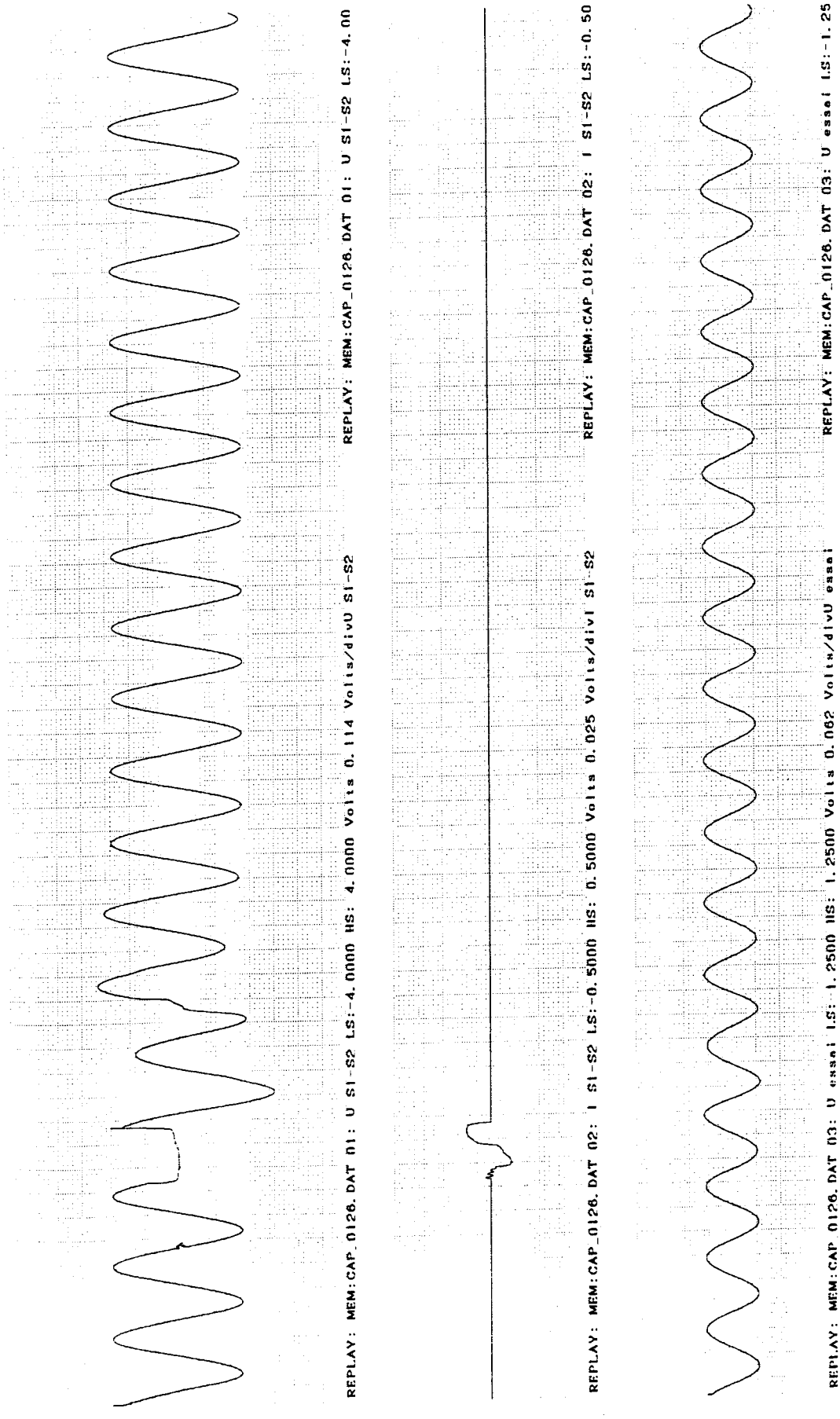
FERRO-RESONANCE a 1,9 U_{1n}



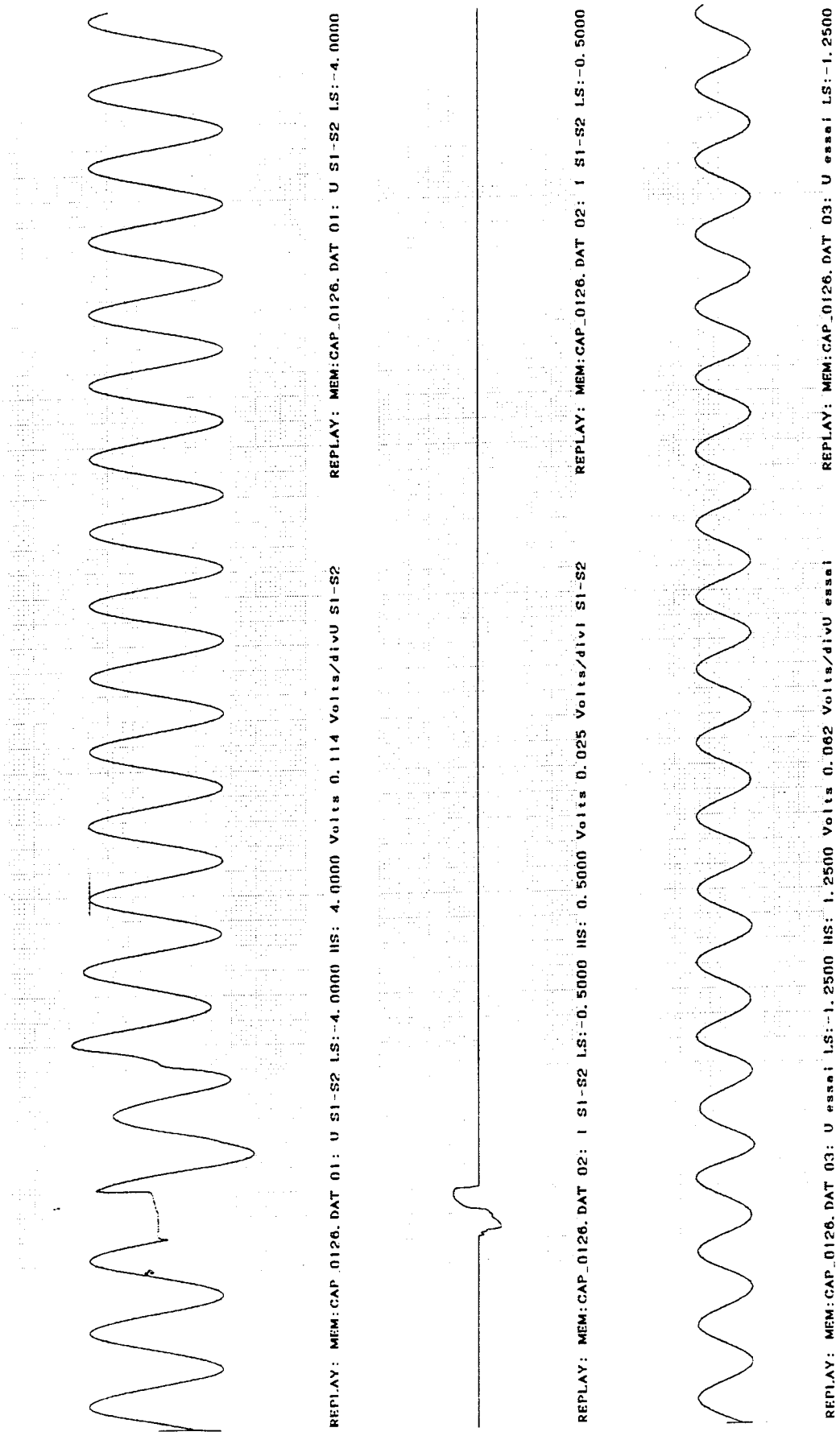
FERRO-RESONANCE a 1,9 U_{1n}



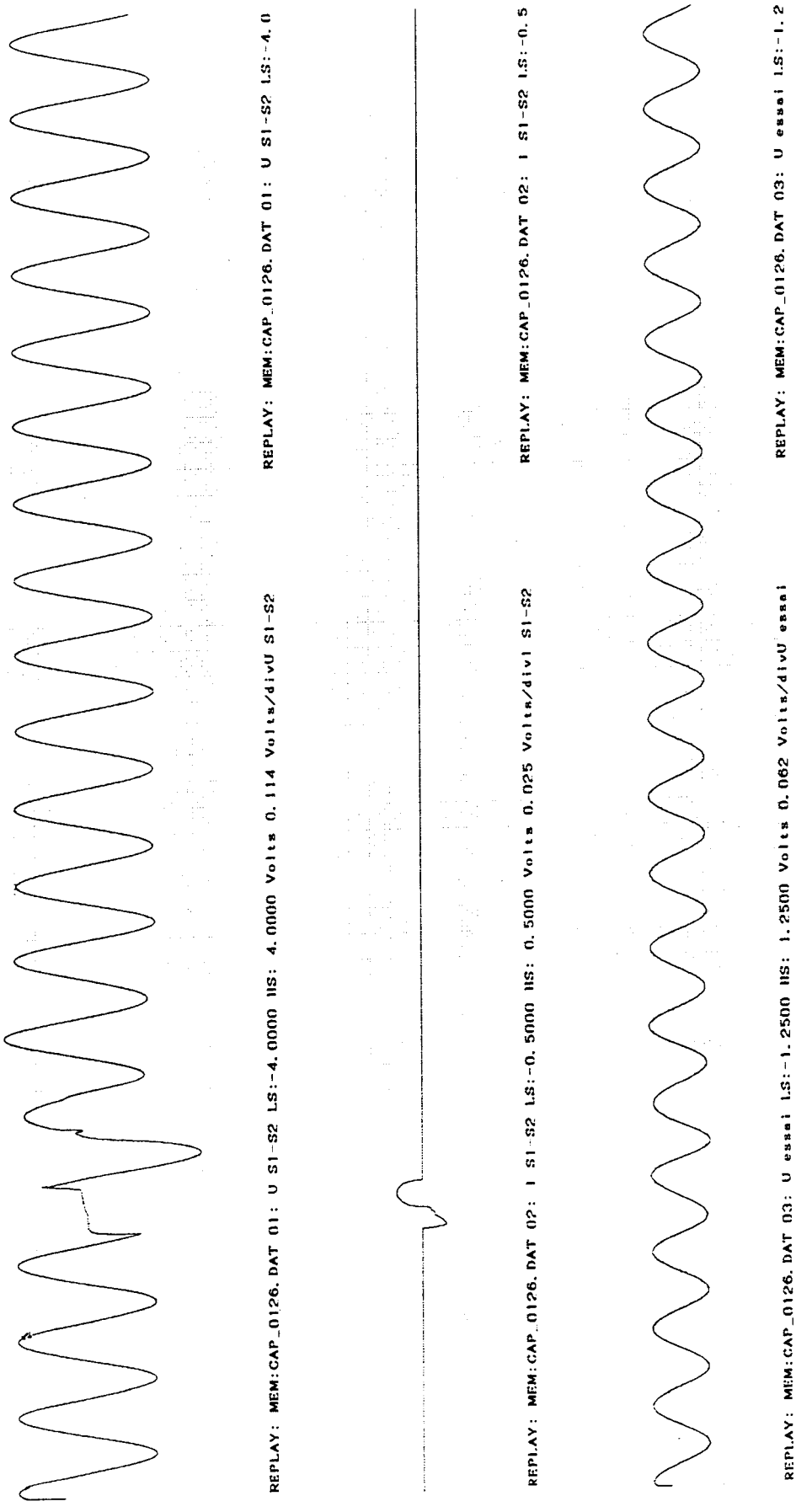
FERRO-RESONANCE a 1,9 U_{1n}



