2 TEST METHOD

During the isolation tests, the equipment remained off, thus the functional verification was done before and after the procedure.

The functional verification of the equipment under test was applied by the customer, concerning the items shown in Table 1.

Table 1: Functional verification items	
1	Raise and lower position commands. At the automatic mode, varying the voltage via Variac
2	Operation count
3	Current and voltage inference
4	Memories
5	Alarms and failures register
6	Data exhibition and IHM operation
7	Communication doors

The definition of the Circuit Groups that should be applied at the isolation tests was done by the customer as seen on Table 2.

Table 2: Groups	
Circuit	**Terminals**
1	Connector X1 – All terminals
2	Connector X2 – Terminals 1 and 2
3	Connector X2 – Terminals 3 to 17; Connector X3 – All terminals
4	Connector X2 – Terminals 18 to 20
5	Connectors X5 to X9 – All terminals
6	Connector X10 – All terminals
7	RS232

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The isolation test is defined according to the Table 3, below:

Table 3: Isolation test, following IEC 60255-27:2013 and IEC 60255-5:2000 standards.		
Test	**Applied level**	**Method / Application points**
Voltage impulse	Application of 5 impulses of 5 kV, in each polarity	The application points are shown in Table 6.

During the immunity tests, the sample remained on and running regularly, connected to a "Simulation-Device" provided by the client.

The sample was monitored by observing the controller´s panel (measurements shown by the display and alarm signalization). The equipment's functional verification was done before, during and after the procedure, following the items seen on Table 1, by the client.

Table 4: Immunity to 1MHz electrical transients, according to IEC 61000-4-18:2006			
Test	**Applied standard**	**Applied level**	**Method / Application points**
Immunity to 1MHz electrical transients	IEC 61000-4-18	+/- 2,5 kV at common mode +/- 1 kV no differential mode	Application at positive and negative polarities during 2s and repetition rate of 400Hz.

Figure 2 – Sample tested at the cabinet setup.

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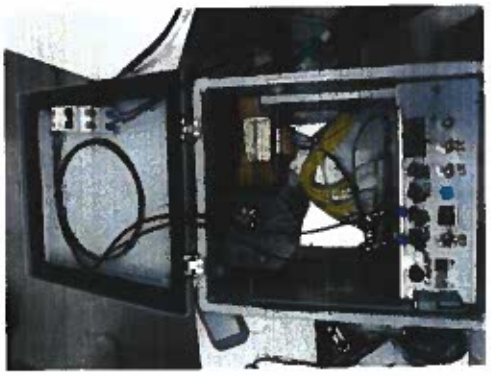

Figure 3 – Simulation-Device, provided by the client, connected to the equipment under test.

In Figures 4 and 5 the setups used during the tests are exhibited:

Figure 4 – Setup used during the voltage impulse test, according to IEC 60255-27:2013 e IEC 60255-5:2000 standard.

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Figure 5 – Setup used during the IEC 61000-4-18:2006 standard tests.

3 LAB EQUIPMENT

The equipment used is as set on Table 5:

Table 5: Equipment used during the test

Equipment description	LEO registration number	Next calibration date
Digital thermos-hygrometer	203	06/19/2018
Digital oscilloscope	543	05/02/2020
1000:1 Voltage probe	580	Not applicable
Digital multimeter	375	04/15/2020
Variac	137	Not applicable
Impulse generator	125	Not applicable
Transient generator	121	Not applicable
Coupler / Decoupler	337	Not applicable

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4 RESULTS

Tables 6 and 8 display results.

Table 6: Voltage impulses tests results according to IEC 60255-27:2013 and IEC 60255-5:2000 standards

Application points	Applied level (kV)	Results
{All circuits} x {Ground} (Circuit 7 grouped to the Ground)	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 1} x {Circuit 2}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 1} x {Circuit 3}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 1} x {Circuit 4}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 1} x {Circuit 5}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 1} x {Circuit 6}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 2} x {Circuit 3}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 2} x {Circuit 4}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 2} x {Circuit 5}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 2} x {Circuit 6}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 3} x {Circuit 4}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 3} x {Circuit 5}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 3} x {Circuit 6}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 4} x {Circuit 5}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements

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Table 6 continuation		
{Circuit 4} x {Circuit 6}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
{Circuit 5} x {Circuit 6}, the others grounded	+ 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
	- 5	Meets the IEC 60255-27 and IEC 60255-5 requirements
Initial temperature: 22,5 °C		**Final temperature:** 20,5 °C
Initial relative humidity: 69 %		**Final relative humidity:** 77 %

Note: The application points are the circuits that the client stated as usable for the tests, so the circuits not listed in the table were not tested.

The conformity criteria used to evaluate the immunity test results, as described by the IEC 60255-26:2013 standard, are as follow:

Table 7: Immunity test acceptance criteria		
Criteria	**Function**	**Acceptance criteria**
A	Protection	Normal operation within specified limits, during and after the test.
	Command and control	Normal operation within specified limits, during and after the test.
	Measurements	No degradation during the test.
	Man-machine interface and Visual alarms	Neither degradation nor function loss was observed during the test. No loss of stored data.
	Data communication	Possibility of increasing the bit error rate but without loss of data transmission.
	Binary input, binary output and output contacts	Undesirable state change during the state is not allowed.
B	Protection	Normal operation within specified limits, during and after the test.
	Command and control	Normal operation within specified limits, during and after the test.
	Measurements	Temporary degradation during the test, with self-recovery after the test, without loss of stored data.
	Man-machine interface and Visual alarms	Temporary degradation or loss of function during the test, with self-recovery at the end of the test. No loss of stored data.
	Data communication	Possibility of increasing the bit error rate but without loss of data transmission.
	Binary input, binary output and output contacts	Undesirable state change during the state is not allowed.

Table 7 continuation		
C	Protection	Temporary loss of function provided it is self-recoverable. Unwanted operations should not be observed.
	Command and control	Temporary loss of function provided it is self-recoverable. Unwanted operations should not be observed.
	Measurements	Temporary loss of function provided it is self-recoverable.
	Man-machine interface and Visual alarms	Temporary loss of function provided it is self-recoverable.
	Data communication	Temporary loss of function provided it is self-recoverable. Possibility of loss of data transmission.
	Binary input, binary output and output contacts	Undesirable state change during the test is not allowed.

Table 8: Immunity to 1MHz electrical transients results, according to IEC 60255-26:2013 and IEC 61000-4-18:2006 standards.

Application points		Level (kV)	Results	Acceptance criteria according to IEC 60255-26:2013	According / Not According	Notes
AC Supply	{Phase} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Neutral} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Phase, Neutral} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Phase} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Supply (X2 Connector)	{Terminal 3} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
Supply (X2 Connector)	{Terminal 3} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Seal-Engine (X2 Connector)	{Terminal 4} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Terminal 4} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None

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Table 8 continuation						
Raise Tap (X2 Connector)	{Terminal 5} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	B	B	According	(1)
	{Terminal 5} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Lower Tap (X2 Connector)	{Terminal 6} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	B	B	According	(2)
	{Terminal 6} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Neutral Light to Neutral (X2 Connector)	{Terminal 7} x {Ground}	+ 2,5	B	B	According	(1)
		- 2,5	A	B	According	None
	{Terminal 7} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Neutral Light to Phase (X2 Connector)	{Terminal 8} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
Neutral Light to Phase (X2 Connector)	{Terminal 8} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Polarity Indication (X2 Connector)	{Terminal 10} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Terminal 10} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Operations Controller (X2 Connector)	{Terminal 11} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Terminal 11} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Potentiometric Divider '+' (X2 Connector)	{Terminal 12} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Terminal 12} x {Neutral}	+ 1,0	B	B	According	(2)
		- 1,0	B	B	According	(1)
Potentiometric Divider Cursor (X2 Connector)	{Terminal 13} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Terminal 13} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None

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Table 8 continuation						
Potentiometric Divider '-' (X2 Connector)	{Terminal 14} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Terminal 14} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Digital input (X2 Connector)	{Terminal 15} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	B	B	According	(1)
	{Terminal 15} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
External Indicator Reset (X2 Connector)	{Terminal 16} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	B	B	According	(2)
	{Terminal 16} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Voltage Measurement (X2 Connector)	{Terminal 17} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Terminal 17} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
I '+' (X3 Connector)	{Terminal 1} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Terminal 1} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
N '-' (X3 Connector)	{Terminal 2} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Terminal 2} x {Neutral}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Frontal RS232	{All terminals} x {Ground}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
RS232 (communication – located at the backside)	{All terminals} x {Ground}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Auxiliary Relay (X2 Connector)	{18, 19 and 20 Terminals} x {Ground}	+ 2,5	A	B	According	None
		- 2,5	A	B	According	None
	{Terminal 18} x {Terminal 19}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None

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Table 8 continuation						
Auxiliary Relay (X2 Connector)	{Terminal 18} x {Terminal 20}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
	{Terminal 19} x {Terminal 20}	+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
X5 to X7, X9 and X10 connectors (All terminals)		+ 1,0	A	B	According	None
		- 1,0	A	B	According	None
Initial temperature: 21,8 °C			**Final temperature:** 22,8 °C			
Initial relative humidity: 74 %			**Final relative humidity:** 70 %			
Supply: 120 V / 60 Hz						

Notes: (1) – Sample reset, returning to normal operation after application; (2) – Display illumination turned off, returning to normal after application.

The uncertainties of the quantities involved are shown in Table 9, below:

Table 9: Uncertainties		
Test concerning the standard:		Uncertainties
IEC 61000-4-18	Voltage (V)	± 3,0 %
	Time (µs)	± 2,4 %
IEC 60255-27 / IEC 60255-5 – Voltage Impulse	Voltage (V)	± 3,0 %
	Time (µs)	± 2,4 %
Temperature		± 2,0 °C
Relative humidity		± 10 %

5 NOTES

5.1 Tests performed on July 11th and 12th, 2018.

5.2 Performed by:

- Mario F. Barbosa – Electronic Technician - CREA 5061534362 – IPT

5.3 Tests accompanied by:

- Felipe Vilaça Marchezini – Toshiba

This report was originally published in Portuguese on September 6th, 2018

São Paulo, September 6th, 2018.

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Electrical and Optical Equipment Laboratory

Electrical. Eng. Dr. Mário Leite Pereira Filho
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0000030

Title:
Short-circuit test.

Costumer:
Transformadores e Serviços de Energia das Américas S.A.
Rodovia Fernão Dias, 3045 – Amazonas
32240-090 – Contagem –MG – Brasil
Phone: +55 (31) 3329-6563
leonardo.jose@tseaenergia.com.br
At.: Leonardo José Siqueira Pinto

Test Proposal:
DLA – 19208/2018-AP2

Manufacturer:
The same

Area/Project:
E100/3002

Item under test:
Single phase voltage regulator.

Characteristics of the item under test:
Rated power: 500 kVA.
Rated voltage: 7970 V.
Other characteristics on the page 2.

Test performed:
Type test, listed on page 3, based on the standards ANSI C57.15:2009.

Observations:
The manufacturer's drawings for the item under test are on the pages 13 and 14.

Key-words:
Voltage regulator, short-circuit.

