Test Report

Document No.	B9003315	Copy No.	1	Number of pages	22

Apparatus	Non-enclosed three-phase dry-type power transformer, with encapsulated windings, for continuous duty, with cooling by air natural convection (AN): 800 kVA - 20 kV / 0,4 kV
Designation	1TR800320020
Serial Number	401462
Manufacturer	LEF S.r.l.
Client	LEF S.r.l. Via Morandi 12 50019 Sesto Fiorentino (FI) - Italy
Tested for	-
Date(s) of tests	October 6, 2014
Tested by	CESI S.p.A. Via Rubattino 54 20134 Milano – Italy
Test performed	Verification of dynamic ability to withstand short-circuit

The apparatus, constructed in accordance with the description, drawings and photographs incorporated in this document has been subjected to the series of proving tests in accordance with:

IEC 60076-11 {Ed.1.0} (2004-05)

The results are shown in the record of proving tests and the oscillograms attached hereto. The ratings assigned by the Manufacturer are listed on the ratings page.
The document applies only to the apparatus tested. The responsibility for conformity of any apparatus having the same designations with that tested rests with the Manufacturer.

February 14, 2019

	Assolari Mauro B9003315 2983 AUT	The Manager - Arcidiaco Lorenzo B9003315 821814 APP
Date	Test Engineer in charge	Approved By Document Digitally Signed

Notes

STL-Member

CESI Group members are founder members of the SHORT-CIRCUIT TESTING LIAISON (STL) which has been established in 1969. STL is a forum for voluntary international cooperation of testing organizations.

CESI Group Test Documents description

Type Test Certificate of …….

Issued for type tests of high voltage products (> 1 kV_{ac}; > 1,5 kV_{dc}), which have successfully been carried out in full compliance with the relevant specifications or standards and STL Guides valid at the time of the test. The Type Test Certificate consists of documents unequivocally identifying the test object and describes all conditions under which the tests were conducted. It gives evidence of the unobjectionable behavior of the test object during the tests in line with the normative documents applied as well as of the results of successful testing.

Test Certificate of (complete / selected) Type Tests

Issued if type tests of low voltage products (< 1 kV_{ac}; < 1,5 kV_{dc}) requested by the relevant product standard were passed. For these tests the equipment under test must be clearly identified by technical description, drawings, and additional specifications.

Certificate of Design Verification

Issued for passed design verification tests according to IEC 61439. For these tests the equipment under test must be clearly identified by technical description, drawings, and additional specifications.

Type Test Report

Issued for high and low voltage products if parts of selected type tests have been passed; those shall be carried out in full compliance with the relevant standards but (for high voltage products) do not fulfill all STL requirements for issuing a Type Test Certificate. For these tests the equipment under test must be clearly identified by technical description, drawings, and additional specifications.

Test Report

Issued for all other tests on high and low voltage products which have been carried out according to specifications, standards and/or client instructions

On-Site Test Record

Issued as a record of results acquired during the on-site tests / measurements

Test Award

Can be additionally issued for all named types of test documents above if the tests to be referenced were passed

Tests witnessed by

-

Identification of the object not requested

Only for laboratory requirement, in order to reproduce the test conditions, all the laboratory data are contained in the document marked: B4023487-1

The reported expanded uncertainties are determined in accordance with the Publication JCGM 100 “Evaluation of measurement data – Guide to the expression of uncertainty in measurement” and are based on a standard uncertainty multiplied by a coverage factor k = 2, which for a normal distribution provides a level of confidence of approximately 95 %.

- **Voltage a.c., d.c. :** **± 3,0 %** **Current a.c., d.c. :** **± 3,0 %**
- **Resistance d.c. :** **± 1,0 %** **Time :** **± 1,5 %**
- **Temperature :** **± (2,0 °C + 1 %) up to 350 °C with TC type T**

Test location CESI – Via Rubattino 54 – Milano

Activity code ODV SAP 70001281

Rated characteristics of the tested object assigned by the Client

Dry-type power transformer	
Manufacturer	**LEF S.r.l.**
Type	1TR800320020
Manufacturer's serial number	401462
Year of manufacturing	2014
Number of phases	3
Rated voltage of the high-voltage winding (primary winding)	20 kV ± 2 x 2,5 %
Rated voltage of the low-voltage winding (secondary winding)	400 V
Rated voltage ratio	20 kV / 0,4 kV
Rated frequency	50 Hz
Rated power	800 kVA
Rated current of the high-voltage winding (primary winding)	23,12 A
Rated current of the low-voltage winding (secondary winding)	1156,07 A
Short-circuit impedance at 120°C	6,75 %
Connection symbol	Dyn5
Cooling method	AN
Total mass	2450 kg
Environmental class	E2
Climatic class	C2
Fire behaviour class	F1

Characteristics of the windings	
Highest voltage for equipment applicable to the high-voltage winding	24 kV
Highest voltage for equipment applicable to the low-voltage winding	1,1 kV
Rated insulation levels	IA 125 FI 50 / FI 3
Insulation class	F/F
Type of construction	with circular concentric coils
High-voltage winding conductor	aluminium foil
Low-voltage winding conductor	aluminium foil

Name and signature of Client's witness:

Verification of dynamic ability to withstand short-circuit

Requested values

Test current values were calculated neglecting the system impedance since such declared vale is less than 5% of the short-circuit impedance of the transformer and, on Client's request, considering an identical value of short-circuit impedance in all the three test positions of tap-changer (value referred to the principal tapping).

Tap-changer position	U_r	Z_{SC}	X/R	k x √2	Short-circuit current (*)	
					r.m.s. value	peak value
-	kV	%	-	-	A	A
4/3	20,0	6,747	7,273	2,340	17114	40048
2/1	21,0	"	"	"	"	"
6/5	19,0	"	"	"	"	"

(*) Values of short-circuit current of the low-voltage winding (star-connected).

Test arrangements and test procedures

The transformer was tested connecting a three-phase supply to the high-voltage winding (primary winding).

The low-voltage winding was short-circuited before the application of the voltage to the other winding of the transformer (pre-set short-circuit).

During each test were recorded the line-to-line supply voltages, the phase currents of the low -voltage winding and the fault current, if any, between the mass (insulated) of the transformer and earth.

Nine tests were performed (three tests on each limb):

- three tests with the tap-changer on the principal tapping (with the maximum peak current on the middle limb),
- three tests with the tap-changer in the position corresponding to the highest voltage ratio (with the maximum peak current on one of the outer limbs),
- three tests with the tap-changer in the position corresponding to the lowest voltage ratio (with the maximum peak current on one of the other outer limbs).

