

## OSCILLATORY AND FAST TRANSIENT SWC TEST REPORT ON 38 kV CONTROLLER/RECLOSER

<b>Client:</b> Tavrída Electric North America							
<b>Test Date:</b> 19 May 2016	<b>Project:</b> PL-27166.01						
<b>Nameplate Data:</b>							
<b>Recloser Controller:</b>							
Manufacturer:	Beckwith Electric Co. Inc.						
Model:	M-7679						
Serial No.:	12345						
<b>Three-phase Recloser:</b>							
Manufacturer:	Tavrída Electric						
Type:	OSM25_A1_4						
Impulse level (BIL):	150 kV <sub>peak</sub>						
Rated voltage:	27 kV <sub>rms</sub>						
Rated current:	630 A <sub>rms</sub> continuous						
Serial No.:	163744						
<b>Test Standard:</b>	IEEE Std C37.60-2012, Clause 6.111.2: "Oscillatory and fast transients surge tests"						
<b>Test Witness:</b>	Joel Bryant, Beckwith Electric Co. Inc.; Alexander Sergeyenko, Tavrída Electric						
<b>Atmospheric Conditions:</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">Temperature</td> <td>20.9 °C</td> </tr> <tr> <td>Relative humidity</td> <td>50.6 %</td> </tr> <tr> <td>Barometric pressure</td> <td>754.1 mmHg</td> </tr> </table>	Temperature	20.9 °C	Relative humidity	50.6 %	Barometric pressure	754.1 mmHg
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Relative humidity	50.6 %						
Barometric pressure	754.1 mmHg						
<b>Test Voltage:</b>	Oscillatory +&- 2.5 kV <sub>peak</sub> , Fast Transient +&- 4 kV <sub>peak</sub>						
<b>Test Procedure:</b>	The testing was in accordance with IEEE C37.90.1-2012. Test surges were applied to the control cable in common and transverse mode using an external coupling/decoupling network in accordance with Table 3 and 4 of IEEE C37.90.1. Signal and data circuits were tested using a capacitive clamp. The AC power supply was tested while connected to 120 Volts, 60 Hz supply for all tests.						
<b>Test Results:</b>	The controller and recloser operated normally following the Oscillatory and Fast Transient Tests performed in accordance with the test procedures as per the above document. The controller complied with requirements of IEEE Std. C37.60-2012, Clause 6.111.2".						
<b>Remarks:</b>	None						

Tested by:



Meiru Du, Senior Technician  
High Voltage Laboratory

Reviewed by:



May Wang, Ph.D., P. Eng. *May 31, 2016*  
Manager, High Voltage Laboratory

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**Fast Transient Waveform Validity Tests (Positive)**

(in accordance with IEEE Std C37.90.1-2012, Clause B.2)

Performed before the Fast Transient Test

1. Measuring system feed through test

Generator Output voltage 4 kV

Feed through voltage 0.4 V (pass if  $\leq 1\%$ )

2. Open circuit voltage waveform test

Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification

Test duration 60 s ( $\geq 60$  s)

Burst period 301 ms (240 to 360 ms)

Burst duration 15 ms (12 to 18 ms)

Repetition rate 2.40 kHz (2 to 3 kHz)

Impulse duration 63 ns (35 to 65 ns to 50% value)

Rise time 4.36 ns (3.5 to 6.5 ns – 10% to 90%)

Peak voltage level (no load) 4.4 kV (3.6 to 4.4 kV when set to 4 kV)

Output impedance 51.4  $\Omega$  (40 to 60  $\Omega$ )

