

TEST REPORT

NO. 1819.2121286.0680

| | | |
|--|---------------------------|---|
| ELSTEEL (Pvt) Ltd. Spur Road-2, Phase-1, EPZ Katunayake 11420 SRI LANKA | | CLIENT |
| ELSTEEL (Pvt) Ltd. | | MANUFACTURER |
| Busbar systems for low-voltage switchgear and controlgear assemblies | | TEST OBJECT |
| Elsteel TM Plug & Power Panel | | TYPE |
| Test sample | | SERIAL NO. |
| Rated operational voltage | U_e 415 V, AC | RATED CHARACTERISTICS GIVEN BY THE CLIENT |
| Rated insulation voltage | U_i 1000 V, AC | |
| Rated impulse withstand voltage | U_{imp} 12 kV | |
| Rated peak withstand current | I_{pk} up to 176 kA | |
| Rated short-time withstand current | I_{cw} up to 80 kA, 1 s | |
| Rated frequency | f_n 50 Hz | |
| IEC 61439-2: 2011-08 | | NORMATIVE DOCUMENT |
| Verification of short-circuit withstand strength | | RANGE OF TESTS PERFORMED |
| 02 November 2012 and 22 February 2013 | | DATE OF TEST |
| See Sub-clause 4.6 | | TEST RESULT |



RONALD BORCHERT
Senior engineer
Berlin, 05 April 2013



MICHAEL HEISE
Test engineer in charge



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This test document comprises 32 sheets.

Distribution

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1. Present at the test

Mr. Heise IPH test engineer in charge

Mr. Priyan ELSTEEL (Pvt) Ltd.

2. Test performed

Verification of short-circuit withstand strength IEC 61439-2, Sub-clause: 10.11

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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: | Busbar system for low-voltage switchgear and controlgear assemblies | |
| Type: | Elsteel TM Plug & Power Panel | |
| Manufacturer: | ELSTEEL (Pvt) Ltd. | |
| Serial No.: | Test sample | |
| Year of manufacture: | 2012 | |
| Rated characteristics: | Rated operational voltage | U_e 415 V |
| | Rated insulation voltage | U_i 1000 V |
| | Rated impulse withstand voltage | U_{imp} 12 kV |
| | Rated peak withstand current | I_{pk} up to 176 kA |
| | Rated short-time withstand current | I_{cw} up to 80 kA, 1 s |
| | Rated frequency | f_n 50 Hz |
| Test panel 1 | | |
| Overall dimensions: | Width | 2000 mm |
| | Height | 2100 mm |
| | Depth | 600 mm |
| Busbars: | Main busbar system (L1/L2/L3/N) | |
| | Dimensions | 2 x 100 mm x 10 mm |
| | Material | Bare copper |
| | Busbar system B (L1/L2/L3/N) | |
| | Dimensions | 1 x 20 mm x 10 mm |
| | Material | Bare copper |
| | Busbar system C (L1/L2/L3/N) | |
| | Dimensions | 1 x 50 mm x 10 mm |
| | Material | Bare copper |
| Test panel 2 | | |
| Overall dimensions: | Width | 2200 mm |
| | Height | 2300 mm |
| | Depth | 600 mm |
| Busbars: | Busbar systems A and D (L1/L2/L3/N) | |
| | Dimensions | 2 x 100 mm x 10 mm |
| | Material | Bare copper |
| | Busbar system B (L1/L2/L3/N) | |
| | Dimensions | 1 x 60 mm x 10 mm |
| | Material | Bare copper |
| | Busbar systems F1 (L1/L2/L3/N) | |
| | Dimensions | 1 x 80 mm x 10 mm |
| | Material | Bare copper |
| | Busbar system F4 (L1/L2/L3/N) | |
| | Dimensions | 1 x 40 mm x 10 mm |
| | Material | Bare copper |

3.2 Identity documents

The manufacturer confirms that the test object has been manufactured in compliance with the drawings given in this document. IPH have verified that the drawings submitted by the client and detailed in this test report represent the apparatus tested in all essential details with respect of the characteristics to be proven by the tests.

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 |
|---|---------------------------------|-----------------|---------|----------|
| BUSBAR ARRANGEMENT OF SHORT CCT. TEST TEST PANEL-1 FOR PLUG AND POWER AND AABH SYSTEM | TTA/12/EL/PP/G2 Sheet 1 of 1 | 01.11.2012 | Elsteel | Sheet 31 |
| BUSBAR ARRANGEMENT OF SHORT CCT. TEST PANEL-2 FOR PLUG AND POWER AND AABH SYSTEM | TTA/13/EL/PP/G2 Sheet 1 of 1 | 01.02.2013 | Elsteel | Sheet 32 |

Test objects received by IPH on: 15 February 2013

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4. Verification of short-circuit withstand strength

4.1 Test laboratory

Low-voltage test laboratory, test room 10

4.2 Normative document

IEC 61439-2: 2011-08 and IEC 61439-1: 2011-08, Sub-clause 10.11.5

4.3 Required test parameters

- Verification of short-circuit withstand strength of busbar B in panel 1

| | |
|---------------------------|---------|
| Peak current | 52.5 kA |
| Short-circuit current | 25 kA |
| Duration of short-circuit | 1 s |
- Verification of short-circuit withstand strength of busbar C in panel 1

| | |
|---------------------------|--------|
| Peak current | 105 kA |
| Short-circuit current | 50 kA |
| Duration of short-circuit | 1 s |
- Verification of short-circuit withstand strength of busbar F4 of panel 2 with supply 1

| | |
|---------------------------|--------|
| Peak current | 105 kA |
| Short-circuit current | 50 kA |
| Duration of short-circuit | 1 s |
- Verification of short-circuit withstand strength of busbars A and B of panel 2 with supply 1

| | |
|---------------------------|--------|
| Peak current | 143 kA |
| Short-circuit current | 65 kA |
| Duration of short-circuit | 1 s |
- Verification of short-circuit withstand strength of busbar F1 (100 mm) of panel 2 with supply 1

| | |
|---------------------------|--------|
| Peak current | 176 kA |
| Short-circuit current | 80 kA |
| Duration of short-circuit | 1 s |
- Verification of short-circuit withstand strength of busbar F4 of panel 2 with supply 2

| | |
|---------------------------|--------|
| Peak current | 105 kA |
| Short-circuit current | 50 kA |
| Duration of short-circuit | 1 s |
- Verification of short-circuit withstand strength of busbars D and F1 (100 mm) of panel 2 with supply 2

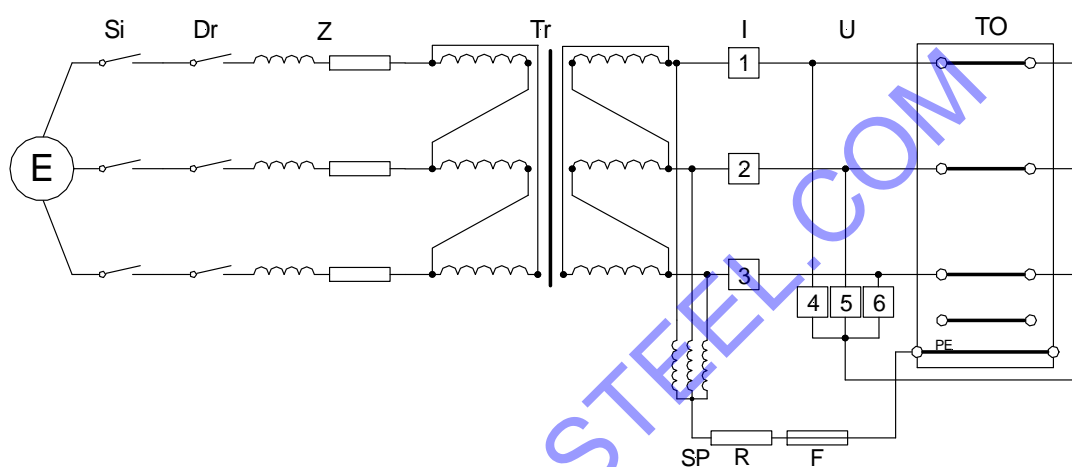
| | |
|---------------------------|--------|
| Peak current | 176 kA |
| Short-circuit current | 80 kA |
| Duration of short-circuit | 1 s |