Approval:

Authorized Signatory
Claudio Cerqueira Siqueira
High Power – AP-2

Head of the Adrianópolis Laboratories Department - DLA
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Date of issue: 24/4/2019

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rated characteristics of the tested item assigned by the manufacturer

Power:		500 kVA
Pass power:		5000 kVA
Voltage:		7970 V
Current:		627 A
Frequency:		60 Hz
Number of phases:		1
Voltage class:		15 kV
Regulation rate:		±10% in 32 degrees of 0,625%
Power frequency withstand voltage:		34 kV
Lightning impulse withstand voltage (NBI):		110 kV
Short-circuit impedance:		
Position +16:	Máx. 0,23 %	
Position -16:	Máx. 0,23 %	
Specification standard:		IEEE Std C57.15:2009
Conductor Material:		Series: Al – Excitation: Al
Equipment Status:		New
Cooling type:		ONAN
Limit of the temperature rise:		
Oil (top):	55 / 65 °C	
Windings:	55 / 65 °C	
Total mass:		5029 lbs
Active part mass w/ cover:		2685 lbs
Tank and accessories mass:		899,5 lbs
Volume of oil:		194 gal
Oil type:		Naphthenic
Serial number of the voltage regulator:		F18411
Model:		HCMR
Date of manufacture:		February/2019
Drawing:		
Characteristics nameplate:		Z3-0232467 – REV. 1
Constructive:		Z4-4613031 – REV. 1

Obs: CEPEL is not responsible for the information assigned by the manufacturer.

equipment on CEPEL:	02/21/2019
equipment conditions before the test:	new.
dimensional identification of the tested:	according to the drawings provided by the manufacturer.

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table of the carried out tests

type of test: short circuit	**page**
1 application of symmetrical current at the position +16	5
1 application of symmetrical current at the position +16	6
1 application of asymmetrical current at the position +16	7
1 application of symmetrical current at the position -16	8
1 application of symmetrical current at the position -16	9
1 application of asymmetrical current at the position -16	10

test executers:

Cláudio Cerqueira Siqueira - CEPEL
Cristiano sobreira Xavier - CEPEL
Marcelo Guimarães Rodrigues - CEPEL
Mario Gonçalves - CEPEL
Robson Bianchi - CEPEL

witnesses to the tests:

Daniela Franciely Santos do Céu - TSEA

test assembler:

Adilson Jacinto Teixeira - SM21

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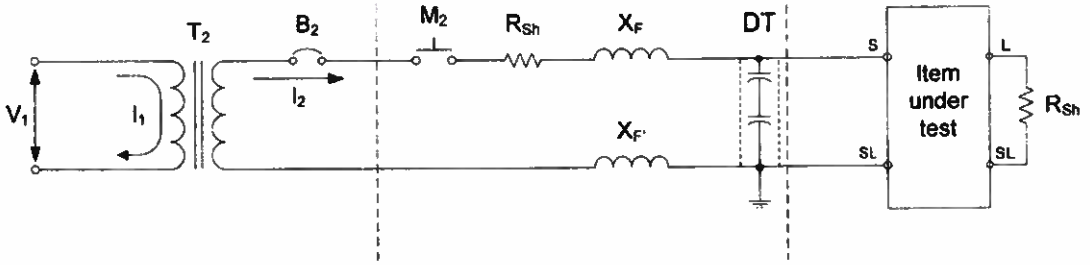
short-circuit test		
test circuit conditions:	**power factor** < 0,1	**frequency** 60 Hz
source:	to the terminals S - SL with the terminals L – SC short-circuited through a shunt of 0.1mΩ (photo 1 – page 12).	

Test circuit



legenda:

T_2	-	short-circuit transformer;
B_2	-	circuit-breaker;
M_2	-	making switch;
X_F e $X_{F'}$	-	current limiting reactor;
DT	-	voltage divider;
R_{Sh}	-	shunt for currents measurement;
V_1	-	input voltage of the short-circuit transformer;
I_1	-	short-circuit transformer input current;
V_S	-	voltage regulator voltage source side tested;
I_S	-	current source side of the voltage regulator tested;
I_L	-	load side current of the tested voltage regulator;
I_F	-	regulator fault current.

Obs.:

The maximum global uncertainty values of the source side current measurement systems, load side current and source side voltage are, respectively, 0,78% (k = 2,00), 0,58% (k = 2,00) and 0,42% (k = 2,00).

The expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA-4/02.

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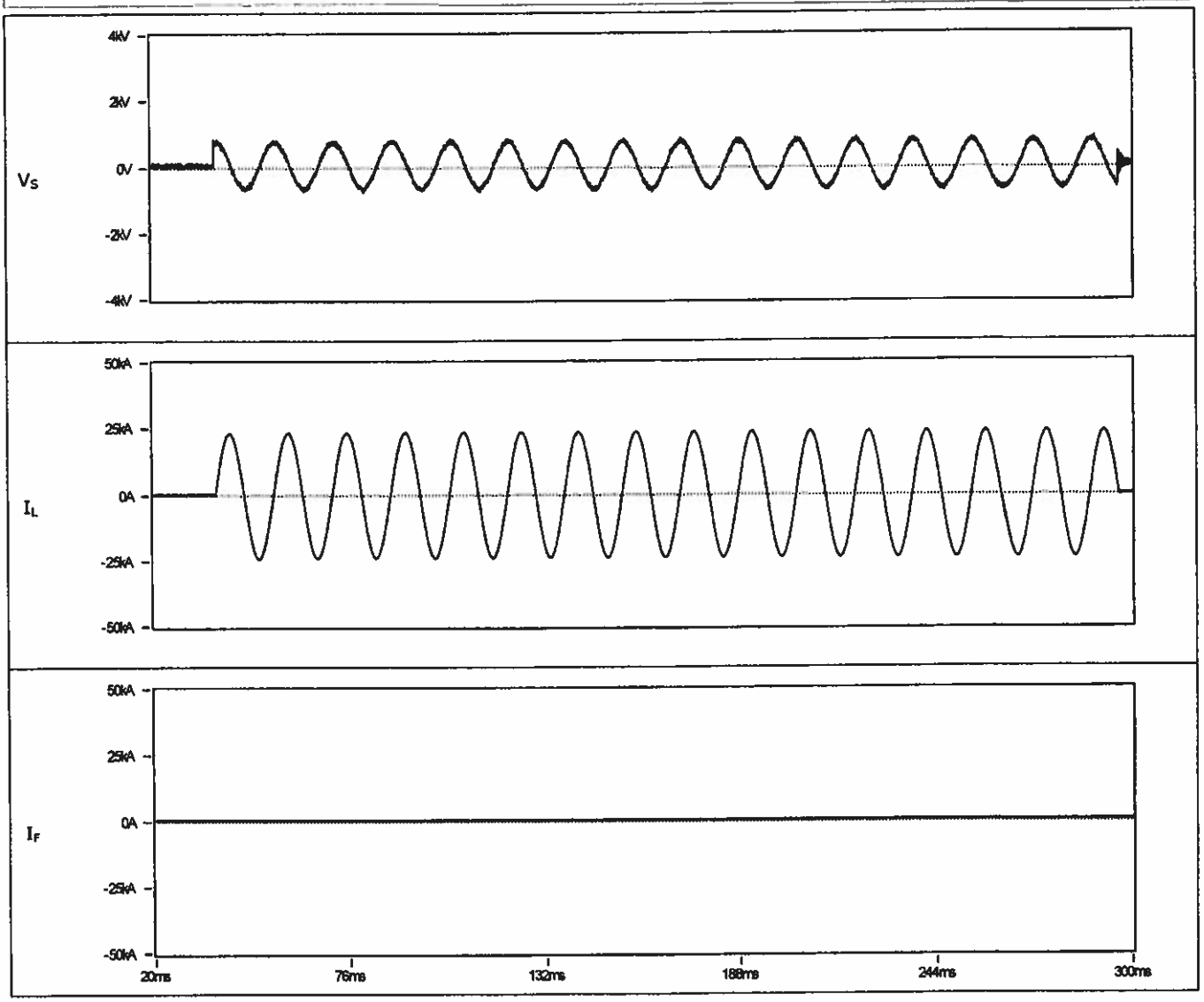

Application 1		RMS	Peak			RMS	Peak
Source side voltage	V_S	598,5 V	-	Load side current	I_L	15,05 kA	21,62 kA
Switch position	+16			Current Duration	250 ms		

Apl161 (580x160)

Date - Application timing: 02/28/2019 - 08:48:21

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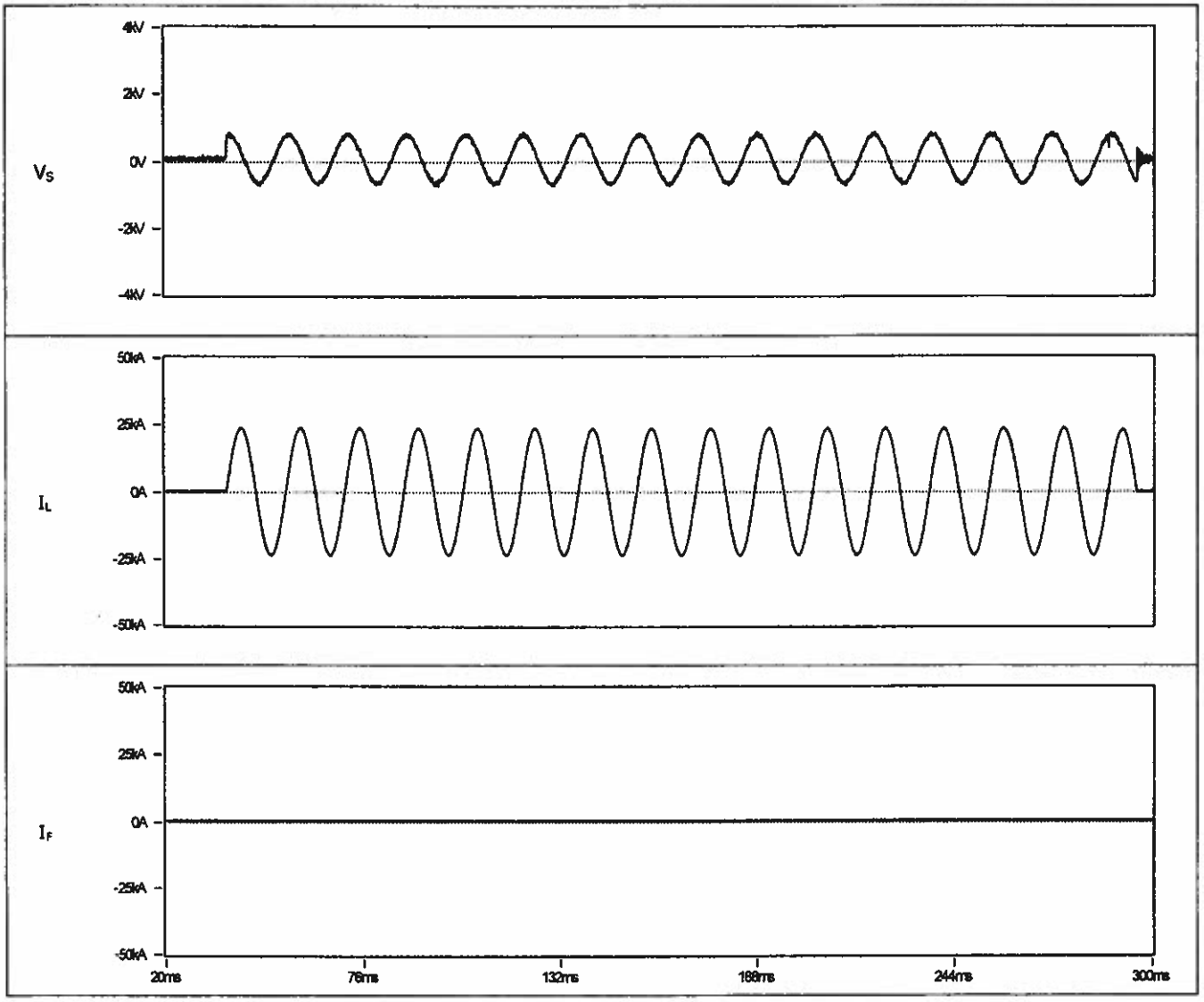