4. Test Pass X Test Fail \_\_\_\_\_

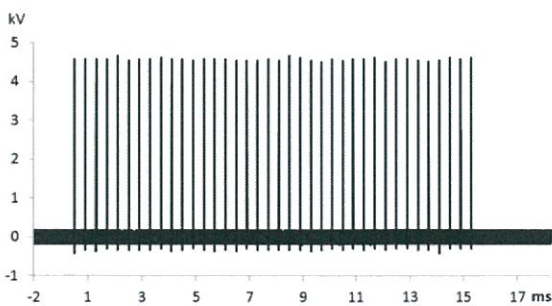


Figure 1

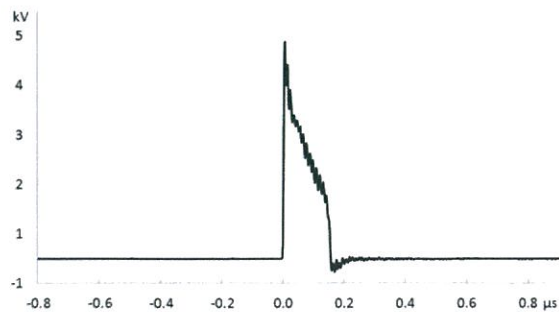


Figure 2

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**Fast Transient Waveform Validity Tests (Positive)**

(in accordance with IEEE Std C37.90.1-2012, Clause B.2)

Performed after the Fast Transient Test

5. Measuring system feed through test

Generator Output voltage   +4   kV

Feed through voltage   23   V (pass if  $\leq 1\%$ )

6. Open circuit voltage waveform test

Recorded waveforms – Figures 1 and 2.

7. Test Generator performance verification

Test duration   60.0   s ( $\geq 60$  s)

Burst period   300   ms (240 to 360 ms)

Burst duration   15   ms (12 to 18 ms)

Repetition rate   2.5   kHz (2 to 3 kHz)

Impulse duration   64   ns (35 to 65 ns to 50% value)

Rise time   4.9   ns (3.5 to 6.5 ns – 10% to 90%)

Peak voltage level (no load)   4.15   kV (3.6 to 4.4 kV when set to 4 kV)

Output impedance   53.3    $\Omega$  (40 to 60  $\Omega$ )

8. Test Pass   X   Test Fail           

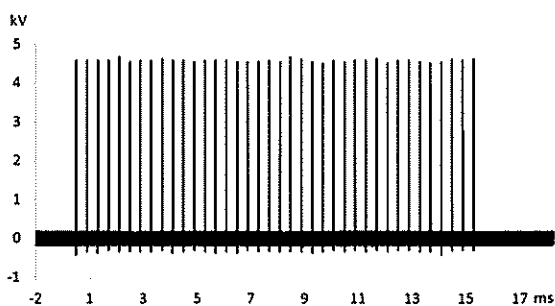


Figure 1

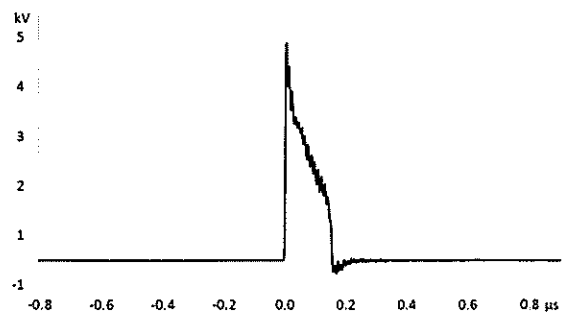


Figure 2

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**Fast Transient Waveform Validity Tests (Negative)**

(in accordance with IEEE Std C37.90.1-2012, Clause B.2)

Performed before the Fast Transient Test

1. Measuring system feed through test

Generator Output voltage   4   kV

Feed through voltage   2.4   V (pass if ≤ 1%)

2. Open circuit voltage waveform test

Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification

Test duration   60   s (≥ 60 s)

Burst period   286   ms (240 to 360 ms)

Burst duration   15.3   ms (12 to 18 ms)

Repetition rate   2.38   kHz (2 to 3 kHz)

Impulse duration   65   ns (35 to 65 ns to 50% value)

Rise time   5.46   ns (3.5 to 6.5 ns – 10% to 90%)

Peak voltage level (no load)   3.68   kV (3.6 to 4.4 kV when set to 4 kV)

Output impedance   57.1   Ω (40 to 60 Ω)

