

TEST REPORT

NO. 00360-14-0048

SINER Engenharia e Comércio Ltda.
Vila Sul Americana
Rua Novo Hamburgo, 249
Carapicuíba – SP
BRAZIL

CLIENT

SINER

MANUFACTURER

Metal-enclosed AC switchgear

TEST OBJECT

-Qtclad - Qtsiem

TYPE

CE0001, CE0002, CE0003

SERIAL NO.

Rated voltage	U_r	24 kV	RATED CHARACTERISTICS GIVEN BY THE CLIENT
Rated normal current	I_r	1250 A	
Rated frequency	f_r	60 Hz	
Rated peak withstand current	I_p	52 kA	
Rated short-time withstand current	I_k	20 kA	
Internal arc classification	IAC AFLR 20 kA 1 s kA		

IEC 62271-200: 2011-10

NORMATIVE
DOCUMENT

Test under conditions of arcing due to an internal fault with three-phase arc initiation

RANGE OF TESTS
PERFORMED

- in the current transformer compartment of unit 3
- in the lower busbar compartment of unit 3
- in the circuit breaker compartment of unit 2
- in the upper busbar compartment of unit 2

10 to 11 March 2014

DATE OF TEST

The requirements specified in IEC 62271-200 for obtaining the internal arc classification IAC AFLR 20 kA 1 s with arc initiation were met in the test mentioned above.

TEST RESULT



H. ZINNBAUER
Head of Centre of Competence
High-Power/High-Voltage
Berlin, 05 May 2014



C. KRUSCHA
Test engineer in charge



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This test document comprises 49 sheets.

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SINER Engenharia e Comércio Ltda.

1. Present at the test

Mr.	Kruscha	IPH test engineer in charge
Mr.	Moritz	IPH test engineer
Mr.	Sigolo	SINER
Mr.	Fernandes	SINER
Mr.	Souza Silva	SINER
Mr.	Santiago	TOSHIBA
Mr.	Vieira	Q&T

2. Test performed

Test under conditions of arcing due to an internal fault with three-phase arc initiation

- in the current transformer compartment of unit 3
- in the lower busbar compartment of unit 3
- in the circuit breaker compartment of unit 2
- in the upper busbar compartment of unit 2

3. Identity of the test object

3.1 Technical data and characteristics

The technical data and characteristics of the test object are defined by the following parameters and specified by the client

Test object: Metal-enclosed AC switchgear
 Type: -Qtclad - Qtsiem
 Manufacturer: SENER
 Serial No.: CE0001, CE0002, CE0003
 Year of manufacture: 2013

Data:	Rated voltage	U_r	24 kV
	Rated short-duration power-frequency withstand voltage	U_d	50 kV
	Rated lightning impulse withstand voltage	U_p	125 kV
	Rated frequency	f_r	60 Hz
	Rated normal current (main busbar)	I_r	1250 A
	Rated normal current (outgoing feeder)	I_r	1250 A
	Rated peak withstand current	I_p	52 kA
	Rated short-time withstand current	I_k	20 kA
	Rated duration of short-circuit	t_k	1 s
Characteristics:	Number of units		3
	Height		2360 mm
	Width of unit 1/2/3		1000/1000/1000 mm
	Depth		2450 mm
	Busbar dimensions		
	Main busbar		1 x 80 mm x 10 mm
	Vertical busbar		1 x 80 mm x 10 mm
	Pole centres distance		275 mm
	Earthing bar		1 x 40 mm x 10 mm
	Pressure relief:		upwards
	Bottom of switchgear:		closed

Technical data and characteristics (continued)

Built-in components:

Unit 1

Vacuum circuit breaker	On withdrawable element
Manufacturer	Siemens
Type	3AH
Bushings of withdrawable element	
Manufacturer	Tyco
Type	BPTM
Current transformer (TC 1, 2, 3, 4, 5, 6)	
Manufacturer	Brasformer
Type	BCS
Bushings to unit 2	
Manufacturer	Tyco
Type	BPTM

Unit 2

Vacuum circuit breaker	On withdrawable element
Manufacturer	Siemens
Type	3AH
Bushings of withdrawable element	
Manufacturer	Tyco
Type	BPTM
Current transformer (TC 1, 2, 3, 4, 5, 6)	
Manufacturer	Brasformer
Type	BCS
Bushings to unit 3	
Manufacturer	Tyco
Type	BPTM

Unit 3

Current transformer (TC 1, 2, 3)	
Manufacturer	Brasformer
Type	BCS
Bushings	
Manufacturer	Tyco
Type	BPTM

Unit 1 - 3

Metal enclosure	
Manufacturer	Q&T Equipamentos
Type	Qtclaid-Qtsiem

3.2 Identity documents

The manufacturer confirms that the test object has been manufactured in compliance with the drawings given in this document. IPH did not verify this compliance in detail.

The identity of the test object is fixed by the following drawings and data submitted by the client:

Name of drawing	Drawing No.	Date of drawing	Author	Notes
Montagem típico 1	110.701.010ES	22/07/2013	SINER	Sheet 47
Montagem típico 2	110.701.011ES	22/07/2013	SINER	Sheet 48
Montagem típico 3	110.701.012ES	22/07/2013	SINER	Sheet 49
Cubículo de media tensão 24 KV típico 01	110.701.001ES	22/07/2013	SINER	1)
Montagem típico 1 cortes	110.701.007ES	22/07/2013	SINER	1)
Cubículo de media tensão 24 KV típico 02	110.701.003ES	27/07/2013	SINER	1)
Montagem típico 2 cortes	110.701.008ES	22/07/2013	SINER	1)
Cubículo de media tensão 24 KV típico 03 – medição	110.701.005ES	27/07/2013	SINER	1)
Montagem típico 3 cortes	110.701.009ES	22/07/2013	SINER	1)

1) These drawings are not part of this test document. They are not part of this test document and are retained in the IPH archives.

Entry of test object at IPH: 07 March 2014

4. Test under conditions of arcing due to an internal fault

4.1 Test laboratory

High-power test laboratory, test bay 1

4.2 Normative document

IEC 62271-200: 2011-10

4.3 Required test parameters

Required test values as agreed with the client:

Peak current	52 kA
Arc fault current	20 kA
Arc fault duration	1 s
Internal arc classification	IAC AFLR 20 kA 1 s

Distances of the test object to the walls of the room mock-up			Spacing of indicators
Front	F	freely accessible	300 mm
Right side wall	L	freely accessible	300 mm
Left side wall	L	100 mm	none
Rear side wall	R	1000 mm	300 mm
Ceiling height above test object		640 mm	-
Ceiling height above floor		3500 mm	

Assessment of the behaviour under conditions of arcing due to an internal fault on the basis of the criteria 1 to 5 of IEC 62271-200

4.4 Test arrangement

The switchgear consisted of three units. The test was conducted in a mock-up of a room with a ceiling height of 3500 mm above the floor. The switchgear was set-up with its left side wall having a distance of 100 mm and with its rear wall having a distance of 1000 mm to the corner of the room mock-up. The gap between the switchgear and the test bay wall on the right remained uncovered. The front and left roof projection was >1000 mm.

Fabric indicators representing accessibility type A were placed vertically in front of the operator's side, the right side wall and the rear wall of the switchgear up to a height of 2 m in a uniform and in a checkerboard pattern thus covering an area of 40-50 %. The spacing between indicators and switchgear was 300 mm.

Fabric indicators representing accessibility type A were placed horizontally in front of operator's side, the right side wall and the rear wall of the switchgear in a height of 2 m above the floor in the region between 300 mm and 800 mm in a uniform and in a checkerboard pattern thus covering an area of 40-50 %.

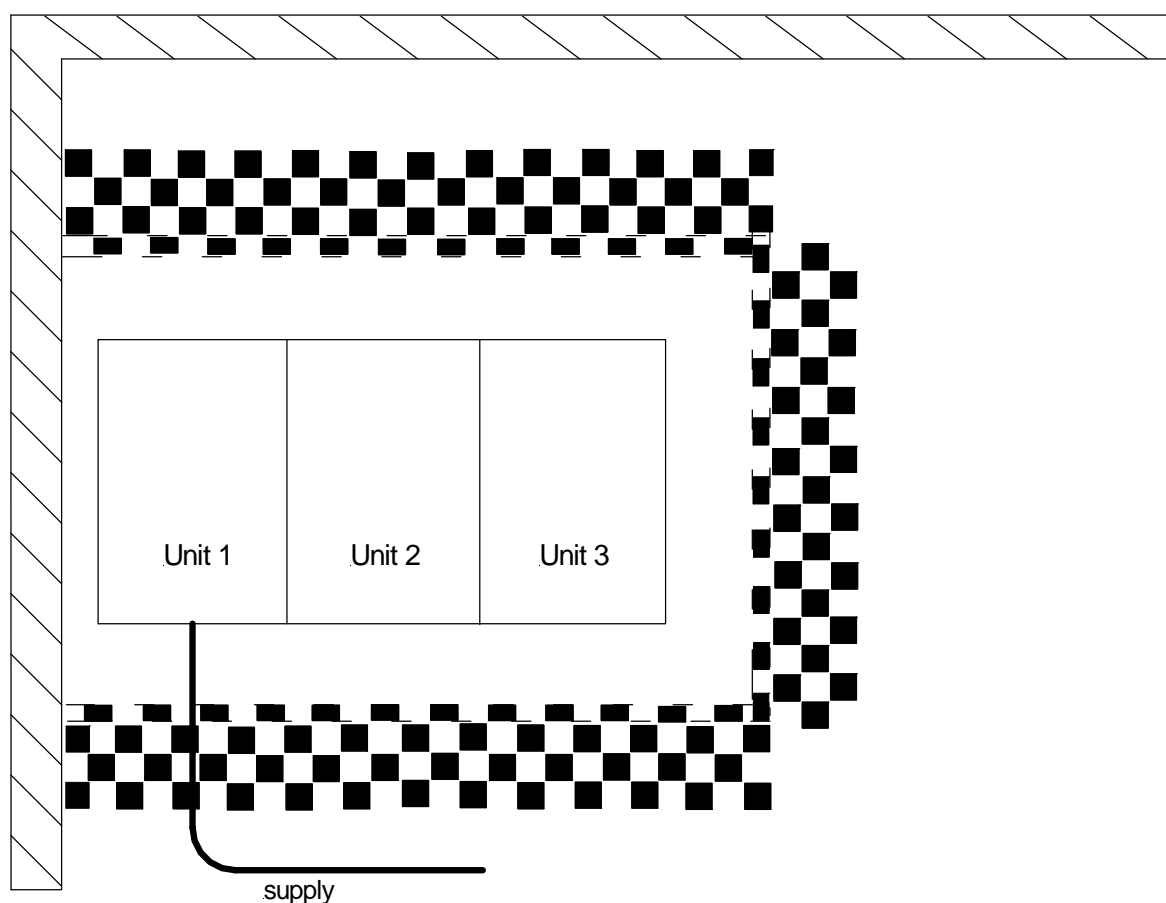


Figure 1: Test object set-up in the room mock-up fitted with indicators for IAC AFLR (top view)

