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CONTROLLER OSCILLATORY AND FAST TRANSIENT SWC TEST REPORT

Client:	Schweitzer Engineering Laboratories Inc., 2440 NE Hopkins Court, Pullman, WA, 99163 USA		
Test Date:	October 9th ,2015	**Project:**	PL-27147
Nameplate Data:			
Recloser Controller:			
Manufacturer:	Schweitzer Engineering Laboratories, Inc.		
Model:	SEL-651RA		
Part No:	0651RA01XFAXAA1A111XCXXX		
Serial No.:	1152590494		
Three-phase Recloser:			
Manufacturer:	Eaton		
Type:	Kyle Nova15		
Impulse level (BIL):	110 kV_{peak}		
Rated voltage:	15.5 kV_{rms}		
Rated current:	630 A_{rms} continuous		
Serial No.:	CP571 404340-SH		
Test Standard:	IEEE C37.60-2012, Clause 6.111.2: "Oscillatory and fast transients surge tests"		
Test Witness:	Mark Feltis – Schweitzer Engineering Laboratories Inc.,		
Atmospheric Conditions:	Temperature	22.1 °C	
	Relative humidity	55.6 %	
	Barometric pressure	748.0 mmHg	
Test Voltage:	Oscillatory - 2.5 kV_{peak} , Fast Transient – 4 kV_{peak}		
Test Procedure:	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.		
Test Results:	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 C37.60-2012, Clause 6.111.2".		
Remarks:	None		

Tested by:

Hamish Miller, EIT.
Test Engineer, High Voltage Laboratory

Reviewed by:

Nov. 6, 2015

Alex Babakov, P. Eng.
Test Engineer, High Voltage Laboratory

Fast Transient Waveform Validity Tests

(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 2.1 V (pass if ≤ 1%)

2. Open circuit voltage waveform test

   Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification

Test duration	60.0	s	(≥ 60 s)
Burst period	293.6	ms	(240 to360 ms)
Burst duration	14.9	ms	(12 to 18 ms)
Repetition rate	2.5	kHz	(2 to 3 kHz)
Impulse duration	62	ns	(35 to 65 ns to 50% value)
Rise time	5.6	ns	(3.5 to 6.5 ns – 10% to 90%)
Peak voltage level (no load)	4.20	kV	(3.6 to 4.4 kV when set to 4 kV)
Output impedance	40.6	Ω	(40 to 60 Ω)

4. Test Pass X Test Fail _____

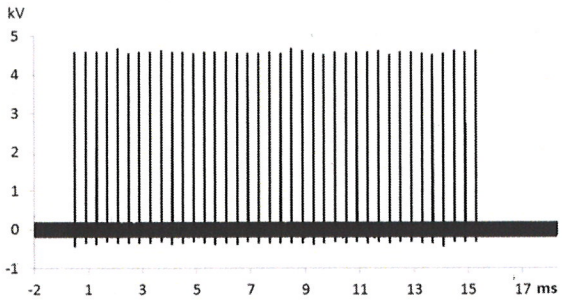

Figure 1

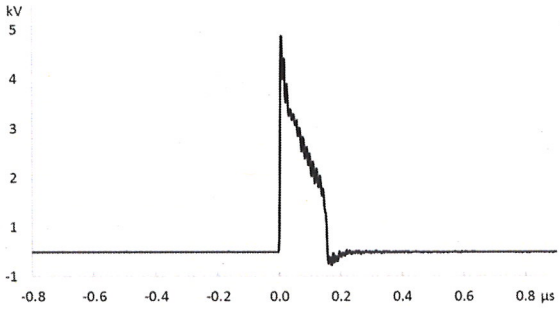

Figure 2

Fast Transient Waveform Validity Tests

(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 11.6 V (pass if ≤ 1%)

2. Open circuit voltage waveform test

   Recorded waveforms – Figures 1 and 2.

3. Test Generator performance verification

Test duration	60.0	s	(≥ 60 s)
Burst period	282.2	ms	(240 to360 ms)
Burst duration	14.8	ms	(12 to 18 ms)
Repetition rate	2.6	kHz	(2 to 3 kHz)
Impulse duration	35.3	ns	(35 to 65 ns to 50% value)
Rise time	5.4	ns	(3.5 to 6.5 ns – 10% to 90%)
Peak voltage level (no load)	4.18	kV	(3.6 to 4.4 kV when set to 4 kV)
Output impedance	49.5	Ω	(40 to 60 Ω)

4. Test Pass X Test Fail _____

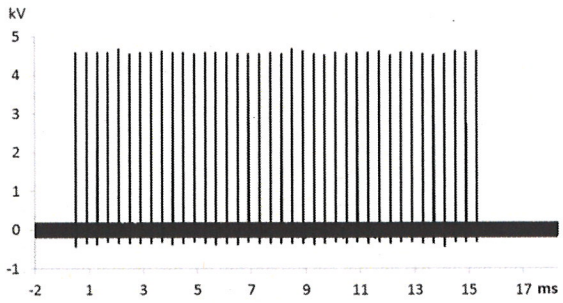

Figure 1

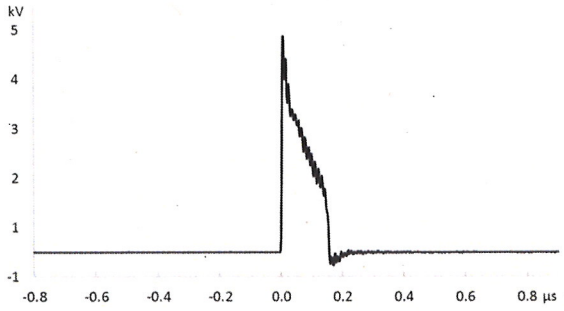

Figure 2

Oscillatory Waveform Validity Tests

(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 9.4 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	0.91	MHz	(0.9 to 1.1 MHz)
Waveform envelope decay	5.1	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)	2.25	kV	(2.25 to 2.5 kV when set to 2.5 kV)
Output impedance	184	Ω	(160 to 240 Ω)