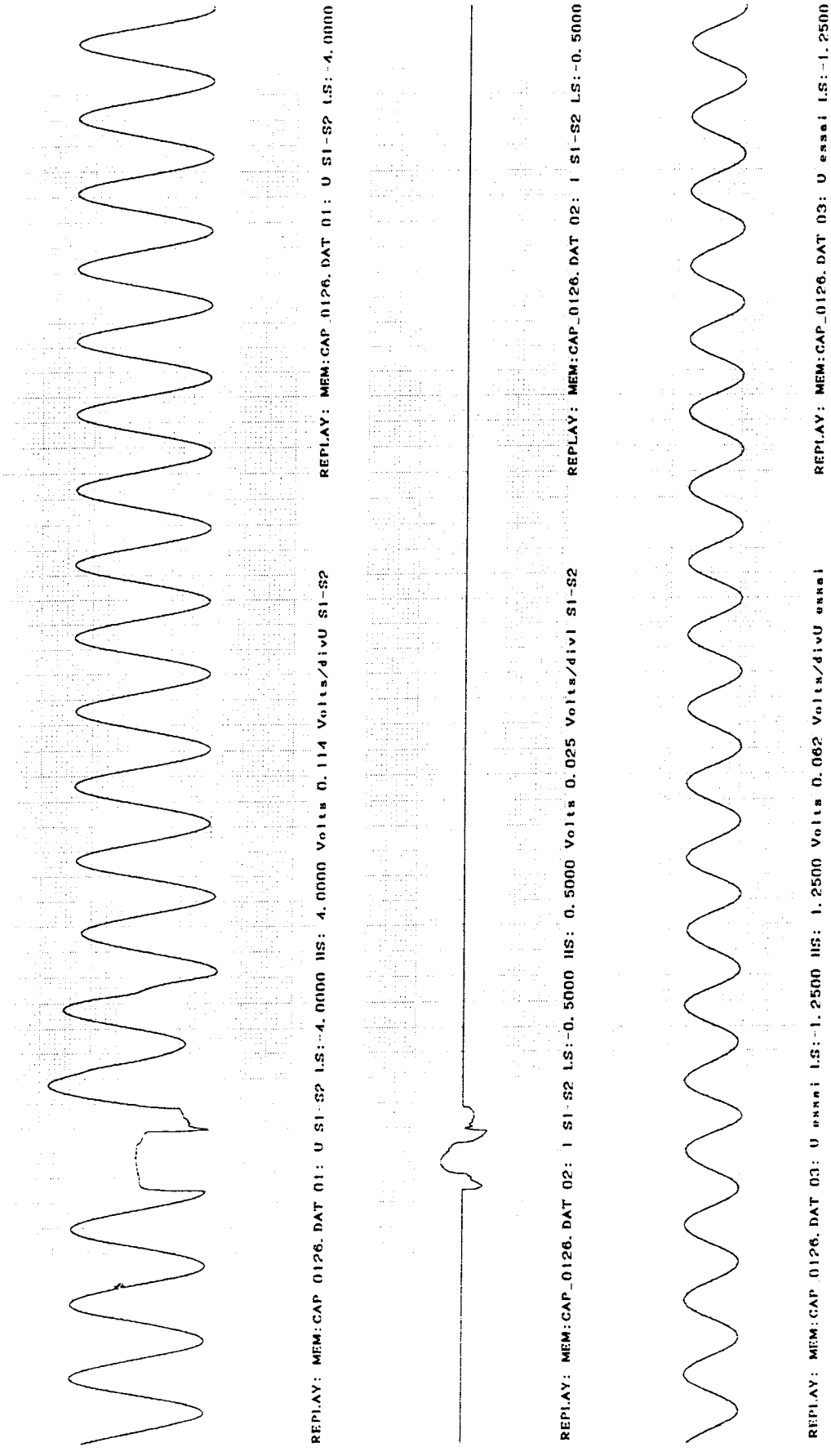
FERRO-RESONANCE a 1,9 U_{1n}



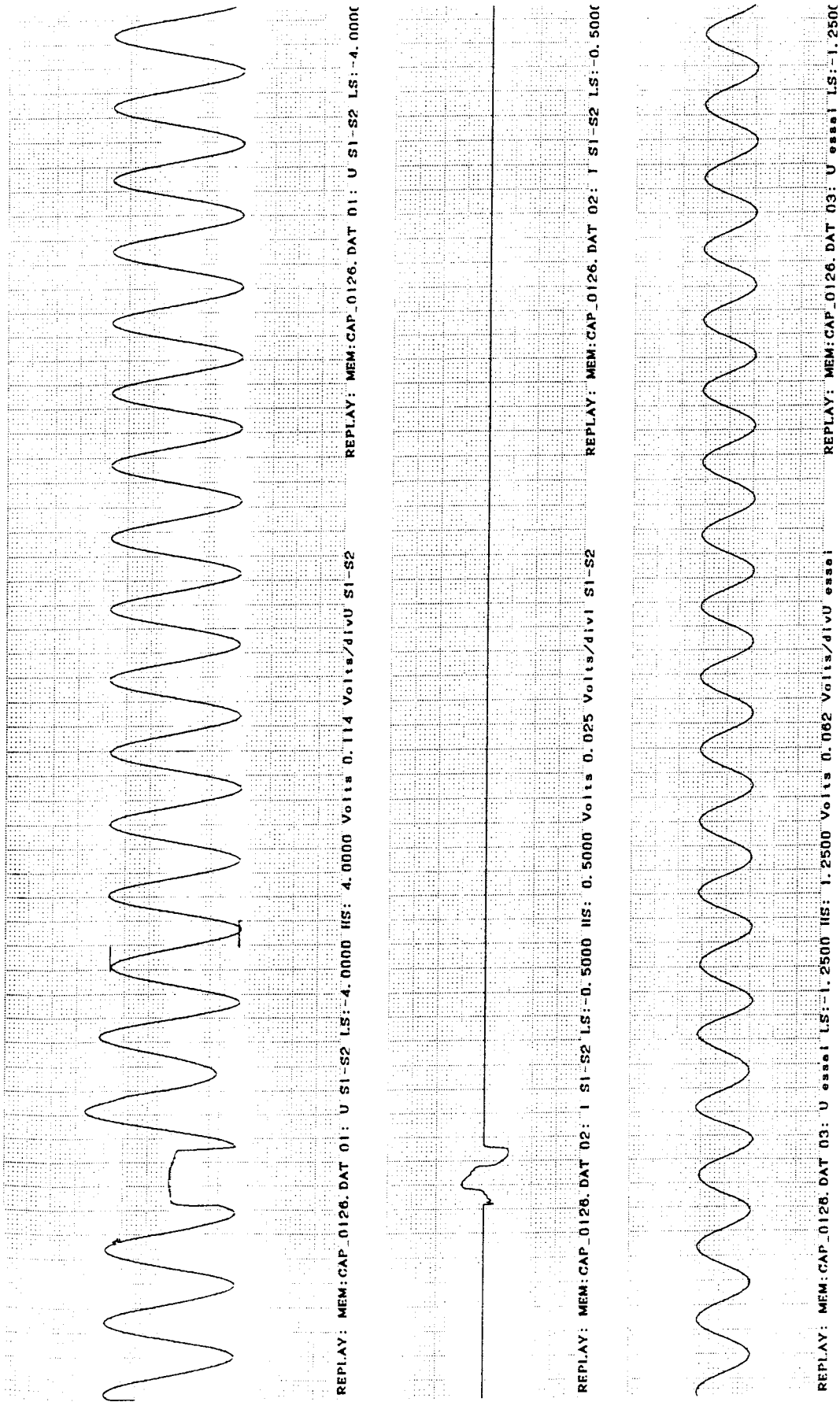
FERRO-RESONANCE a 1,9 U_{1n}



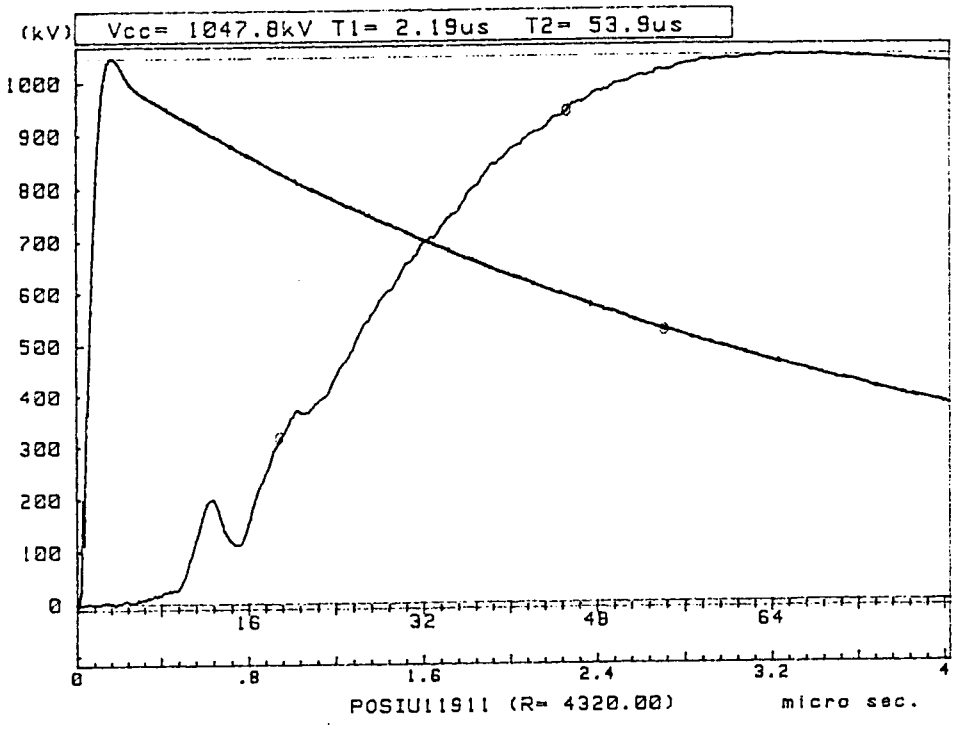