Test arrangement (continued)

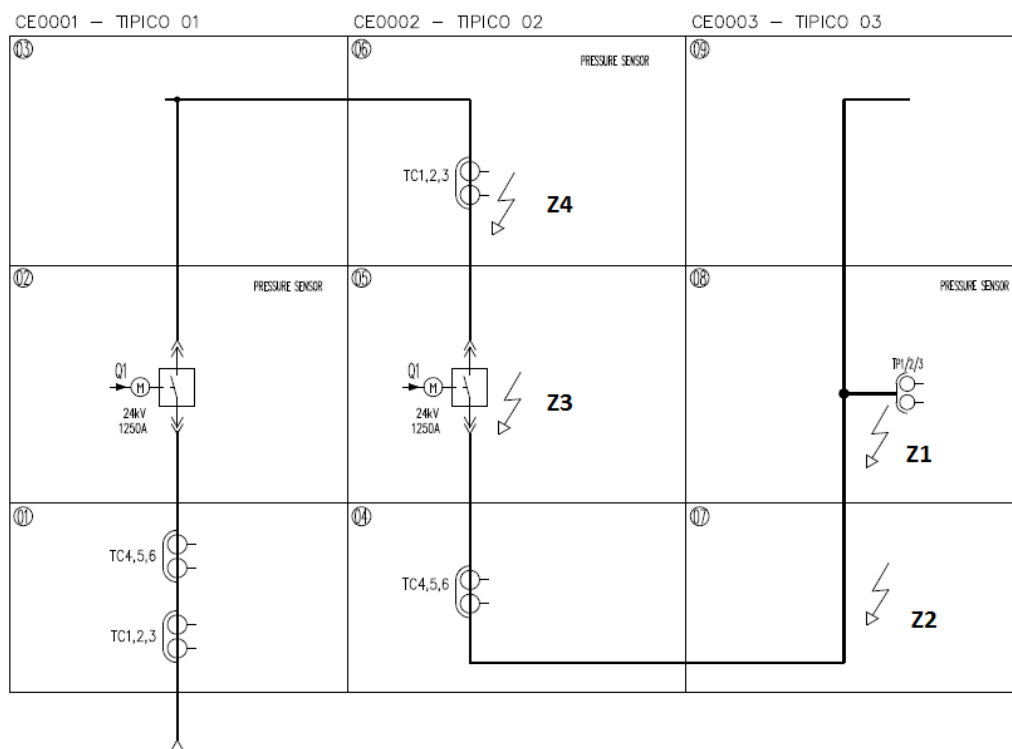


Figure 2: Test object in the room mock-up (front view)

Points of arc initiation:

- Z1 Three-phase arc initiation in the current-transformer compartment of unit 3
- Z2 Three-phase arc initiation in the lower compartment of unit 3
- Z3 Three-phase arc initiation in the circuit-breaker compartment of unit 2
- Z4 Three-phase arc initiation in the busbar compartment of unit 2

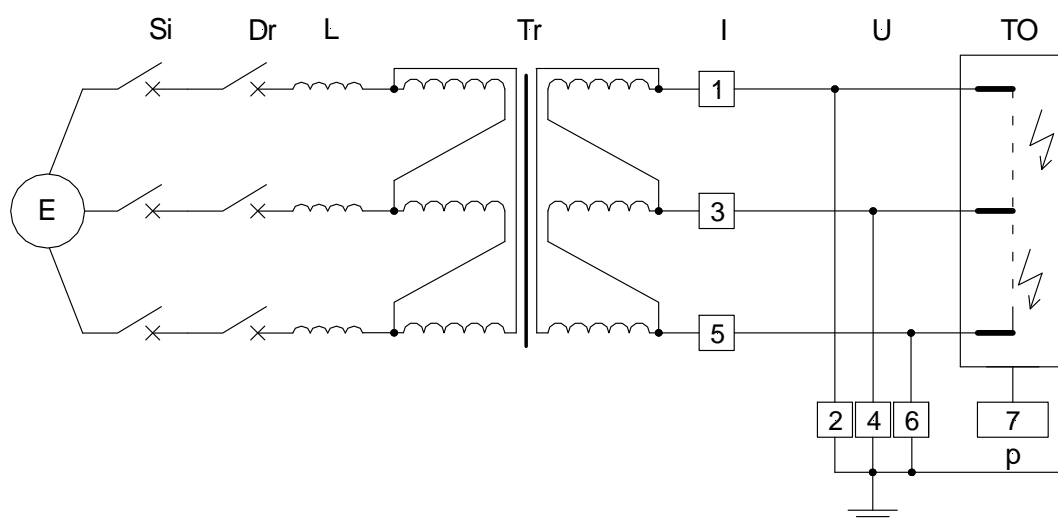
Pressure measurement

- p1 Ignition compartment

4.5 Test and measuring circuits

Technical data of test circuits

Test requirement		Tests under conditions of arc due to an internal fault
Test No.		114 0820 and 114 0826 114 0821 to 114 0824
Number of phases	(Test circuit)	3
Number of poles/phases	(Test object)	3
Power frequency	Hz	50
Power factor $\cos \varphi$		< 0.15
Earthing conditions	Grid	Not earthed
	Short-circuit transformer	Not earthed
	Short-circuit point	Not earthed
Short-circuit transformer		D/d



E Supply
Si Master breaker
Dr Making switch
L Current-limiting reactor
Tr Short-circuit transformer

I Current measurement
U Voltage measurement
p Pressure measurement
TO Test object
1 - 7 Measuring points

Figure 3: Test circuit

Technical data of measuring circuits

Measuring point	Symbol	Measured quantity	Measuring sensor/device
1	i L1	Current L1	Rogowski measuring device
2	u L1	Voltage L1	RC divider
3	i L2	Current L2	Rogowski measuring device
4	u L2	Voltage L2	RC divider
5	i L3	Current L3	Rogowski measuring device
6	u L3	Voltage L3	RC divider
7	p1 ¹⁾	Pressure in arc initiation compartment	Sensor 10 bar
-	P_ges	Arc power	Calculated value
-	W	Arc energy	Calculated value
Recording instrument: BE 256 transient recorder system			
1) To reduce pressure measurement disturbances, the measuring signals have been subjected to filtering (low-pass). The filter limit in Hz is given in the oscillogram designation after Index f.			

4.6 Test results

Test requirement:

Test under conditions of arc due to an internal fault

Test No.	114	0820
Test voltage	kV	24.2
Prospective peak short-circuit current	L1	44.3
	L2	39.5
	L3	54.3
Prospective symmetrical short-circuit current	L1	20.3
	L2	20.6
	L3	20.2
Average		20.4
Duration of short-circuit	s	1.01
Notes		1)

Notes:

- 1) Current setting at rated voltage (verification of prospective current)

Test results (continued)

Test requirement:	Test under conditions of arc due to an internal fault
Date of test:	10 March 2014
Condition of test object before test:	As after previous test
Supply of test object:	Three-phase at the cable terminals of unit 1
Arc initiation:	In the current transformer compartment of unit 3 using metal wire of 0.5 mm diameter

Test No.	114	0822
Test voltage	kV	24.2
Peak current	L1	41.8
	L2	38.3
	L3	51.1
Arc fault current	L1	20.1
	L2	20.3
	L3	20.1
Average		20.2
Arc fault duration	s	1.0
Equivalent arc fault duration	s	1.02
related to a symmetrical arc fault current of	kA	20.0
Maximum power	MW	63.4
Energy converted	MWs	30.6
Pressure p1 in the arc initiation compartment	mbar	190
Maximum pressure after	ms	12.0

Notes and condition of test object after test:

Criteria of assessment 1 to 5 of IEC 62271-200: 2011-10:		Compliance:
1	Correctly secured doors, covers etc., do not open. Deformations are accepted provided that no part on any side comes as far as the position of the indicators or walls.	Yes
2	No fragmentation of the enclosure occurs within the time specified for the test. Projections of small parts, up to an individual mass of 60 g, are accepted.	Yes
3	Arc does not cause holes in the accessible sides up to a height of 2.0 m.	Yes
4	Indicators do not ignite due to the effect of hot gases.	Yes
5	The enclosure remains connected to its earthing point.	Yes

Test results (continued)

Test requirement:	Test under conditions of arc due to an internal fault
Date of test:	10 March 2014
Condition of test object before test:	As after previous test
Supply of test object:	Three-phase at the cable terminals of unit 1
Arc initiation:	In the lower busbar compartment of unit 3 using metal wire of 0.5 mm diameter

Test No.	114	0823
Test voltage	kV	24.2
Peak current	L1	42.4
	L2	38.7
	L3	51.5
Arc fault current	L1	20.1
	L2	20.5
	L3	20.0
Average		20.2
Arc fault duration	s	1.01
Equivalent arc fault duration	s	1.02
related to a symmetrical arc fault current of	kA	20.0
Maximum power	MW	62.7
Energy converted	MWs	30.0
Pressure p1 in the arc initiation compartment	mbar	148
Maximum pressure after	ms	10.3

Notes and condition of test object after test:

Criteria of assessment 1 to 5 of IEC 62271-200: 2011-10:		Compliance:
1	Correctly secured doors, covers etc., do not open. Deformations are accepted provided that no part on any side comes as far as the position of the indicators or walls.	Yes
2	No fragmentation of the enclosure occurs within the time specified for the test. Projections of small parts, up to an individual mass of 60 g, are accepted.	Yes
3	Arc does not cause holes in the accessible sides up to a height of 2.0 m.	Yes
4	Indicators do not ignite due to the effect of hot gases.	Yes
5	The enclosure remains connected to its earthing point.	Yes

Test results (continued)

Test requirement: Test under conditions of arc due to an internal fault
Date of test: 11 March 2014
Condition of test object before test: As after previous test
Supply of test object: Three-phase at the cable terminals of unit 1
Arc initiation: In the circuit breaker compartment of unit 2 using metal wire of 0.5 mm diameter

Test No.	114	0824
Test voltage	kV	24.2
Peak current	L1	42.4
	L2	38.6
	L3	51.3
Arc fault current	L1	20.1
	L2	20.4
	L3	20.0
Average		20.2
Arc fault duration	s	1.01
Equivalent arc fault duration	s	1.02
related to a symmetrical arc fault current of	kA	20.0
Maximum power	MW	63.0
Energy converted	MWs	26.5

Notes and condition of test object after test:

Criteria of assessment 1 to 5 of IEC 62271-200: 2011-10:		Compliance:
1	Correctly secured doors, covers etc., do not open. Deformations are accepted provided that no part on any side comes as far as the position of the indicators or walls.	Yes
2	No fragmentation of the enclosure occurs within the time specified for the test. Projections of small parts, up to an individual mass of 60 g, are accepted.	Yes
3	Arc does not cause holes in the accessible sides up to a height of 2.0 m.	Yes
4	Indicators do not ignite due to the effect of hot gases.	Yes
5	The enclosure remains connected to its earthing point.	Yes

Test results (continued)

Test requirement:	Test under conditions of arc due to an internal fault
Date of test:	11 March 2014
Condition of test object before test:	As after previous test
Supply of test object:	Three-phase at the cable terminals of unit 1
Arc initiation:	Three-phase in the busbar compartment of unit 2 using metal wire of 0.5 mm diameter

Test No.	114	0826
Test voltage	kV	24.2
Peak current	L1	44.7
	L2	37.2
	L3	51.9
Arc fault current	L1	20.5
	L2	20.5
	L3	20.1
Average		20.4
Arc fault duration	s	1.01
Equivalent arc fault duration	s	1.03
related to a symmetrical arc fault current of	kA	20.0
Maximum power	MW	59.2
Energy converted	MWs	30.6

Notes and condition of test object after test:

Criteria of assessment 1 to 5 of IEC 62271-200: 2011-10:		Compliance:
1	Correctly secured doors, covers etc., do not open. Deformations are accepted provided that no part on any side comes as far as the position of the indicators or walls.	Yes
2	No fragmentation of the enclosure occurs within the time specified for the test. Projections of small parts, up to an individual mass of 60 g, are accepted.	Yes
3	Arc does not cause holes in the accessible sides up to a height of 2.0 m.	Yes
4	Indicators do not ignite due to the effect of hot gases.	Yes ¹⁾
5	The enclosure remains connected to its earthing point.	Yes

1) One horizontal indicator on the front side was ignited by glowing particles.

5. Photos



Photo 1: Test object without indicators before test (front view)



Photo 2: Test object without indicators before test (rear side view)



Photo 3: Test object without indicators before test (right side view)



Photo 4: rating plate section 1



Photo 5: rating plate section 2



Photo 6: rating plate section 3

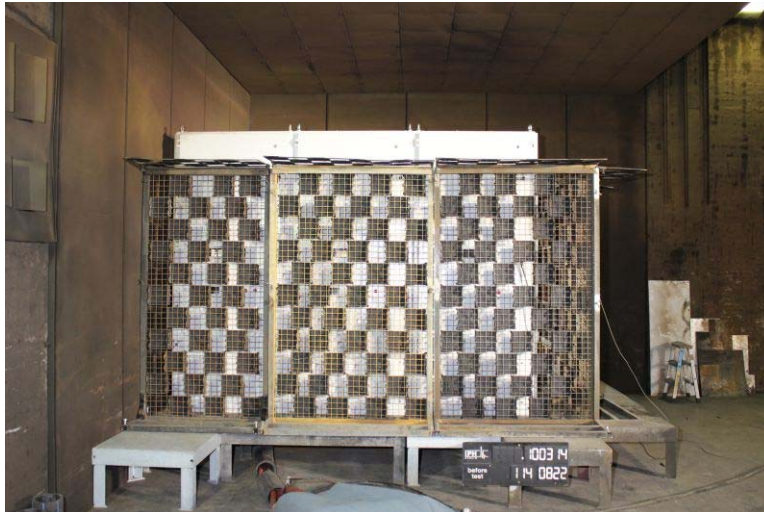


Photo 7: Test object before Test No. 114 0822 (front view)



Photo 8: Test object before Test No. 114 0822 (rear side view)



Photo 9: Test object before Test No. 114 0822 (right side view)



Photo 10: Test object before Test No. 114 0822 (ignition wire)



Photo 11: Test object before Test No. 114 0822 (point of arc initiation)



Photo 12: Test object after Test No. 114 0822 (front view)



Photo 13: Test object after Test No. 114 0822 (rear side view)



Photo 14: Test object after Test No. 114 0822 (right side view)



Photo 15: Test object before Test No. 114 0823 (front view)



Photo 16: Test object before Test No. 114 0823 (rear side view)



Photo 17: Test object before Test No. 114 0823 (right side view)



Photo 18: Test object before Test No. 114 0823 (ignition wire)



Photo 19: Test object before Test No. 114 0823 (point of arc initiation)

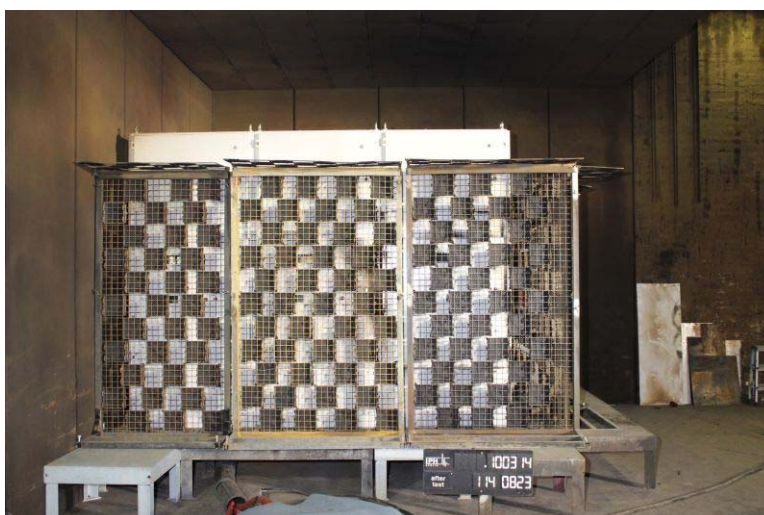


Photo 20: Test object after Test No. 114 0823 (front view)



Photo 21: Test object after Test No. 114 0823 (rear side view)

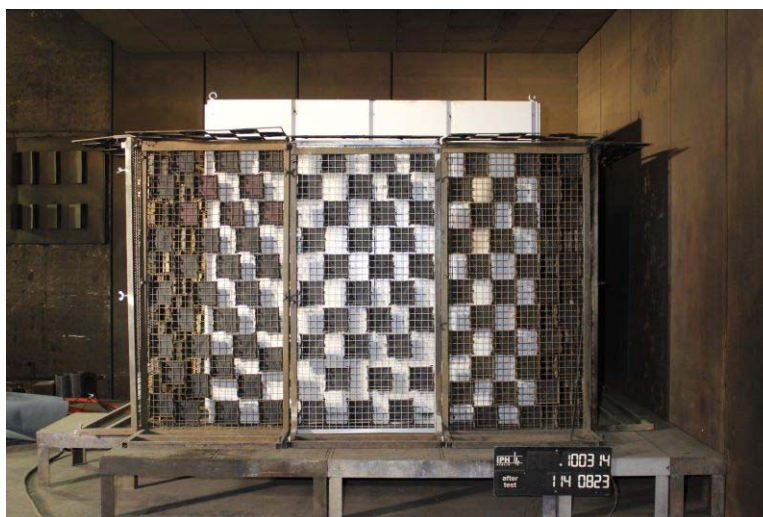


Photo 22: Test object after Test No. 114 0823 (right side view)

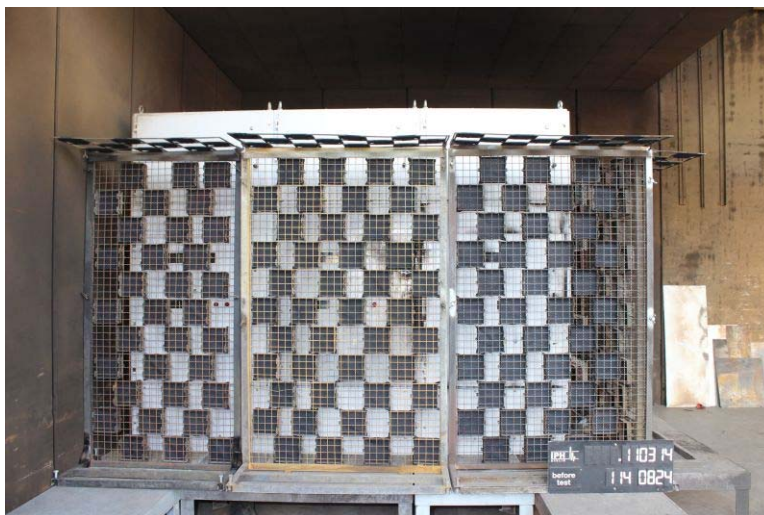


Photo 23: Test object before Test No. 114 0824 (front view)



Photo 24: Test object before Test No. 114 0824 (rear side view)



Photo 25: Test object before Test No. 114 0824 (right side view)



Photo 26: Test object before Test No. 114 0824 (ignition wire)



Photo 27: Test object before Test No. 114 0824 (point of arc ignition)



Photo 28: Test object after Test No. 114 0824 (front view)



Photo 29: Test object after Test No. 114 0824 (rear side view)



Photo 30: Test object after Test No. 114 0824 (right side view)



Photo 31: Test object before Test No. 114 0826 (front view)



Photo 32: Test object before Test No. 114 0826 (rear side view)

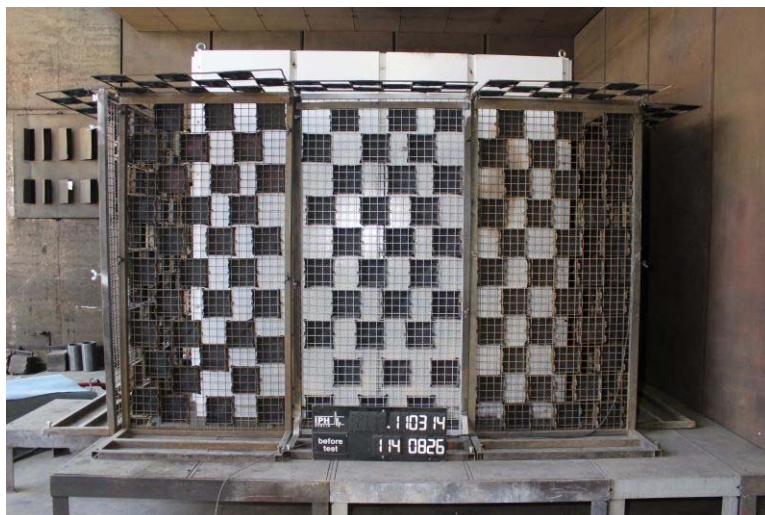


Photo 33: Test object before Test No. 114 0826 (right side view)



Photo 34: Test object before Test No. 114 0826 (ignition wire)



Photo 35: Test object before Test No. 114 0826 (point of arc ignition)