4.4 Test arrangement

According to IEC 61439-1: 2011-08, Sub-clause 10.11.5.1

4.5 Test and measuring circuits

Technical data of test circuits



| | | | |
|----|---------------------------|-------|-----------------------------------|
| E | Power supply (grid) | TO | Test object |
| Si | Master breaker | I | Current measurement |
| Dr | Making switch | U | Voltage measurement |
| Z | Test current impedance | 1 - 6 | Measuring points |
| Tr | Short-circuit transformer | R | Fault current limiting resistance |
| SP | Artificial star point | F | Fault current detecting device |

Figure 1: Test circuit for verification of short-circuit withstand strength

Technical data of measuring circuits

| Measuring point | Measured quantity | Measuring sensor/device |
|-----------------|--------------------------|---------------------------|
| 1 | Short-circuit current L1 | Rogowski measuring device |
| 2 | Short-circuit current L2 | Rogowski measuring device |
| 3 | Short-circuit current L3 | Rogowski measuring device |
| 4 | Voltage L1 | RC divider |
| 5 | Voltage L2 | RC divider |
| 6 | Voltage L3 | RC divider |

4.6 Test results

| | |
|---------------------------------------|--|
| Test requirement: | Verification of short-circuit withstand strength of busbars B and C in panel 1 |
| Date of test: | 02 November 2012 |
| Connection of the test object: | By copper bar 100 mm x 10 mm to the busbar supply point A |
| Short-circuit point: | At the end of the resp. busbar system |
| Condition of test object before test: | As after previous tests |

| Test No. | | 1012 1506 | 1012 1507 | 1012 1509 | |
|---------------------------|----------------------------------|-----------|-----------|-----------|------|
| Peak current | kA | L1 | 52.8 | 38.6 | 110 |
| | | L2 | 41.2 | 40.4 | 86.3 |
| | | L3 | 46.0 | 37.0 | 90.7 |
| Short-circuit current | kA | L1 | 24.9 | 25.4 | 52.1 |
| | | L2 | 25.5 | 25.6 | 51.8 |
| | | L3 | 25.4 | 25.3 | 50.0 |
| | Average | 25.3 | 25.4 | 51.2 | |
| Duration of short-circuit | ms | 96.6 | 993 | 1007 | |
| Joule integral | 10 ⁶ A ² s | L1 | 70.6 | 642 | 2783 |
| | | L2 | 68.2 | 654 | 2730 |
| | | L3 | 63.1 | 638 | 2501 |
| Equivalent 1-s current | kA | - | 25.3 | 51.4 | |
| Notes | | 1) | 2) | 3) | |
| Evaluation after test | | OK | OK | OK | |

Notes:

- 1) Peak current test of busbar B
- 2) Short-time withstand current test of busbar B
- 3) Peak- and short-time withstand current test of busbar C

Condition of test object after test:

OK - Conductors and busbars did not show any undue deformation.

The supporting insulating parts did not show any significant signs of deterioration.

There was no loosening of parts used for the connection of conductors and conductors did not separate from the outgoing terminals.

The fault current detecting device did not respond.

Test results (continued)

Test requirement: Verification of short-circuit withstand strength of busbar F4 (200 mm) of panel 2 with supply 1

Date of test: 21 February 2013

Connection of the test object: By copper bar 100 mm x 10 mm to the busbar supply point S1

Short-circuit point: At the end of the busbar system F4

Condition of test object before test: As after previous tests

| Test No. | 1013 0186 | | |
|---------------------------|----------------------------------|------|------|
| Peak current | kA | L1 | 86.2 |
| | | L2 | 93.1 |
| | | L3 | 109 |
| Short-circuit current | kA | L1 | 51.4 |
| | | L2 | 51.2 |
| | | L3 | 51.0 |
| | Average | 51.2 | |
| Duration of short-circuit | ms | | 1000 |
| Joule integral | 10 ⁶ A ² s | L1 | 2651 |
| | | L2 | 2640 |
| | | L3 | 2657 |
| Equivalent 1-s current | kA | | 51.2 |
| Notes | | | 1) |
| Evaluation after test | | | OK |

Notes:

1) Peak- and short-time withstand current test, support distance 200 mm

Condition of test object after test:

OK - Conductors and busbars did not show any undue deformation.

The supporting insulating parts did not show any significant signs of deterioration.

There was no loosening of parts used for the connection of conductors and conductors did not separate from the outgoing terminals.

The fault current detecting device did not respond.

Test results (continued)

| | |
|---------------------------------------|--|
| Test requirement: | Verification of short-circuit withstand strength of busbars A and B of panel 2 with supply 1 |
| Date of test: | 21 February 2013 |
| Connection of the test object: | By copper bar 100 mm x 10 mm to the busbar supply point S1 |
| Short-circuit point: | At the end of the resp. busbar system |
| Condition of test object before test: | As after previous tests |

| Test No. | | 1013 0188 | 1013 0180 | |
|---------------------------|----------------------------------|-----------|-----------|------|
| Peak current | kA | L1 | 122 | 151 |
| | | L2 | 131 | 116 |
| | | L3 | 157 | 127 |
| Short-circuit current | kA | L1 | 69.3 | 67.1 |
| | | L2 | 68.9 | 66.7 |
| | | L3 | 69.1 | 66.9 |
| | Average | 69.1 | 66.9 | |
| Duration of short-circuit | ms | 1001 | 1000 | |
| Joule integral | 10 ⁶ A ² s | L1 | 4831 | 4605 |
| | | L2 | 4798 | 4479 |
| | | L3 | 4912 | 4537 |
| Equivalent 1-s current | kA | 69.1 | 66.9 | |
| Notes | | 1) | 2) | |
| Evaluation after test | | OK | OK | |

Notes:

- 1) Peak- and short-time withstand current test of busbar A
- 2) Peak- and short-time withstand current test of busbar B

Condition of test object after test:

OK - Conductors and busbars did not show any undue deformation.

The supporting insulating parts did not show any significant signs of deterioration.

There was no loosening of parts used for the connection of conductors and conductors did not separate from the outgoing terminals.

The fault current detecting device did not respond.

Test results (continued)

| | |
|---------------------------------------|--|
| Test requirement: | Verification of short-circuit withstand strength of busbars F1 (100 mm) of panel 2 with supply 1 |
| Date of test: | 21 February 2013 |
| Connection of the test object: | By copper bar 100 mm x 10 mm to the busbar supply point S1 |
| Short-circuit point: | At the end of the resp. busbar system |
| Condition of test object before test: | As after previous tests |

| Test No. | | 1013 0193 | 1013 0194 |
|---------------------------|----------------------------------|-----------|-----------|
| Peak current | kA | L1 | 143 |
| | | L2 | 153 |
| | | L3 | 183 |
| Short-circuit current | kA | L1 | 81.8 |
| | | L2 | 81.7 |
| | | L3 | 82.0 |
| | Average | 81.8 | |
| Duration of short-circuit | ms | 99.8 | 996 |
| Joule integral | 10 ⁶ A ² s | L1 | 704 |
| | | L2 | 710 |
| | | L3 | 825 |
| Equivalent 1-s current | kA | - | 81.2 |
| Notes | | 1) | 2) |
| Evaluation after test | | OK | OK |

Notes:

- 1) Peak current test of busbar F1, support distance 100 mm
- 2) Short-time withstand current test of busbar F1, support distance 100 mm

Condition of test object after test:

OK - Conductors and busbars did not show any undue deformation.

The supporting insulating parts did not show any significant signs of deterioration.

There was no loosening of parts used for the connection of conductors and conductors did not separate from the outgoing terminals.

The fault current detecting device did not respond.

Test results (continued)

| | |
|---------------------------------------|--|
| Test requirement: | Verification of short-circuit withstand strength of busbar F4 of panel 2 with supply 2 |
| Date of test: | 22 February 2013 |
| Connection of the test object: | By copper bar 100 mm x 10 mm to the busbar supply point S2 |
| Short-circuit point: | At the end of the busbar system F4 |
| Condition of test object before test: | As after previous tests |

| Test No. | | 1013 0195 | 1013 0196 | |
|---------------------------|----------------------------------|-----------|-----------|------|
| Peak current | kA | L1 | 106 | 77.0 |
| | | L2 | 83.6 | 80.3 |
| | | L3 | 91.0 | 73.9 |
| Short-circuit current | kA | L1 | 49.2 | 50.4 |
| | | L2 | 50.2 | 50.5 |
| | | L3 | 49.3 | 50.3 |
| | Average | 49.6 | 50.4 | |
| Duration of short-circuit | ms | 99.9 | 1003 | |
| Joule integral | 10 ⁶ A ² s | L1 | 290 | 2564 |
| | | L2 | 263 | 2583 |
| | | L3 | 256 | 2557 |
| Equivalent 1-s current | kA | - | 50.5 | |
| Notes | | 1) | 2) | |
| Evaluation after test | | OK | OK | |

Notes:

- 1) Peak current test of busbar F4, support distance 100 mm
- 2) Short-time withstand current test of busbar F4, support distance 100 mm

Condition of test object after test:

OK - Conductors and busbars did not show any undue deformation.