Application 2		RMS	Peak			RMS	Peak
Source side voltage	V_S	596,7V	-	Load side current	I_L	15,13 kA	21,59 kA
Switch position	+16			Current Duration	250 ms		

Apl162 (580x160)

Date - Application timing: 02/28/2019 - 09:05:09

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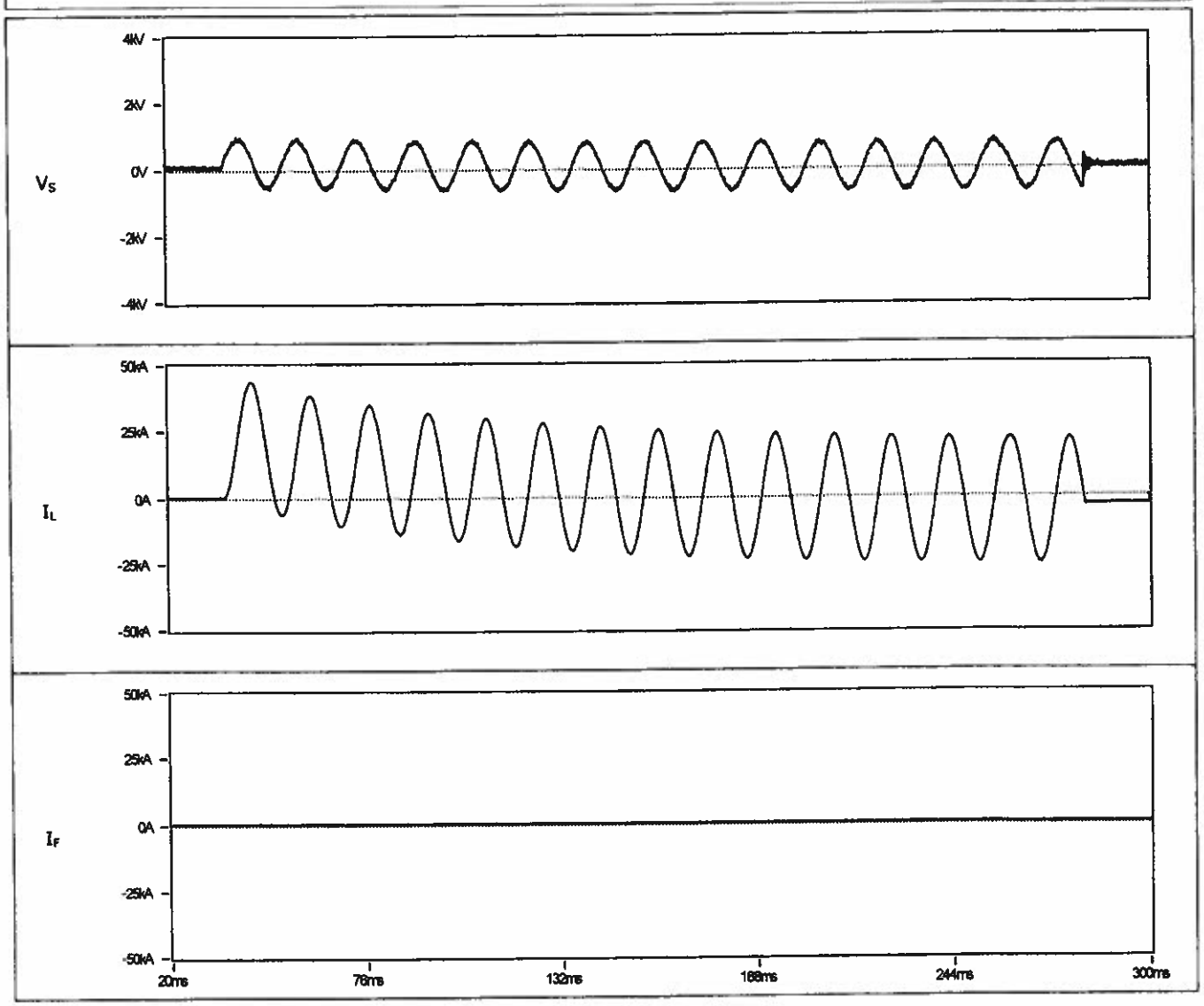

Application 3		RMS	Peak			RMS	Peak
Source side voltage	V_S	595,5V	-	Load side current	I_L	15,11 kA	39,29 kA
Switch position	+16			Current Duration	250 ms		

Apl163 (580x160)

Date - Application timing: 02/28/2019 - 09:18:51

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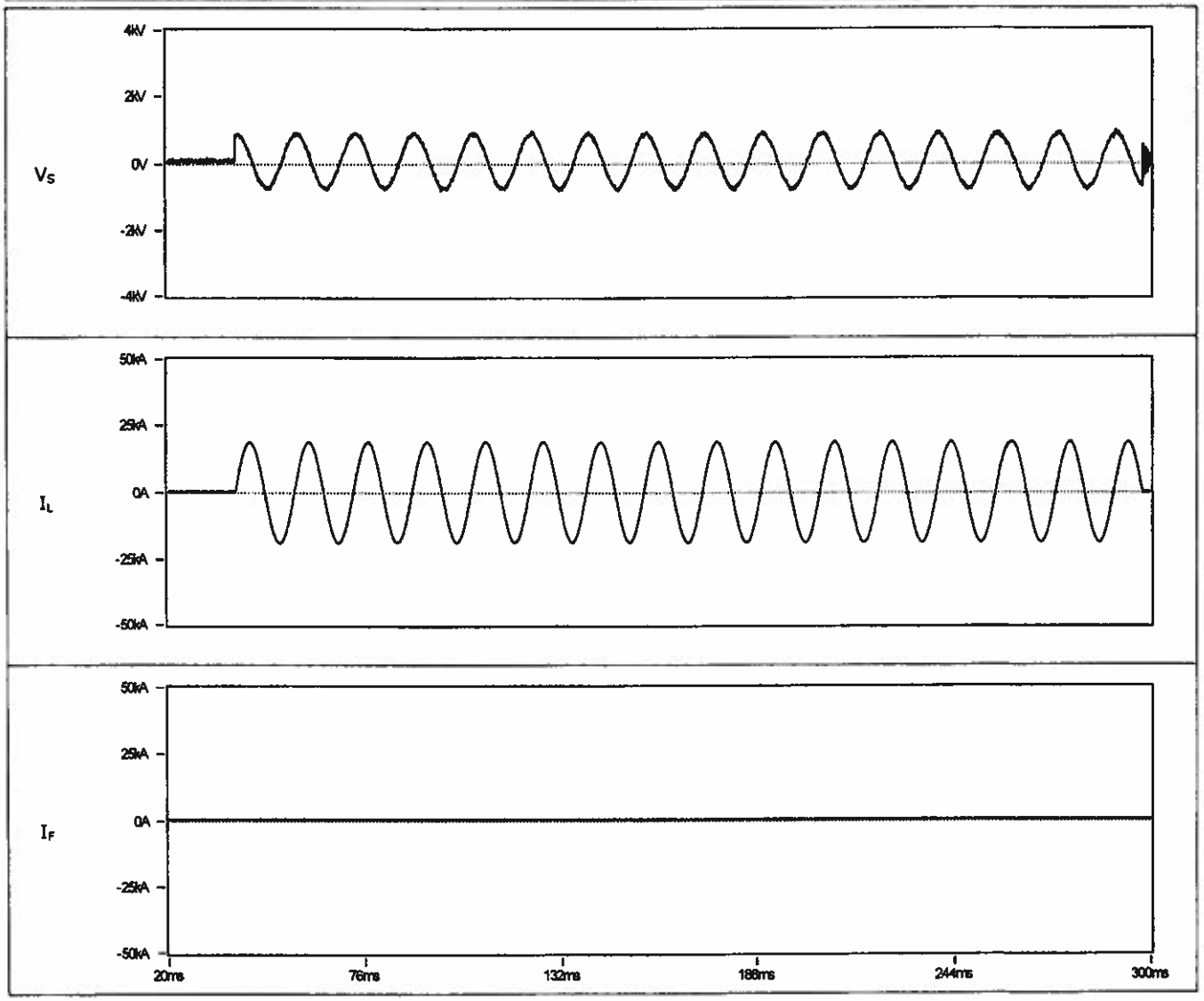
Representante Legal
ELECTROPAR S.A.



Application 4		RMS	Peak			RMS	Peak
Source side voltage	V_S	596,2 V	-	Load side current	I_L	14,91 kA	21,09 kA
Switch position	-16			Current Duration	250 ms		

Apl166 (580x160)

Date - Application timing: 02/28/2019 - 09:29:43

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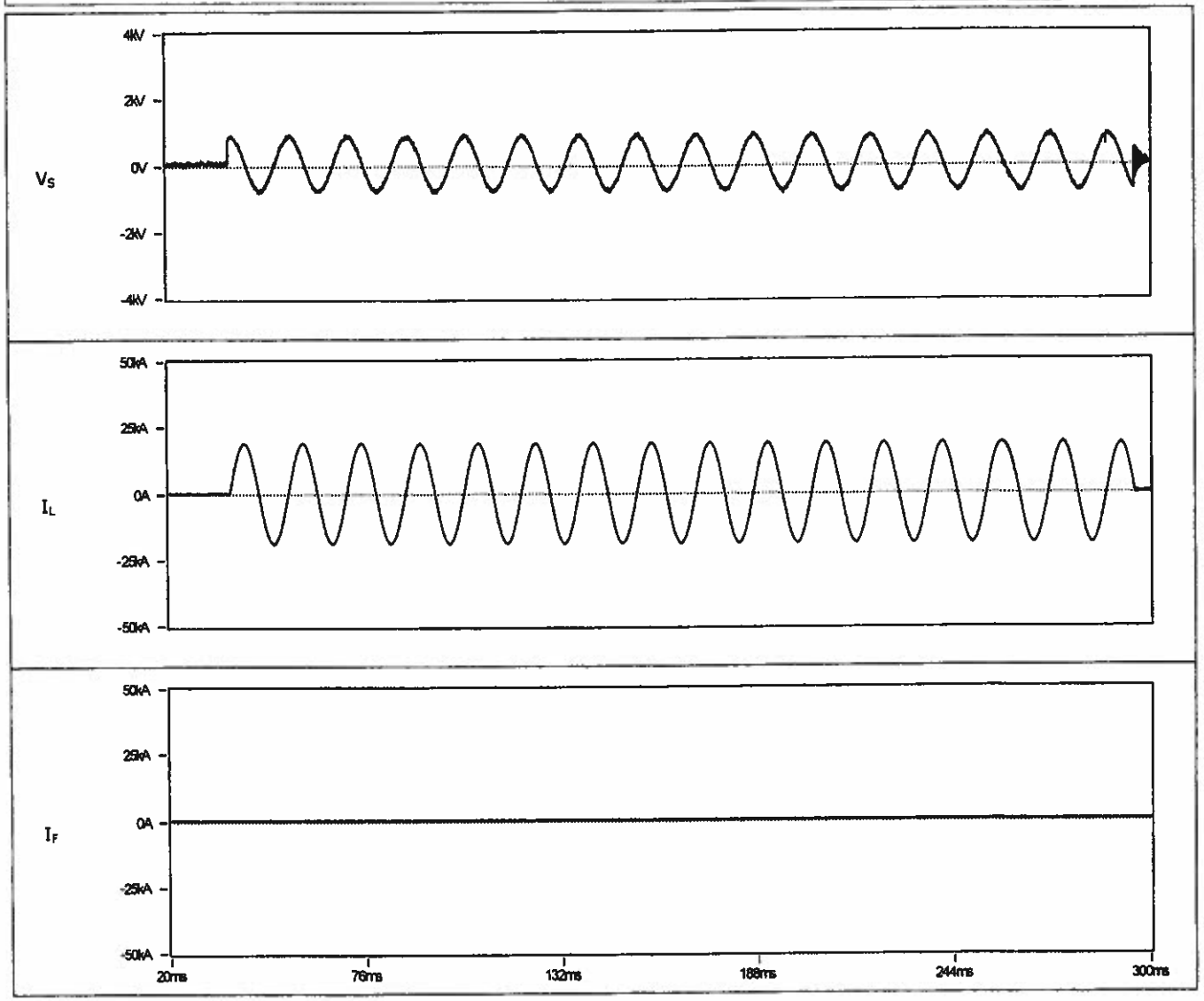