FERRO-RESONANCE a 1,9 U_{1n}



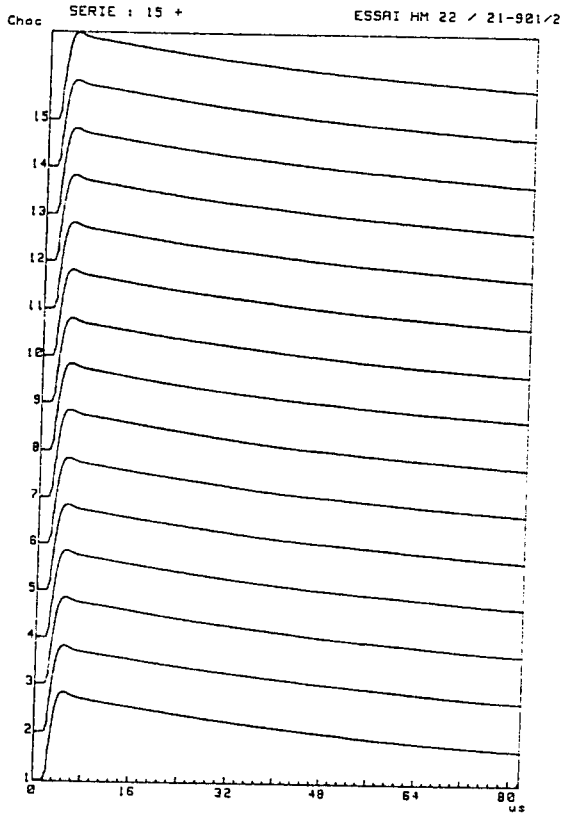
FERRO-RESONANCE a 1,9 U_{1n}



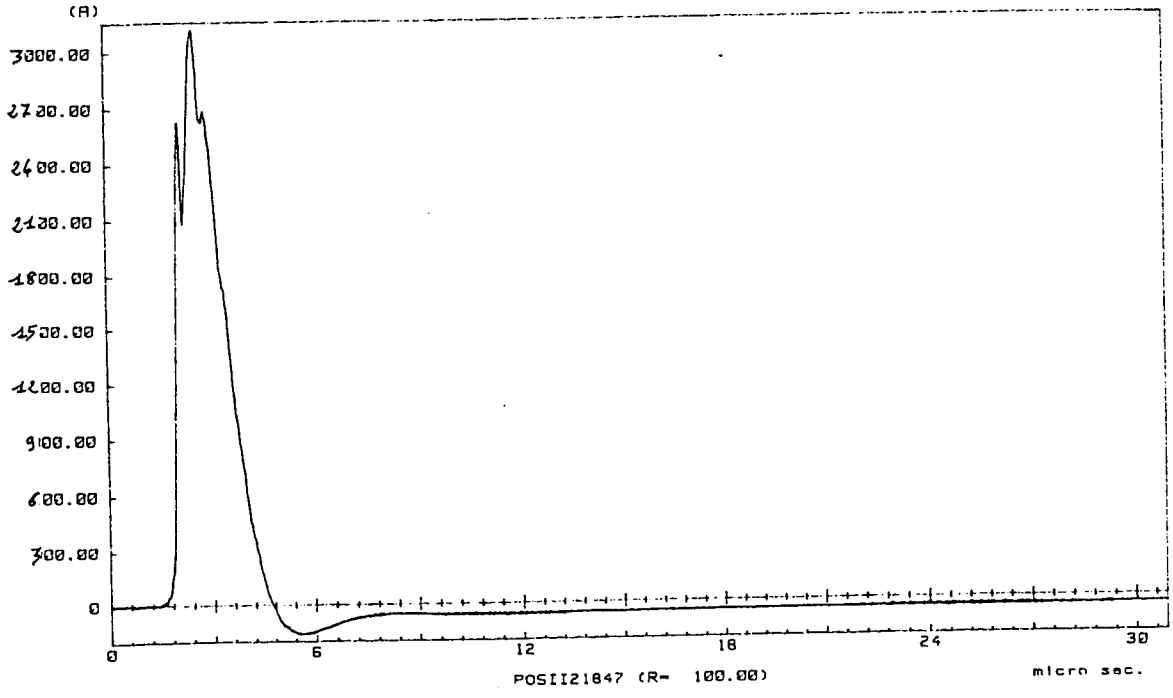
POSITIVE WAVE SHAPE



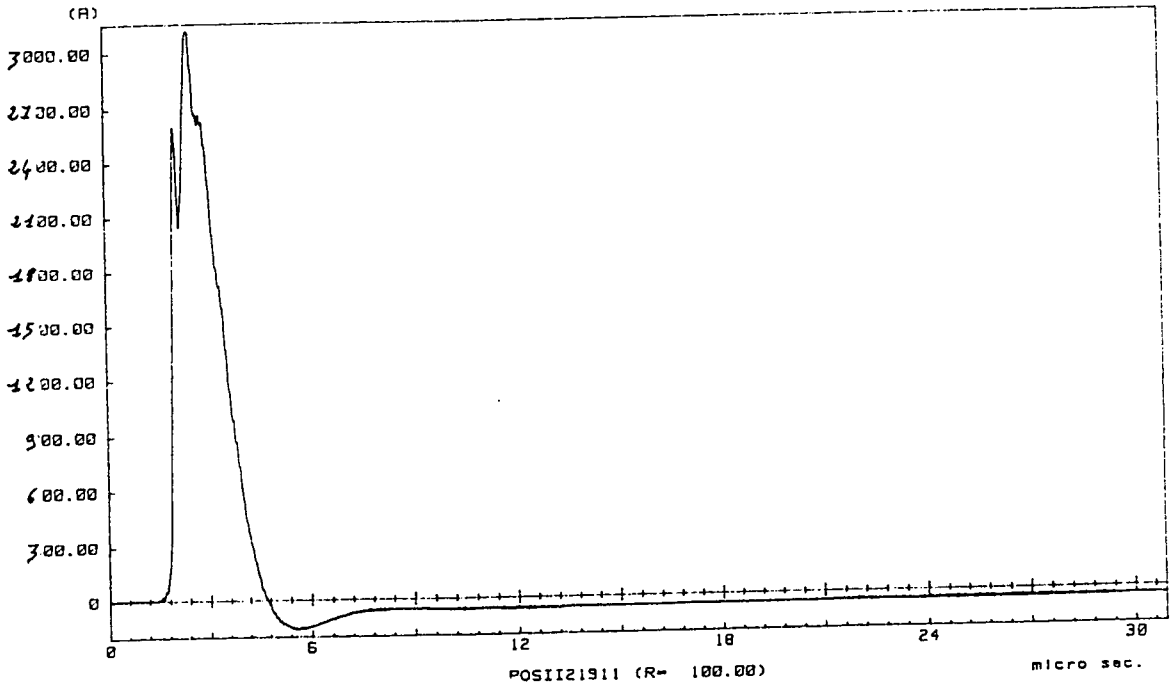