4. Test Pass   X   Test Fail           

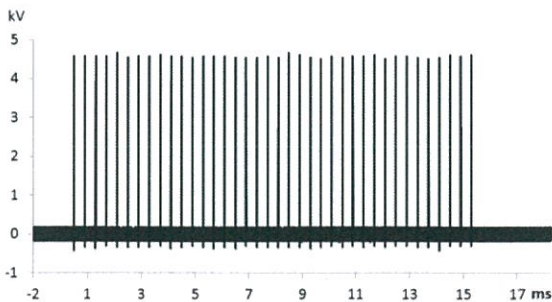


Figure 1

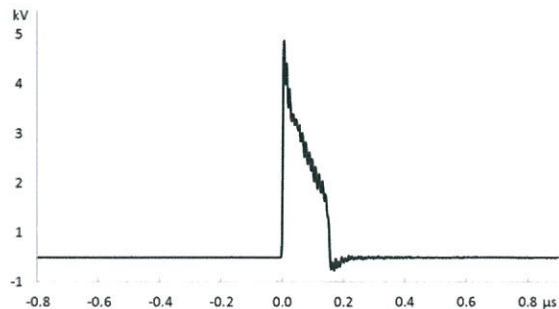


Figure 2

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**Fast Transient Waveform Validity Tests (Negative)**

(in accordance with IEEE Std C37.90.1-2012, Clause B.2)

Performed after the Fast Transient Test

1. Measuring system feed through test

Generator Output voltage  -4  kV

Feed through voltage  31  V (pass if  $\leq 1\%$ )

2. Open circuit voltage waveform test

Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification

Test duration  60  s ( $\geq 60$  s)

Burst period  300  ms (240 to 360 ms)

Burst duration  15  ms (12 to 18 ms)

Repetition rate  2.5  kHz (2 to 3 kHz)

Impulse duration  63  ns (35 to 65 ns to 50% value)

Rise time  4.9  ns (3.5 to 6.5 ns – 10% to 90%)

Peak voltage level (no load)  4.06  kV (3.6 to 4.4 kV when set to 4 kV)

Output impedance  56.1   $\Omega$  (40 to 60  $\Omega$ )

4. Test Pass  X  Test Fail

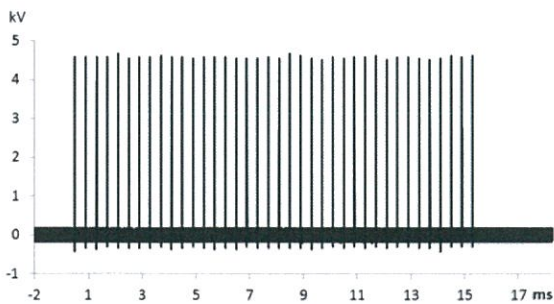


Figure 1

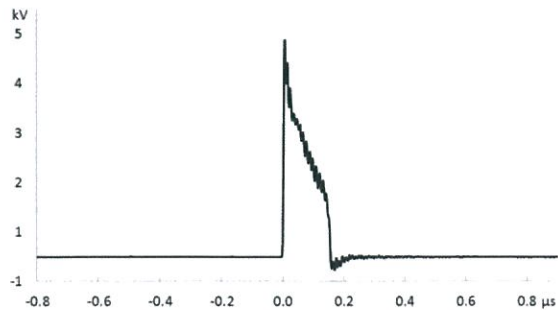


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**Oscillatory Waveform Validity Tests (Positive)**

(in accordance with IEEE Std C37.90.1-2012, Clause B.2)

Performed before the Oscillatory SWC Test

1. Measuring system feed through test

Generator Output voltage 2.5 kV

Feed through voltage 24 V (pass ≤ 1%)

2. Open circuit voltage waveform test

Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification

Test duration 2.1 s (2 to 2.2 s)

Repetition rate 7 bursts per period (6-10 bursts per 16.7 ms)

Oscillation frequency 0.91 MHz (0.9 to 1.1 MHz)

Waveform envelope decay 5.4 μs (4 to 6 μs to 50%)

Rise time of the first peak 80 ns (60 to 90 ns – 10% to 90%)