Short-circuit tests with three-phase current

Test circuit: M0022
Test frequency: 50 Hz
Reference number of the oscillograms: B4023487

Conditions of the transformer before the tests: as supplied by the Client

Transformer prearranged on the voltage ratio: 20 kV / 0,4 kV

Date: October 6, 2014

Test	Oscillogram	Tap-changer position	No-load supply voltage	Test current			Duration
				peak value	r.m.s. value	average value	
No.	No./sheets	-	kV	A	A	A	s
1	1/1	4/3	22,70	26590	11430 11340 11530	11430	0,11
2	2/1	4/3	22,80	41030	17200 17220 17270	17230	0,5
3	3/1	4/3	22,84	41260	17230 17240 17300	17260	0,5
4	4/1	4/3	22,81	41230	17220 17260 17290	17260	0,5
5	5/1	2/1	22,77	39960	16800 16830 16900	16840	0,5
6	6/1	2/1	22,74	39990	16770 16790 16890	16820	0,5
7	7/1	2/1	22,82	40200	16820 16850 16980	16880	0,5
8	8/1	6/5	22,75	40530	17530 17560 17690	17590	0,5
9	9/1	6/5	22,78	41340	17570 17560 17730	17620	0,5
10	10/1	6/5	22,83	41120	17620 17630 17800	17680	0,5

Conditions of the transformer after the tests: see notes

- Externally did not show any damage.
- After the test CESI has placed two seals on the W column of the power transformer (see photos no.4 and no.5).

Measurement of short-circuit inductance

The measurement of short-circuit inductance was performed before the short-circuit tests and after every series of three tests by means of a Schering bridge (Maxwell diagram) which allows a reproducibility of at least ± 0,2%.

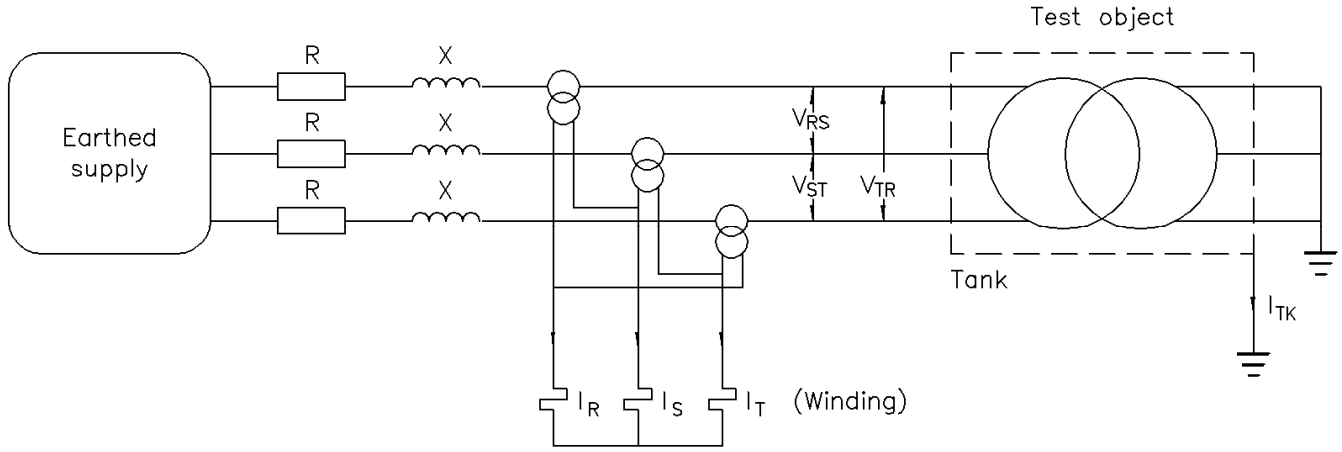
For all measurements the transformer was set-up in the following conditions:
- the tap-changer was placed in the position corresponding to the highest voltage ratio,
- the terminals of the low-voltage winding were short-circuited,
- the measurement points were applied to the terminals of the high-voltage winding, delta-connected.

Date: October 6, 2014

tap-changer position	measurement effected		short-circuit inductance [mH] measured at the terminals			variation [%] from the initial measurement			short-circuit inductance [mH] calculated for single limb			variation [%] from the initial value		
			U-V	U-W	V-W	U-V	U-W	V-W	U	V	W	U	V	W
2/1	before the tests		229,80	230,22	230,45	-	-	-	344,167	346,116	345,424	-	-	-
2/1	after the test no.	4	230,07	230,52	230,60	0,12	0,13	0,07	344,617	346,205	345,965	0,13	0,03	0,16
2/1	after the test no.	7	230,13	230,54	230,60	0,14	0,14	0,07	344,757	346,165	345,985	0,17	0,01	0,16
2/1	after the test no.	10	230,16	230,57	230,69	0,16	0,15	0,10	344,772	346,361	346,000	0,18	0,07	0,17

Maximum variation of short-circuit inductance stated by Standard: 4 %.

Test circuit M0022



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

Correspondence between laboratory circuit phase and test object terminal

Laboratory circuit phase	Test object terminal
R	U
S	V
T	W

Photo no. 1

Photo no. 2

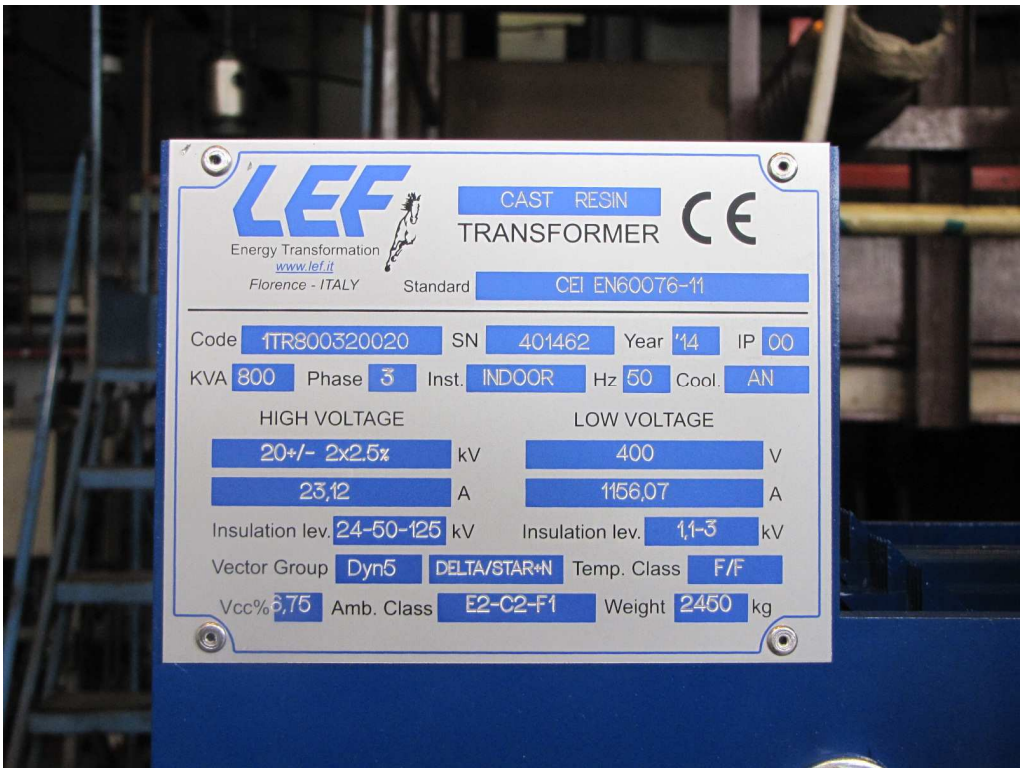

LEF
Energy Transformation
www.lef.it
Florence - ITALY
CAST RESIN
TRANSFORMER
CE
Standard CEI EN60076-11
Code ITR800320020 SN 401462 Year '14 IP 00
KVA 800 Phase 3 Inst. INDOOR Hz 50 Cool. AN
HIGH VOLTAGE
LOW VOLTAGE
20+/- 2x2.5% kV
400 V
23,12 A
1156,07 A
Insulation lev. 24-50-125 kV
Insulation lev. 1,1-3 kV
Vector Group Dyn5 DELTA/STAR+N Temp. Class F/F
Vcc% 6,75 Amb. Class E2-C2-F1 Weight 2450 kg