15 POSITIVE LIGHTNING SERIE



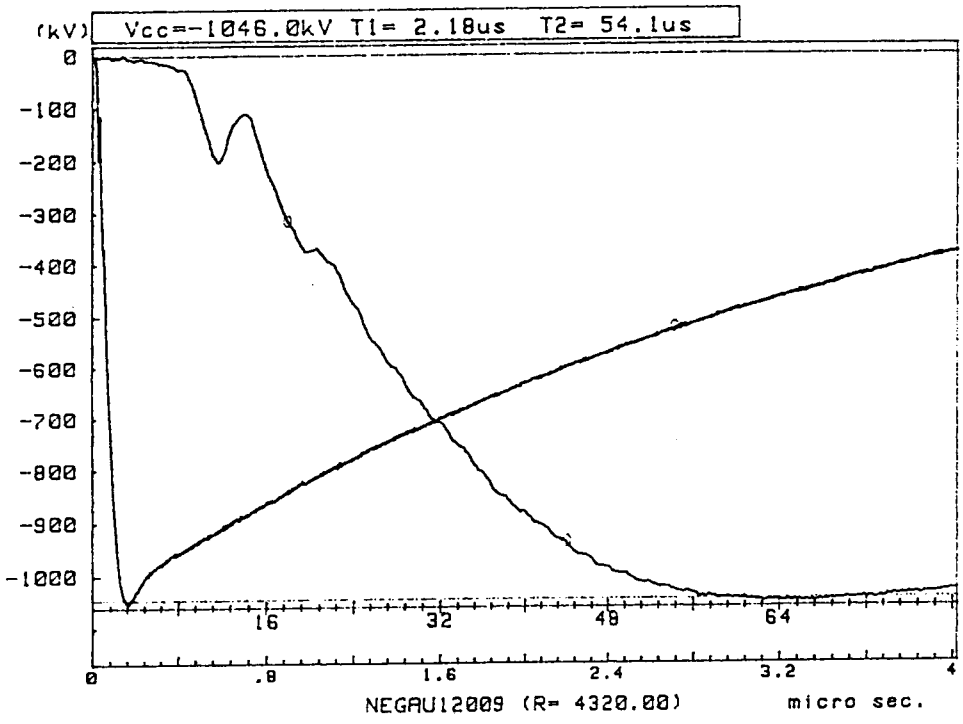
HF CURRENT OF THE FIRST POSITIVE LIGHTNING



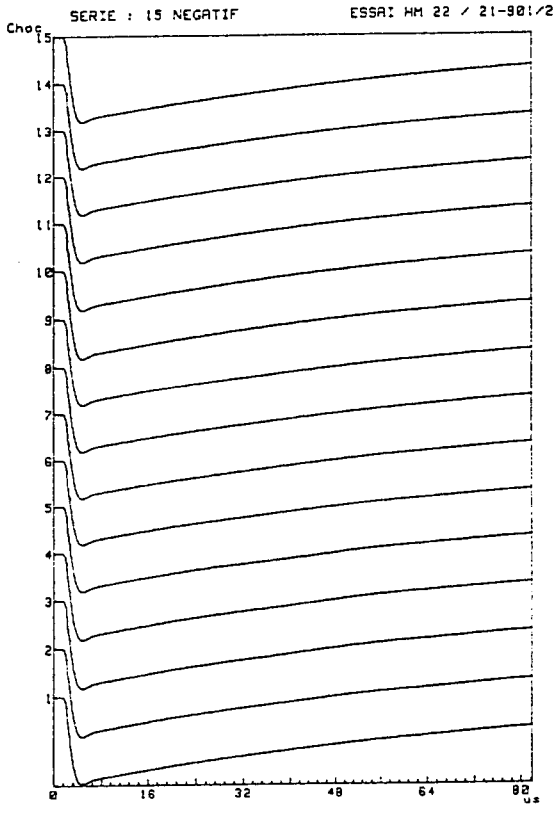
HF CURRENT OF THE FIFTEENTH POSITIVE LIGHTNING



