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CONTROLLER OSCILLATORY SWC TEST REPORT

Client:	Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA		
Test Date:	19 April 2012	**Project:**	21645-27

Nameplate Data:

Recloser Controller:

Manufacturer:	Schweitzer Engineering Laboratories, Inc.
Model:	SEL-651R-2
Serial No.:	1113060652
Model No.:	0651R223XGA8AE2112XXXX

Three-phase Recloser:

Manufacturer:	T&B
Catalog No.:	MVR3-27-12-N-PT
Impulse level (BIL):	150 kV_{peak}
Rated voltage:	29.3 kV_{rms}
Rated current:	800 A_{rms} continuous/12.5 kA interrupting
Serial No.:	PT01

Test Witness:	Eric Stratte - Schweitzer Engineering Laboratories, Inc.
Test Standard:	IEEE C37.60-2003, Clause 6.13.1: "Oscillatory and fast transients surge tests"
Atmospheric Conditions:	Temperature 21 °C Relative humidity 25.0 % Barometric pressure 762 mmHg
Test Voltage:	2.5 kV_{peak}
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 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.
Test Results:	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 "IEEE C37.60-2003, Clause 6.13.1".
Remarks:	None

Tested by:

8/24/2012

Alex Babakov, P. Eng.
Project Engineer

Reviewed by:

Aug 29, 2012

M. Wang, P. Eng.
High Voltage Specialist Engineer

APPENDIX 2

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 3.2 V (pass ≤ 1%)

2. Open circuit voltage waveform test

   Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification

Test duration	2.04	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	5.5	µs	(4 to 6 µs to 50%)
Rise time of the first peak	61	ns	(60 to 90 ns – 10% to 90%)
Peak voltage level (no load)	2.5	kV	(2.25 to 2.5 kV when set to 2.5 kV)
Output impedance	231	Ω	(160 to 240 Ω)

4. Test Pass X Test Fail _____

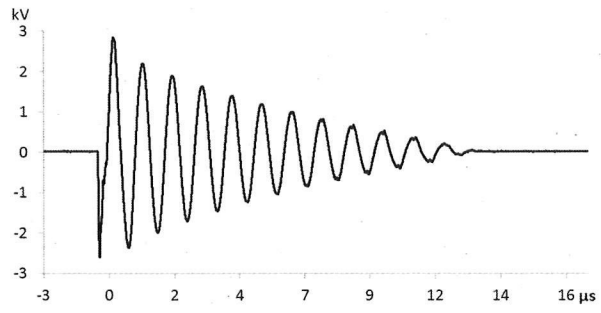

Figure 1

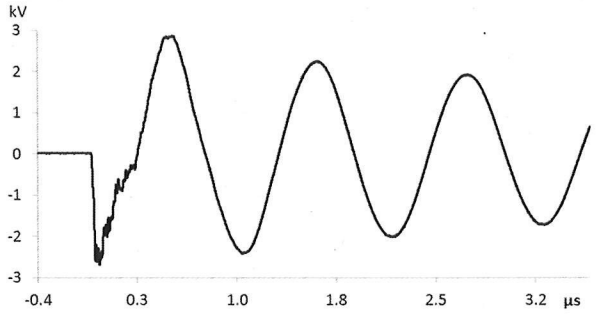

Figure 2

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 ___24___ V (pass ≤ 1%)

6. Open circuit voltage waveform test

   Recorded waveforms – Figures 1 and 2.

7. Test Generator performance verification

Test duration	2.02	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	4.4	µs	(4 to 6 µs to 50%)
Rise time of the first peak	60.2	ns	(60 to 90 ns – 10% to 90%)
Peak voltage level (no load)	2.77	kV	(2.25 to 2.5 kV when set to 2.5 kV)
Output impedance	230	Ω	(160 to 240 Ω)