Application 5		RMS	Peak			RMS	Peak
Source side voltage	V_S	595,8 V	-	Load side current	I_L	14,93 kA	21,12 kA
Switch position	-16			Current Duration	250 ms		

Apl167 (580x160)

Date - Application timing: 02/28/2019 - 10:06:08

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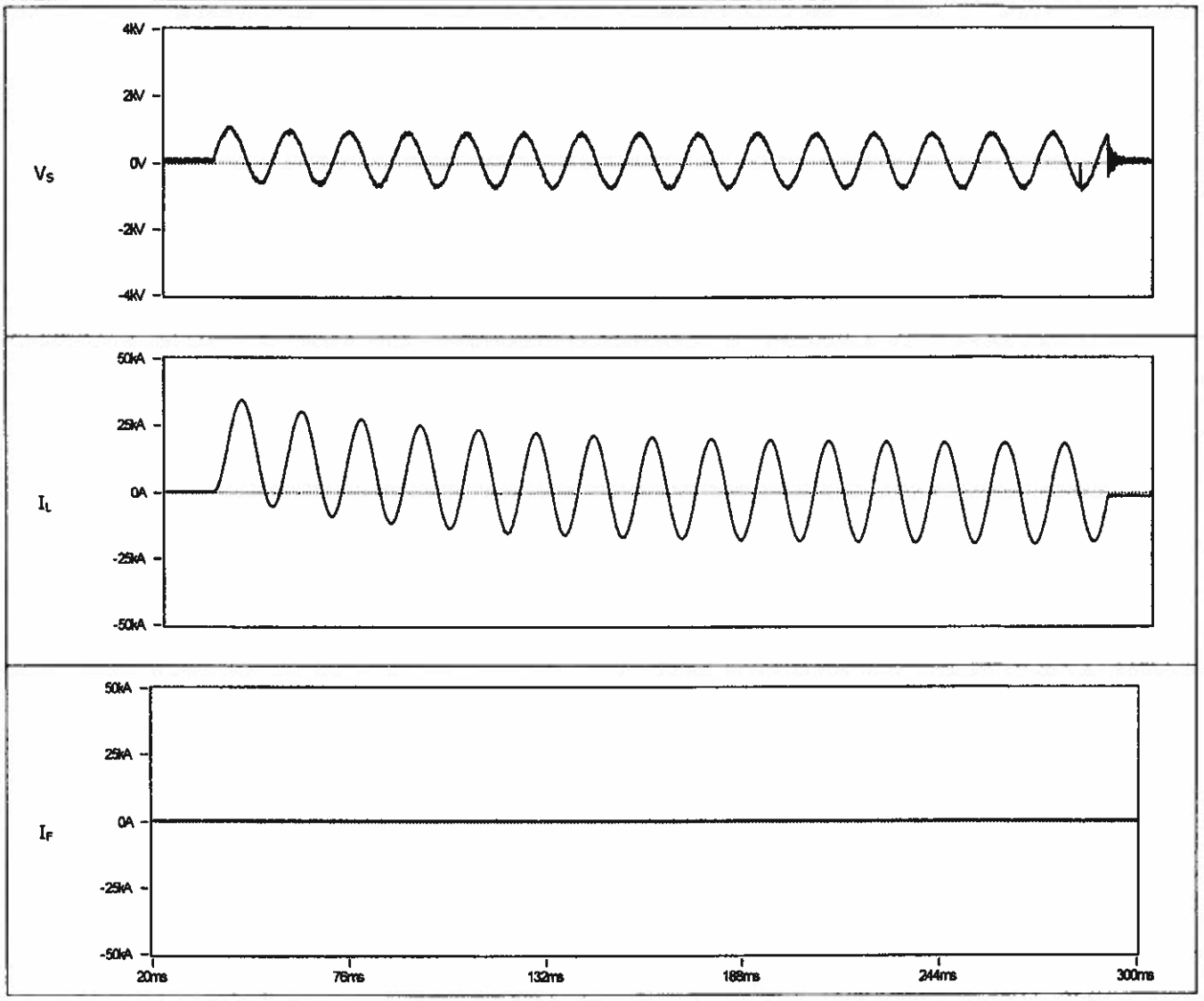

Application 6		RMS	Peak			RMS	Peak
Source side voltage	V_S	596,1 V	-	Load side current	I_L	14,98 kA	38,79 kA
Switch position	-16			Current Duration	250 ms		

Apl168 (580x160)

Date - Application timing: 02/28/2019 - 10:18:35

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inductance measurements

Instrument	Hameg programable LCR
calibration certificate	CA1-141/2016
next calibration	July/ 2019

position	terminals	before (µH)	after (µH)	variation (%)
+16	SL – L	54,81	57,64	5,2
-16	SL – L	58,63	61,79	5,4

environment temperature	26,2 °C	36,9 °C
environment humidity	68,2%	54,2%
date	02/28/19	02/28/19

The maximum overall uncertainty value of the inductance measurement system is 2,33 (k = 2,00).

The expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA-4/02.

final remarks

a) The picture 1 (page 12) shows the tested voltage regulator.
b) There was no meaningful variation between current rms values in the beginning and in the end of each one of the six current applications performed.
c) The routine tests before and after the short-circuit test were not carried out by CEPEL.
d) The inspection of the active part, after the test, was not effectuated by CEPEL.

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ELECTROBRAS S.A.

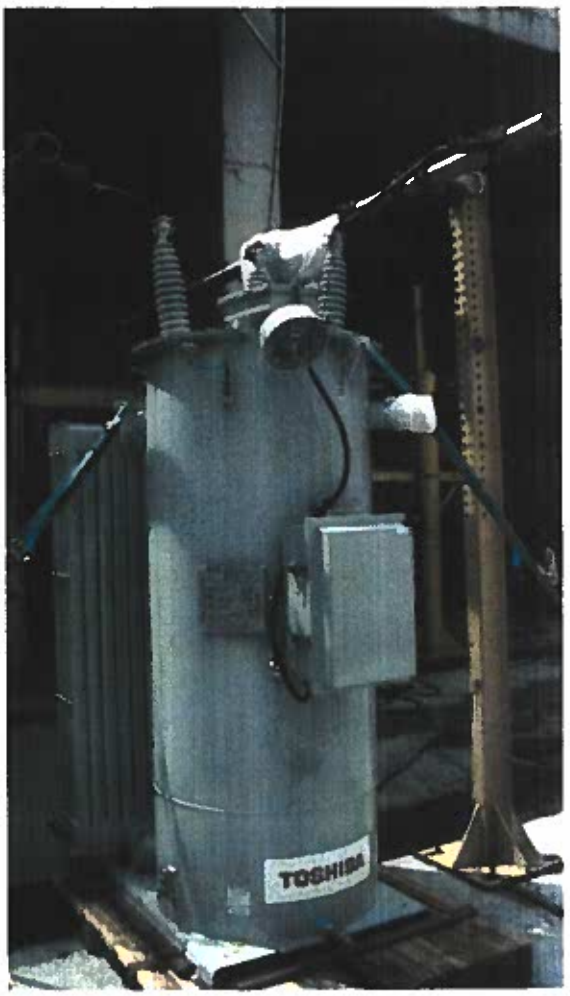

Photo 1 – test arrangement.

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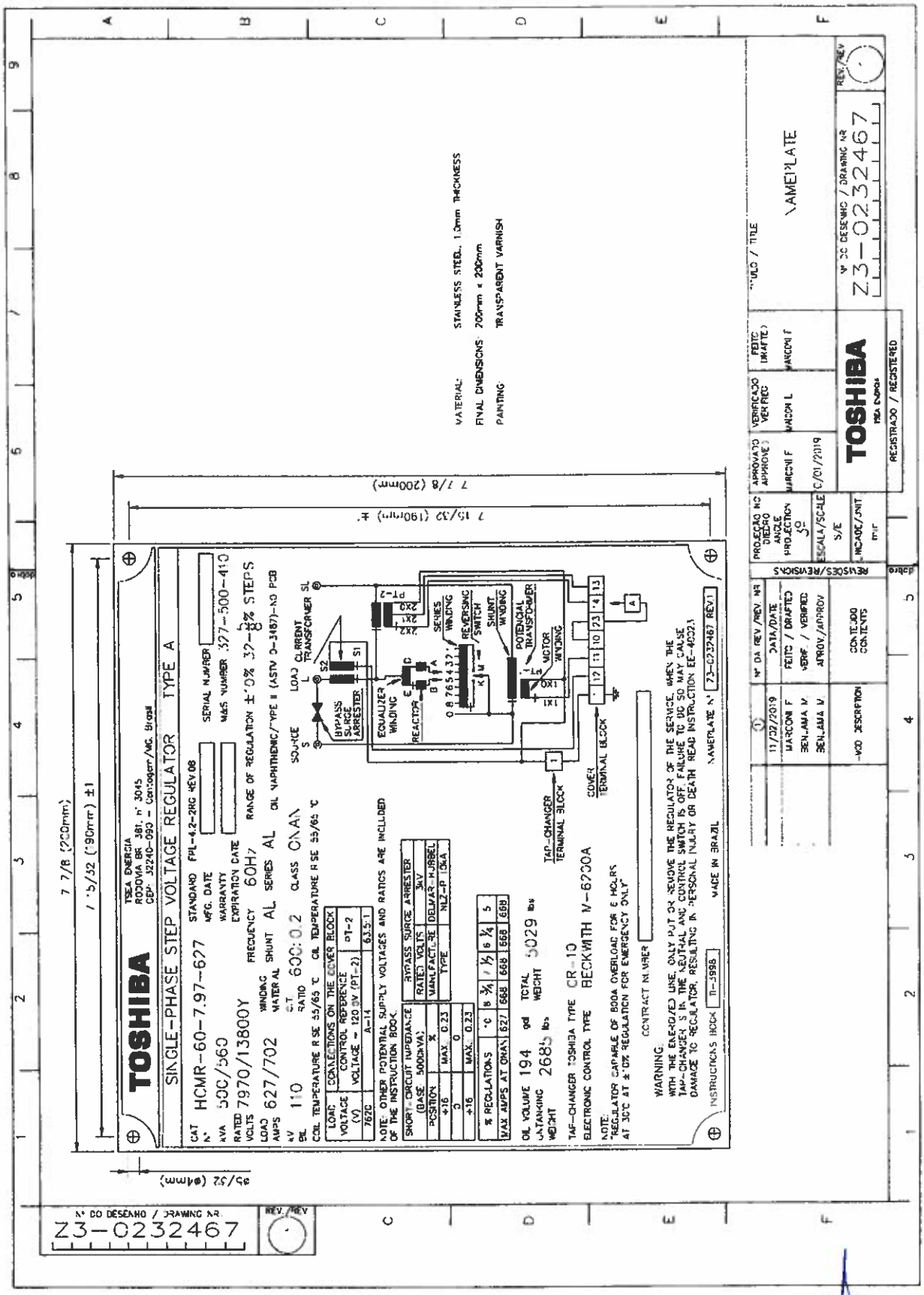
Representante Legal
ELECTROPAR S.A.