Peak voltage level (no load) 2.46 kV (2.25 to 2.5 kV when set to 2.5 kV)

Output impedance 198.1 Ω (160 to 240 Ω)

4. Test Pass X Test Fail \_\_\_\_\_

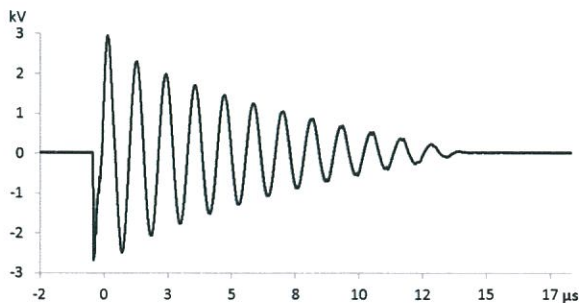


Figure 1

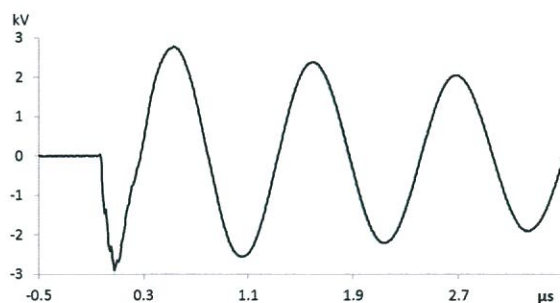


Figure 2

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**Oscillatory Waveform Validity Tests (Positive)**

(in accordance with IEEE Std C37.90.1-2012, Clause B.2)

Performed after the Oscillatory SWC Test

5. Measuring system feed through test

Generator Output voltage +2.5 kV

Feed through voltage 10 V (pass  $\leq 1\%$ )

6. Open circuit voltage waveform test

Recorded waveforms – Figures 1 and 2.

7. Test Generator performance verification

Test duration 2.1 s (2 to 2.2 s)

Repetition rate 7 bursts per period (6-10 bursts per 16.7 ms)

Oscillation frequency 0.91 MHz (0.9 to 1.1 MHz)

Waveform envelope decay 4.4  $\mu$ s (4 to 6  $\mu$ s to 50%)

Rise time of the first peak 64 ns (60 to 90 ns – 10% to 90%)

Peak voltage level (no load) 2.50 kV (2.25 to 2.5 kV when set to 2.5 kV)

Output impedance 166.9  $\Omega$  (160 to 240  $\Omega$ )

8. Test Pass X Test Fail \_\_\_\_\_

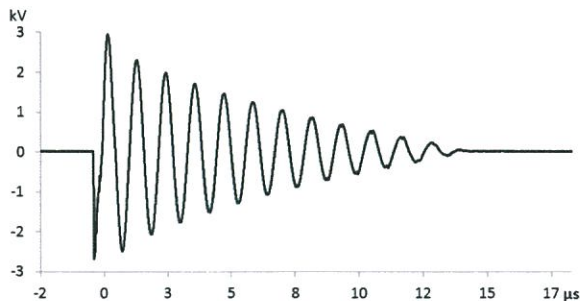


Figure 1

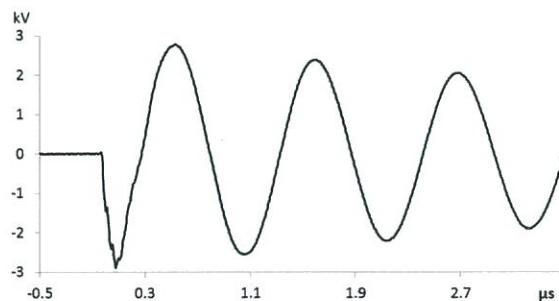


Figure 2

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**Oscillatory Waveform Validity Tests (Negative)**

(in accordance with IEEE Std C37.90.1-2012, Clause B.2)

Performed before the Oscillatory SWC Test

1. Measuring system feed through test

Generator Output voltage 2.5 kV

Feed through voltage 21 V (pass  $\leq 1\%$ )

2. Open circuit voltage waveform test

Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification

Test duration 2.07 s (2 to 2.2 s)