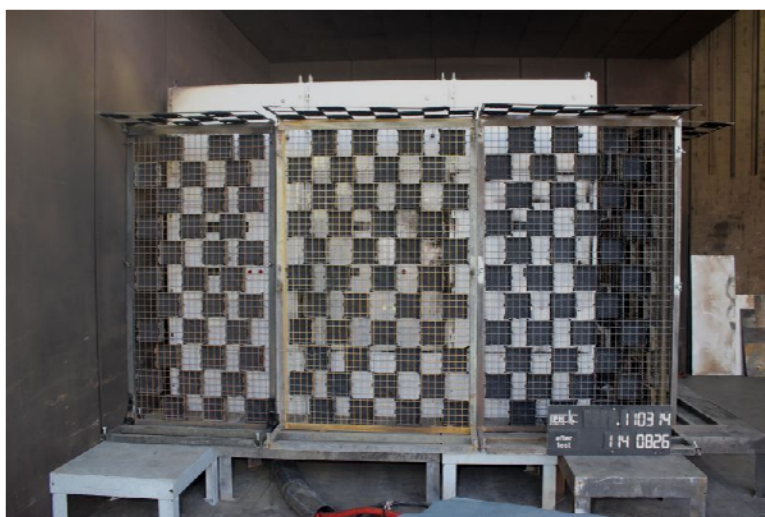


Photo 36: Test object after Test No. 114 0826 (front view)



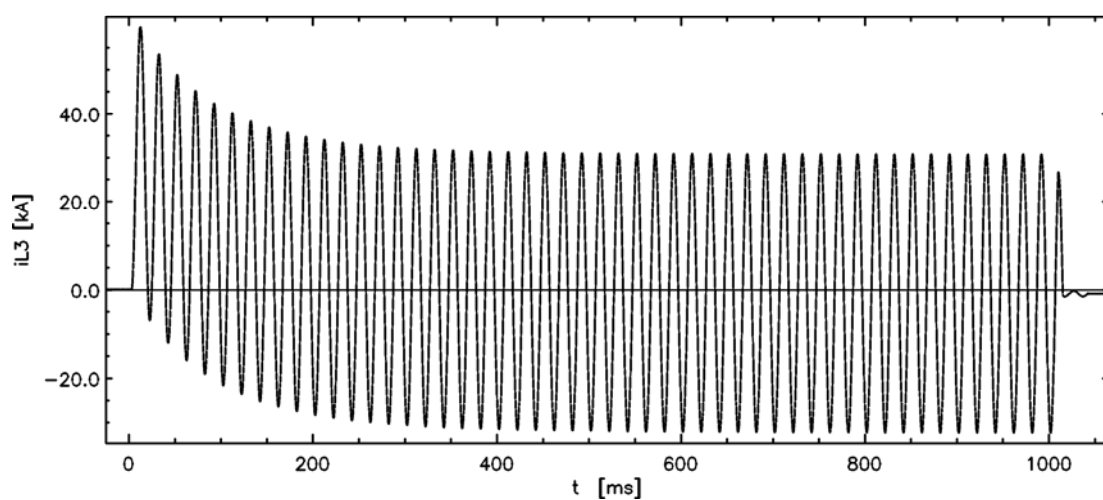
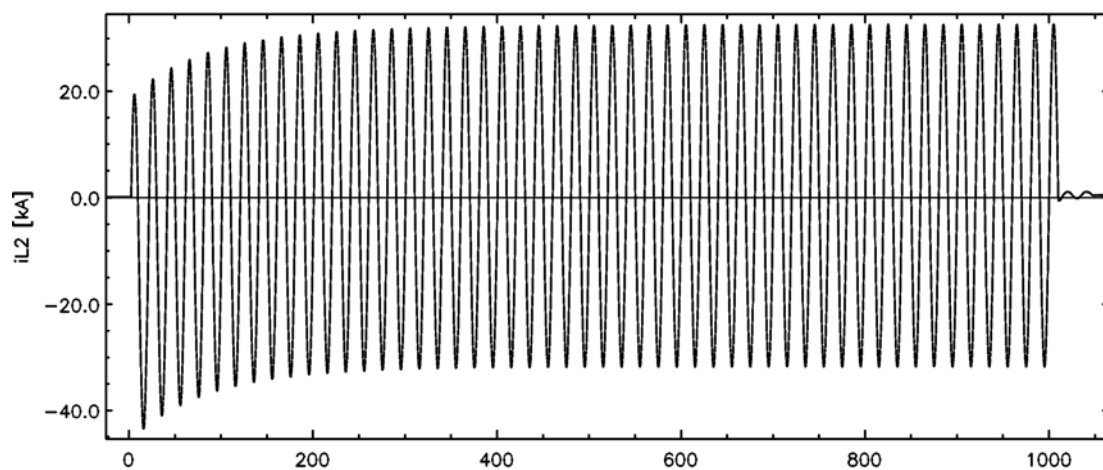
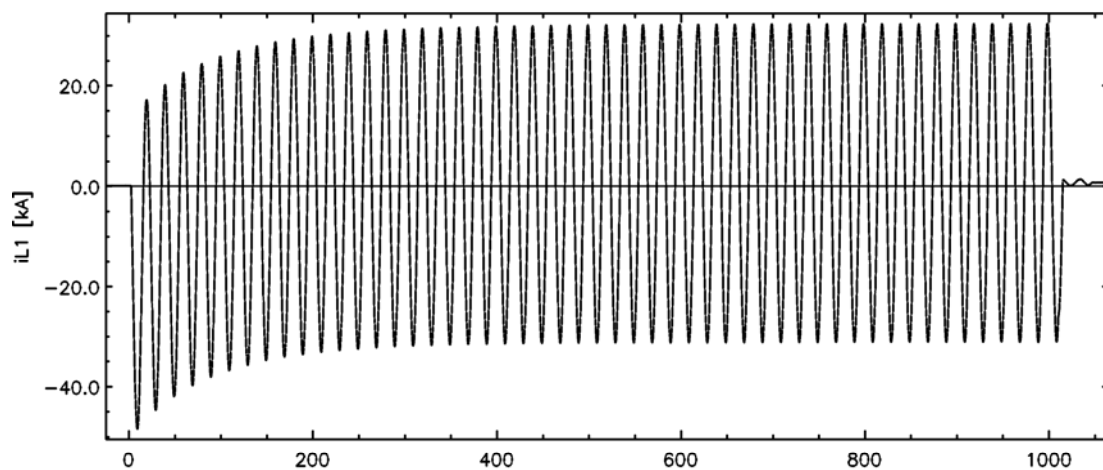
Photo 37: Test object after Test No. 114 0826 (rear side view)



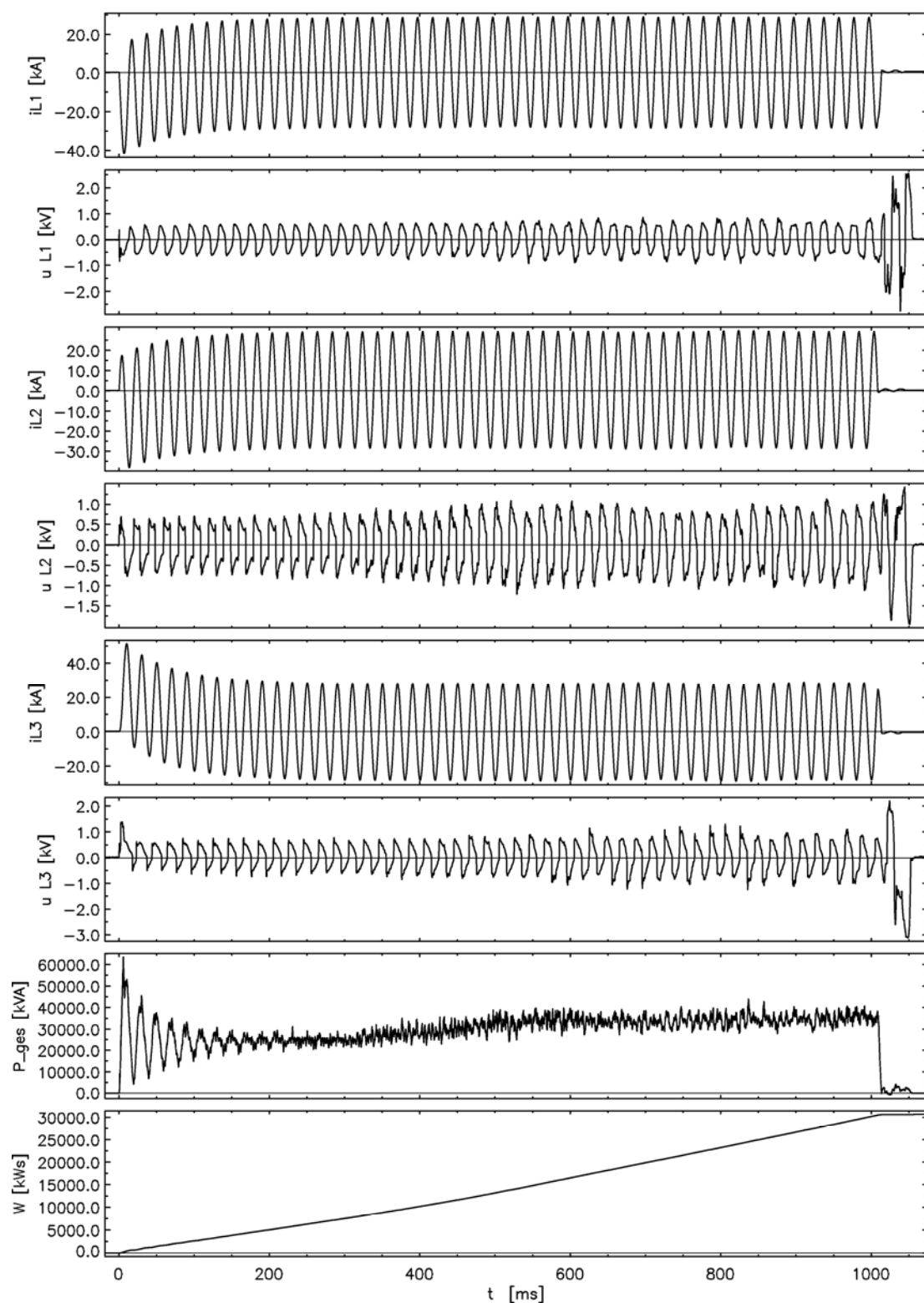
Photo 38: Test object after Test No. 114 0826 (right side view)