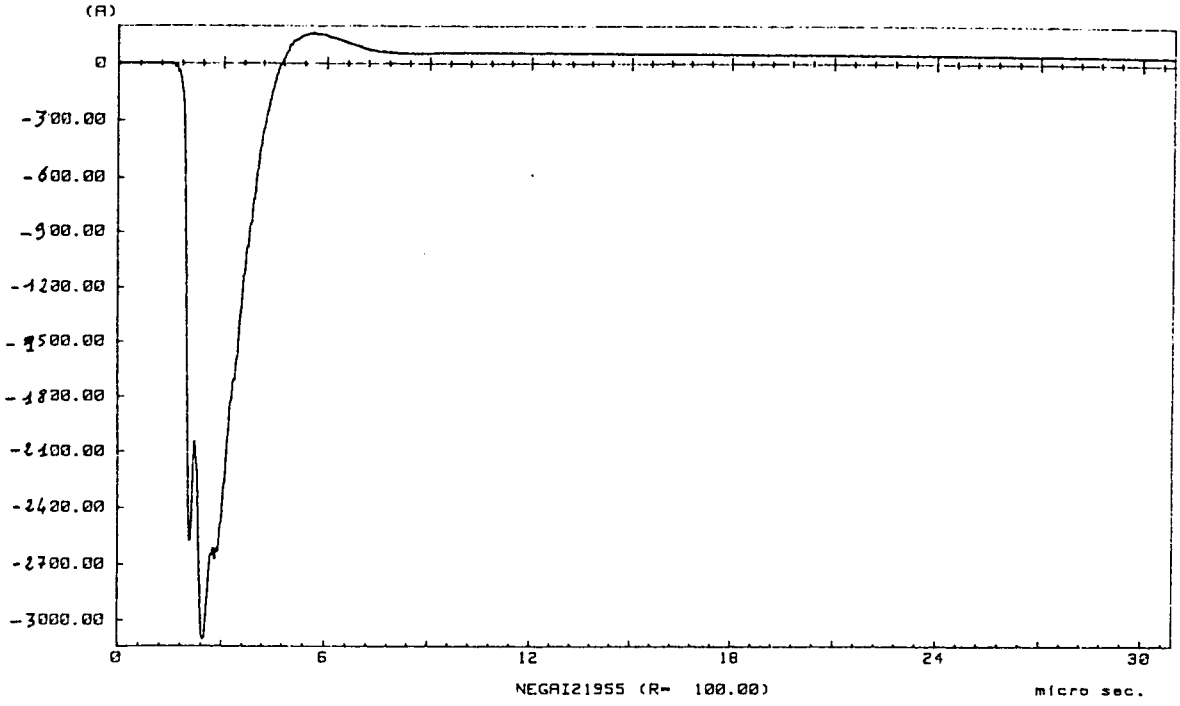
NEGATIVE WAVE SHAPE



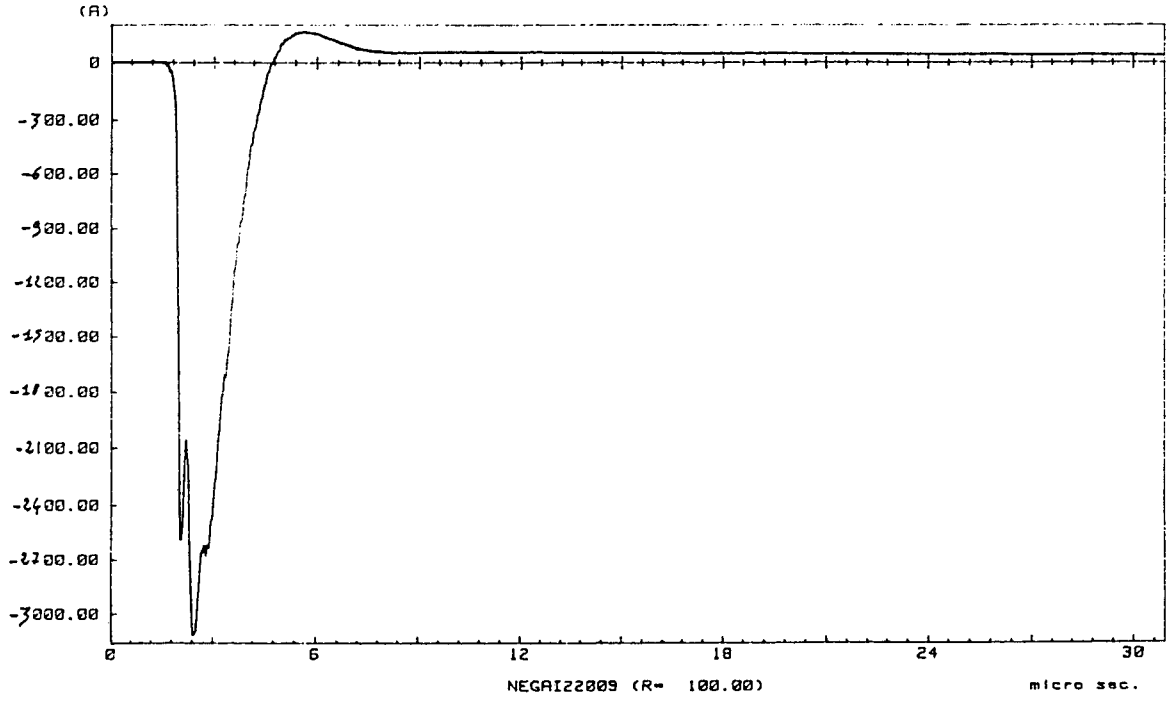
15 NEGATIVE LIGHTNING SERIE



HF CURRENT OF THE FIRST NEGATIVE LIGHTNING

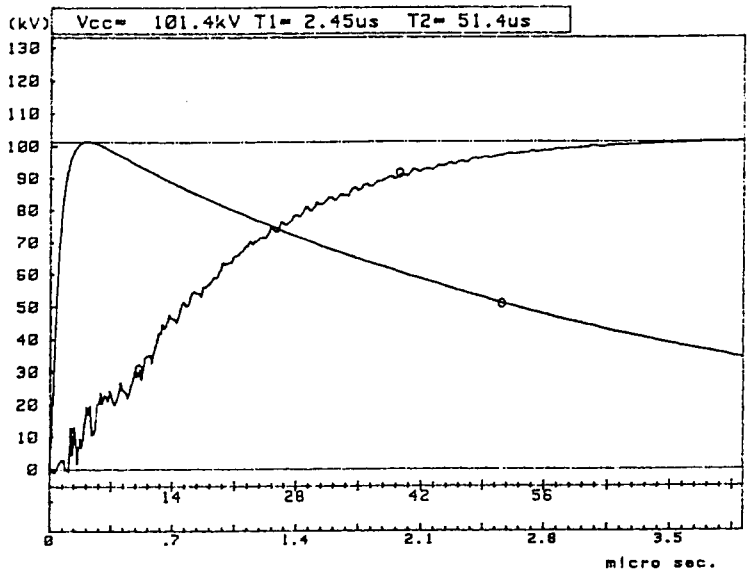


HF CURRENT OF THE FIFTEENTH NEGATIVE LIGHTNING

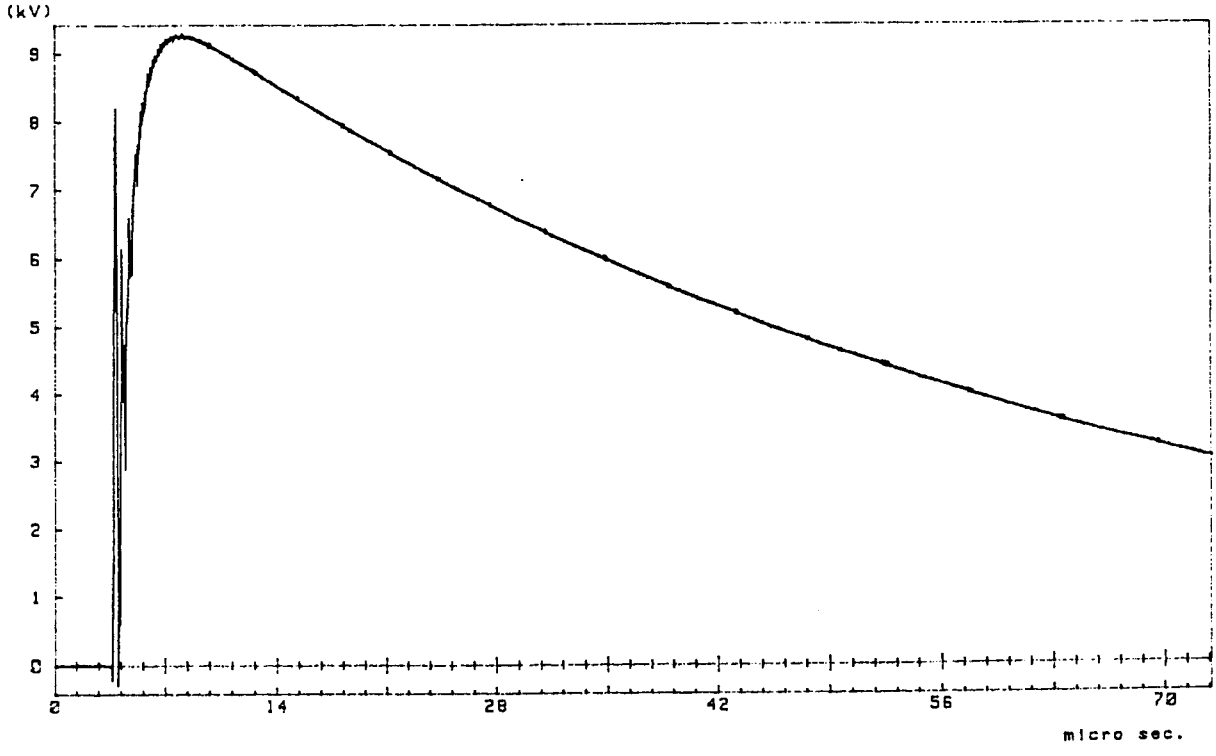


U1 POSITIVE WAVE SHAPE

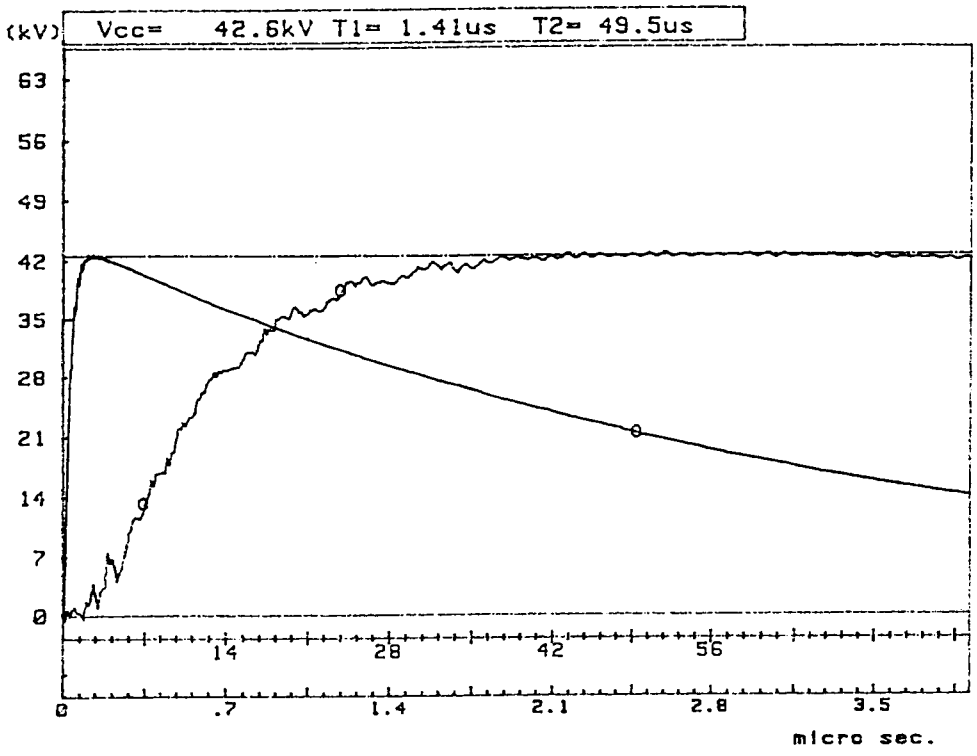
