# CONTROLLER OSCILLATORY SWC TEST REPORT

<table>
<thead>
<tr>
<th>Client:</th>
<th>Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Date:</td>
<td>9 February 2012</td>
</tr>
<tr>
<td>Nameplate Data:</td>
<td></td>
</tr>
<tr>
<td><strong>Recloser Controller:</strong></td>
<td></td>
</tr>
<tr>
<td>Manufacturer:</td>
<td>Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA</td>
</tr>
<tr>
<td>Model:</td>
<td>SEL-651R-2</td>
</tr>
<tr>
<td>Serial No.:</td>
<td>1113060561</td>
</tr>
<tr>
<td><strong>Three-phase Recloser:</strong></td>
<td></td>
</tr>
<tr>
<td>Manufacturer:</td>
<td>G&amp;W</td>
</tr>
<tr>
<td>Type:</td>
<td>VIP388ER-125</td>
</tr>
<tr>
<td>Impulse level (BIL):</td>
<td>125 kV&lt;sub&gt;peak&lt;/sub&gt;</td>
</tr>
<tr>
<td>Rated voltage:</td>
<td>27 kV&lt;sub&gt;rms&lt;/sub&gt;</td>
</tr>
<tr>
<td>Rated current:</td>
<td>800 A&lt;sub&gt;rms&lt;/sub&gt; continuous/12.5 kA interrupting</td>
</tr>
<tr>
<td>Serial No.:</td>
<td>2011-1014-0047</td>
</tr>
<tr>
<td>Test Witness:</td>
<td>Alex Bradley - Schweitzer Engineering Laboratories, Inc</td>
</tr>
<tr>
<td>Test Standard:</td>
<td>IEEE C37.60-2003, Clause 6.13.1: &quot;Oscillatory and fast transients surge tests&quot;</td>
</tr>
<tr>
<td>Atmospheric Conditions:</td>
<td>Temperature 22 °C</td>
</tr>
<tr>
<td>Test Voltage:</td>
<td>2.5 kV&lt;sub&gt;peak&lt;/sub&gt;</td>
</tr>
<tr>
<td>Test Procedure:</td>
<td>Test surge was applied to the control cable in common mode using a capacitive clamp and transverse mode through 1.5 mH coils. Test surge were applied to ac power input in common mode and transverse mode using an external coupling filter. The AC power supplied to the controller was 120 Volts, 60 Hz.</td>
</tr>
<tr>
<td>Test Results:</td>
<td>The controller and recloser operated normally following the Oscillatory SWC Test performed in accordance with the test procedures as per the above document. The controller complied with requirements of &quot;IEEE C37.60-2003, Clause 6.13.1&quot;.</td>
</tr>
<tr>
<td>Remarks:</td>
<td>None</td>
</tr>
</tbody>
</table>

Tested by: Alex Babakov, P. Eng. Project Engineer

Reviewed by: M. Wang, P. Eng. High Voltage Specialist Engineer

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APPENDIX 1

Oscillatory SWC Waveform Validity Tests
(in accordance with IEEE Std C37.90.1-2002, Clause A.2)

Performed before the Oscillatory SWC Test

1. Measuring system feed through test
   Generator Output voltage ______ 2.5 ______ kV
   Feed through voltage ______ 1.0 ______ 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 ______ 8 ______ bursts per period (6-10 bursts per 16.7 ms)
   Oscillation frequency ______ 0.94 ______ MHz  (0.9 to 1.1 MHz)
   Waveform envelope decay ______ 4.3 ______ µs  (4 to 6 µs to 50%)
   Rise time of the first peak ______ 73 ______ ns  (60 to 90 ns – 10% to 90%)
   Peak voltage level (no load) ______ 2.4 ______ kV  (2.25 to 2.5 kV when set to 2.5 kV)
   Output impedance ______ 227 ______ Ω  (160 to 240 Ω)

4. Test Pass ______ X ______ Test Fail ________

   ![Figure 1](image1.png)
   ![Figure 2](image2.png)

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APPENDIX 2

Oscillatory SWC Waveform Validity Tests
(in accordance with IEEE Std C37.90.1-2002, Clause A.2)

Performed after the Oscillatory SWC Test

5. Measuring system feed through test
   Generator Output voltage ______ 2.5 ______ kV
   Feed through voltage ______ 8.5 ______ V (pass \leq 1\%)

6. Open circuit voltage waveform test

   Recorded waveforms – Figures 1 and 2.