The supporting insulating parts did not show any significant signs of deterioration.

There was no loosening of parts used for the connection of conductors and conductors did not separate from the outgoing terminals.

The fault current detecting device did not respond.

Test results (continued)

| | |
|---------------------------------------|--|
| Test requirement: | Verification of short-circuit withstand strength of busbars D and F1 (100 mm) of panel 2 with supply 2 |
| Date of test: | 22 February 2013 |
| Connection of the test object: | By copper bar 100 mm x 10 mm to the busbar supply point S2 |
| Short-circuit point: | At the end of the resp. busbar system |
| Condition of test object before test: | As after previous tests |

| Test No. | | 1013 0200 | 1013 0201 | |
|---------------------------|----------------------------------|-----------|-----------|------|
| Peak current | kA | L1 | 186 | 190 |
| | | L2 | 147 | 141 |
| | | L3 | 159 | 164 |
| Short-circuit current | kA | L1 | 82.1 | 82.7 |
| | | L2 | 84.9 | 83.0 |
| | | L3 | 83.7 | 84.0 |
| | Average | 83.6 | 83.2 | |
| Duration of short-circuit | ms | 1011 | 1015 | |
| Joule integral | 10 ⁶ A ² s | L1 | 6979 | 7087 |
| | | L2 | 7337 | 7071 |
| | | L3 | 7165 | 7233 |
| Equivalent 1-s current | kA | 84.1 | 83.8 | |
| Notes | | 1) | 2) | |
| Evaluation after test | | OK | OK | |

Notes:

- 1) Peak- and short-time withstand current test of busbar D
- 2) Peak- and short-time withstand current test of busbar F1, support distance 100 mm

Condition of test object after test:

OK - Conductors and busbars did not show any undue deformation.

The supporting insulating parts did not show any significant signs of deterioration.

There was no loosening of parts used for the connection of conductors and conductors did not separate from the outgoing terminals.

The fault current detecting device did not respond.

5. Photos

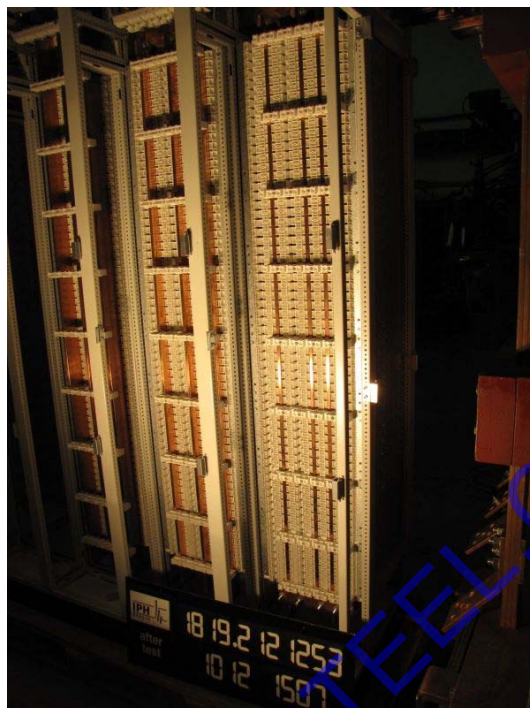


Photo 1: Test object after the verification of short-circuit withstand strength of busbar B in panel 1

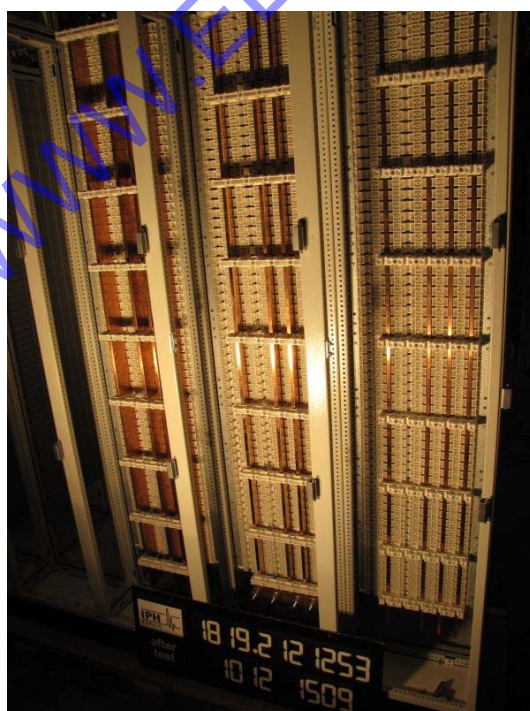


Photo 2: Test object after the verification of short-circuit withstand strength of busbar C in panel 1



Photo 3: Test object after the verification of short-circuit withstand strength of busbar F4 in panel 2

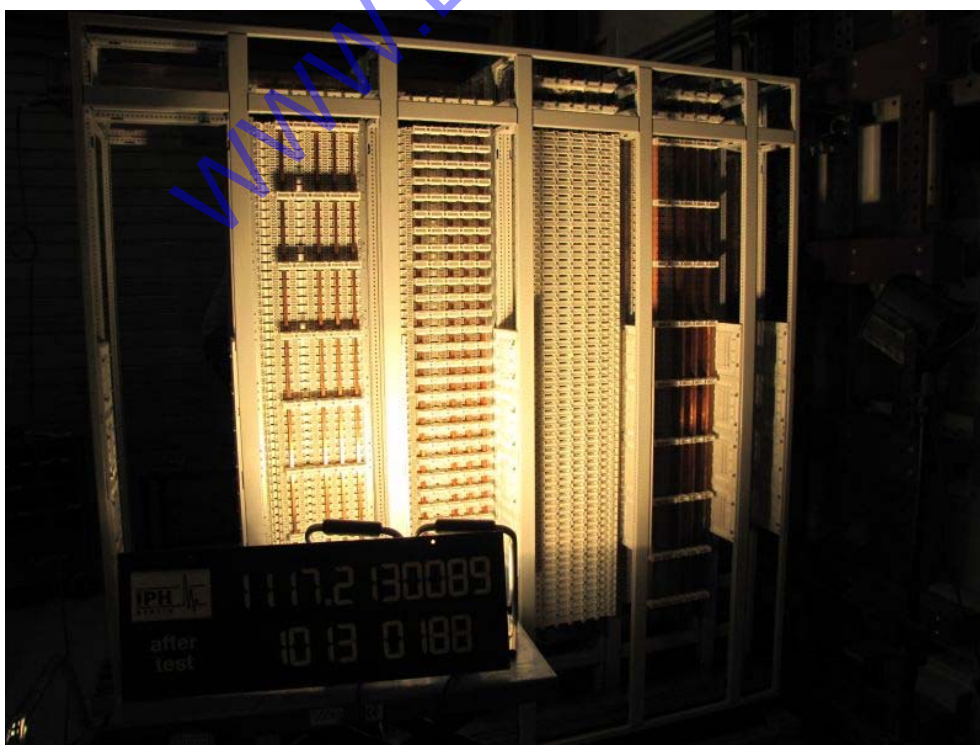


Photo 4: Test object after the verification of short-circuit withstand strength of busbar A in panel 2



Photo 5: Test object after the verification of short-circuit withstand strength of busbar A in panel 2



Photo 6: Test object after the verification of short-circuit withstand strength of busbar B in panel 2



Photo 7: Test object after the verification of short-circuit withstand strength of busbar F1 in panel 2



Photo 8: Test object after the verification of short-circuit withstand strength of busbar F4 in panel 2