Photo no. 3

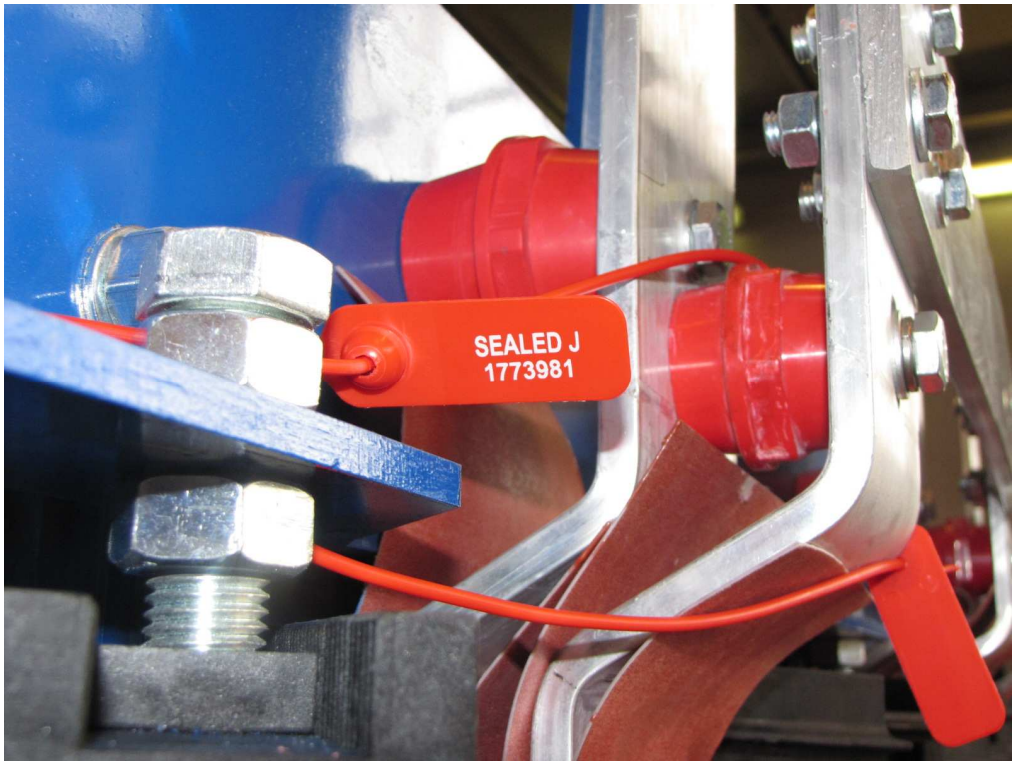
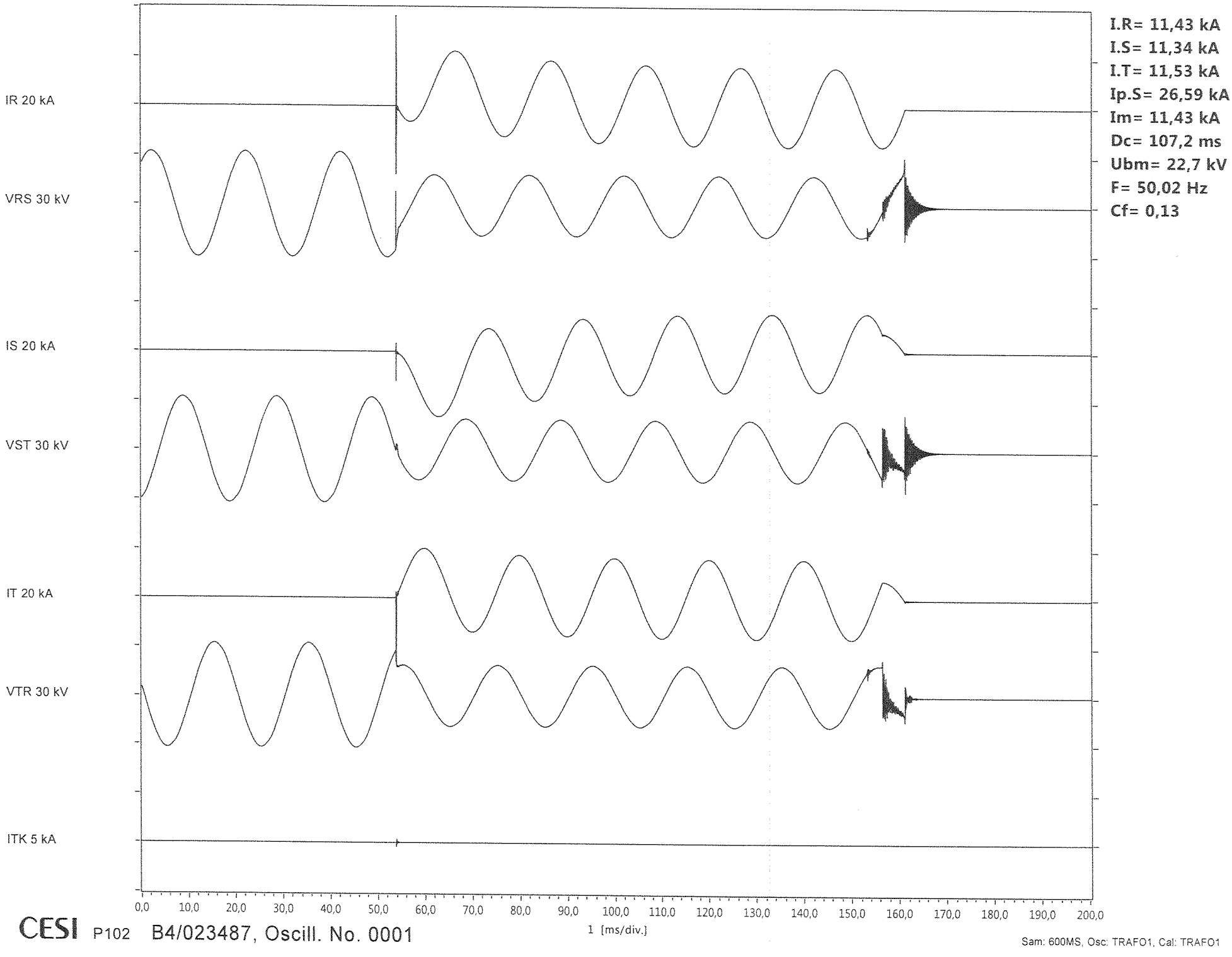