6. Oscillograms

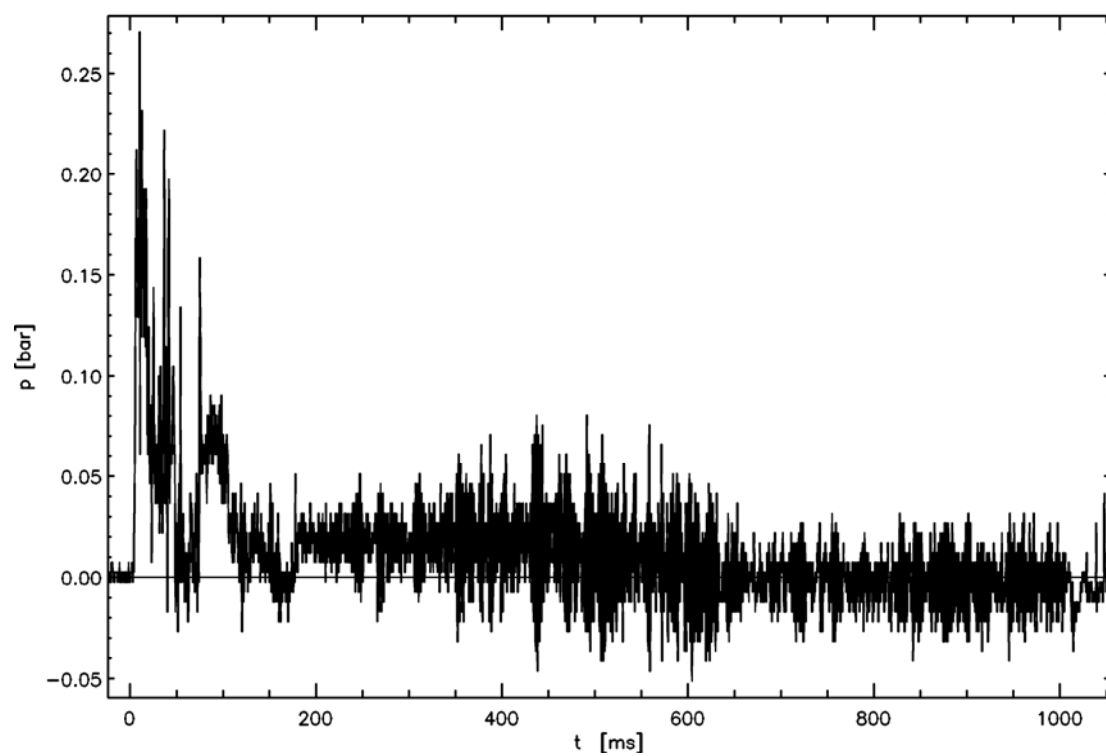
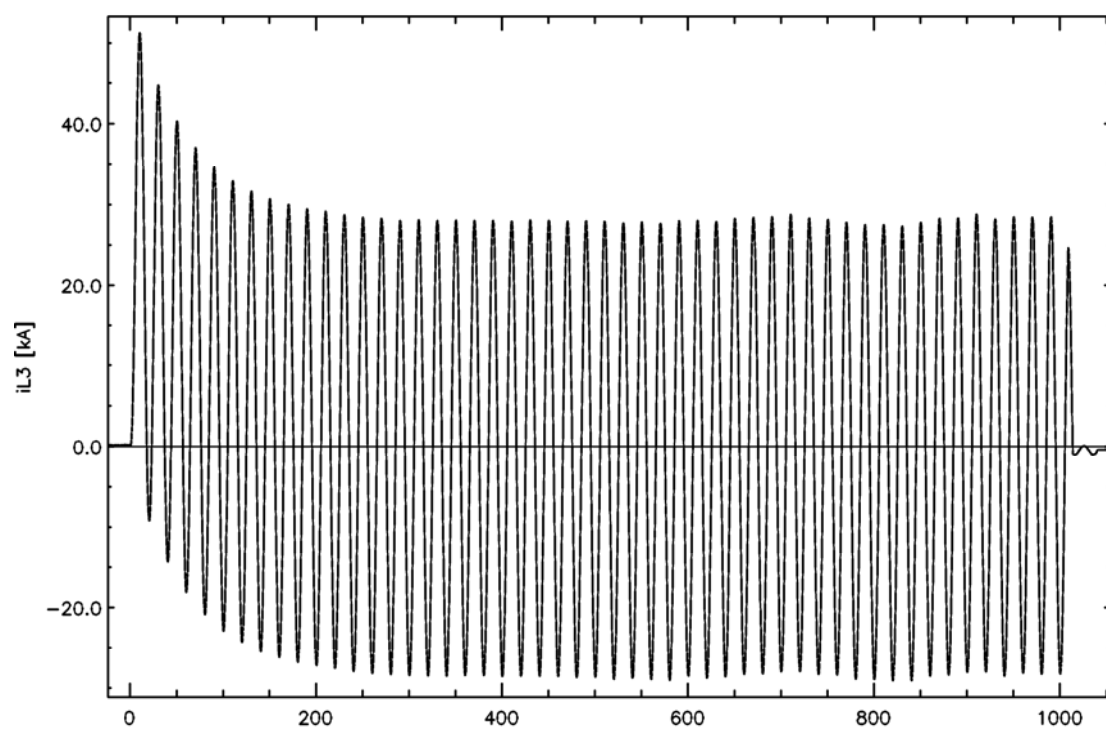
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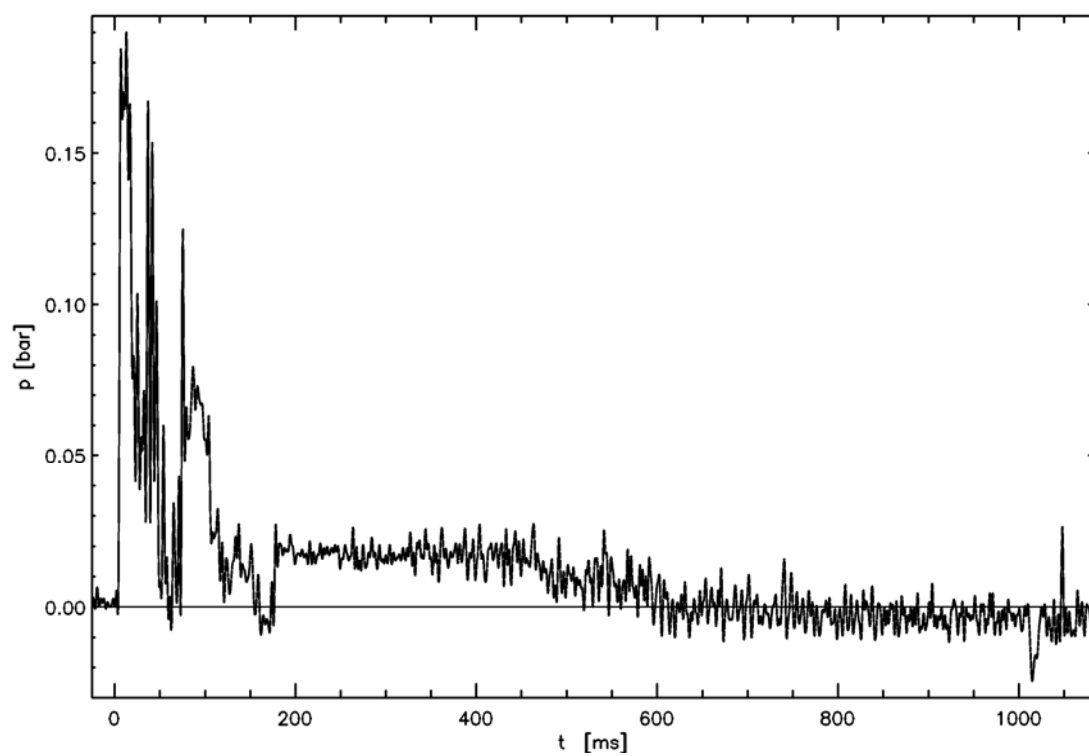
