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CONTROLLER OSCILLATORY SWC TEST REPORT

Client:	Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA	
Test Date:	6 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.:	1113060652	
Three-phase Recloser:		
Manufacturer:	G&W	
Type:	Viper-ST	
Impulse level (BIL):	110 kV_{peak}	
Rated voltage:	15.5 kV_{rms}	
Rated current:	800 A_{rms} continuous	
Serial No.:	VIP378ER-12-1-St P1 – Demo unit	
Test Witness:	Alex Bradley - Schweitzer Engineering Laboratories, Inc	
Test Standard:	IEEE C37.60-2003, Clause 6.13.1: "Oscillatory and fast transients surge tests"	
Atmospheric Conditions:	Temperature	22 °C
	Relative humidity	30 %
	Barometric pressure	763.5 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:

Alex Babakov, P. Eng.
Project Engineer

Reviewed by:

M. Wang, P. Eng. March 2, 2012
High Voltage Specialist Engineer

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 _____

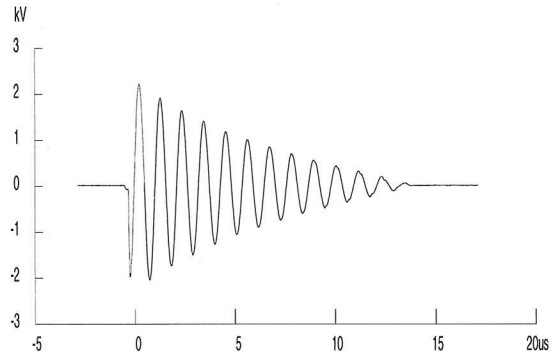

Figure 1

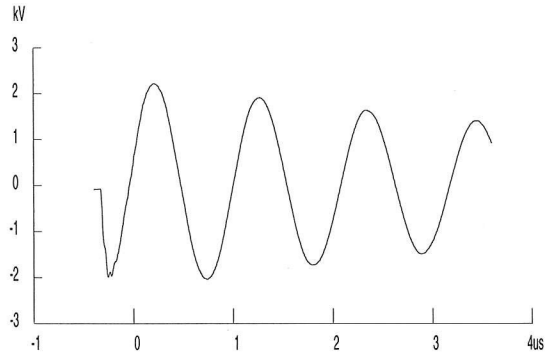

Figure 2

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 8.5 V (pass ≤ 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	µs	(4 to 6 µs 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	Ω	(160 to 240 Ω)

8. Test Pass X Test Fail _____

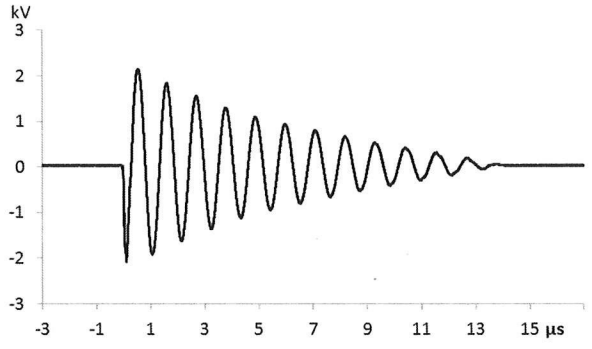

Figure 1

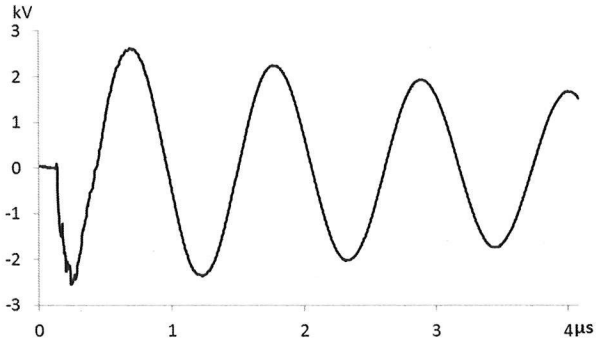

Figure 2

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CONTROLLER FAST TRANSIENT SWC TEST REPORT

Client:	Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA	
Test Date:	6 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.:	1113060652	
Three-phase Recloser:		
Manufacturer:	G&W	
Type:	Viper-ST	
Impulse level (BIL):	110kV$_{peak}$	
Rated voltage:	15.5 kV$_{rms}$	
Rated current:	800 A$_{rms}$ continuous	
Serial No.:	VIP378ER-12-1-St P1 – Demo unit	
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 °C
	Relative humidity	30 %
	Barometric pressure	763.5 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:

Alex Babakov, P. Eng.
Project Engineer

Reviewed by:

M. Wang, P. Eng. March 12, 2012
High Voltage Specialist Engineer

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 to360 ms)
Test duration	60	s	(≥ 60 s)

4. Test Pass ___X___ Test Fail _____

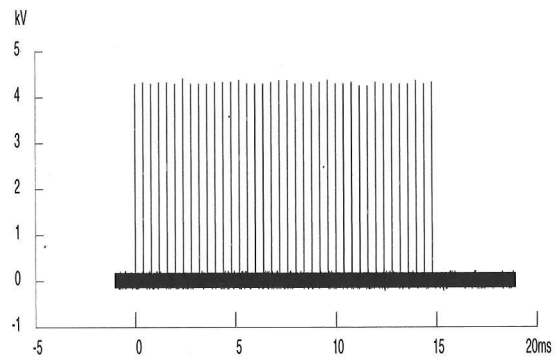

Figure 1

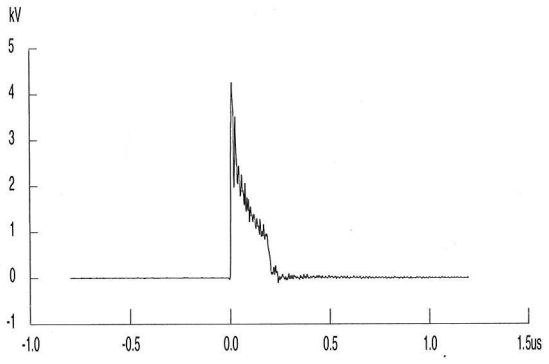

Figure 2

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___ 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 to360 ms)
Test duration	60.1	s	(≥ 60 s)

8. Test Pass ___X___ Test Fail _____

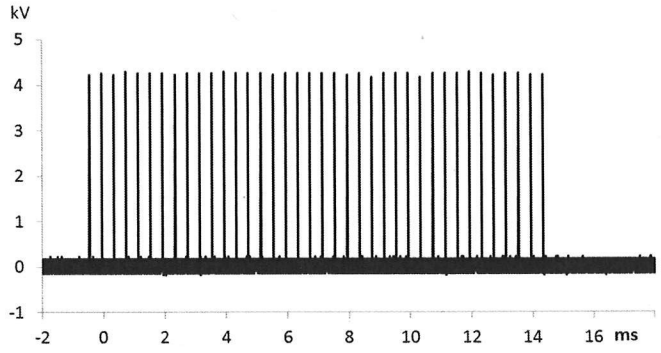

Figure 1

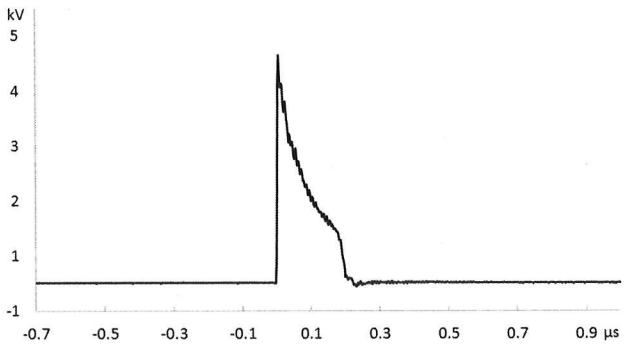

Figure 2

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RECLOSER-CONTROLLER SIMULATED SURGE ARRESTER OPERATION TEST REPORT

Client:	Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA		
Test Date:	30 & 31 January 2012	**Project:**	21414-27

Nameplate Data:

Recloser Controller:

Manufacturer:	Schweitzer Engineering Laboratories, Inc., Pullman, WA, 99163-5603, USA
Model:	SEL-651R-2
Serial No.:	1113060652

Three-phase Recloser:

Manufacturer:	G&W Electric Co., 3500 W. 127th Street, Blue Island IL, 60406, USA
Type:	Viper-ST
Catalog No.:	VIP378ER-12-1 ST P1
Impulse level (BIL):	110 kV_{peak}
Rated voltage:	15.5 kV_{rms}
Rated current:	800 A_{rms} continuous
Serial No.:	DEMO unit

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

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

Atmospheric Conditions:

	30 January 2012	31 January 2012
Temperature	15.1 °C	14.8 °C
Relative humidity	39.1 %	38.6 %
Barometric pressure	754.0 mmHg	754.0 mmHg

Nominal Test Voltage and Current: 88 kV_{peak} (110 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:

Prepared by:

M. Wang, P. Eng. March 12, 2012
High Voltage Specialist Engineer

Reviewed by:

12 March/12
A.J. Vandermaar, P. Eng.
Manager, High Voltage Laboratory