RODOLFO PEREZ
Representante Legal
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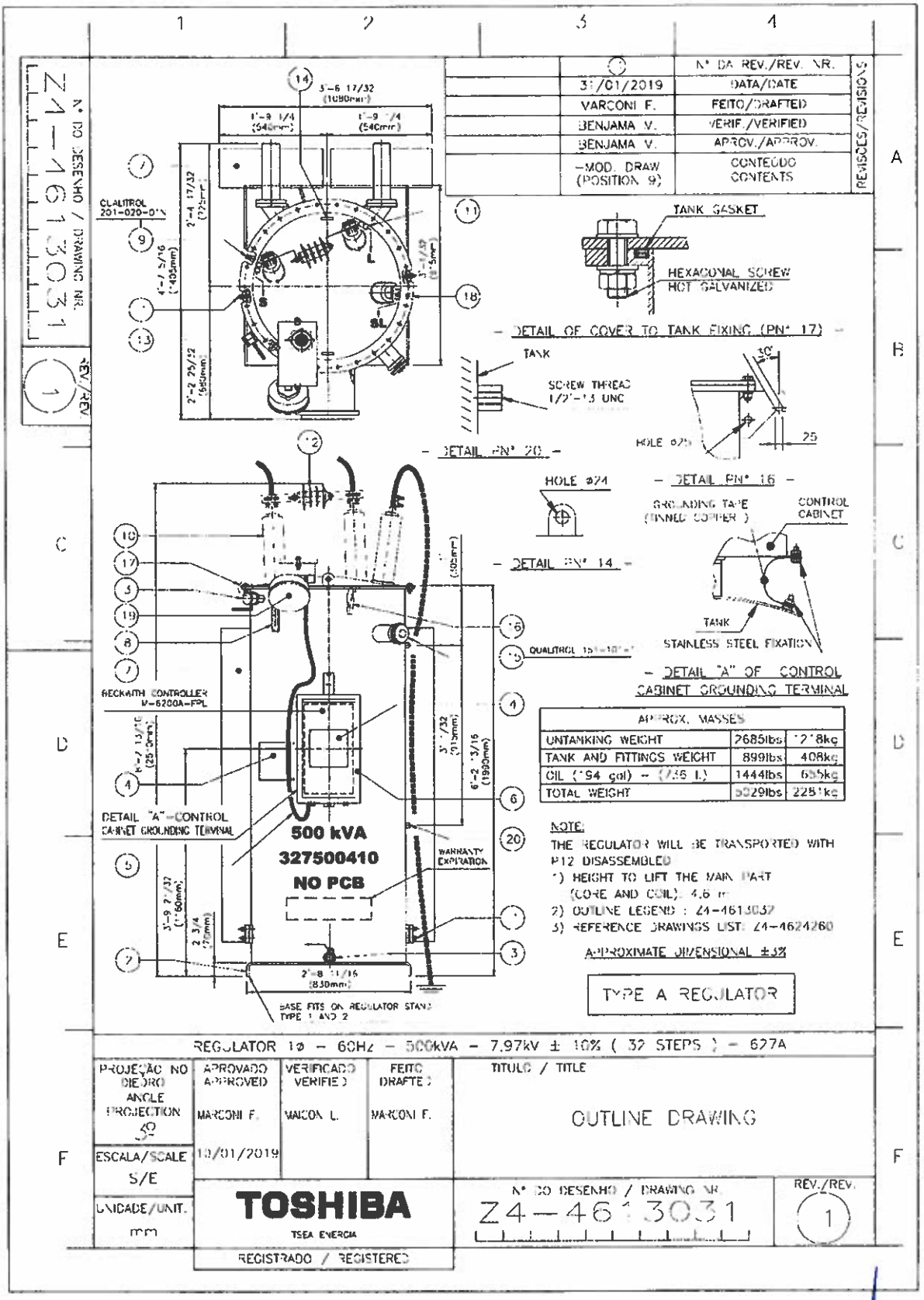

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Representante Legal
ELECTROPAR S.A.

Title:
Short-circuit test.

Costumer:
Transformadores e Serviços de Energia das Américas S.A.
Rodovia Fernão Dias, 3045 – Amazonas
32240-090 – Contagem –MG – Brasil
Phone: +55 (31) 3329-6563
leonardo.jose@tseaenergia.com.br
At.: Leonardo José Siqueira Pinto

Test Proposal:
DLA – 19210/2018-AP2

Manufacturer:
The same

Area/Project:
E100/3002

Item under test:
Single phase voltage regulator.

Characteristics of the item under test:
Rated power: 667 kVA.
Rated voltage: 14400 V.
Other characteristics on the page 2.

Test performed:
Type test, listed on page 3, based on the standards ANSI C57.15:2009.

Observations:
The manufacturer's drawings for the item under test are on the pages 13 and 14.

Key-words:
Voltage regulator, short-circuit.

Approval:

Authorized Signatory
Claudio Cerqueira Siqueira
High Power – AP-2

Head of the Adrianópolis Laboratories Department - DLA
Alberto Junqueira
ajsl@cepel.br

Telephone: (21) 2666-6273
Fax: (21) 2667-3079
Date of issue: 24/4/2019

This report is not a certificate of compliance. The results presented refer only to the tested items.

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Classificated of Access: Confidential.

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rated characteristics of the tested item assigned by the manufacturer

Power:		677 kVA
Pass power:		6770 kVA
Voltage:		14400 V
Current:		470 A
Frequency:		60 Hz
Number of phases:		1
Voltage class:		24,2 kV
Regulation rate:		±10% in 32 degrees of 0,625%
Power frequency withstand voltage:		50 kV
Lightning impulse withstand voltage (NBI):		150 kV
Short-circuit impedance:		
Position +16:	Máx. 0,30 %	
Position -16:	Máx. 0,30 %	
Specification standard:		IEEE Std C57.15:2009
Conductor Material:		Series: Al – Excitation: Al
Equipment Status:		New
Cooling type:		ONAN
Limit of the temperature rise:		
Oil (top):	55 / 65 °C	
Windings:	55 / 65 °C	
Total mass:		6799 lbs
Active part mass w/ cover:		3710 lbs
Tank and accessories mass:		1362 lbs
Volume of oil:		232 gal
Oil type:		Naphthenic
Serial number of the voltage regulator:		F18417
Model:		HCMR
Date of manufacture:		February/2019
Drawing:		
Characteristics nameplate:		Z3-0232468 – REV. 1
Constructive:		Z4-4613033 – REV. 1

Obs: CEPEL is not responsible for the information assigned by the manufacturer.

equipment on CEPEL:	02/21/2019
equipment conditions before the test:	new.
dimensional identification of the tested:	according to the drawings provided by the manufacturer.

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table of the carried out tests

type of test: short circuit	**page**
1 application of symmetrical current at the position +16	5
1 application of symmetrical current at the position +16	6
1 application of asymmetrical current at the position +16	7
1 application of symmetrical current at the position -16	8
1 application of symmetrical current at the position -16	9
1 application of asymmetrical current at the position -16	10

test executers:

Cláudio Cerqueira Siqueira - CEPEL
Cristiano sobreira Xavier - CEPEL
Marcelo Guimarães Rodrigues - CEPEL
Mario Gonçalves - CEPEL
Robson Bianchi - CEPEL

witnesses to the tests:

Daniela Franciely Santos do Céu - TSEA

test assembler:

Adilson Jacinto Teixeira - SM21

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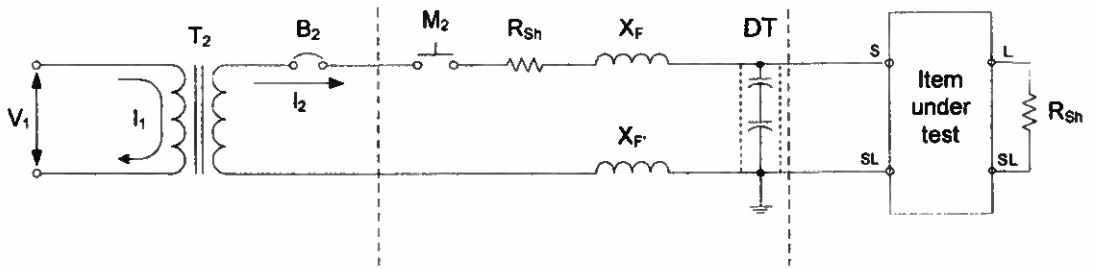
short-circuit test

test circuit conditions: **power factor** < 0,1 **frequency** 60 Hz

source: to the terminals S - SL with the terminals L – SC short-circuited through a shunt of 0.1mΩ (photo 1 – page 12).

Test circuit



legenda:

T_2	-	short-circuit transformer;
B_2	-	circuit-breaker;
M_2	-	making switch;
X_F e $X_{F'}$	-	current limiting reactor;
DT	-	voltage divider;
R_{Sh}	-	shunt for currents measurement;
V_1	-	input voltage of the short-circuit transformer;
I_1	-	short-circuit transformer input current;
V_S	-	voltage regulator voltage source side tested;
I_S	-	current source side of the voltage regulator tested;
I_L	-	load side current of the tested voltage regulator;
I_F	-	regulator fault current.

Obs.:

The maximum global uncertainty values of the source side current measurement systems, load side current and source side voltage are, respectively, 0,78% (k = 2,00), 0,58% (k = 2,00) and 0,42% (k = 2,00).

The expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA-4/02.