U1 = 101,4 kV



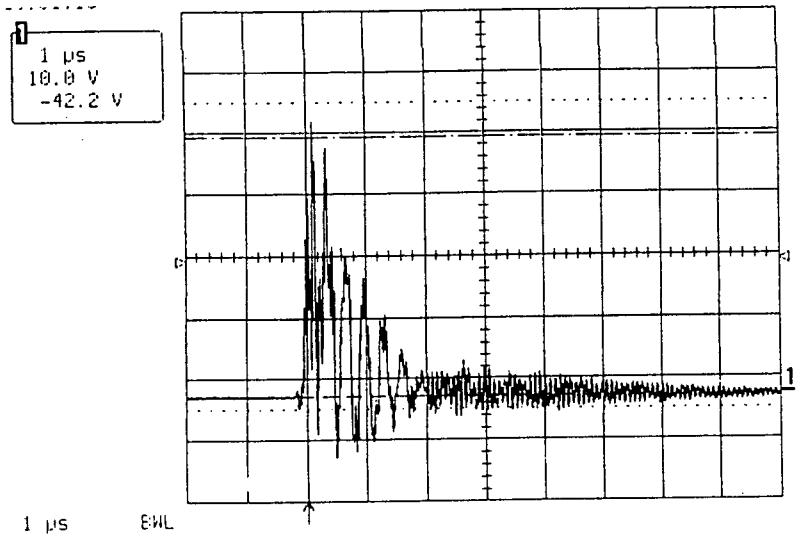
U2 POSITIVE WAVE SHAPE



POSITIVE WAVE SHAPE AT 50%

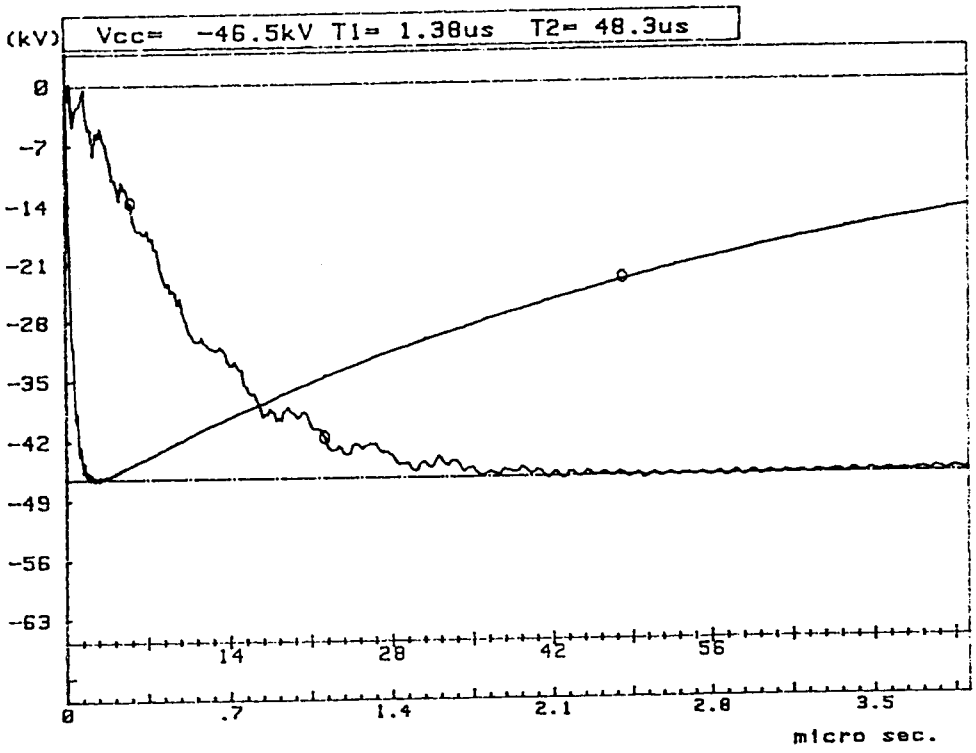


I S2-P2 CURRENT AT 50%

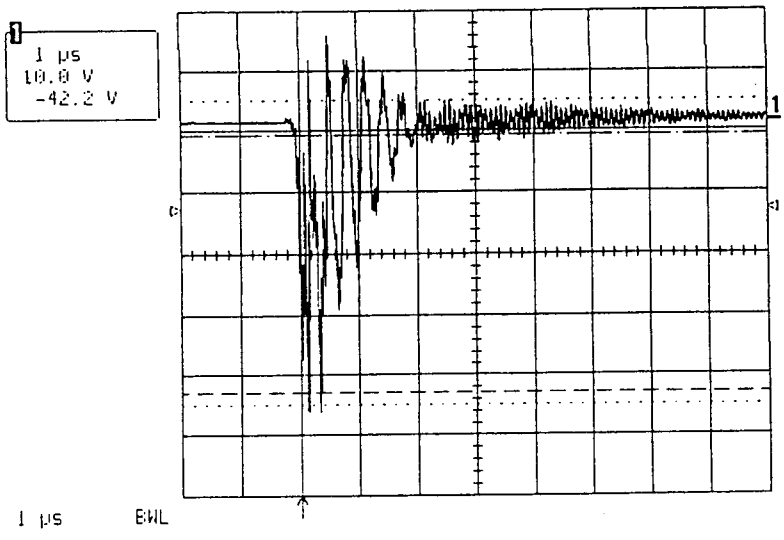


I s2-p2 = 42 A crête

NEGATIVE WAVE SHAPE AT 50%

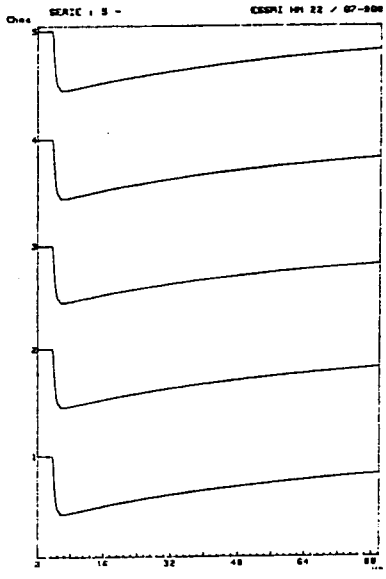


I S2-P2 CURRENT AT 50%

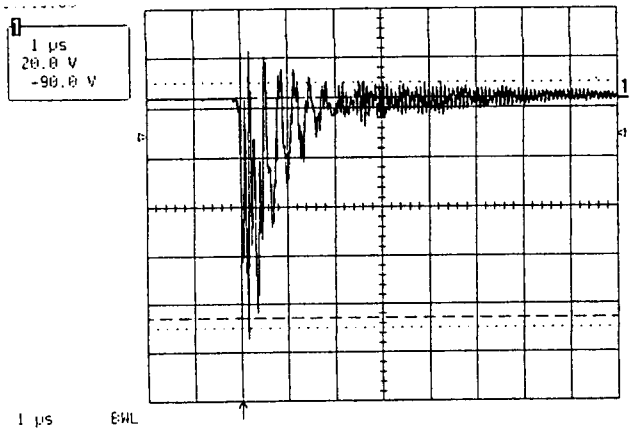


I s2-p2 = 44 A crête