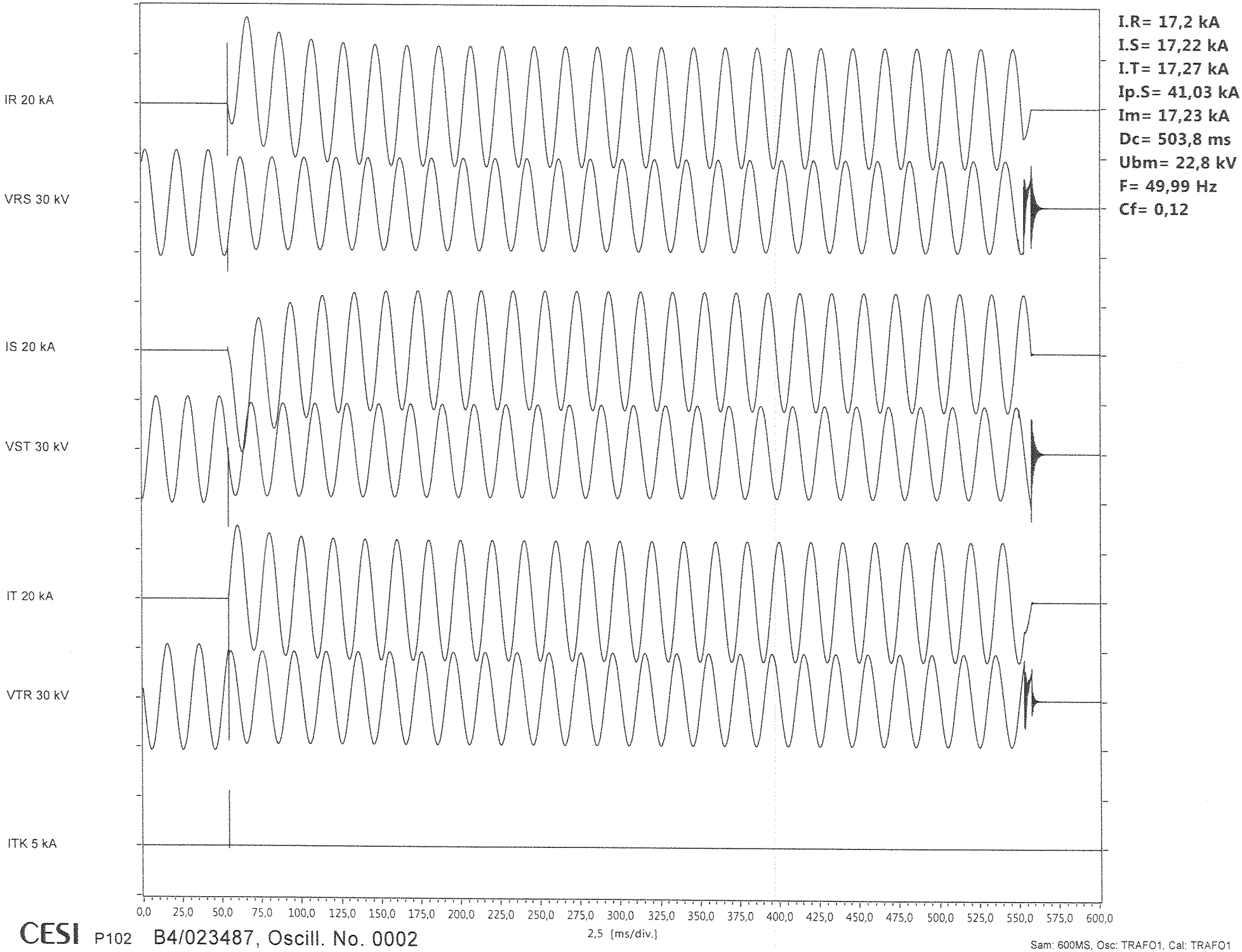
Photo no. 4

Photo no. 5



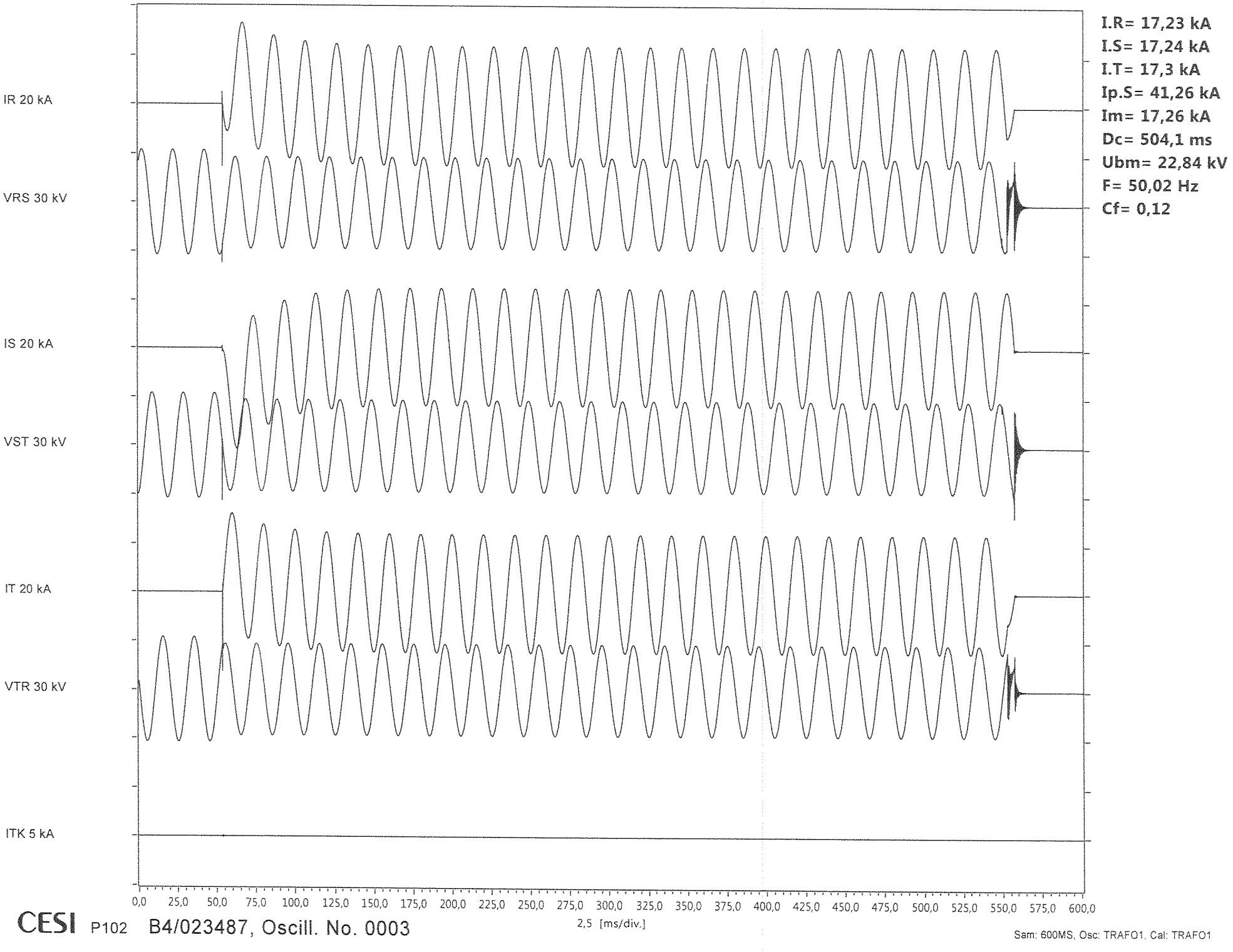
CESI P102 B4/023487, Oscill. No. 0001

Sam: 600MS, Osc: TRAFO1, Cal: TRAFO1



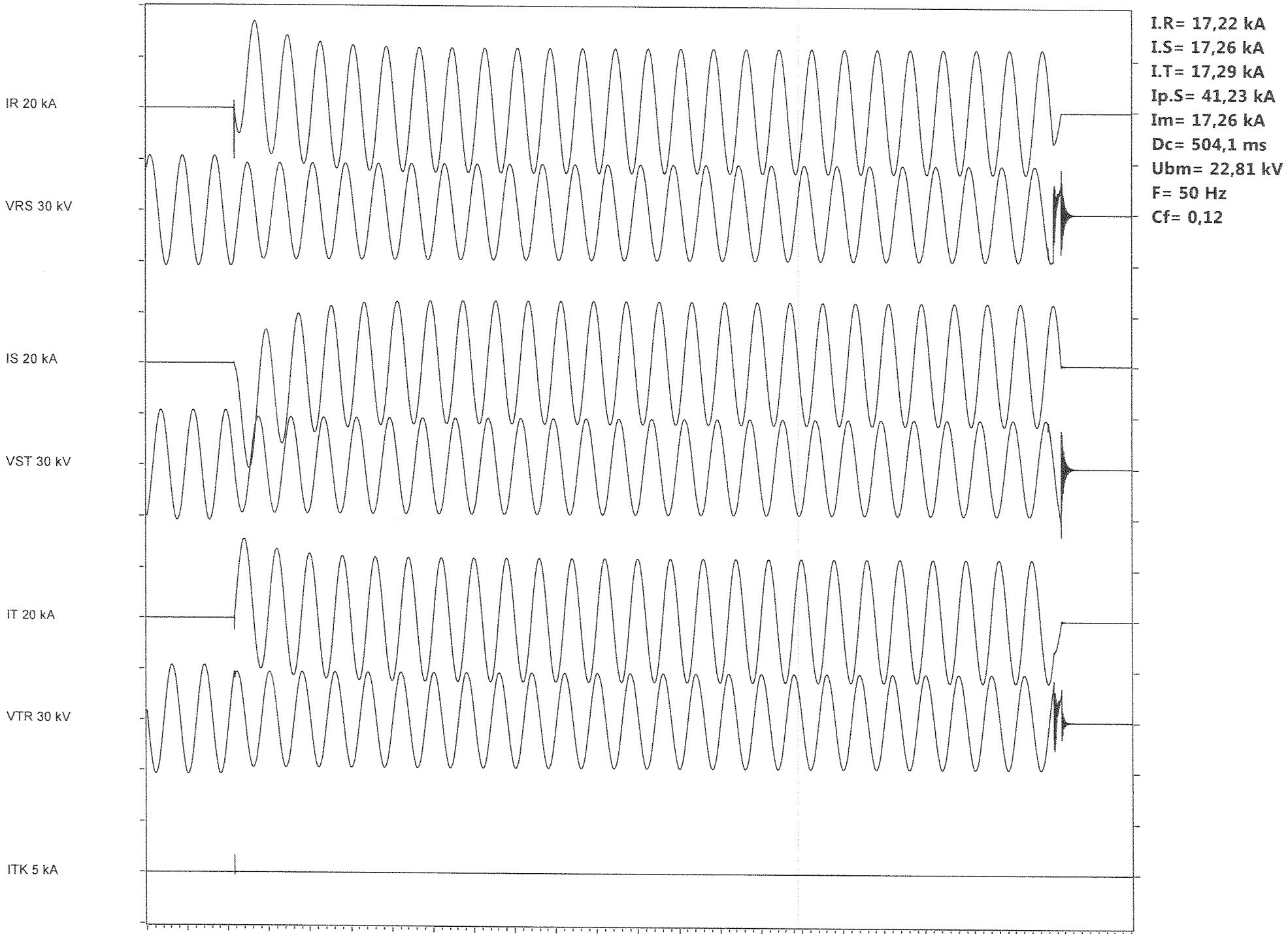