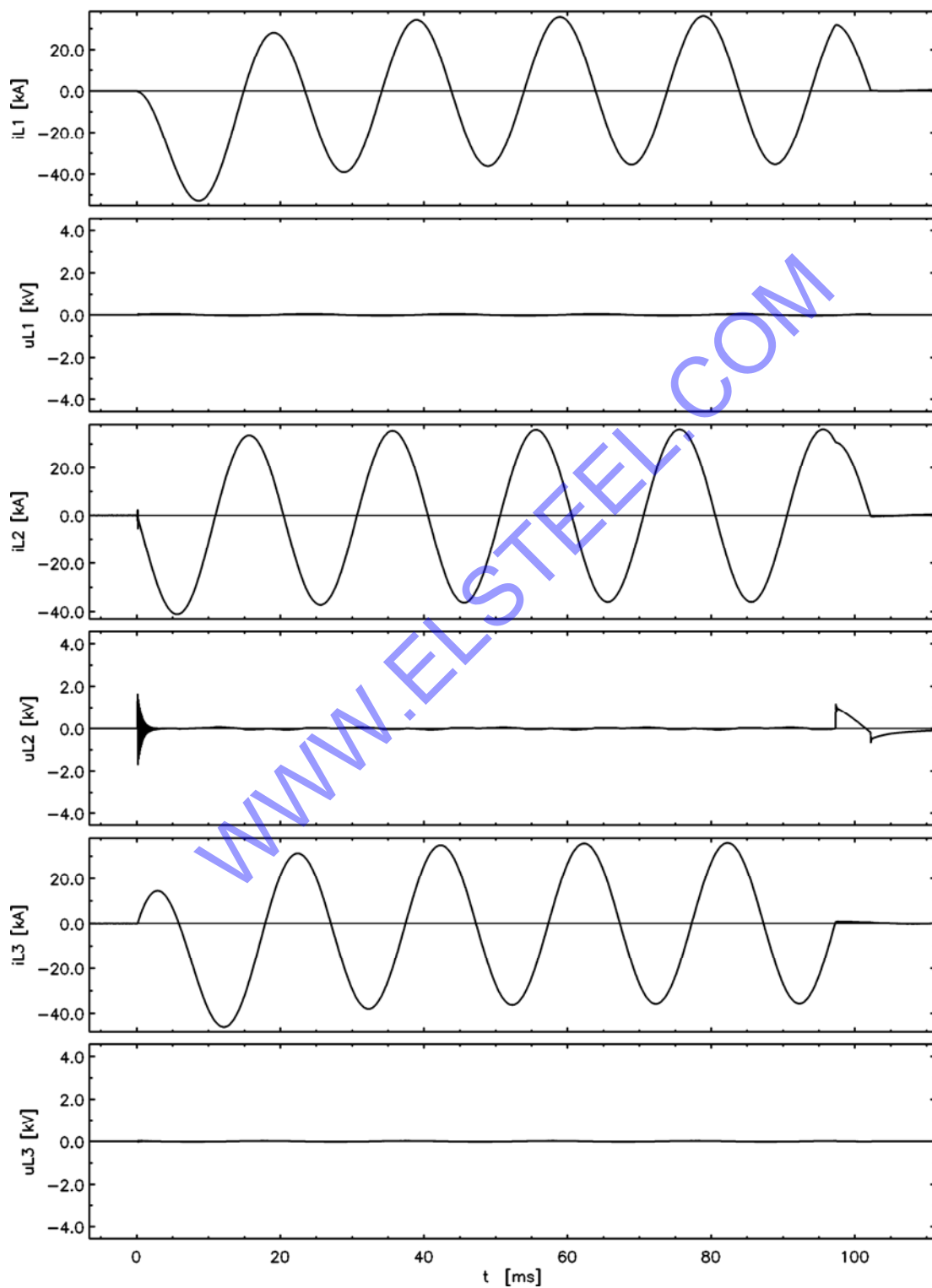
Photo 9: Test object after the verification of short-circuit withstand strength of busbar D in panel 2



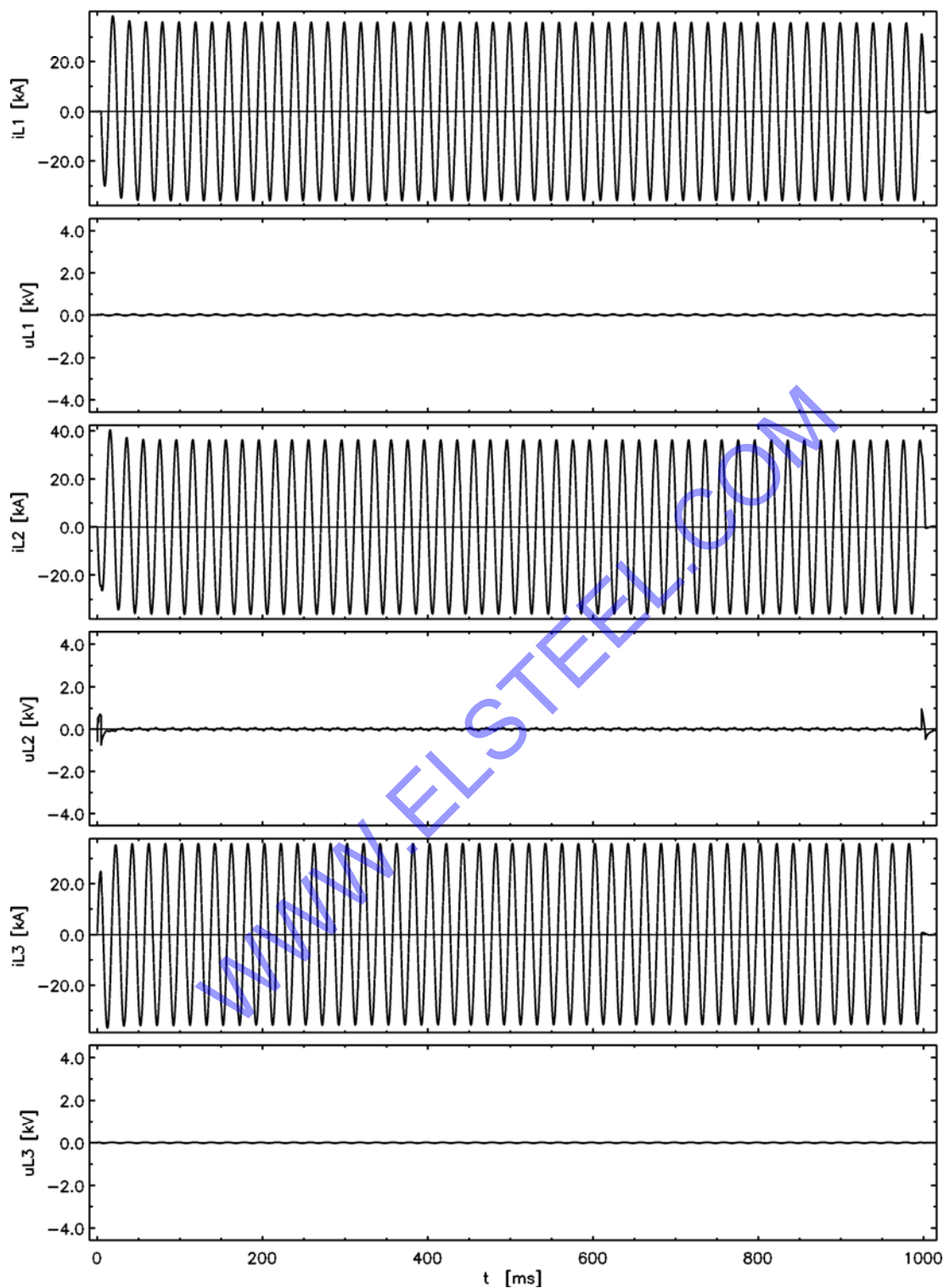
Photo 10: Test object after the verification of short-circuit withstand strength of busbar F1 in panel 2