7. Test Generator performance verification
   Test duration ______ 2.09 ______ s (2 to 2.2 s)
   Repetition rate ______ 8 ______ bursts per period (6-10 bursts per 16.7 ms)
   Oscillation frequency ______ 0.91 ______ MHz (0.9 to 1.1 MHz)
   Waveform envelope decay ______ 4.8 ______ \mu s (4 to 6 \mu s to 50\%)
   Rise time of the first peak ______ 81 ______ ns (60 to 90 ns – 10\% to 90\%)
   Peak voltage level (no load) ______ 2.4 ______ kV (2.25 to 2.5 kV when set to 2.5 kV)
   Output impedance ______ 185 ______ \Omega (160 to 240 \Omega)

8. Test Pass _____ X _____ Test Fail _________

![Figure 1](image1)

![Figure 2](image2)

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# CONTROLLER FAST TRANSIENT SWC TEST REPORT

| Client: | Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA |
| Test Date: | 9 February 2012 | Project: 21414-27 |

**Nameplate Data:**
- **Recloser Controller:**
  - Manufacturer: Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA
  - Model: SEL-651R-2
  - Serial No.: 1113060561
- **Three-phase Recloser:**
  - Manufacturer: G&W
  - Type: VIP388ER-125
  - Impulse level (BIL): 125 kV<sub>peak</sub>
  - Rated voltage: 27 kV<sub>res</sub>
  - Rated current: 800 A<sub>reg</sub> continuous/12.5 kA interrupting
  - Serial No.: 2011-1014-0047

**Test Witness:** Alex Bradley - Schweitzer Engineering Laboratories, Inc.

**Test Standard:** IEEE Std C37.60-2003, Clause 6.13.1: "Oscillatory and fast transients surge tests"

**Atmospheric Conditions:**
- Temperature: 22 ºC
- Relative humidity: 30 %
- Barometric pressure: 759 mmHg

**Test Voltage:** 4.0 kV<sub>peak</sub>

**Test Procedure:** Test surge was applied to the control cable in common mode using a capacitive clamp and transverse mode through 1.5 mH coils. Test surges were applied to ac power input in common mode and transverse mode using an external coupling filter. The AC power supplied to the controller was 120 Volts, 60 Hz.

**Test Results:** The controller and recloser operated normally following the Fast Transient SWC Test performed in accordance with the test procedures as per the above document. The controller complied with requirements of "C37.60-2003, Clause 6.13.1".

**Remarks:** None

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Tested by: Alex Babakov, P. Eng.  
Project Engineer

High Voltage Specialist Engineer

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APPENDIX 1

Fast Transient SWC Waveform Validity Tests
(in accordance with IEEE Std C37.90.1-2002, Clause A.2)

Performed before the Fast Transient SWC 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
   Rise time ______ 5.3 ______ ns (3.5 to 6.5 ns – 10% to 90%)
   Peak voltage level (no load) ______ 4.3 ______ kV (3.6 to 4.4 kV when set to 4 kV)
   Output impedance ______ 50 ______ Ω (40 to 60 Ω)
   Impulse duration ______ 54 ______ ns (35 to 65 ns to 50% value)
   Repetition rate ______ 2.5 ______ kHz (2 to 3 kHz)
   Burst duration ______ 14.8 ______ ms (12 to 18 ms)
   Burst period ______ 300 ______ ms (240 to 360 ms)
   Test duration ______ 60 ______ s (≥ 60 s)

4. Test Pass ______ X ______ Test Fail ________

![Figure 1](image1.png)
![Figure 2](image2.png)