CESI P102 B4/023487, Oscill. No. 0002

Sam: 600MS, Osc: TRAFO1, Cal: TRAFO1



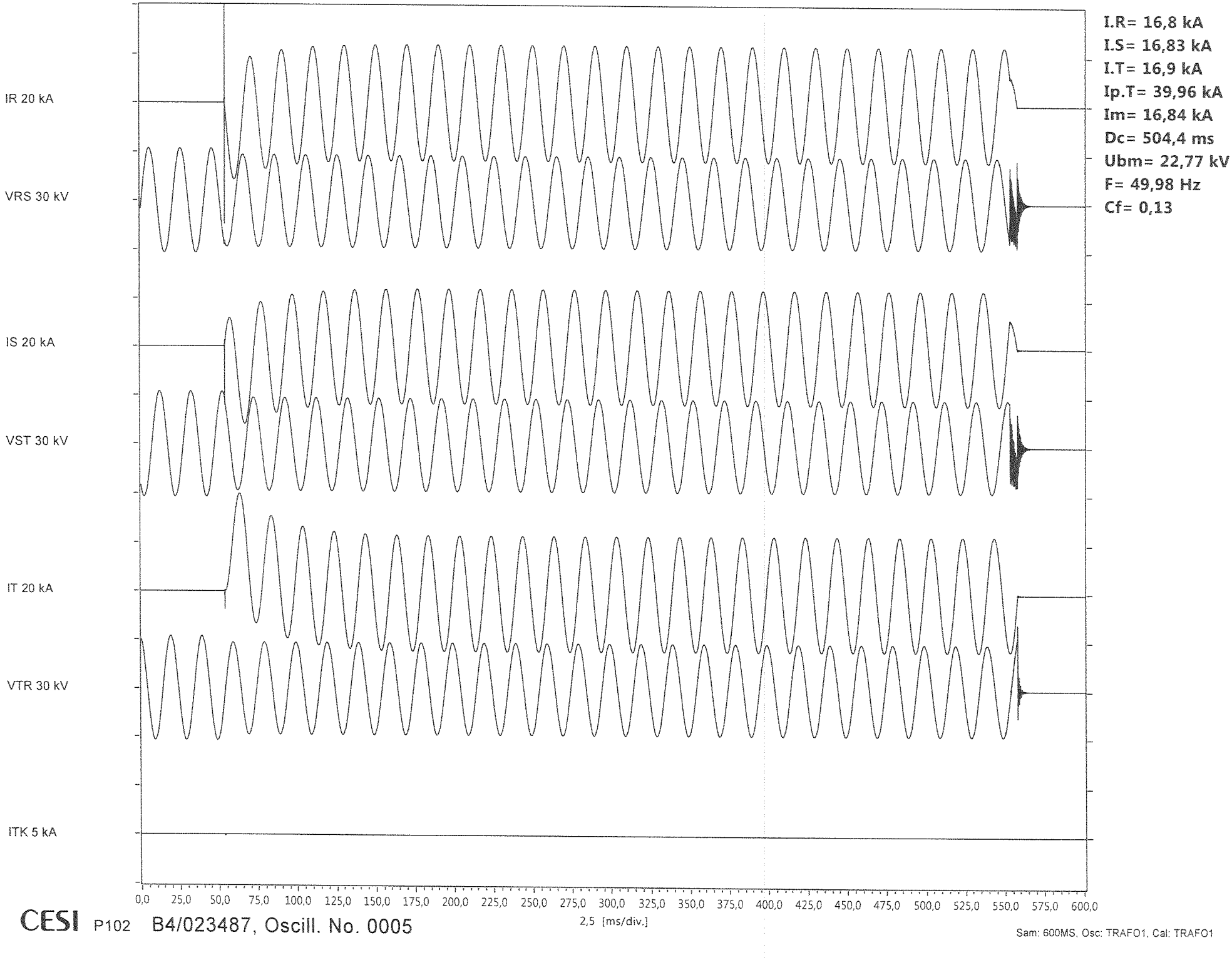
CESI P102 B4/023487, Oscill. No. 0003

Sam: 600MS, Osc: TRAFO1, Cal: TRAFO1



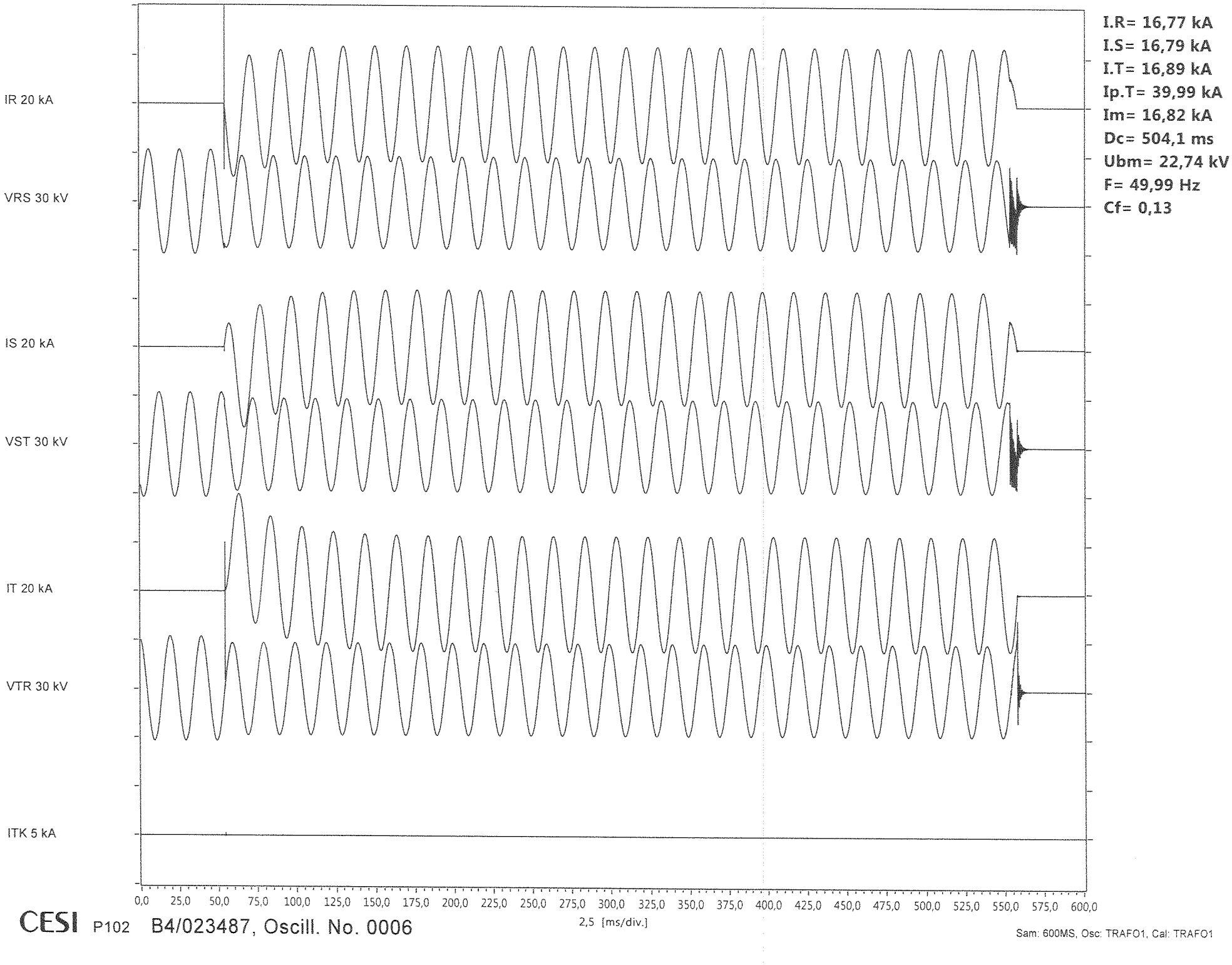