6. Oscillograms

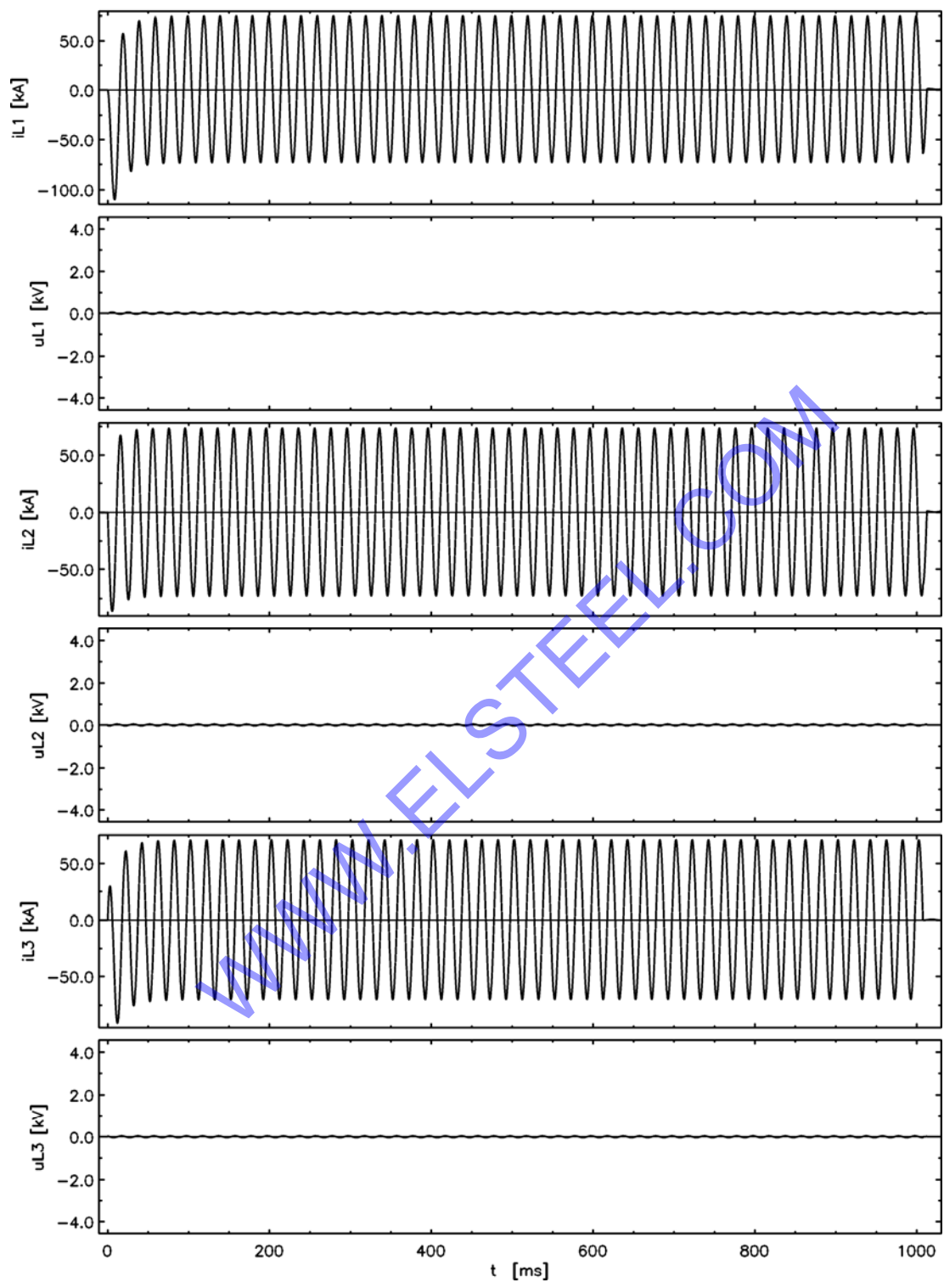
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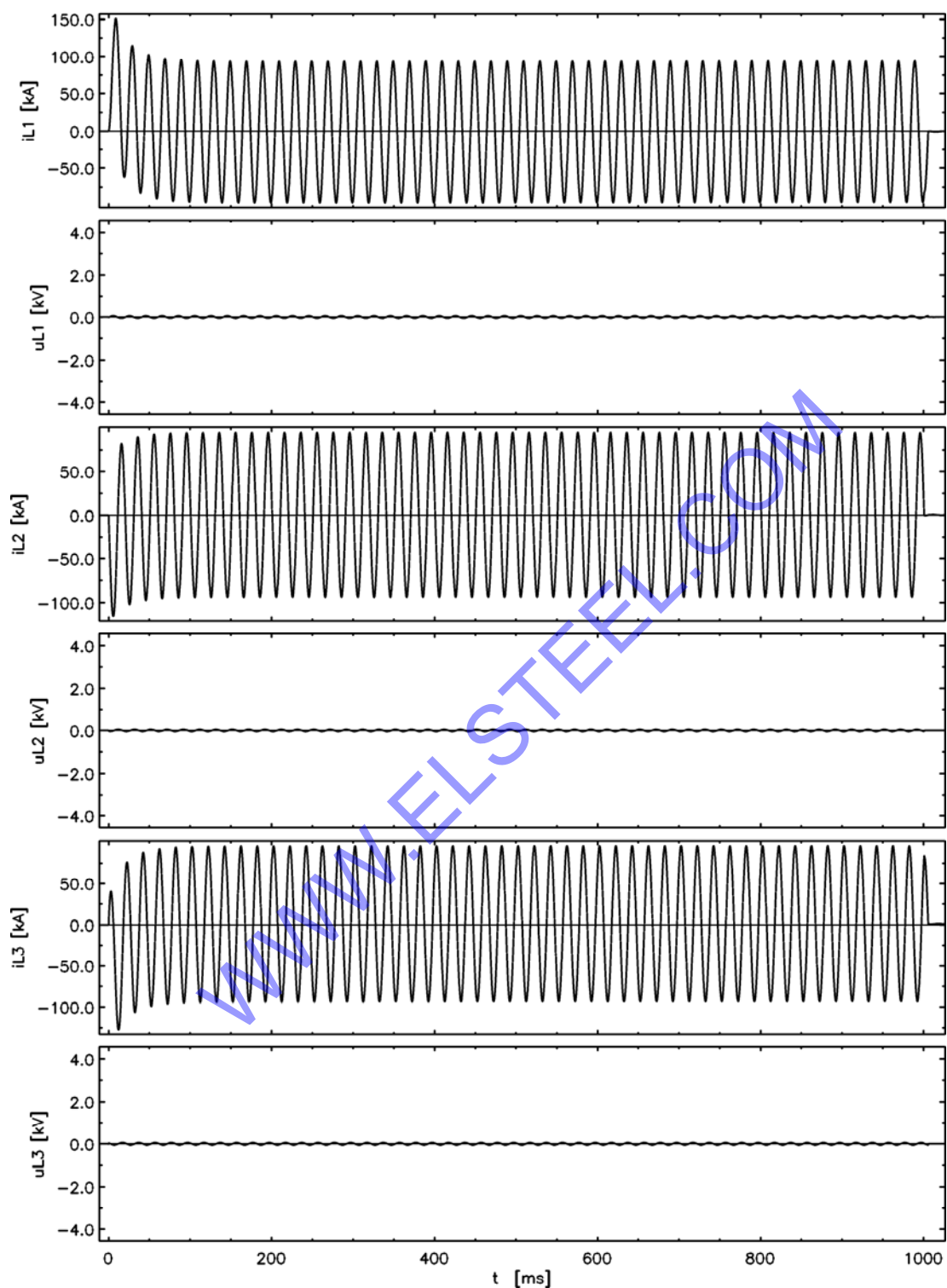
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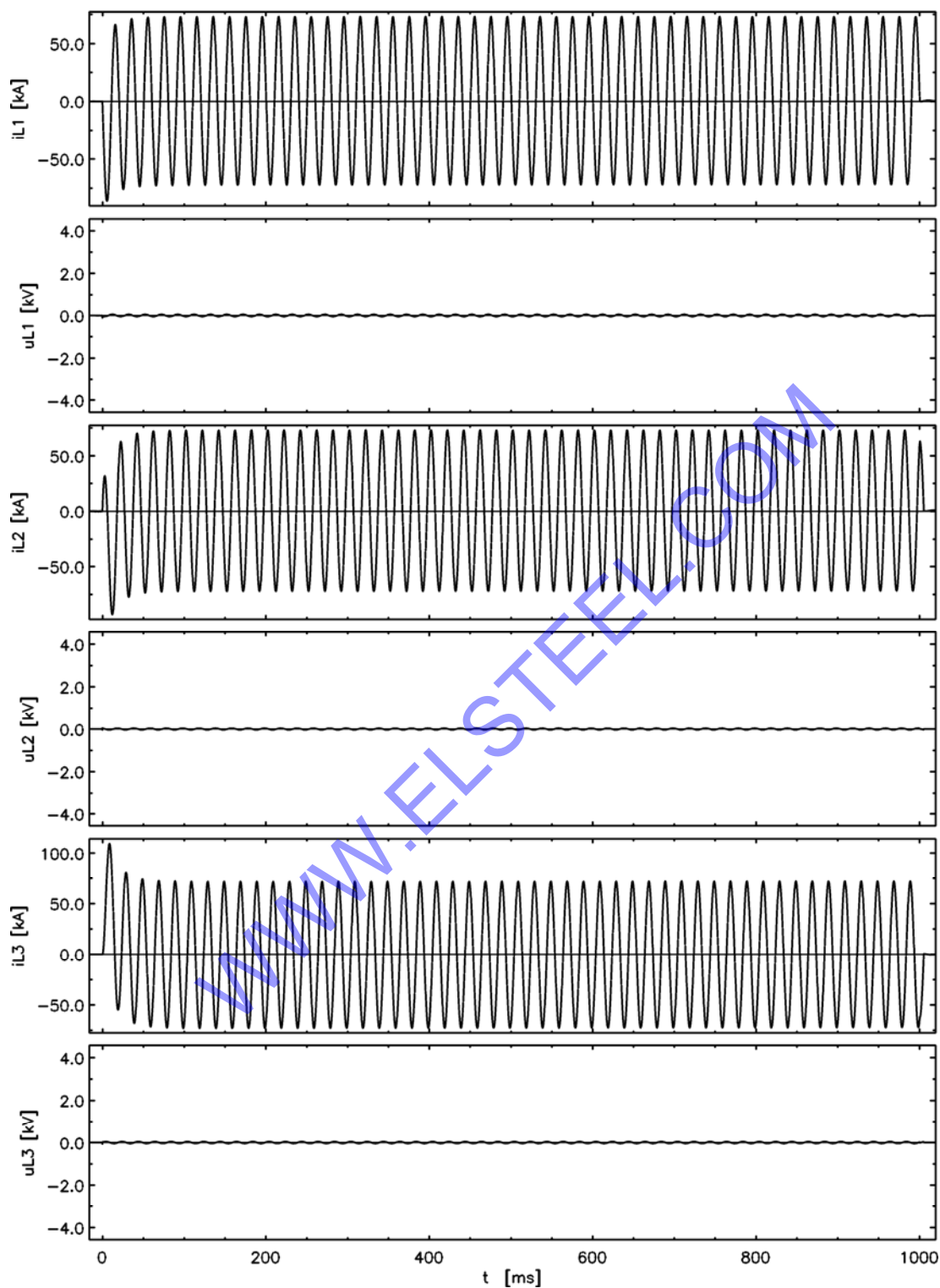