5 NEGATIVE LIGHTNING SERIE

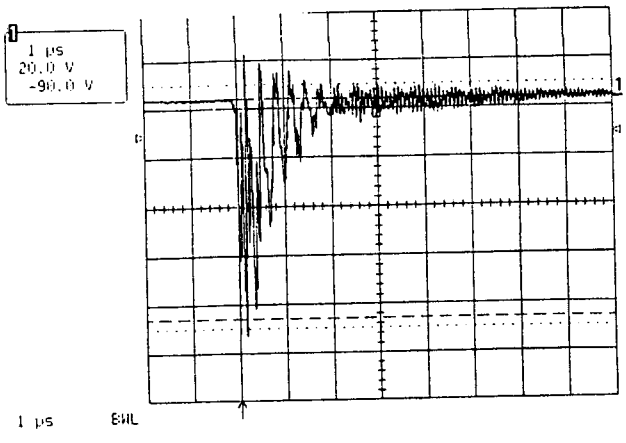


I S2-P2 CURRENT OF THE FIRST NEGATIVE LIGHTNING



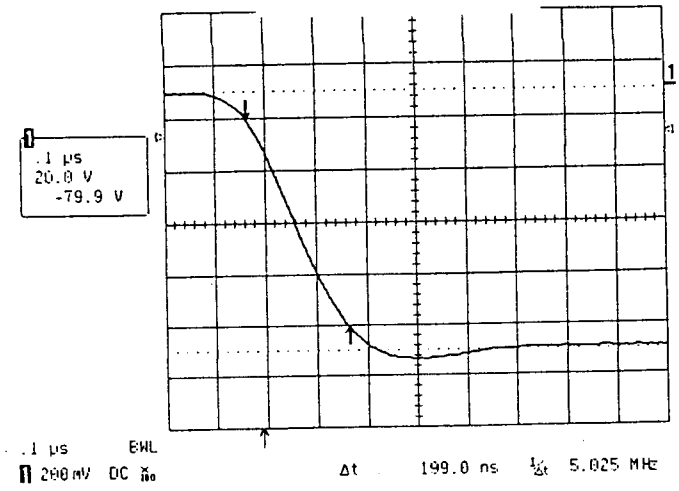
I s2-p2 = 90 A crête

I S2-P2 CURRENT OF THE FIFTH NEGATIVE LIGHTNING

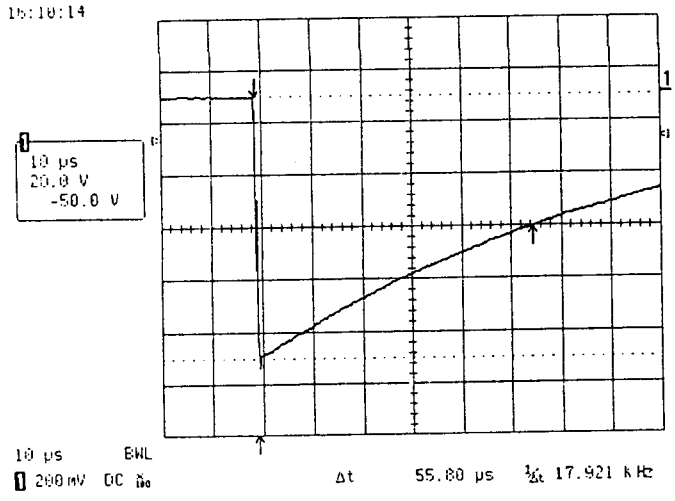


I s2-p2 = 90 A crête

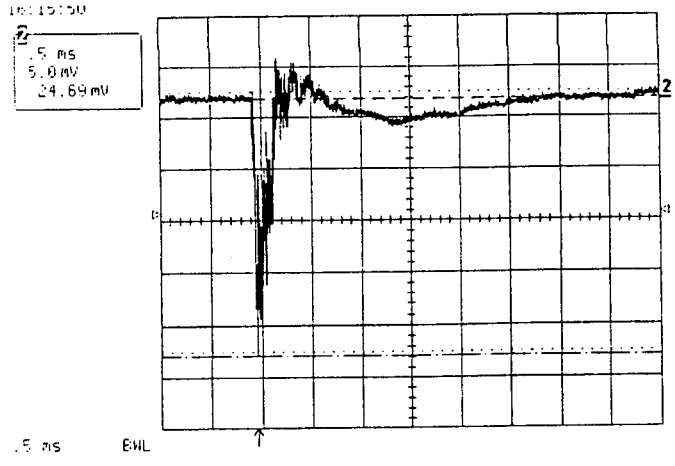
Front time = 199 ns
Peak voltage = 100 V