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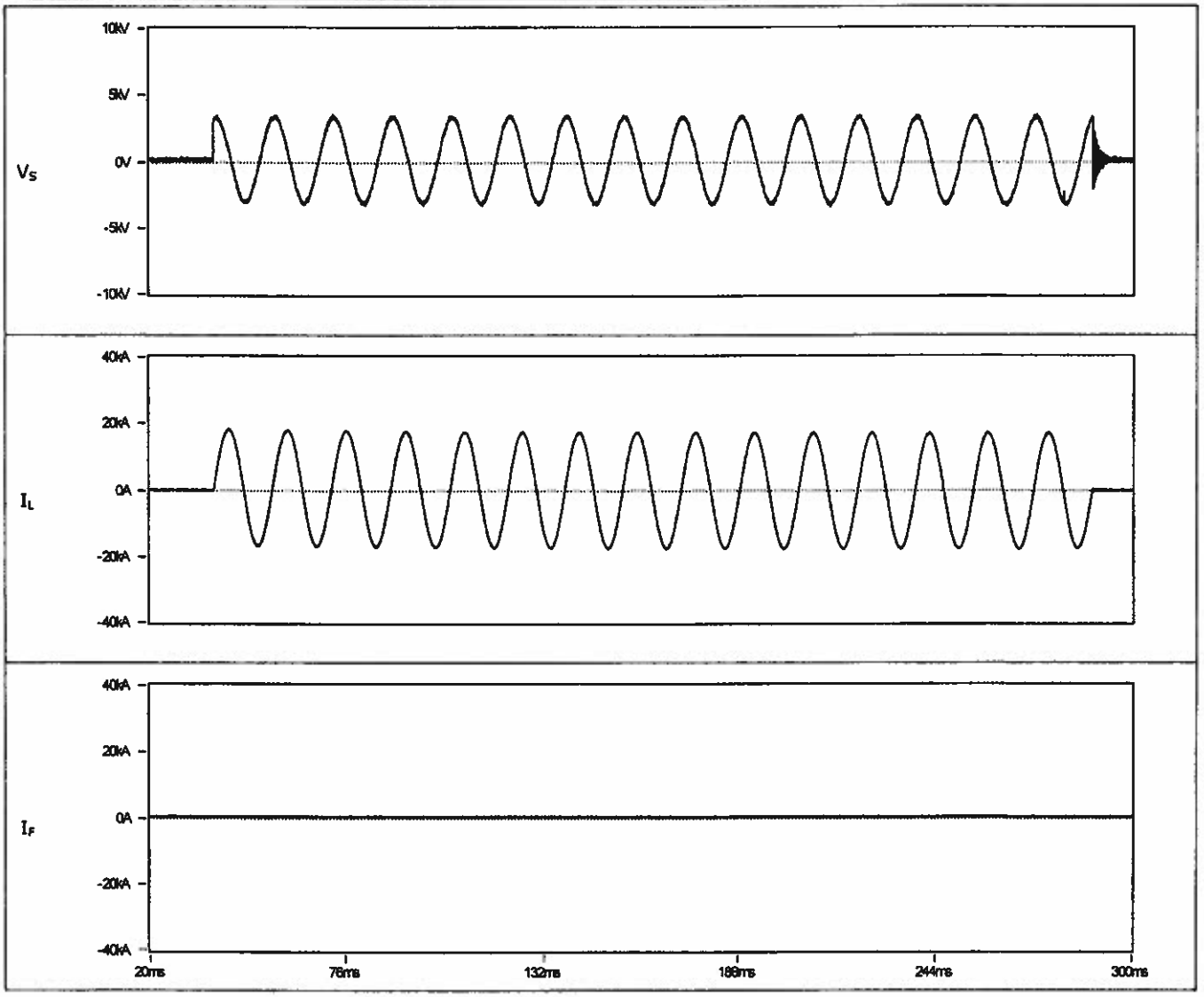

Application 1		RMS	Peak			RMS	Peak
Source side voltage	V_S	2,34 kV	-	Load side current	I_L	11,82 kA	16,93 kA
Switch position	-16			Current Duration	250 ms		

Apl152 (580x160)

Date - Application timing: 02/27/2019 - 09:42:31

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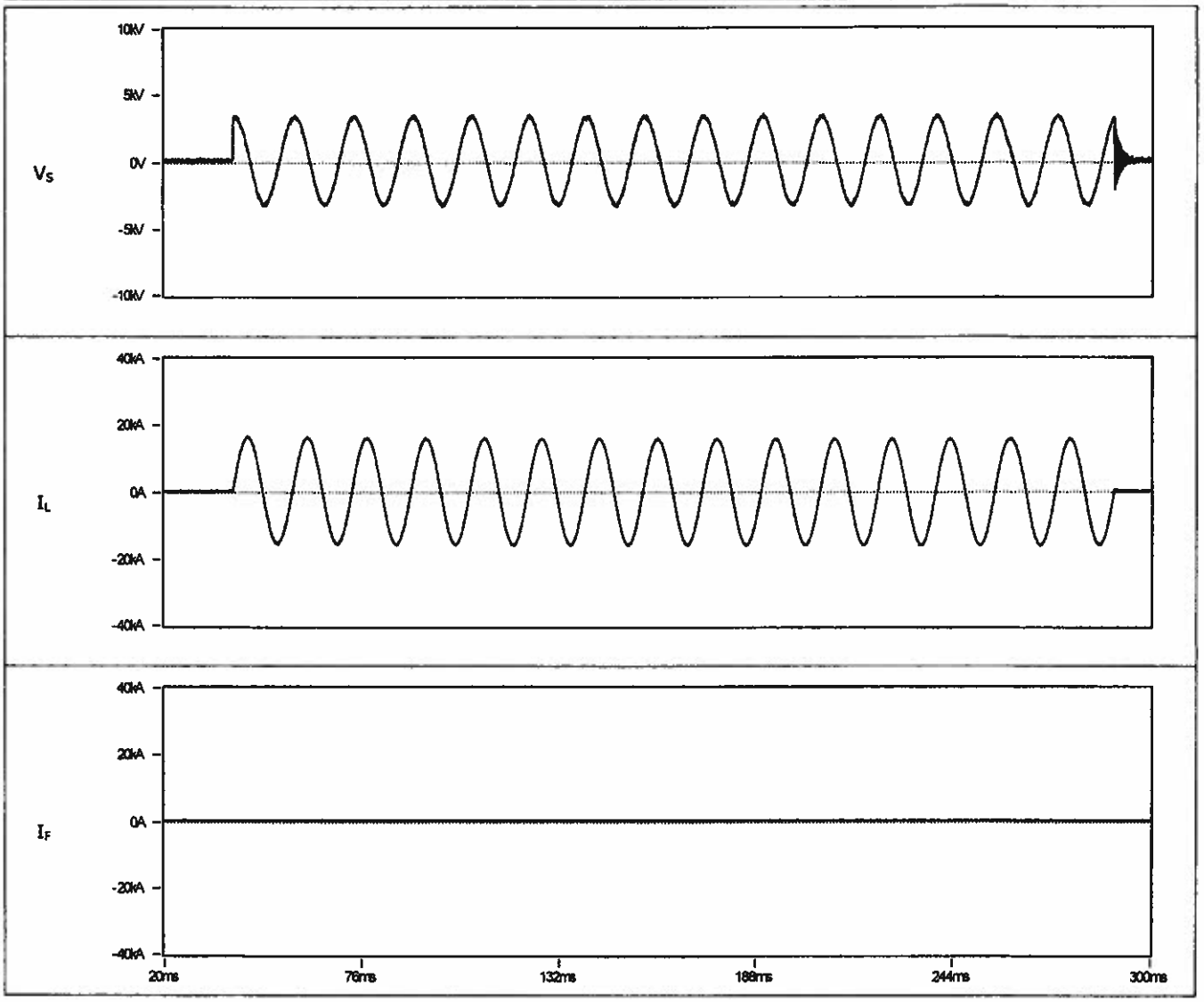

Application 2		RMS	Peak			RMS	Peak
Source side voltage	V_S	2,43 kV	-	Load side current	I_L	11,32 kA	16,52 kA
Switch position	-16			Current Duration	250 ms		

Apl153 (580x160)

Date - Application timing: 02/27/2019 - 09:56:18

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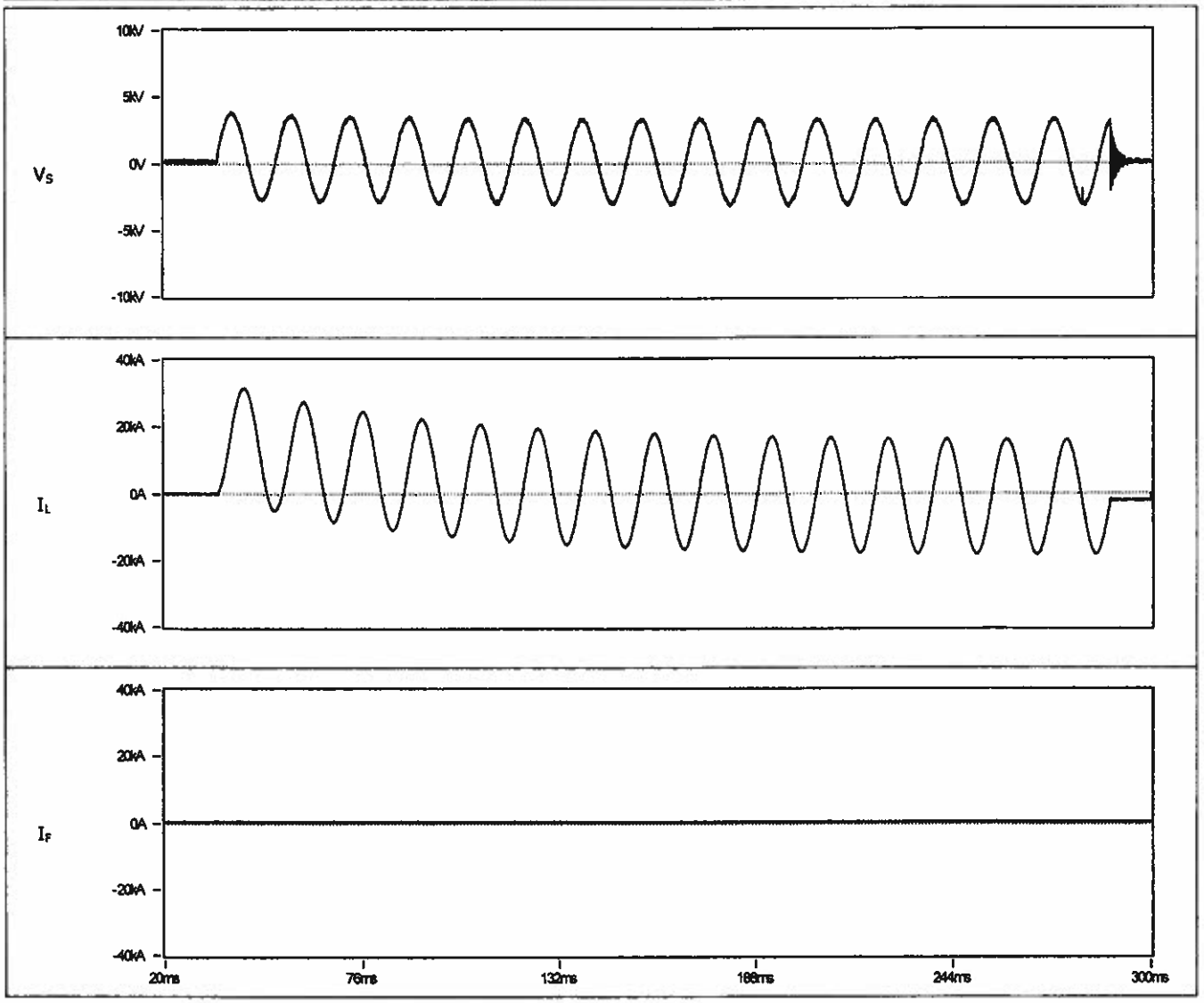

Application 3		RMS	Peak			RMS	Peak
Source side voltage	V_S	2,27 kV	-	Load side current	I_L	11,29 kA	29,35 kA
Switch position	-16			Current Duration	250 ms		

Apl154 (580x160)

