TEST REPORT

KERI

한국전기연구원

KOREA ELECTROTECHNOLOGY RESEARCH INSTITUTE

TEST REPORT

CLASSIFICATION	Performance Test(III)
APPARATUS	Solid insulated Automatic circuit Recloser
DESIGNATION	EPR-1
RATINGS	3 phases 15.5 kV 630 A 16 kA 3 s 60 Hz
APPLIED STANDARD	IEEE Std C37.60:2003 and applicant's specification
RECEIPT No.	TRD10S00692 (April 02, 2010)
APPLICANT	ENTEC Electric & Electronic Co.,Ltd 78-2, Buncheon-ri, Bongdam-eup, Hwaseong-si, Gyeonggi-do, Korea
MANUFACTURER	ENTEC Electric & Electronic Co.,Ltd 78-2, Buncheon-ri, Bongdam-eup, Hwaseong-si, Gyeonggi-do, Korea
DATE OF TESTS	April 21, 2010 ~ August 07, 2010
DATE OF ISSUE	August 20, 2010

The tests have been carried out in accordance with IEEE Std C37.60:2003 and applicant's specification.

The test results are shown in the records of tests with the performance of the apparatus tested and the observations made during the tests. The oscillograms are attached hereto.

The test results apply only to the apparatus tested.

This report shall not be used for any purpose such as PR brochures, propaganda, advertisement and/or legal proceedings, unless for the granted purpose.

No. OF PAGES INCORPORATED: records (13), photographs (1), circuit diagrams (0), drawings & descriptions (1), attachments(1), oscillograms (6)

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Ratings of the test object assigned by manufacturer

Solid insulated Automatic circuit Recloser

Applied standard	IEEE Std C37.60 : 2003
Manufacturer	ENTEC Electric & Electronic Co.,Ltd
Type	EPR-1
Phase	3 phases
Rated voltage	15.5 kV
Rated current	630 A
Rated frequency	60 Hz
Rated breaking current	16 kA(rms)
Rated short time withstand current	16 kA(rms) 3 s
Power frequency withstand voltage	
Dry	50 kV 1 min
Wet	45 kV 10 s
Impulse withstand voltage	110 kV (1.2 × 50) μs
Insulation material	Hydrophobicity EPOXY
Operating voltage	AC 220 V / 24 Vdc
Type of operation	Magnetic Actuator
Serial No.	10020001
Date of manufacture	2010. 2

List of the tests

Description of test	Standard and clause	Test circuit	Sheet No
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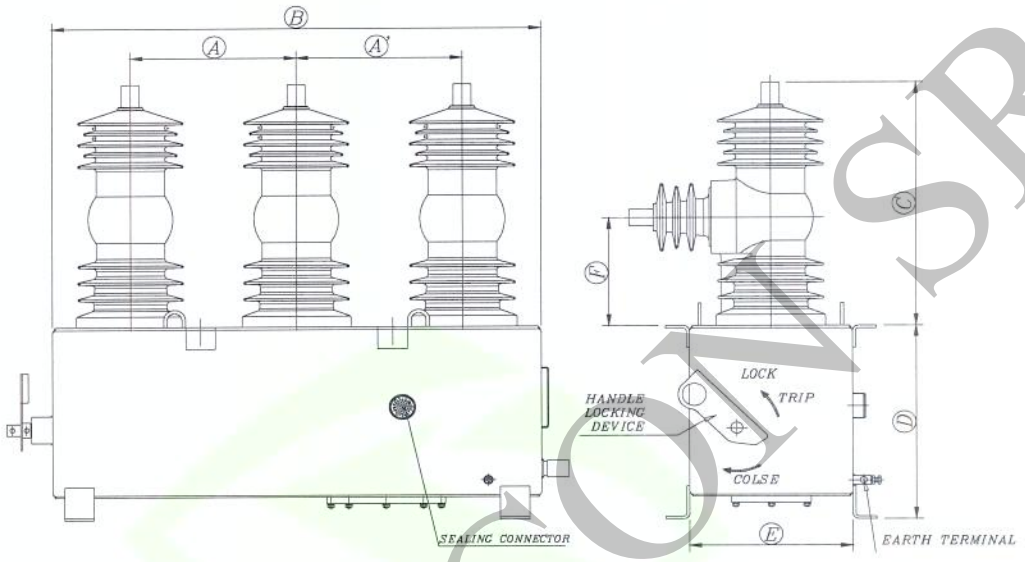
Above tests # marked are witness tests.