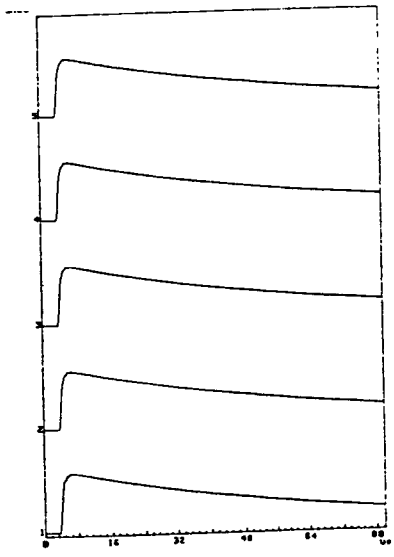
Half level time = 55.8 µs



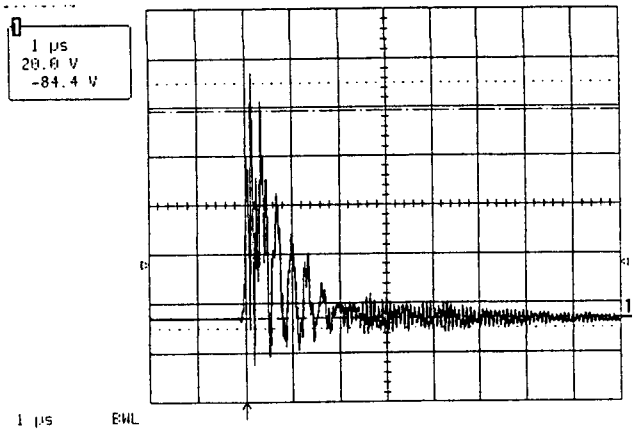
Voltage to S1-S2 terminals = 24.69 mV (peak value)



5 POSITIVE LIGHTNING SERIE

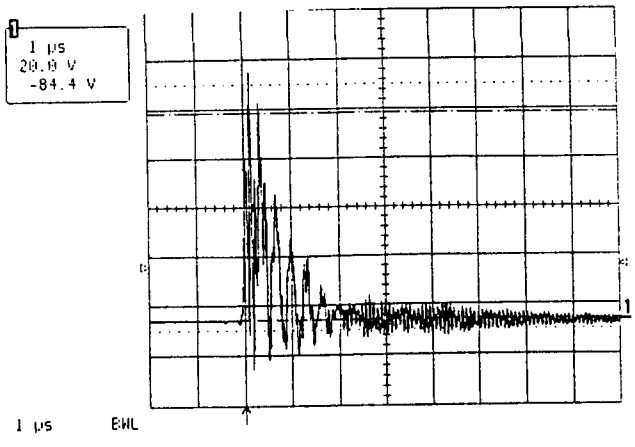


I S2-P2 CURRENT OF THE FIRST POSITIVE LIGHTNING



I s2-p2 = 84 A crête

I S2-P2 CURRENT OF THE FIFTH POSITIVE LIGHTNING



I s2-p2 = 84 A crête