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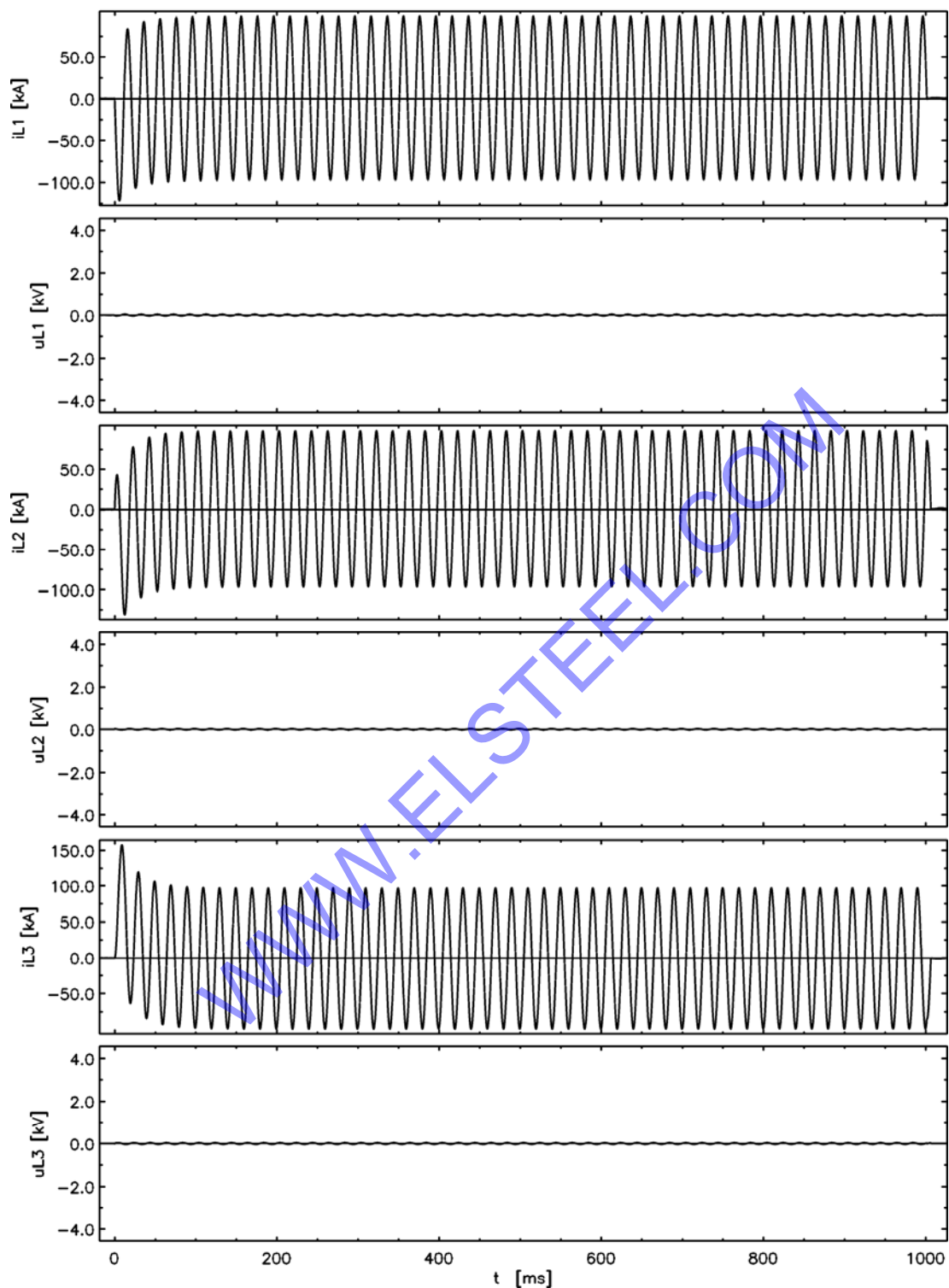
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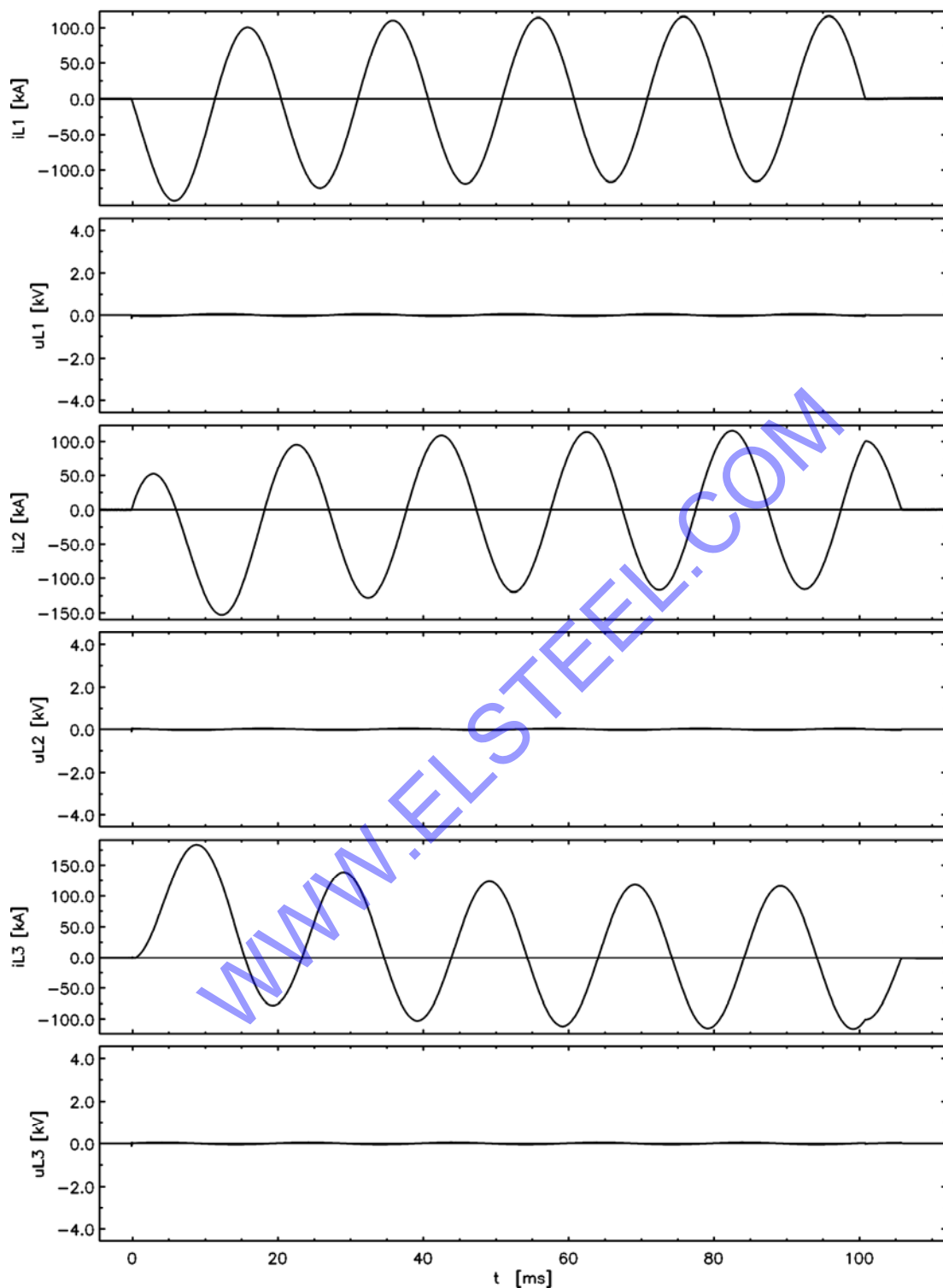
Test-No. 10130186