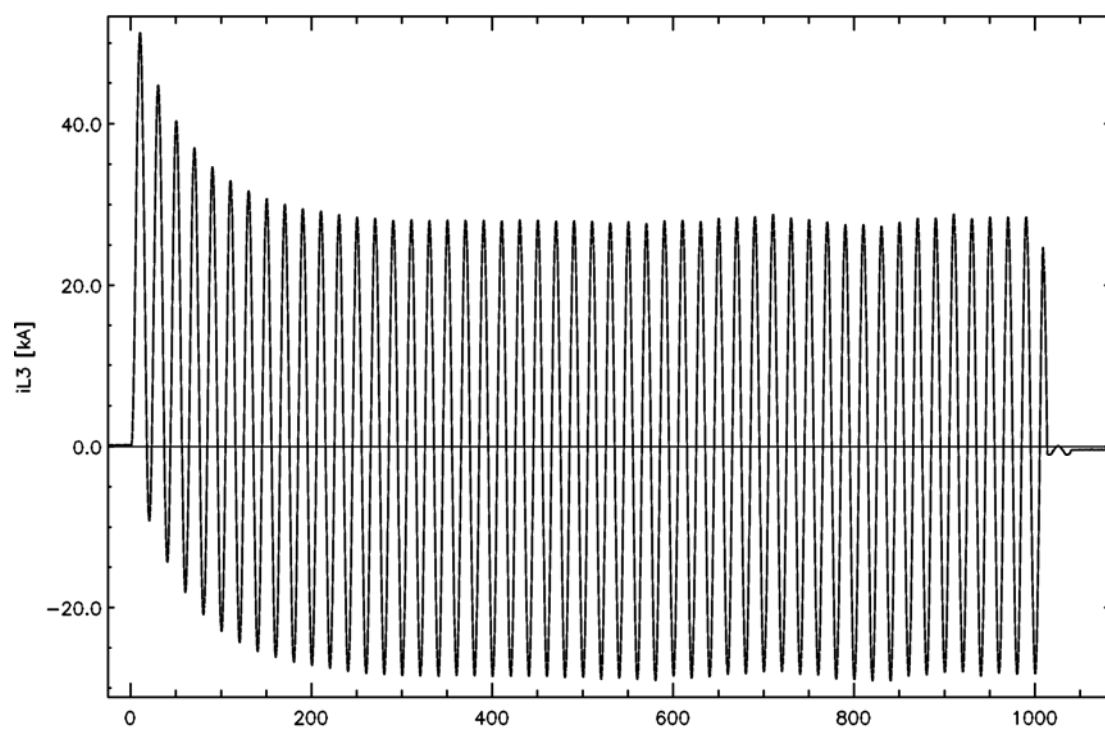
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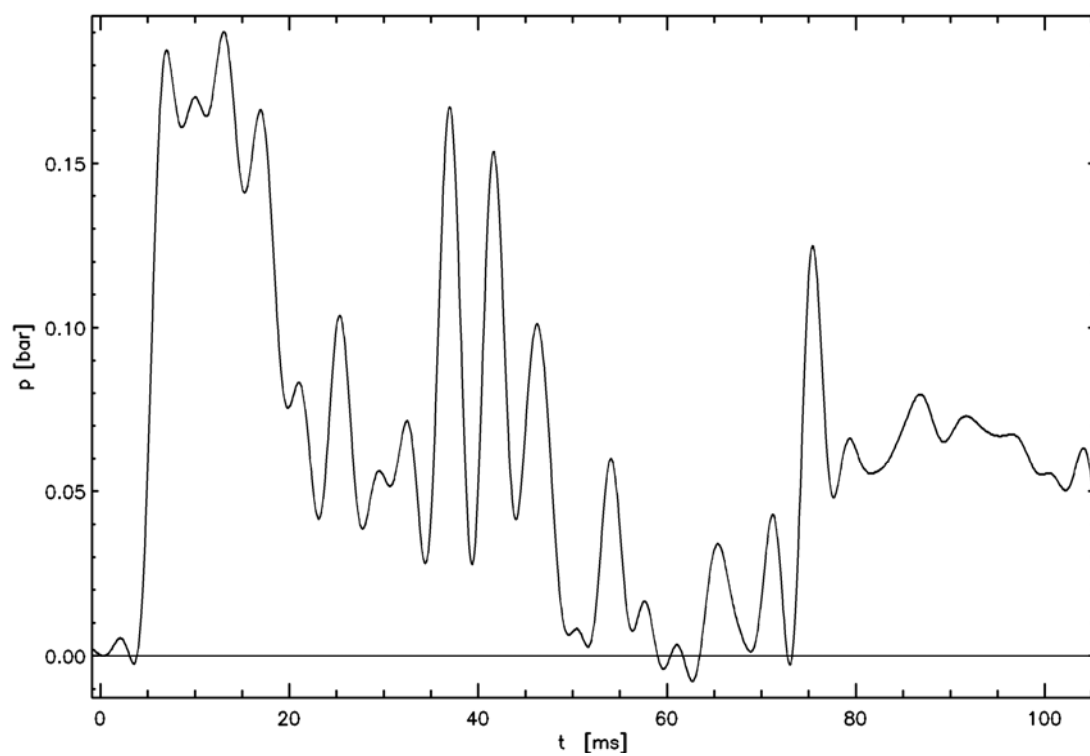
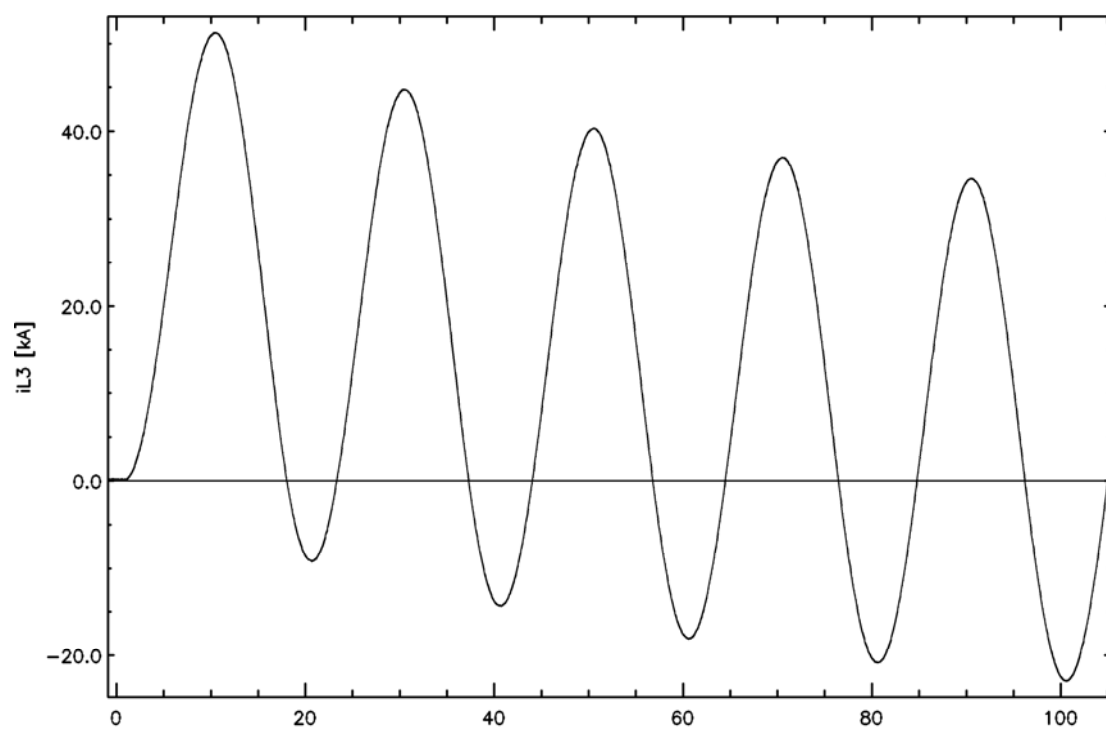
Test-No. 1140822_p