Date - Application timing: 02/27/2019 - 10:01:09

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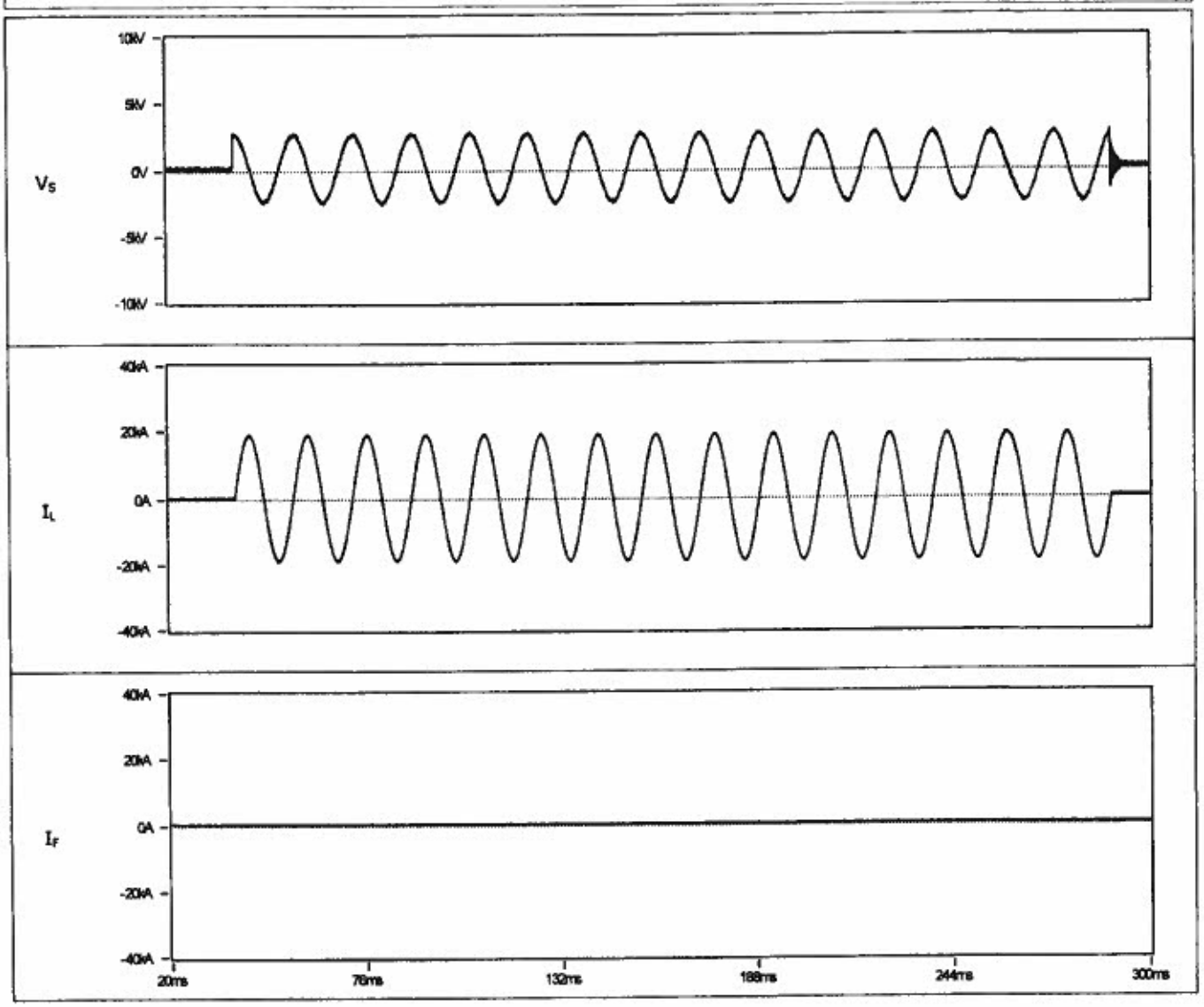

Application 4		RMS	Peak			RMS	Peak
Source side voltage	V_S	1,88 kV	-	Load side current	I_L	11,91 kA	17,05 kA
Switch position	+16			Current Duration	250 ms		

Apl156 (580x160)

Date - Application timing: 02/27/2019 - 10:38:31

RODOLFO PEREZ
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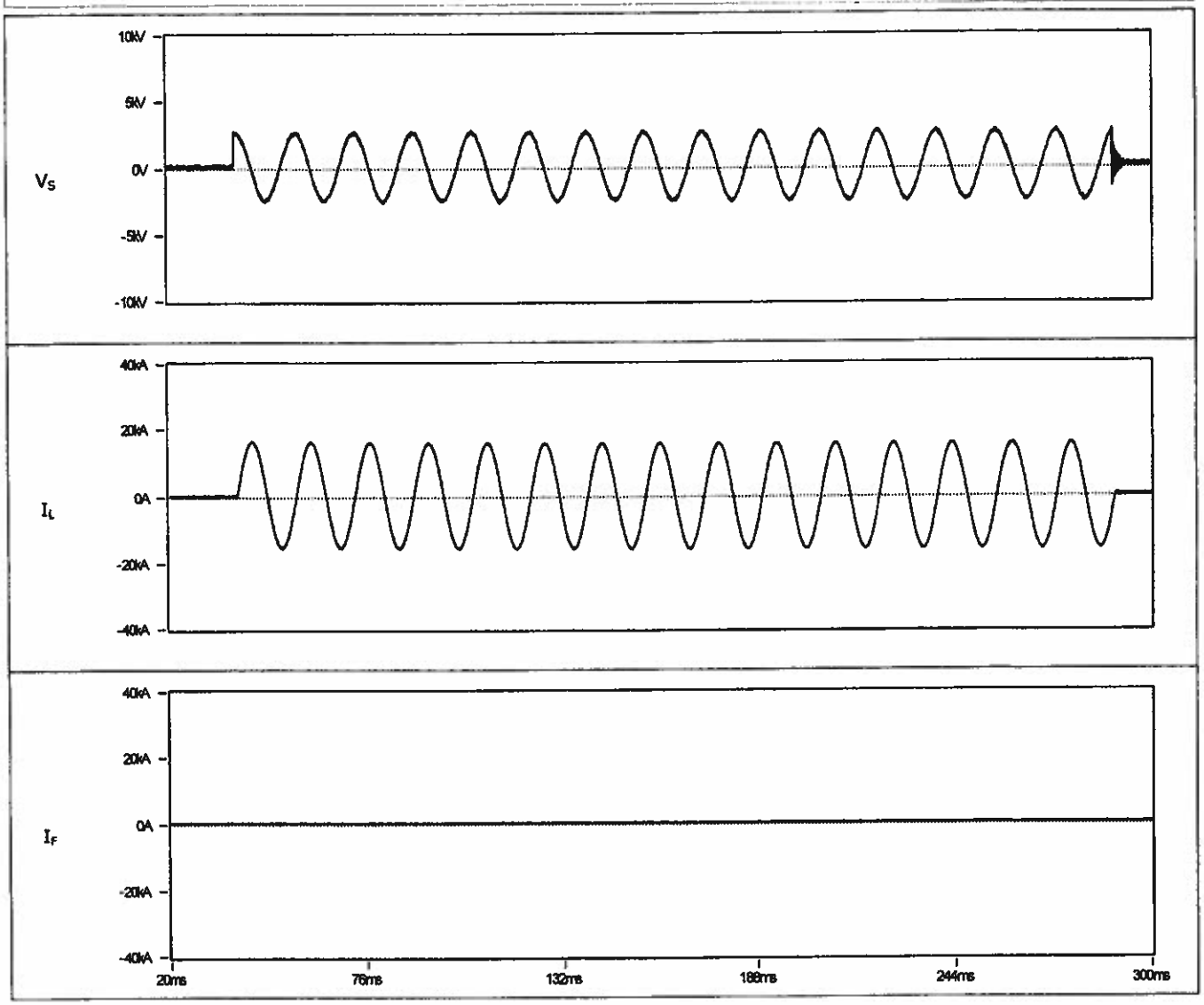
ELECTROPAR S.A.



Application 5		RMS	Peak			RMS	Peak
Source side voltage	V_S	1,88 kV	-	Load side current	I_L	12,02 kA	17,00 kA
Switch position	+16			Current Duration	250 ms		

Apl157 (580x160)

Date - Application timing: 02/27/2019 - 10:57:12

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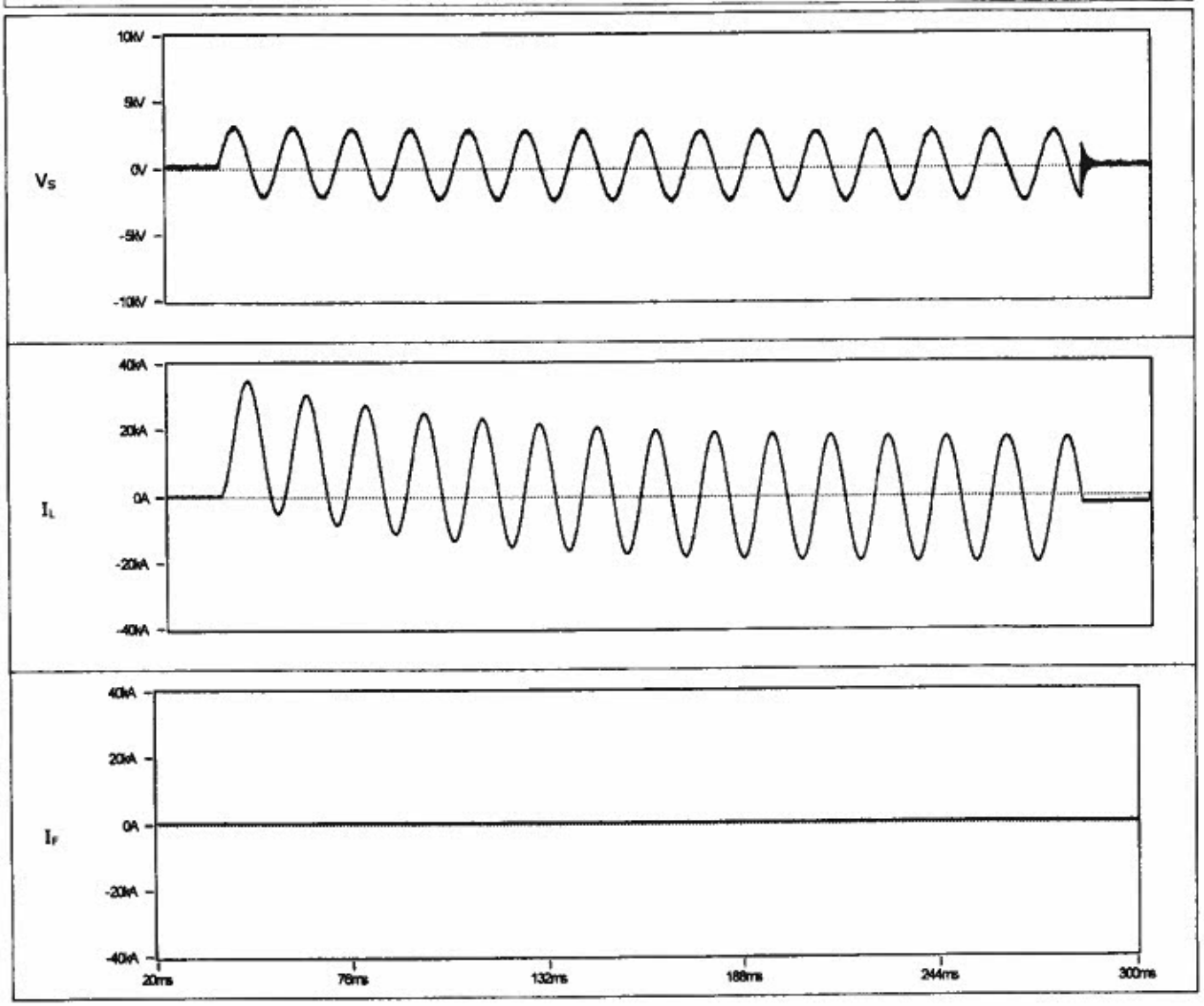
ELECTROPAR S.A.