4. Test Pass X Test Fail _____

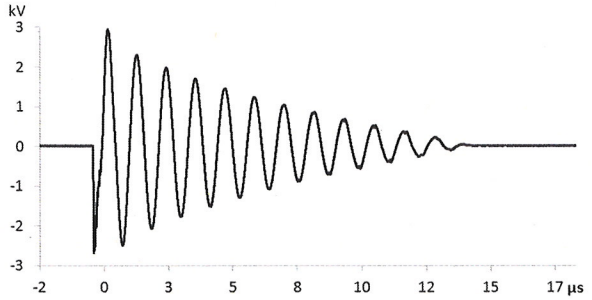

Figure 1

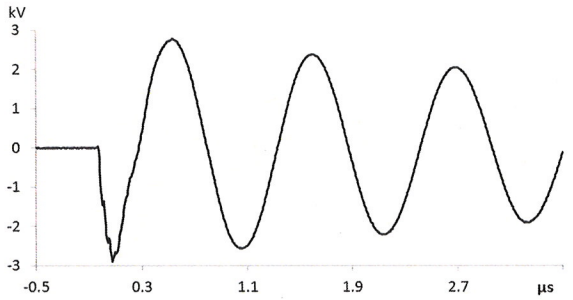

Figure 2

Oscillatory Waveform Validity Tests

(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 kV

   Feed through voltage 14.7 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	9	bursts per period	(6-10 bursts per 16.7 ms)
Oscillation frequency	0.90	MHz	(0.9 to 1.1 MHz)
Waveform envelope decay	5.8	µs	(4 to 6 µs to 50%)
Rise time of the first peak	90	ns	(60 to 90 ns – 10% to 90%)
Peak voltage level (no load)	2.41	kV	(2.25 to 2.5 kV when set to 2.5 kV)
Output impedance	161	Ω	(160 to 240 Ω)

4. Test Pass X Test Fail _____

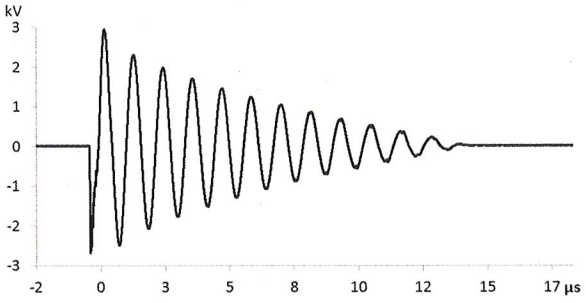

Figure 1

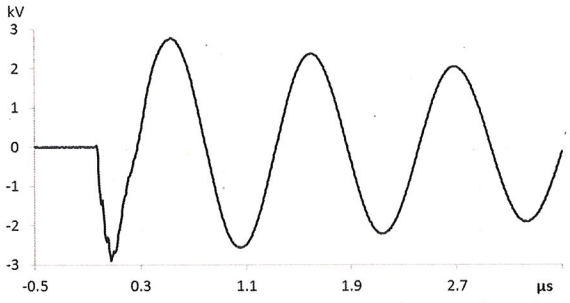

Figure 2

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RECLOSER-CONTROLLER SIMULATED SURGE ARRESTER OPERATION TEST REPORT

Client:	Schweitzer Engineering Laboratories Inc., 2440 NE Hopkins Court, Pullman, WA, 99163 USA		
Test Date:	October 9th & 14th,2015	**Project:**	PL-27147

Nameplate Data:

Recloser Controller:

Manufacturer:	Schweitzer Engineering Laboratories, Inc.
Model:	SEL-651RA
Part No:	0651RA01XDAXAA1A111XCXXX
Serial No.:	1152590494

Three-phase Recloser:

Manufacturer:	Eaton
Type:	Kyle Nova15
Impulse level (BIL):	110 kV_{peak}
Rated voltage:	15.5 kV_{rms}
Rated current:	630 A_{rms} continuous
Serial No.:	CP571 404340-SH

Test Standard: IEEE Std C37.60-2012, Clause 6.111.3: "Simulated Surge Arrester Operation Test"

Test Witness: Mark Feltis – Schweitzer Engineering Laboratories Inc.,

Atmospheric Conditions:

	October 9th, 2015	October 14th, 2015
Temperature	22.1 °C	18.8 °C
Relative humidity	55.6 %	50.8 %
Barometric pressure	748.0 mmHg	758.0 mmHg

Nominal Test Voltage and Current: 88 kV_{peak} (110 kV_{peak} * 0.8), 6.0 kA_{peak}

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

1 – 15 surges of positive polarity and 15 surges of negative polarity were applied to the source bushing with the recloser open.
2 – 15 surges of positive polarity and 15 surges of negative polarity were applied to the source bushing with the recloser closed.
3 – 15 surges of positive polarity and 15 surges of negative polarity were applied to the load bushing with the recloser closed.
4 - 15 surges of positive polarity and 15 surges of negative polarity were applied to a properly rated transformer with the recloser open.
5 - 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 C37.60-2012, Clause 6.111.3, Configurations 1-5.

Remarks: None

Tested by:

Hamish Miller, EIT.
Test Engineer, High Voltage Laboratory

Reviewed by:

Nov. 6/2015

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Test Engineer, High Voltage Laboratory