

# Type Tests on a Triple-Single 27 kV, 16 kA Recloser

IEC 62271-111(Ed.2.0) / IEEE Std C37.60-2012

Clauses 6.2, 6.5, 6.6, 6.101, 6.103, 6.106, 6.109, 6.111



## REPORT OF PERFORMANCE

CLIENT/MANUFACTURER Togami Electric Mfg. Co., Ltd.  
1-1 Ohtakara-Kitamachi  
Saga 840-0802, Japan

TEST OBJECTS Recloser  
Manufacturer: Togami Electric Mfg. Co., Ltd.  
Type: VBN20-A3-Y  
Rated Max. Voltage: 27 kV<sub>rms</sub>, 150 kV BIL  
Rated Current: 800 A<sub>rms</sub> continuous,  
16 kA<sub>rms</sub> interrupting, 16 kA<sub>rms</sub> 3 s short-time  
Mfg. Date: 07/2018  
Unit (Serial) No's: #1 (E000018), #2 (E000019),  
#3(E000020), #4 (E000021),

Recloser Control  
Manufacturer: Schweitzer Engineering Laboratories  
Type: SEL-651R  
Unit (Serial) No's: #1 (1172190162), #2 (1172190163),  
#3(1172190164)  
Firmware Version No: R406-V0  
Mfg. Date: 08/2017

TESTED BY Powertech Labs Inc.  
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TEST DATES 2018-08-20 to 2018-09-07

TEST SPECIFICATIONS IEC 62271-111(Ed.2.0) / IEEE Std C37.60-2012  
Clauses 6.2, 6.5, 6.6, 6.101, 6.103, 6.106, 6.109, 6.111.2, 6.111.3

TEST RESULT **PASS**

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## 13 OSCILLATORY AND FAST TRANSIENT SURGE TESTS

### General Information:

Standard IEEE C37.60-2012, Clause 6.111.2  
 Test Date August 23, 24, 2018  
 Test Leader Meiru Du

### Environmental Conditions:

Date:	23 August 2018	24 August 2018
Temperature	20.8 °C	19.8 °C
Relative humidity	55.1 %	57.4 %
Barometric pressure	752.8 mmHg	750.0 mmHg

### Test Conditions:

The tests was in accordance with IEEE C37.90.1-2012. The controller and recloser were tested while connected to 120 Volts, 60 Hz supply for all tests. Test surges were applied to the AC power cord and control cable using a capacitive clamp and an external coupling/decoupling network in common and transverse mode, in accordance with Table 3 and 4 of IEEE C37.90.1.

Oscillatory Test Voltage: 2.5 kV<sub>peak</sub>  
 Fast Transient Test Voltage: 4.0 kV<sub>peak</sub>

Recloser Unit №: #1  
 Controller Unit №: #2

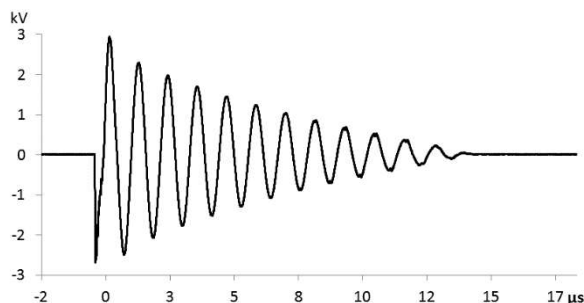
### Oscillatory Waveform Validity Tests

	Pre-Test	Post-Test	Requirements
Generator output voltage:	2.5 kV	2.5 kV	
Feed through voltage test:	22 V	19.2 V	(pass if ≤ 1%)

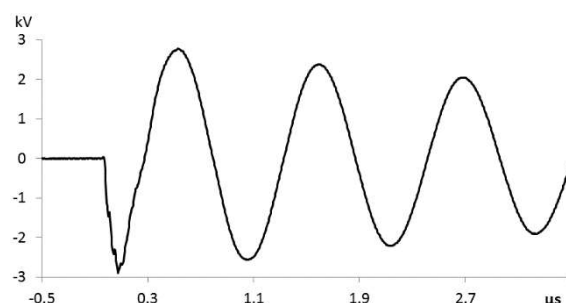
### Test Generator performance verification:

	Pre-Test	Post-Test	Requirements
Test duration:	2.1 s	2.1 s	(2.0 to 2.2 s)
Repetition rate:	8 bursts / 16.7 ms	7 bursts / 16.7 ms	(6 to 10 bursts per 16.7 ms)
Oscillation frequency:	0.92 MHz	0.92 MHz	(0.9 to 1.1 MHz)
Waveform envelope decay:	4.4 μs	5.0 μs	(4 to 6 μs to 50%)
Rise time of the first peak:	84 ns	60 ns	(60 to 90 ns – 10% to 90%)
Peak voltage level (no load):	2.4 kV	2.48 kV	(2.25 to 2.5 kV when set to 2.5 kV)
Output impedance:	230 Ω	236 Ω	(160 to 240 Ω)