Repetition rate 7 bursts per period (6-10 bursts per 16.7 ms)

Oscillation frequency 0.98 MHz (0.9 to 1.1 MHz)

Waveform envelope decay 4.3  $\mu$ s (4 to 6  $\mu$ s to 50%)

Rise time of the first peak 88 ns (60 to 90 ns – 10% to 90%)

Peak voltage level (no load) 2.08 kV (2.25 to 2.5 kV when set to 2.5 kV)

Output impedance 173.9  $\Omega$  (160 to 240  $\Omega$ )

4. Test Pass X Test Fail \_\_\_\_\_

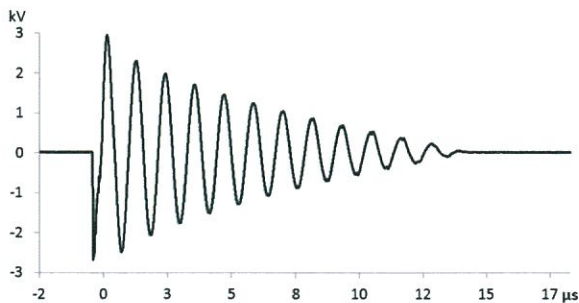
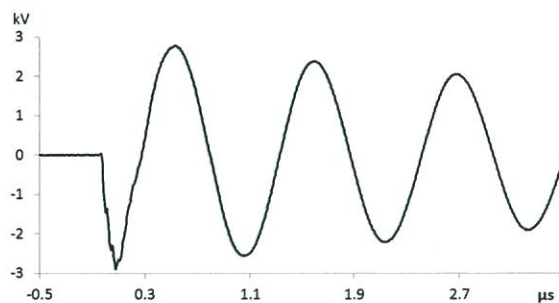


Figure 1



Figure

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**Oscillatory Waveform Validity Tests (Negative)**

(in accordance with IEEE Std C37.90.1-2012, Clause B.2)

Performed after the Oscillatory SWC Test

## 1. Measuring system feed through test

Generator Output voltage  -2.5  kVFeed through voltage  5  V (pass  $\leq 1\%$ )

## 2. Open circuit voltage waveform test

Recorded waveforms – Figures 1 and 2.

## 3. Test Generator performance verification

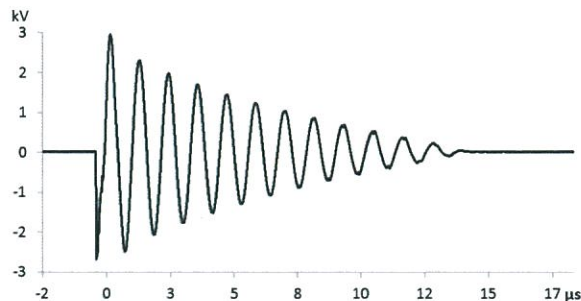
Test duration  2.07  s (2 to 2.2 s)Repetition rate  7  bursts per period (6-10 bursts per 16.7 ms)Oscillation frequency  0.9  MHz (0.9 to 1.1 MHz)Waveform envelope decay  4.4   $\mu$ s (4 to 6  $\mu$ s to 50%)Rise time of the first peak  88  ns (60 to 90 ns – 10% to 90%)Peak voltage level (no load)  2.25  kV (2.25 to 2.5 kV when set to 2.5 kV)Output impedance  191.8   $\Omega$  (160 to 240  $\Omega$ )4. Test Pass  X  Test Fail  

Figure 1

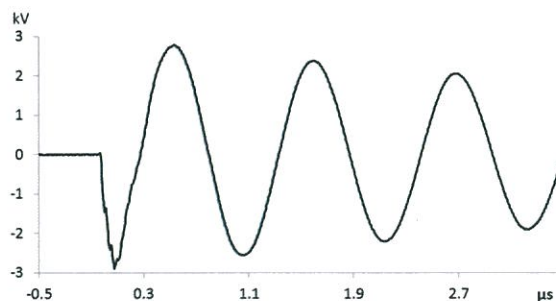


Figure 2

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