CESI P102 B4/023487, Oscill. No. 0004

Sam: 600MS, Osc: TRAFO1, Cal: TRAFO1



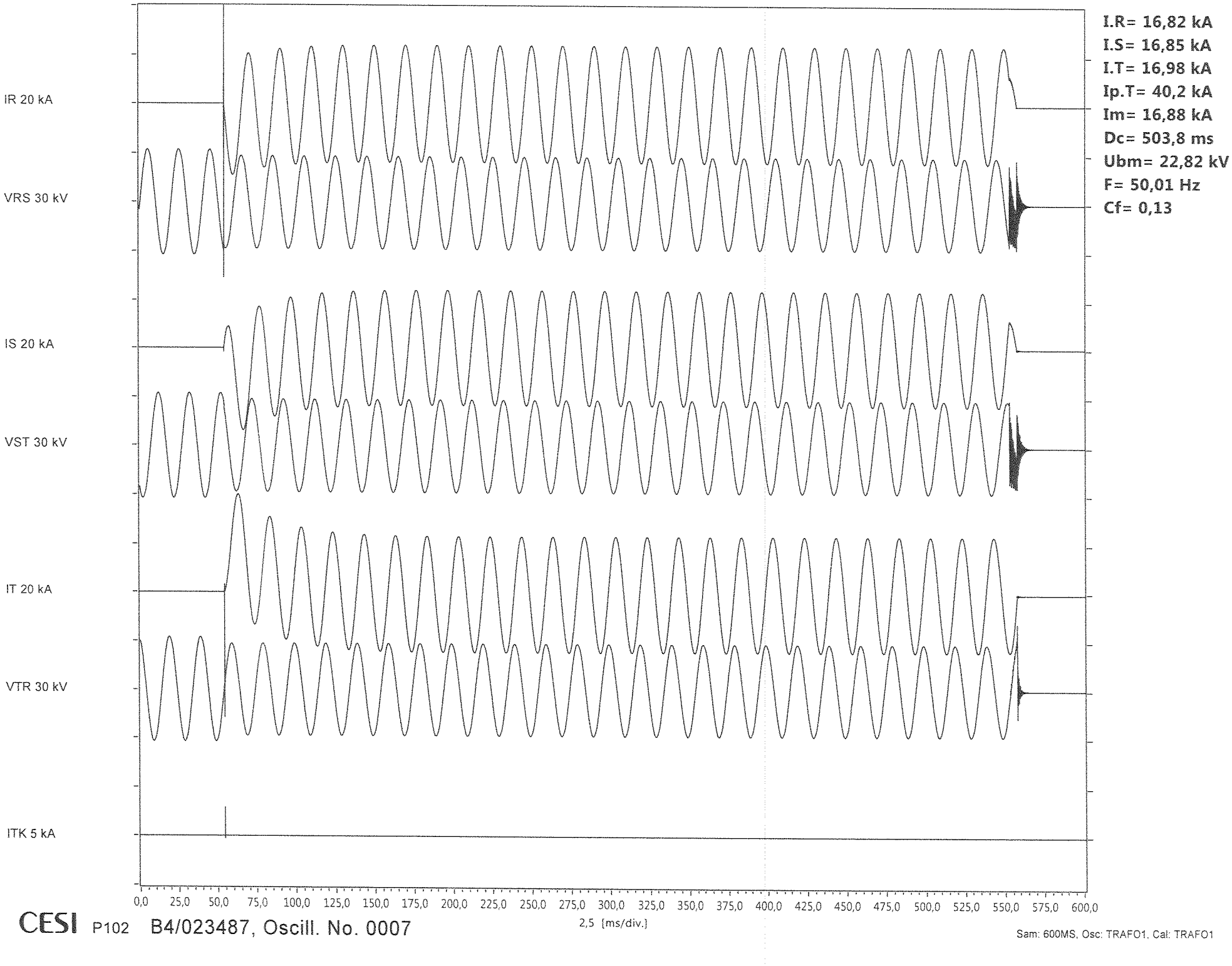
CESI P102 B4/023487, Oscill. No. 0005

Sam: 600MS, Osc: TRAFO1, Cal: TRAFO1



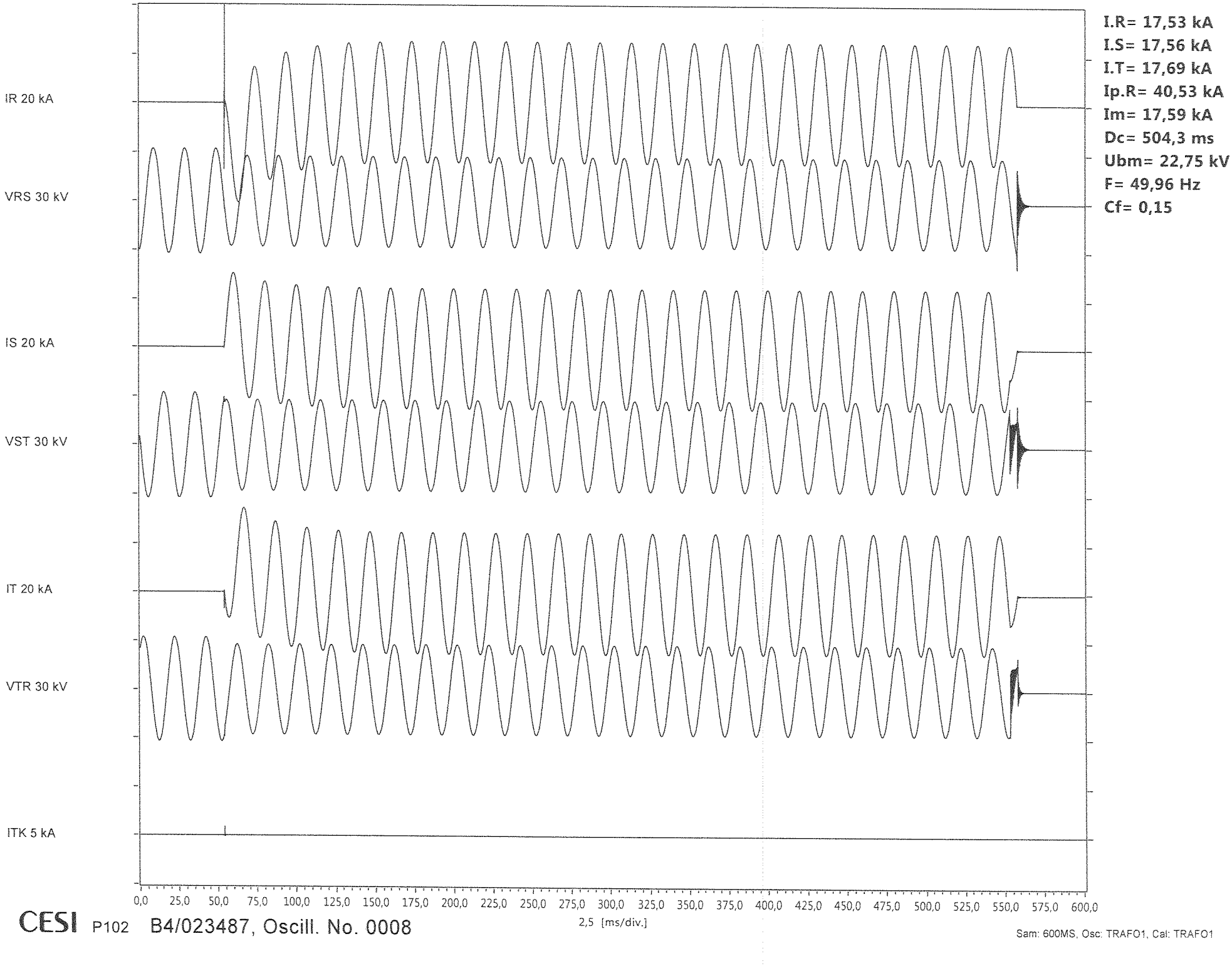