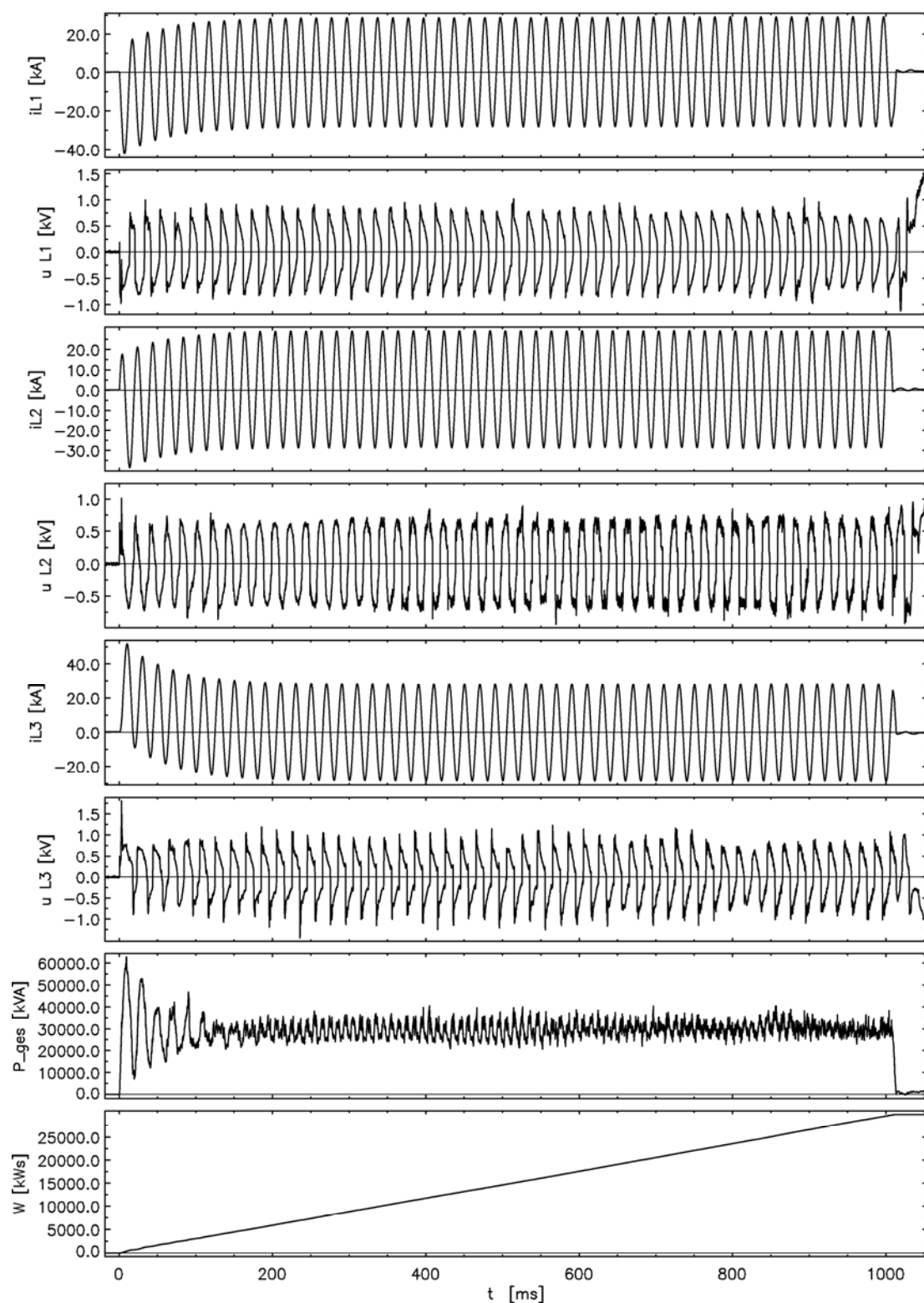
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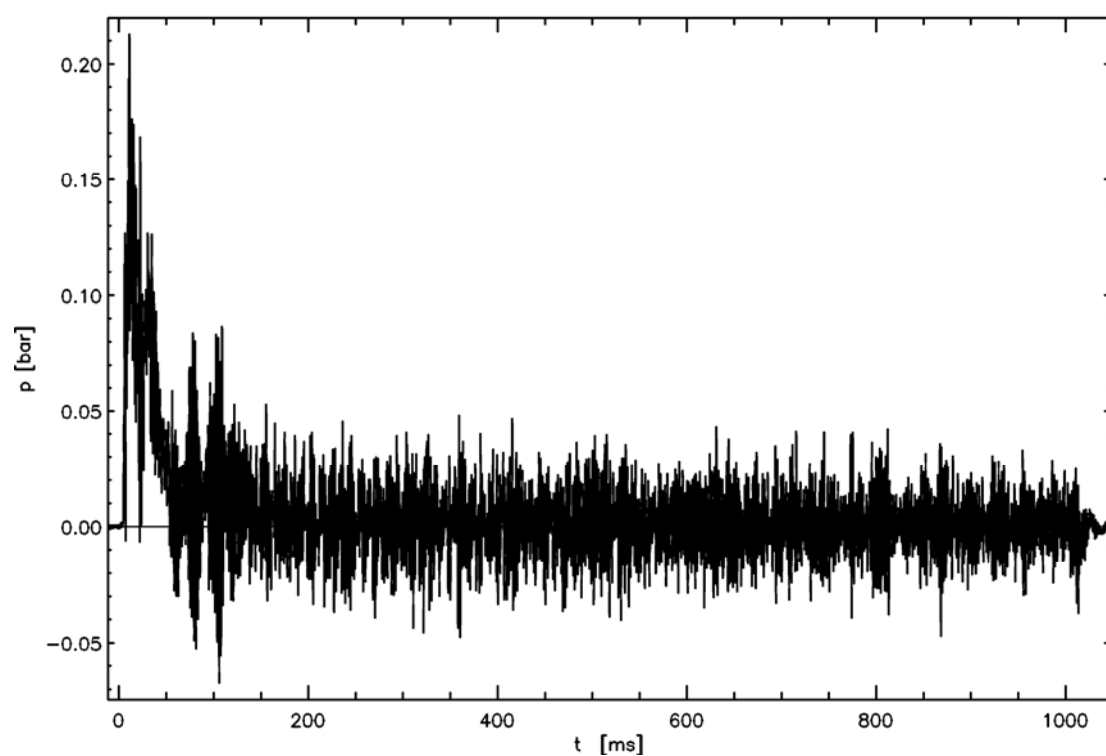
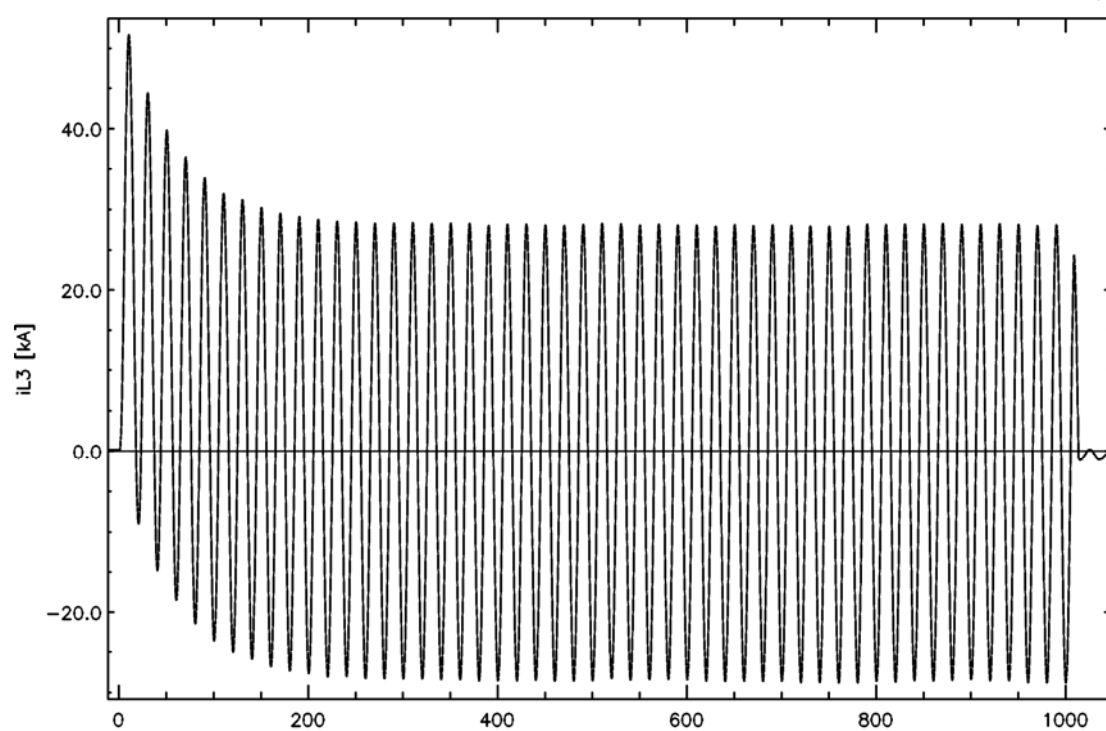
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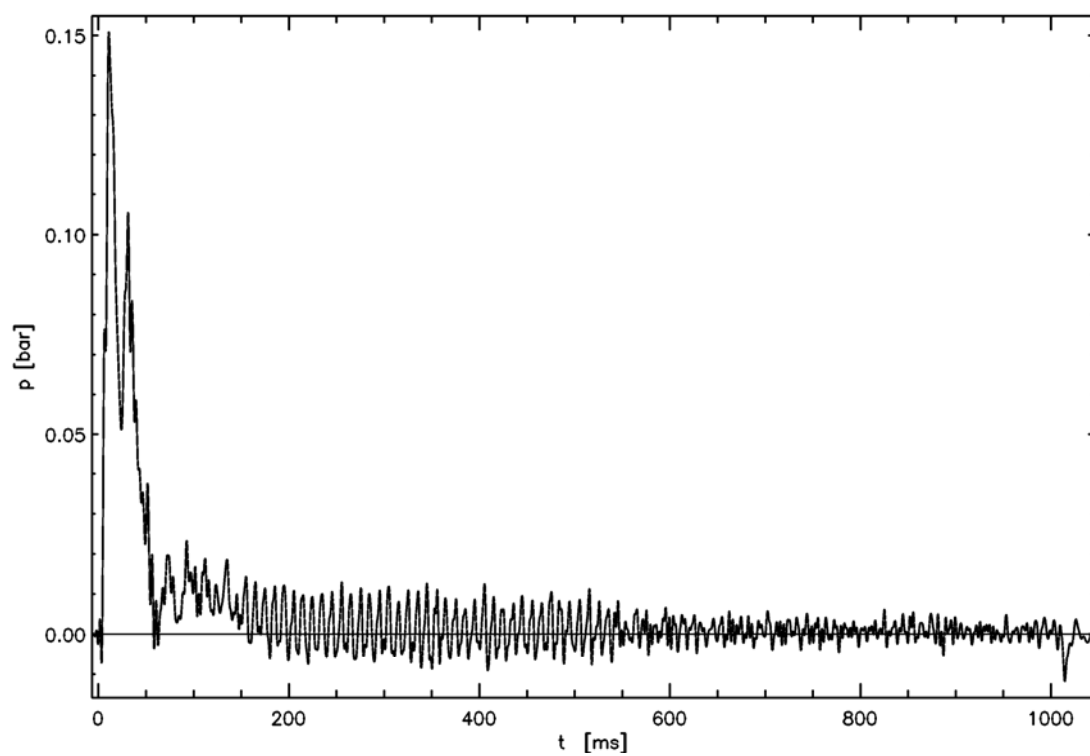
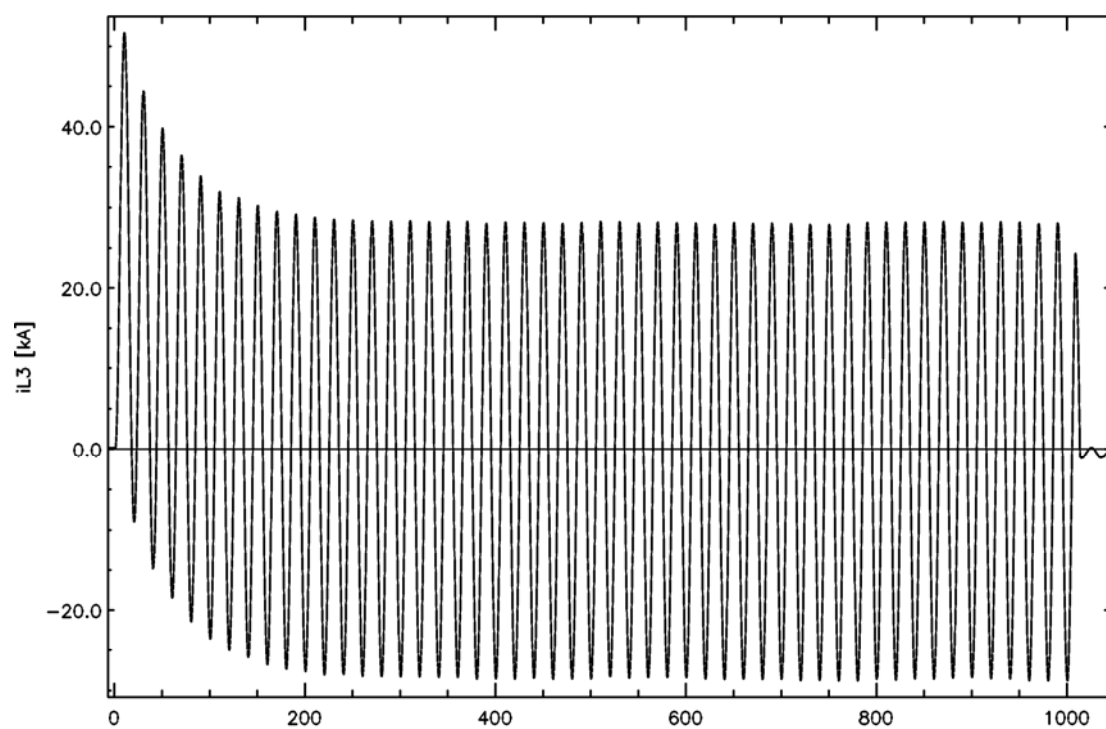
Test-No. 1140823