8. Test Pass ___X___ Test Fail _____

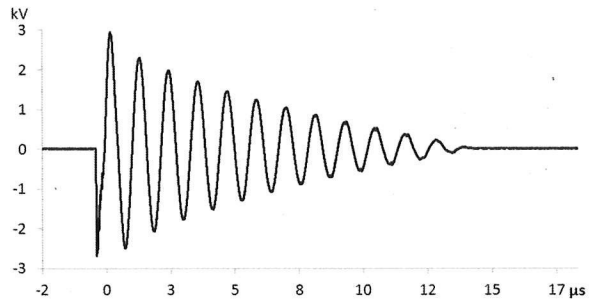

Figure 1

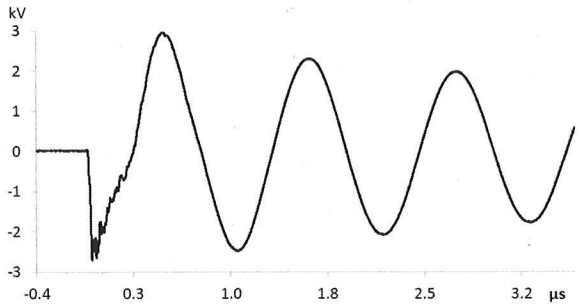

Figure 2

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CONTROLLER FAST TRANSIENT SWC TEST REPORT

Client:	Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA		
Test Date:	19 April 2012	**Project:**	21645-27

Nameplate Data:

Recloser Controller:

Manufacturer:	Schweitzer Engineering Laboratories, Inc.
Model:	SEL-651R-2
Serial No.:	1113060652
Model No.:	0651R223XGA8AE2112XXXX

Three-phase Recloser:

Manufacturer:	T&B
Catalog No.:	MVR3-27-12-N-PT
Impulse level (BIL):	150 kV_{peak}
Rated voltage:	29.3 kV_{rms}
Rated current:	800 A_{rms} continuous/12.5 kA interrupting
Serial No.:	PT01

Test Witness:	Eric Stratte - Schweitzer Engineering Laboratories, Inc.	
Test Standard:	IEEE Std C37.60-2003, Clause 6.13.1: "Oscillatory and fast transients surge tests"	
Atmospheric Conditions:	Temperature	21 °C
	Relative humidity	25.0 %
	Barometric pressure	762 mmHg
Test Voltage:	4.0 kV_{peak}	
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	

Tested by:

8/24/2012

Alex Babakov, P. Eng.
Project Engineer

Reviewed by:

Aug 29, 2012

M. Wang, P. Eng.
High Voltage Specialist Engineer

APPENDIX 2

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 ___4.1___ kV

   Feed through voltage ___0.8___ V (pass if ≤ 1%)

2. Open circuit voltage waveform test

   Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification

Rise time	4.2	ns	(3.5 to 6.5 ns – 10% to 90%)
Peak voltage level (no load)	4.1	kV	(3.6 to 4.4 kV when set to 4 kV)
Output impedance	53	Ω	(40 to 60 Ω)
Impulse duration	64.2	ns	(35 to 65 ns to 50% value)
Repetition rate	2.5	kHz	(2 to 3 kHz)
Burst duration	14.4	ms	(12 to 18 ms)
Burst period	269	ms	(240 to360 ms)
Test duration	60.1	s	(≥ 60 s)

4. Test Pass ___X___ Test Fail _____

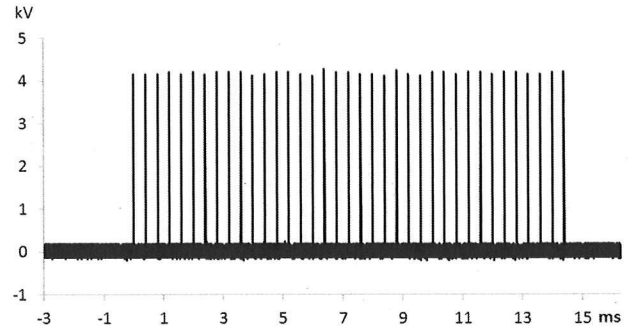

Figure 1

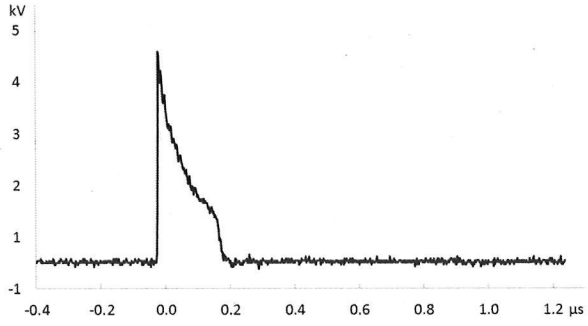

Figure 2

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 4.08 kV

   Feed through voltage 0.8 V (pass if ≤ 1%)

6. Open circuit voltage waveform test

   Recorded waveforms – Figures 1 and 2.