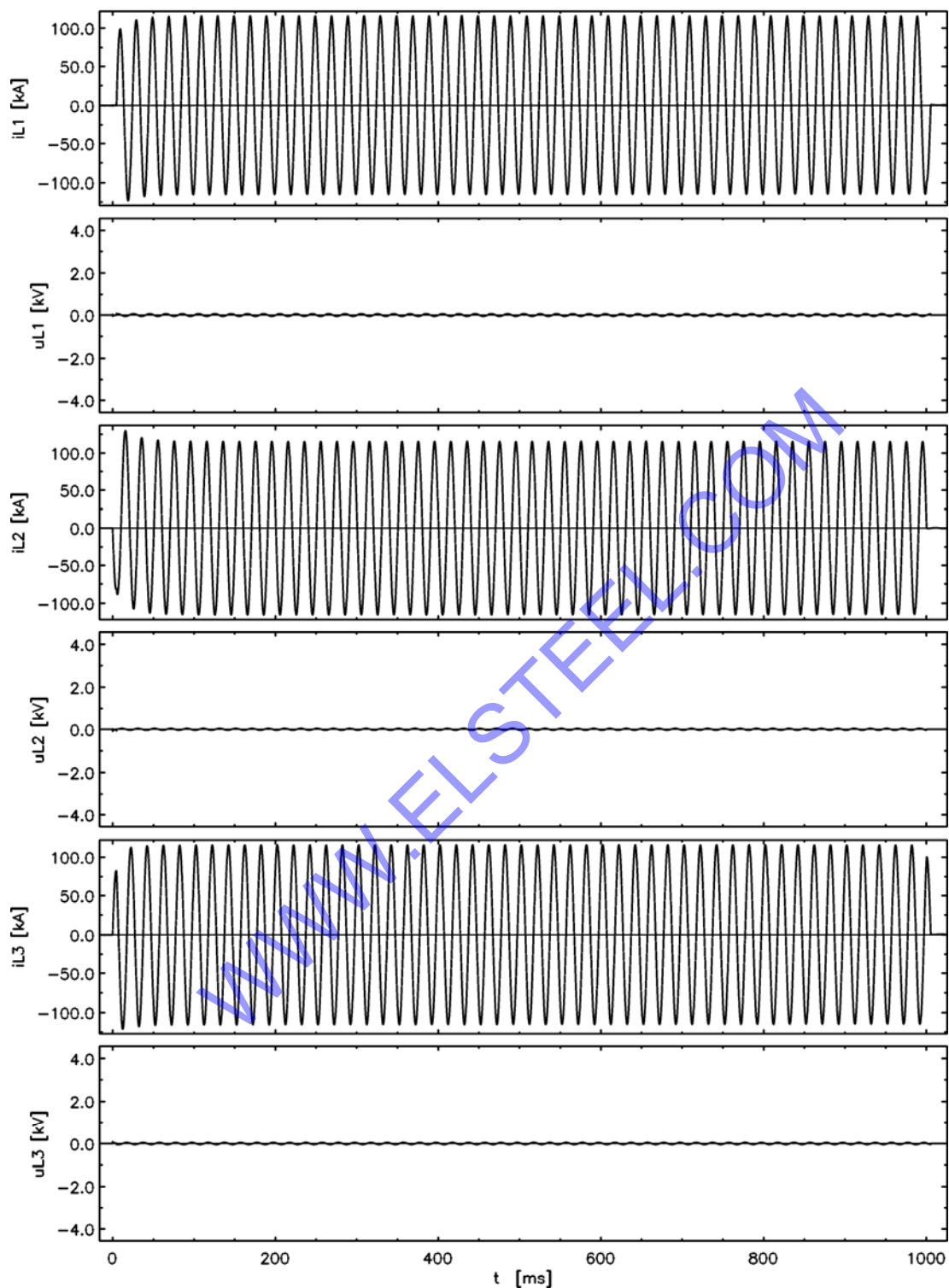
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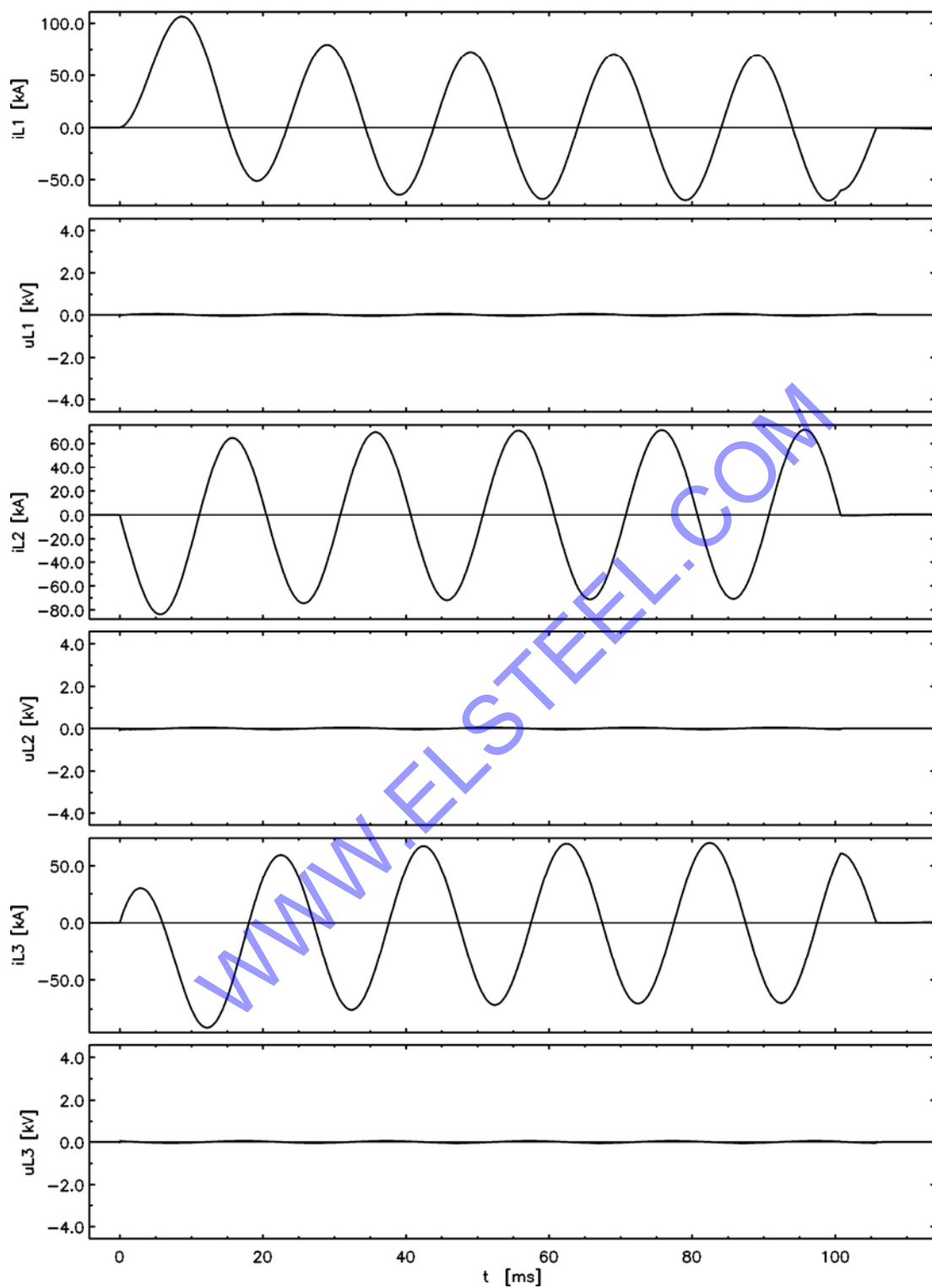
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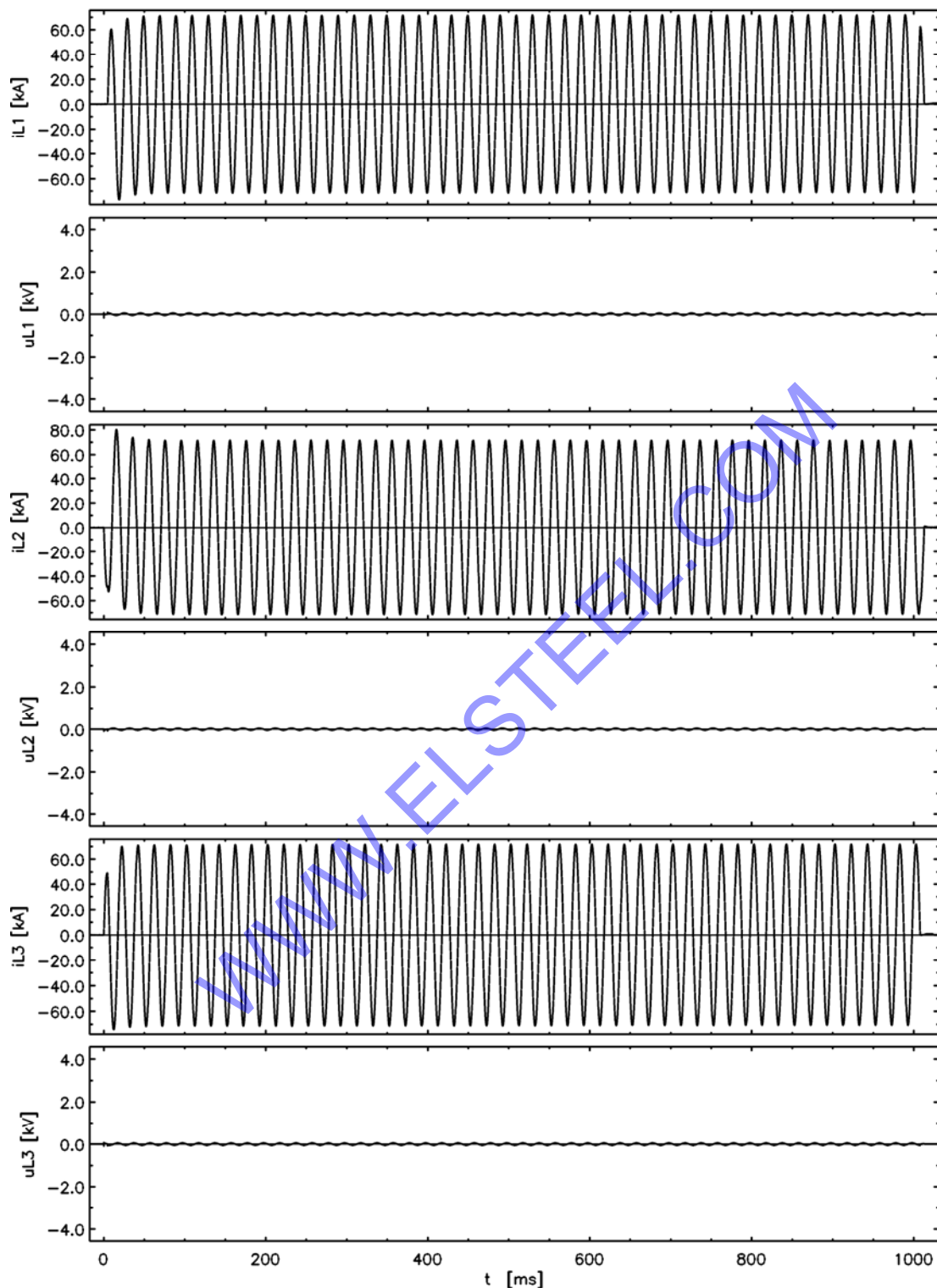