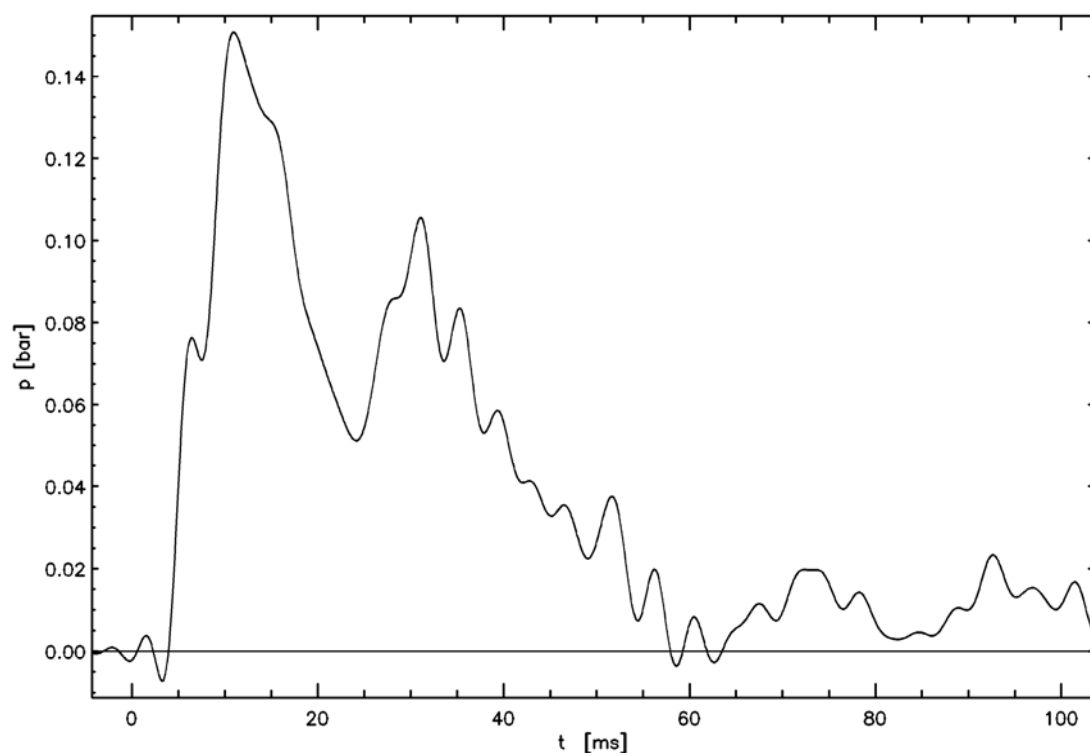
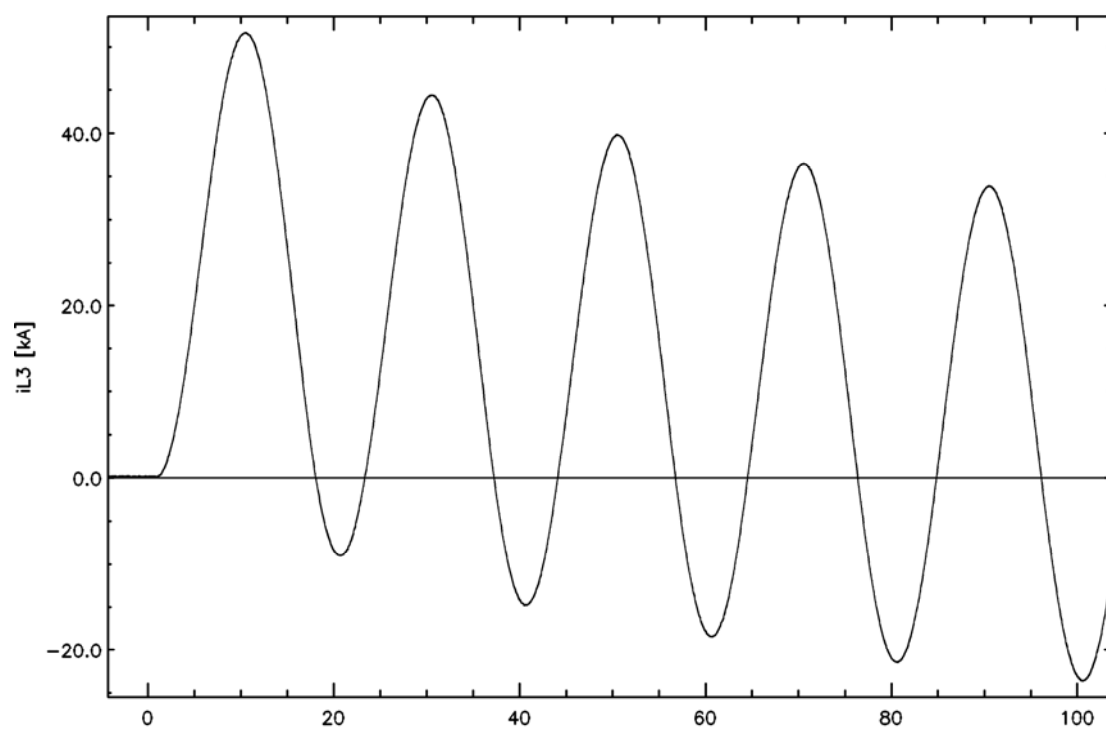
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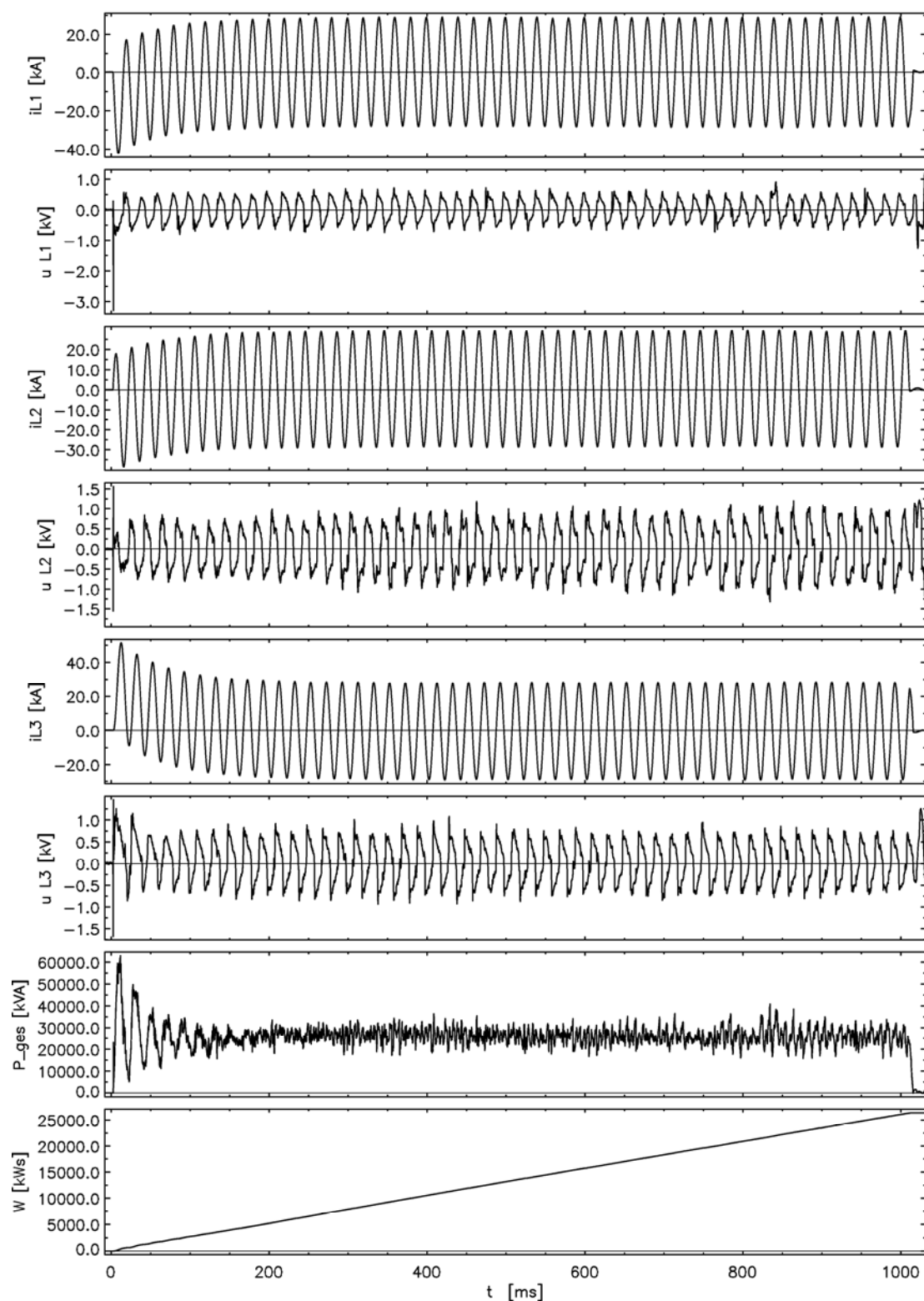
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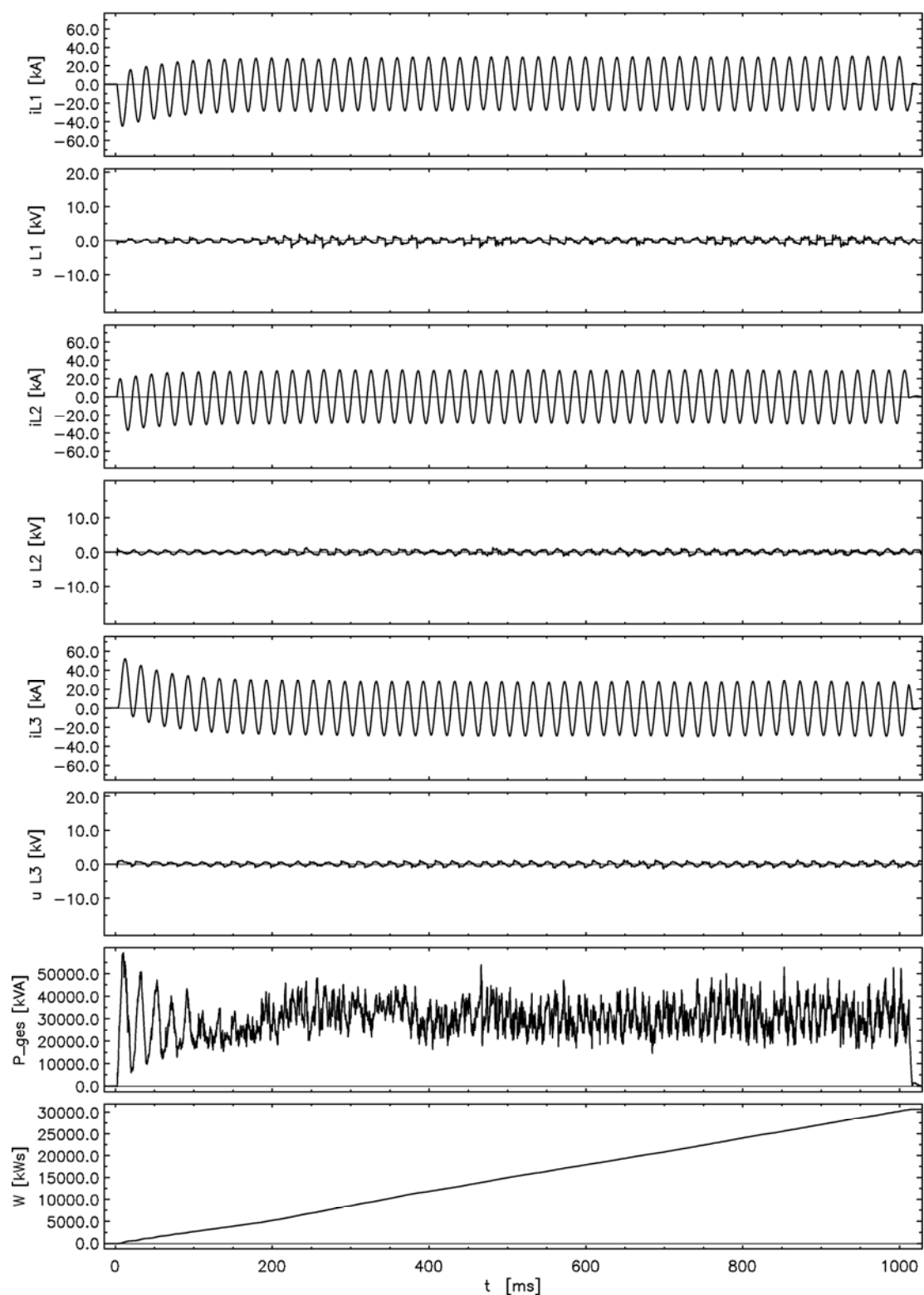
Test-No. 1140823_p_f300_t100



Test-No. 1140824



Test-No. 1140826



7. Drawings