Application 6		RMS	Peak			RMS	Peak
Source side voltage	V_S	1,87 kV	-	Load side current	I_L	12,08 kA	31,08 kA
Switch position	+16			Current Duration	250 ms		

Apl158 (580x160)

Date - Application timing: 02/27/2019 - 11:09:34

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inductance measurements

Instrument	Hameg programable LCR
calibration certificate	CA1-141/2016
next calibration	July/ 2019

position	terminals	before (µH)	after (µH)	variation (%)
+16	SL – L	166,99	170,62	2,17
-16	SL – L	184,46	187,94	1,89

environment temperature	28 ºC	31 °C
environment humidity	68%	70%
date	02/27/2019	02/27/2019

The maximum overall uncertainty value of the inductance measurement system is 2,33 (k = 2,00).

The expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA-4/02.

final remarks

a) The picture 1 (page 12) shows the tested voltage regulator.
b) There was no meaningful variation between current rms values in the beginning and in the end of each one of the six current applications performed.
c) The routine tests before and after the short-circuit test were not carried out by CEPEL.
d) The inspection of the active part, after the test, was not effectuated by CEPEL.

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Representante Legal
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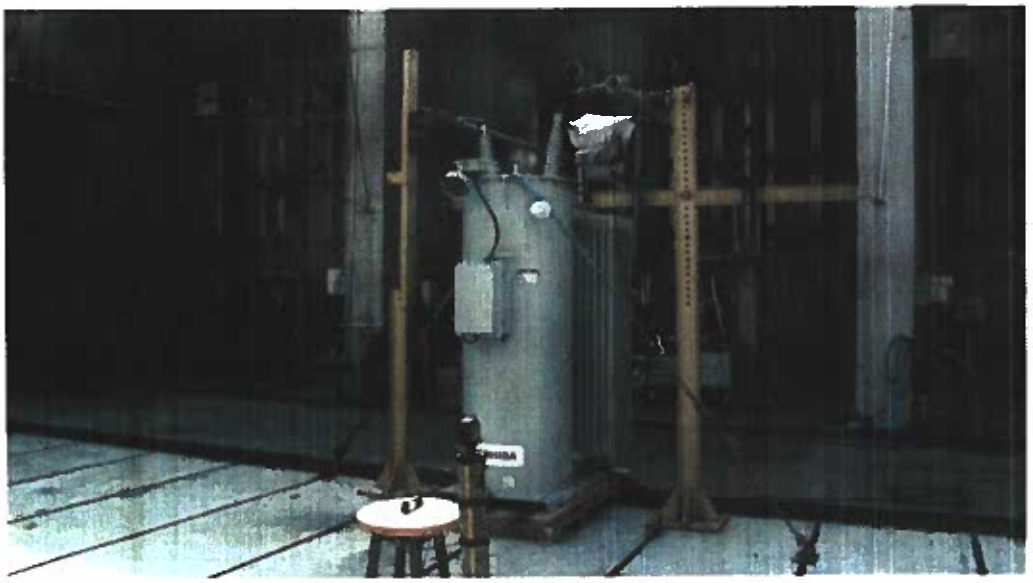

Photo 1 – test arrangement.

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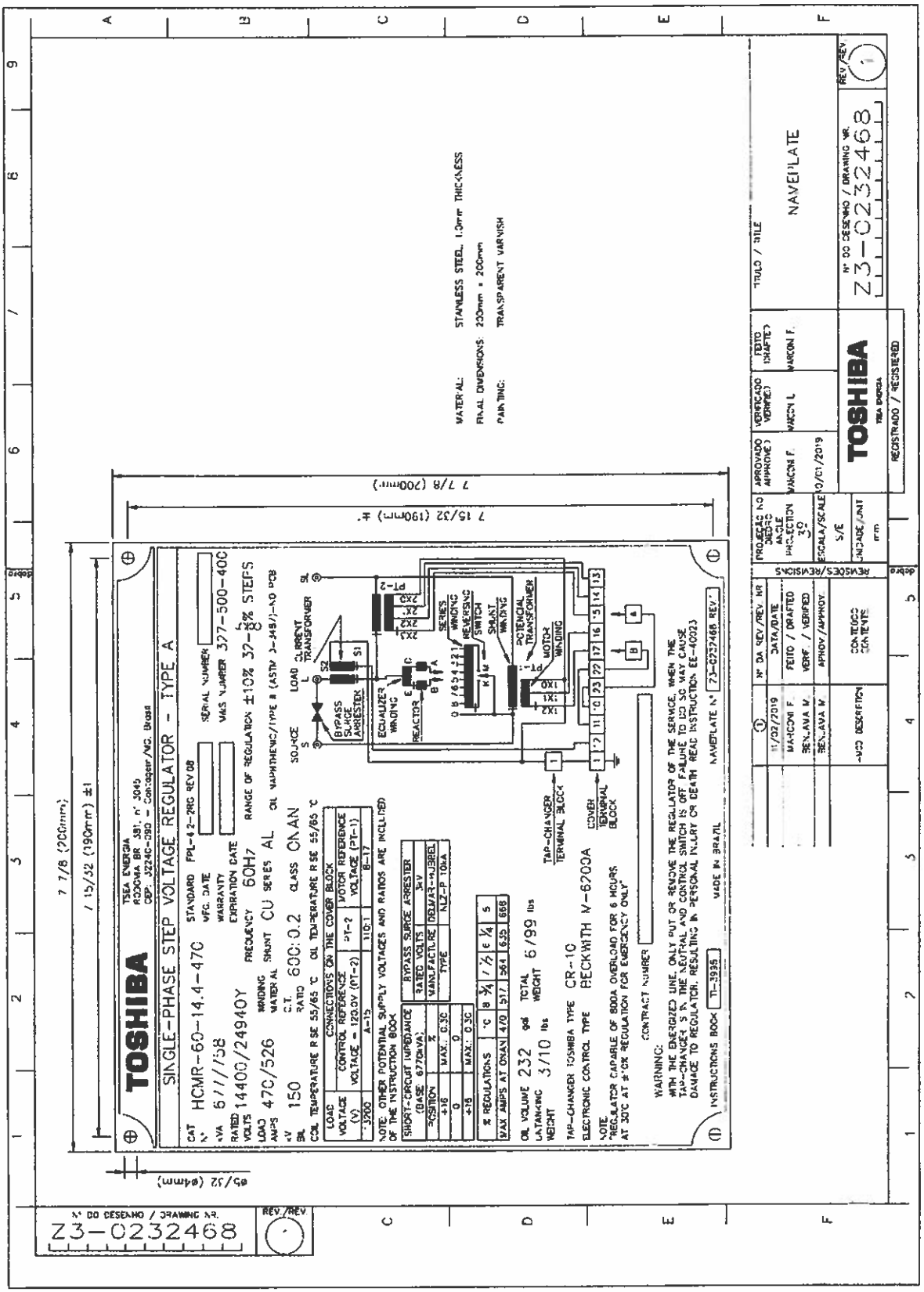
ELECTROPAR S.A.



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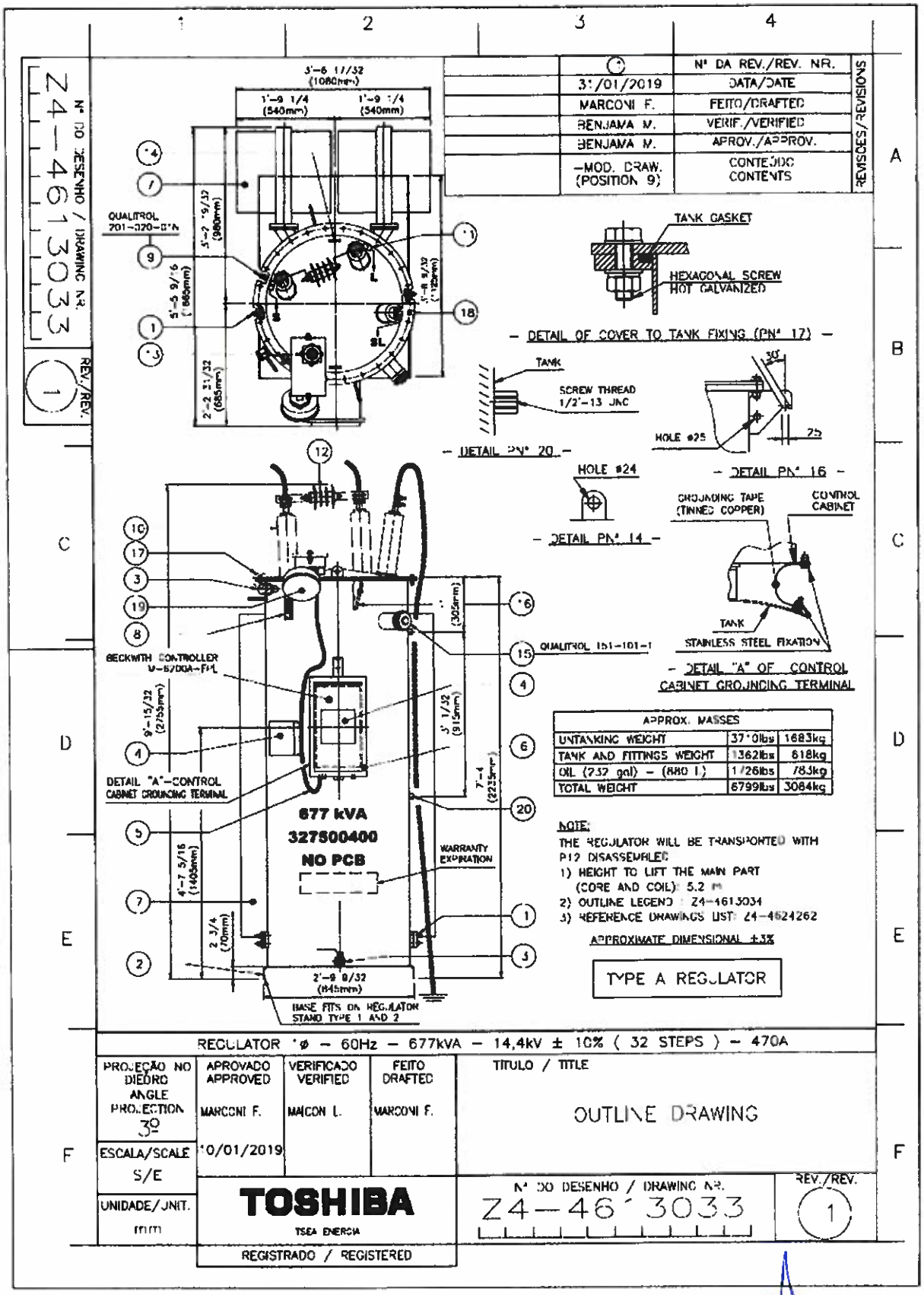

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