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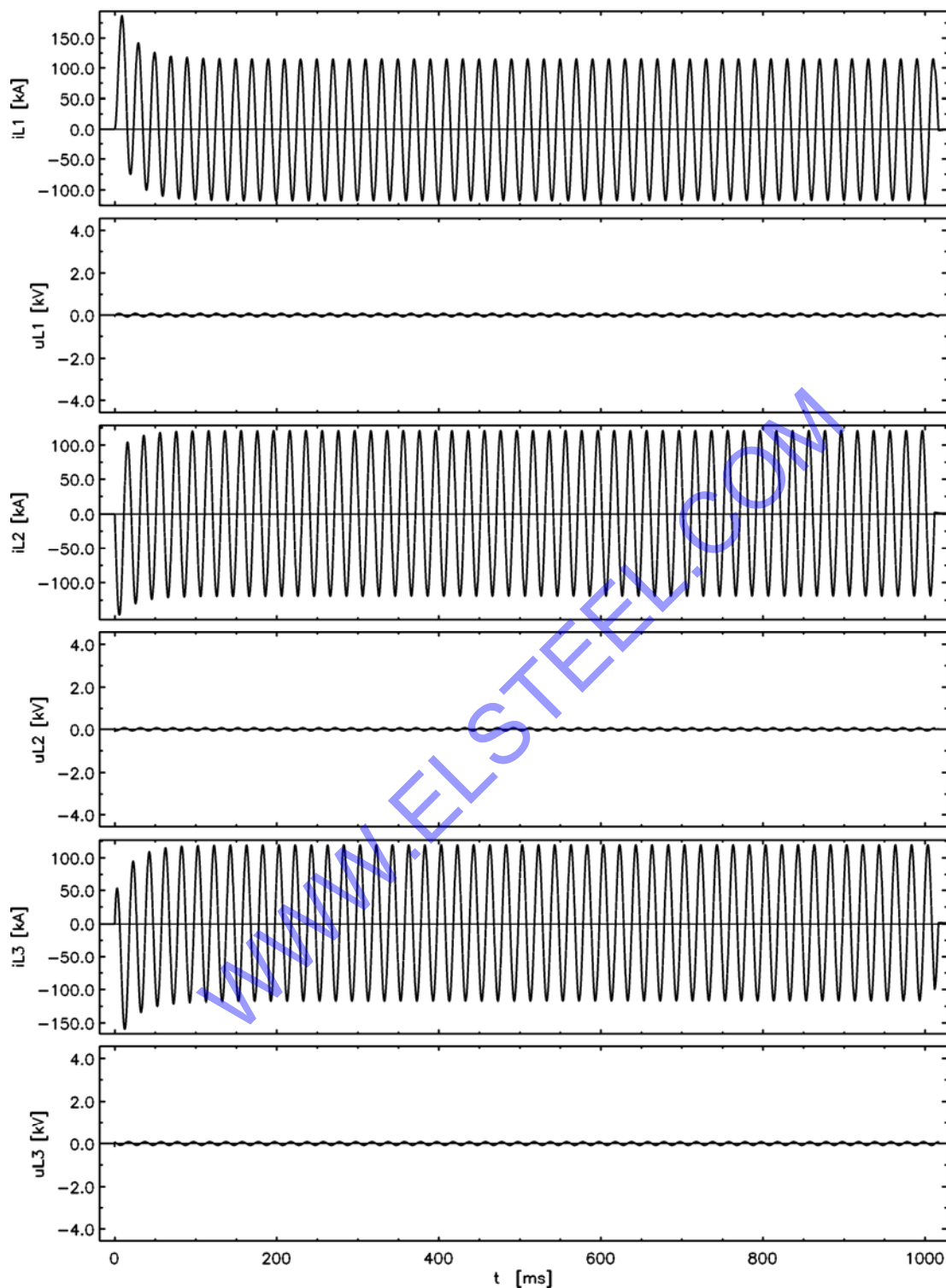
Test-No. 10130195



Test-No. 10130196



Test-No. 10130200



Test-No. 10130201