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APPENDIX 2

Fast Transient SWC Waveform Validity Tests
(in accordance with IEEE Std C37.90.1-2002, Clause A.2)

Performed after the Fast Transient SWC Test

5. Measuring system feed through test
   Generator Output voltage  4  kV
   Feed through voltage 1.8  V  (pass if ≤ 1%)

6. Open circuit voltage waveform test
   Recorded waveforms – Figures 1 and 2.

7. Test Generator performance verification
   Rise time  4.55  ns  (3.5 to 6.5 ns – 10% to 90%)
   Peak voltage level (no load)  4.2  kV  (3.6 to 4.4 kV when set to 4 kV)
   Output impedance  51  Ω  (40 to 60 Ω)
   Impulse duration  59.4  ns  (35 to 65 ns to 50% value)
   Repetition rate  2.5  kHz  (2 to 3 kHz)
   Burst duration  14.8  ms  (12 to 18 ms)
   Burst period  300  ms  (240 to 360 ms)
   Test duration  60.1  s  (≥ 60 s)

8. Test Pass  X  Test Fail

![Figure 1](chart1.png)  ![Figure 2](chart2.png)

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# RECLOSER-CONTROLLER SIMULATED SURGE ARRESTER OPERATION TEST REPORT

<table>
<thead>
<tr>
<th>Client:</th>
<th>Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Date:</td>
<td>2, 6 &amp; 7 February 2012</td>
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</tbody>
</table>

### Nameplate Data:

**Reclouser Controller:**
- Manufacturer: Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA
- Model: SEL-651R-2
- Serial No.: 1113060561

**Three-phase Reclouser:**
- Manufacturer: G&W Electric Co., 3500 W. 127th Street, Blue Island IL, 60406, USA
- Type: Solid dielectric switch
- Catalog No.: VIP388ER-125
- Impulse level (BIL): 125 kV<sub>peak</sub>
- Rated voltage: 27 kV<sub>rms</sub>
- Rated current: 800 A<sub>rms</sub> continuous/12.5 kA interrupting
- Serial No.: 2011-1014-0047

### Test Standard:

### Test Witness:
- Alex Bradley - Schweitzer Engineering Laboratories, Inc.

### Atmospheric Conditions:

<table>
<thead>
<tr>
<th>Date</th>
<th>Temperature</th>
<th>Relative Humidity</th>
<th>Barometric Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Feb. 2012</td>
<td>16.5 °C</td>
<td>36.3 %</td>
<td>754.4 mmHg</td>
</tr>
<tr>
<td>6 Feb. 2012</td>
<td>16.3 °C</td>
<td>37.4 %</td>
<td>754.0 mmHg</td>
</tr>
<tr>
<td>7 Feb. 2012</td>
<td>16.2 °C</td>
<td>32.4 %</td>
<td>751.2 mmHg</td>
</tr>
</tbody>
</table>

### Nominal Test Voltage and Current:
- 100 kV<sub>peak</sub> (125 kV<sub>peak</sub> * 0.8), 7 kA<sub>peak</sub>

### Test Configurations Tested (in accordance with the above standard):

A - 15 surges of positive polarity and 15 surges of negative polarity were applied to the source bushing with the reclouser open.

B - 15 surges of positive polarity and 15 surges of negative polarity were applied to the source bushing with the reclouser closed.

C - 15 surges of positive polarity and 15 surges of negative polarity were applied to the load bushing with the reclouser closed.

D - 15 surges of positive polarity and 15 surges of negative polarity were applied to a properly rated transformer with the reclouser open.

E - 15 surges of positive polarity and 15 surges of negative polarity were applied to a properly rated transformer with the reclouser closed.

### Test Results:
- The controller and reclouser complied with the requirements of IEEE Std C37.60-2003, Clause 6.13.2, Configurations A to E.

### Remarks:
- There was initially a failure of a circuit board in the reclouser. The circuit board in the reclouser was replaced. The tests were repeated and passed.

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High Voltage Specialist Engineer

Manager, High Voltage Laboratory

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