CESI P102 B4/023487, Oscill. No. 0006

Sam: 600MS, Osc: TRAFO1, Cal: TRAFO1



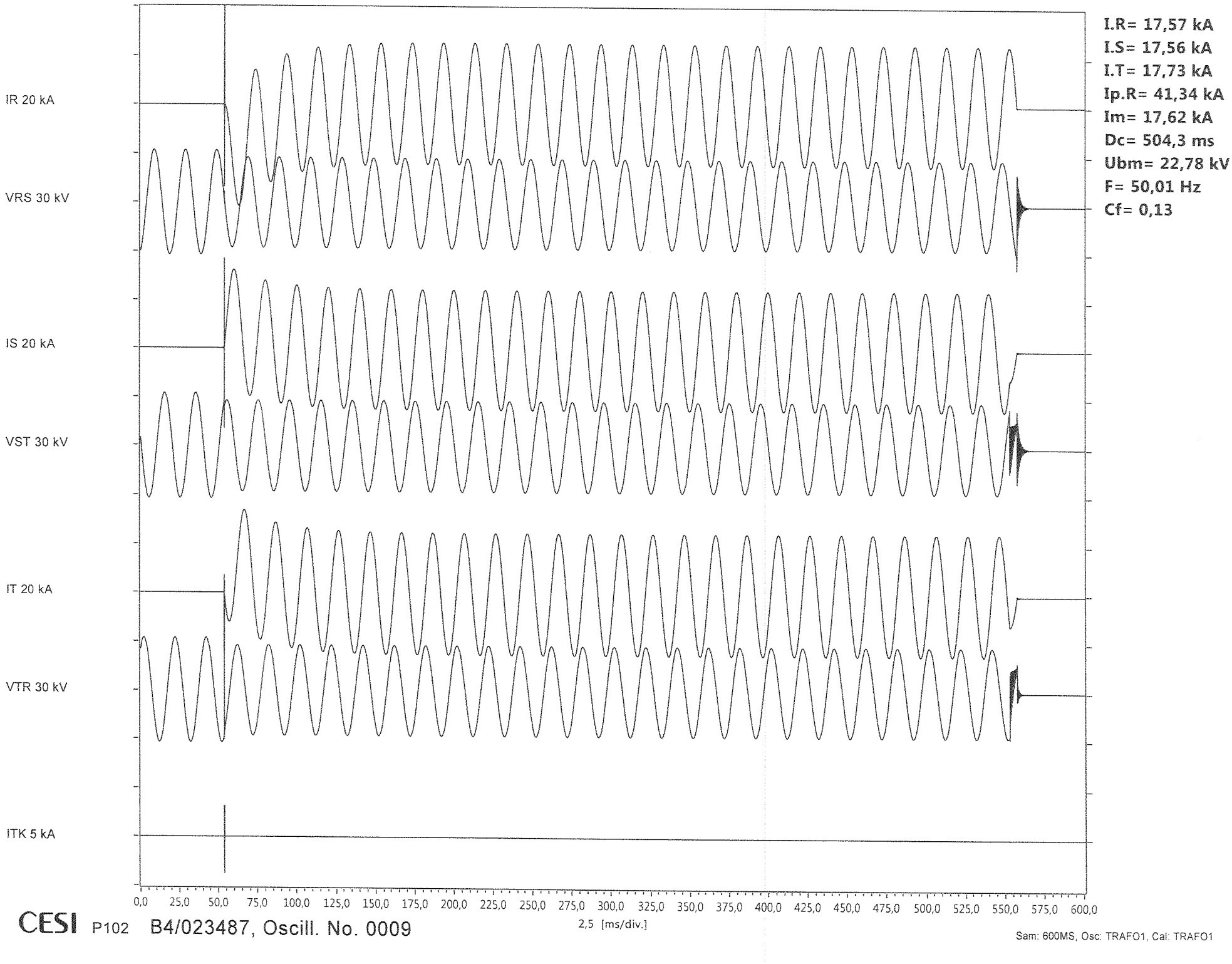
CESI P102 B4/023487, Oscill. No. 0007

Sam: 600MS, Osc: TRAFO1, Cal: TRAFO1



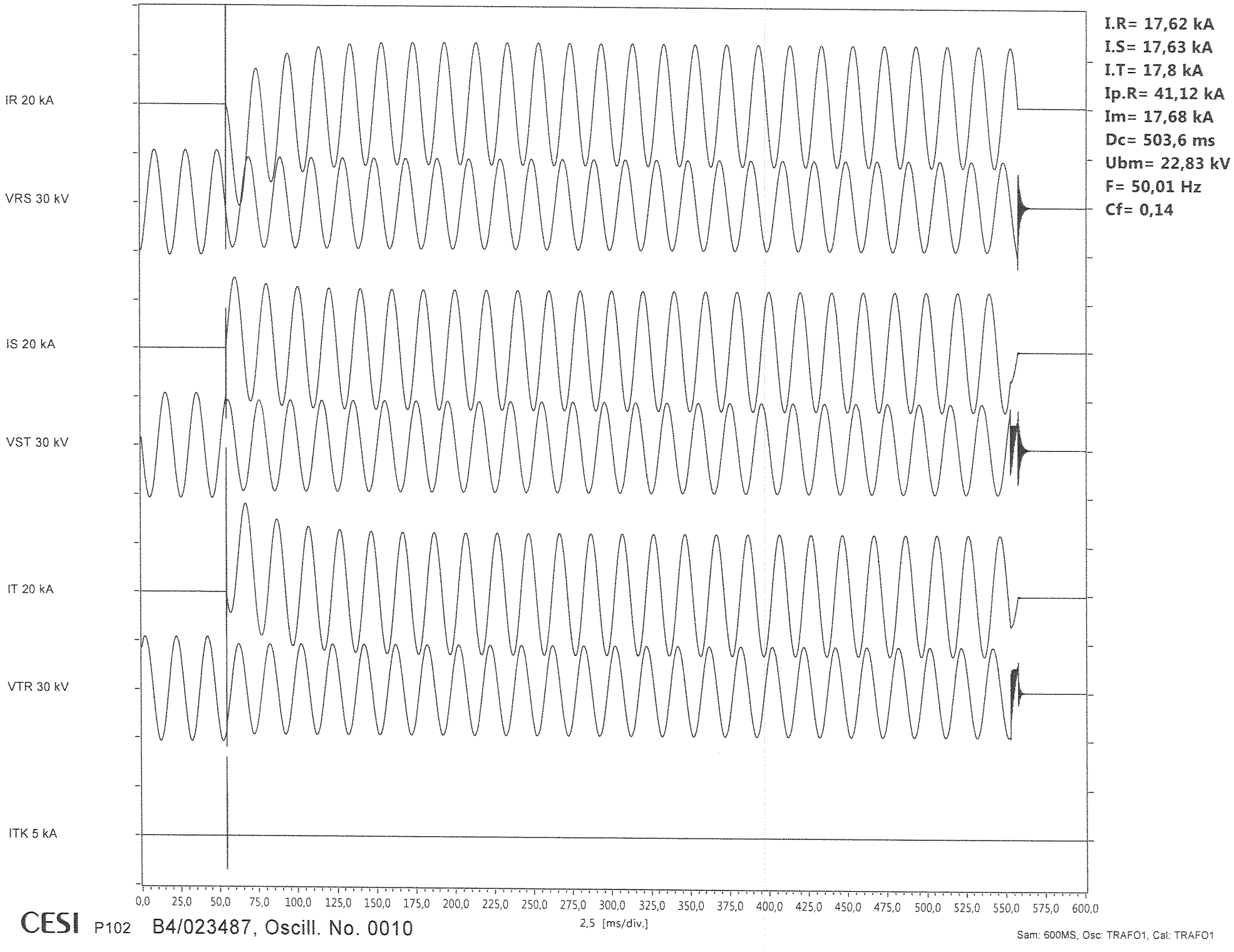
CESI P102 B4/023487, Oscill. No. 0008

Sam: 600MS, Osc: TRAFO1, Cal: TRAFO1



CESI P102 B4/023487, Oscill. No. 0009

Sam: 600MS, Osc: TRAFO1, Cal: TRAFO1



CESI P102 B4/023487, Oscill. No. 0010

Sam: 600MS, Osc: TRAFO1, Cal: TRAFO1