7. Test Generator performance verification

Rise time	5.18	ns	(3.5 to 6.5 ns – 10% to 90%)
Peak voltage level (no load)	4.08	kV	(3.6 to 4.4 kV when set to 4 kV)
Output impedance	51.6	Ω	(40 to 60 Ω)
Impulse duration	64.8	ns	(35 to 65 ns to 50% value)
Repetition rate	2.5	kHz	(2 to 3 kHz)
Burst duration	14.9	ms	(12 to 18 ms)
Burst period	300	ms	(240 to360 ms)
Test duration	60.2	s	(≥ 60 s)

8. Test Pass X Test Fail _____

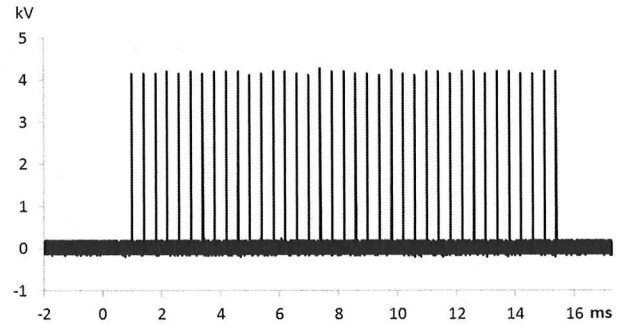

Figure 1

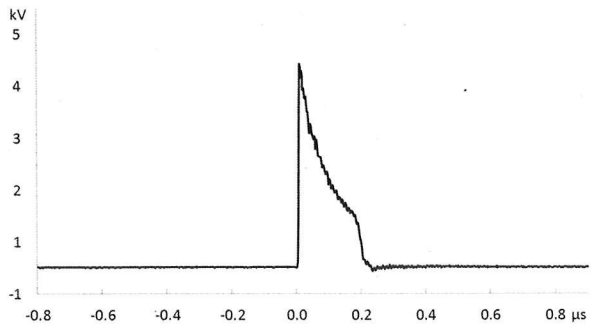

Figure 2

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RECLOSER-CONTROLLER SIMULATED SURGE ARRESTER OPERATION TEST REPORT

Client:	Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA		
Test Date:	16 to 18 May 2012	**Project:**	21645-27

Nameplate Data:

Recloser Controller:

Manufacturer:	Schweitzer Engineering Laboratories, Inc.
Model:	SEL-651R-2
Serial No.:	1113060652
Model No.:	0651R223XGA8AE2112XXXX

Three-phase Recloser:

Manufacturer:	T&B
Catalog No.:	MVR3-27-12-N-PT
Impulse level (BIL):	150 kV_{peak}
Rated voltage:	29.3 kV_{rms}
Rated current:	800 A_{rms} continuous/12.5 kA interrupting
Serial No.:	PT01

Test Standard: IEEE Std C37.60-2003, Clause 6.13.2: "Simulated Surge Arrester Operation Test"

Test Witness: Eric Stratte - Schweitzer Engineering Laboratories, Inc.

Nominal Test Voltage and Current: 120 kV_{peak} (150 kV_{peak} * 0.8), 7 kA_{peak}

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 recloser open.
B – 15 surges of positive polarity and 15 surges of negative polarity were applied to the source bushing with the recloser closed.
C – 15 surges of positive polarity and 15 surges of negative polarity were applied to the load bushing with the recloser closed.
D - 15 surges of positive polarity and 15 surges of negative polarity were applied to a properly rated transformer with the recloser open.
E - 15 surges of positive polarity and 15 surges of negative polarity were applied to a properly rated transformer with the recloser closed.

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

Remarks: None

Tested by:

M. Wang, P. Eng. Aug 24 2012
High Voltage Specialist Engineer

Reviewed by:

24 August/12

A.J. Vandermaar, P. Eng.
Manager, High Voltage Laboratory