### Open circuit voltage waveform test:



**Figure 1: Open circuit voltage burst waveform**



**Figure 2: First few cycles of oscillatory waveform**

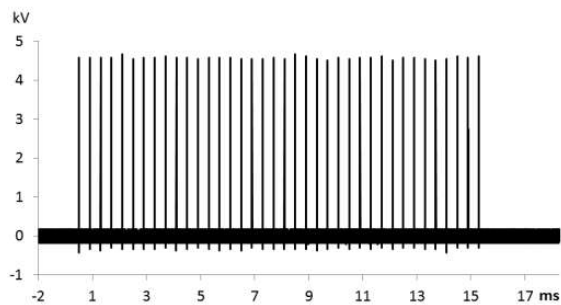
## Fast Transient Waveform Validity Tests

	Pre-Test	Post-Test	Requirements
Generator output voltage:	4.0 kV	4.2 kV	
Feed through voltage test:	38 V	1.6 V	(pass if $\leq 1\%$ of generator output)

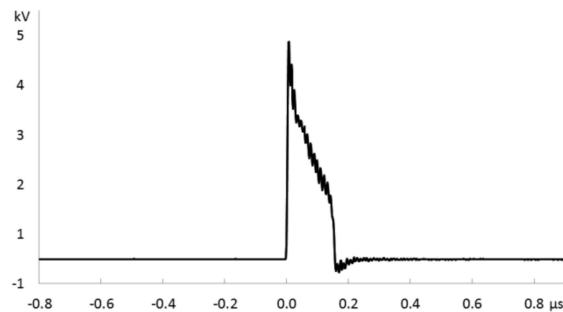
Test Generator performance verification:

	Pre-Test	Post-Test	Requirements
Test duration:	60 s	60 s	( $\geq 60$ s)
Burst period:	300 ms	344 ms	(240 to 360 ms)
Burst duration:	14.7 ms	14.8 ms	(12 to 18 ms)
Repetition rate:	2.5 kHz	2.5 kHz	(2 to 3 kHz)
Impulse duration:	58 ns	60 ns	(35 to 65 ns to 50% value)
Rise time:	5.3 ns	5.0 ns	(3.5 to 6.5 ns – 10% to 90%)
Peak voltage level (no load):	4.2 kV	4.2 kV	(3.6 to 4.4 kV when set to 4 kV)
Output impedance:	58.3 $\Omega$	56.3 $\Omega$	(40 to 60 $\Omega$ )

Open circuit voltage waveform test:



**Figure 3: Open circuit voltage burst waveform**



**Figure 4: One fast transient peak**

### Requirements:

The recloser/FI and controller shall be considered to have passed the tests if – during, or as a result of the tests – all of the conditions below are met for the recloser/FI and controller:

- The specified performance of the recloser/FI and controller does not change beyond specified tolerances;
- No hardware damage occurs;
- No change in calibration beyond normal tolerances result;
- No loss or corruption of stored memory occurs;
- System resets do not occur and manual resetting is not required;
- If disrupted, established communications not affecting protection functions recover within the manufacturer's time period;
- Communication errors, if they occur, do not affect the protective functions of the recloser/FI and controller
- Where the loss of digital pulse synchronization occurs, it does not produce an out of tolerance condition.
- No changes in the electrical, mechanical, or communication status error outputs occur. This includes alarms, status outputs, or targets.
- No erroneous, permanent change of state of the visual, audio or message output results.
- No error outside normal tolerances of the data communication signals (SCADA analogs) occur

### Result:

PASS

## 14 RECLOSER-CONTROLLER SIMULATED SURGE ARRESTER OPERATION TEST

### General Information:

Standard: IEEE C37.60-2012, Clause 6.111.3  
 Test Date: August 20, 21, 22, 2018  
 Test Leader: Meiru Du

### Environmental Conditions:

	20 August 2018	21 August 2018	22 August 2018
Date:	20 August 2018	21 August 2018	22 August 2018
Temperature	25.9 °C	23.7 °C	25.4 °C
Relative humidity	45.0 %	41.9%	44.2%
Barometric pressure	750.0 mmHg	752.2 mmHg	747.5 mmHg

### Test Conditions:

The tests was in accordance with the test set-up requirements outlined in section 6.111.3.2 of the test standard. The control was energized and operational during the tests with settings as follows:

- Value of trip point (pick up setting) not to exceed the rated load current of the device;
- Reclosers set for the maximum number of operations to lock-out;
- Other settings for normal operation consistent with a) and b) above.

The surges were applied using the following test levels and configurations:

Test Voltage: 108 to 132 kV<sub>peak</sub>  
 Surge Current: 5.4 to 6.6 kA<sub>peak</sub>  
 Recloser Unit №: #1  
 Controller Unit №: #2

Configuration	Switch	HV Applied	Conditions
1	Open	Source Terminals	15 positive and 15 negative surges
2	Closed	Source Terminals	15 positive and 15 negative surges
3	Closed	Load Terminals	15 positive and 15 negative surges
4	Open	Properly Rated Transformer	15 positive and 15 negative surges
5	Closed	Properly Rated Transformer	15 positive and 15 negative surges

### Requirements:

During the application of surges, the control shall neither close the recloser/FI from an open position nor open (trip) the recloser/FI from a closed position. No change of state shall occur or be reported.

Following the tests, the recloser/FI and control apparatus shall be capable of performing all normal functions without impairment. The following verifications shall be made following the test if supported by the control apparatus:

- Communicate with an external computer;
- Open and close the recloser;
- Upload event(s) or oscillography captured;
- Receive a firmware download;
- Receive a program download;
- Perform the maximum number of sequence operations for which it is rated at any convenient pick up level.

### Result:

PASS