(Location of witness : ENTEC Electric & Electronic Co., Ltd, Hwaseong-si, Gyeonggi-do, Korea)

1 Verification of dimension

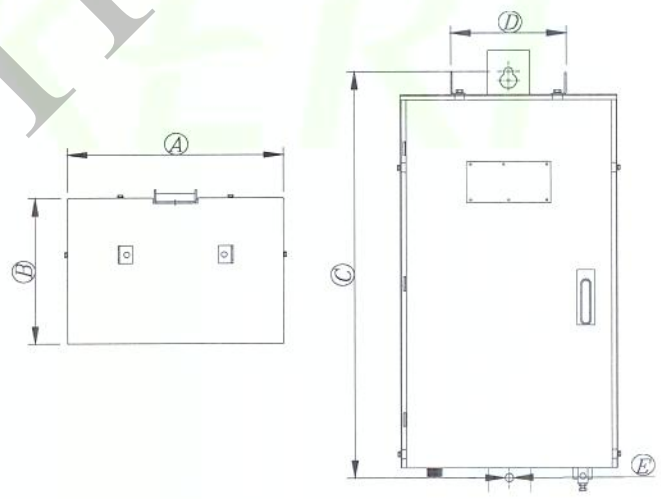
1.1 Main body



(Unit : mm, Tolerance : ±3 %)

Item	A	A'	B	C	D	E	F
Requirement	280	280	825	439	350	274	195.4
Measured value	279.4	281.4	825	435	345.9	274.2	196.3

1.2 Control box



(Unit : mm, Tolerance : ±3 %)

Item	A	B	C	D	E
Requirement	443	323	901.5	236	Φ 17
Measured value	444	323	895	237	Φ 17

2 Partial discharge tests

Test method and requirement	Conditions	Switching device	Voltage application	Test results
The applied voltage is raised to the power frequency dry withstand voltage level (50 kV) for no less than 10 s then decreased to the specified partial discharge test voltage level (9.4 kV). The measured partial discharge shall not exceed 10 pC.	Before dielectric tests	Close	Aa-BbCcF	Less than 0.4 pC
			Bb-AaCcF	Less than 0.4 pC
			Cc-AaBbF	Less than 0.4 pC
		Open	A-aBbCcF	Less than 0.4 pC
			B-AabCcF	Less than 0.4 pC
			C-AaBbcF	Less than 0.4 pC
			a-ABbCcF	Less than 0.4 pC
			b-AaBCcF	Less than 0.4 pC
			c-AaBbCF	Less than 0.4 pC
	After dielectric tests	Close	Aa-BbCcF	Less than 0.3 pC
			Bb-AaCcF	Less than 0.3 pC
			Cc-AaBbF	Less than 0.3 pC
		Open	A-aBbCcF	Less than 0.3 pC
			B-AabCcF	Less than 0.3 pC
			C-AaBbcF	Less than 0.3 pC
			a-ABbCcF	Less than 0.3 pC
			b-AaBCcF	Less than 0.3 pC
			c-AaBbCF	Less than 0.3 pC

* Test frequency : 60 Hz
* Background noise : 0.4 pC (before dielectric tests)
  : 0.3 pC (after dielectric tests)
* A, B, C : Source side terminal, a, b, c : Load side terminal, F : Tank
* Atmospheric conditions : 19 ℃, 42 % RH, 1 013 hPa (before dielectric tests)
  : 19 ℃, 56 % RH, 1 010 hPa (after dielectric tests)

3 Dielectric tests

3.1 Lightning impulse voltage withstand test

Test voltage	Number of shots	Waveshape	Switching device	Voltage application	Test result
110 kV	Positive and negative 3 times at each polarity	(1.2 x 50) μs	Close	AaBbCc-F	Withstood
				Bb-AaCcF	Withstood
			Open	ABC-abcF	Withstood
				abc-ABCF	Withstood
				B-AabCcF	Withstood
				b-AaBCcF	Withstood

* Refer to the Osc. ET(01～02)
* A, B, C : Source side terminal, a, b, c : Load side terminal, F : Tank
* Atmospheric conditions : 15 ℃, 52 % RH, 1 011 hPa

3.2 Power frequency voltage dry withstand test

Test voltage	Test duration	Test frequency	Conditions	Switching device	Voltage application	Test result
50 kV	60 s	60 Hz	Before mechanical duty test	Close	AaBbCc-F	Withstood
					Bb-AaCcF	Withstood
				Open	ABC-abcF	Withstood
					abc-ABCF	Withstood
					B-AabCcF	Withstood
					b-AaBCcF	Withstood

* A, B, C : Source side terminal, a, b, c : Load side terminal, F : Tank
* Atmospheric conditions : 15 ℃, 52 % RH, 1 011 hPa (before mechanical duty test)

3.3 Power frequency voltage wet withstand test

Test voltage	Test duration	Test frequency	Switching device	Voltage application	Test result
45 kV	10 s	60 Hz	Close	AaBbCc-F	Withstood
				Bb-AaCcF	Withstood
			Open	ABC-abcF	Withstood
				abc-ABCF	Withstood
				B-AabCcF	Withstood
				b-AaBCcF	Withstood

* Average precipitation rate : 5 mm/min, Water resistivity : 177 Ω·m
* A, B, C : Source side terminal, a, b, c : Load side terminal, F : Tank
* Atmospheric conditions : 15 ℃, 52 % RH, 1 011 hPa

4 Minimum tripping current tests

4.1 Phase

Setting value A	Specified limit A	Test results A		
		Phase A	Phase B	Phase C
50 (minimum)	45 ~ 55	48.2	49.5	48.9
280 (midium)	252 ~ 308	276	275	273
630 (maximum)	567 ~ 693	623	623	623

4.2 Ground

Setting value A	Specified limit A	Test result A
20 (minimum)	18 ~ 22	19.3
140 (middle)	126 ~ 154	138
300 (maximum)	270 ~ 330	296

5 Radio influence voltage tests (RIV)

Test voltage	Measuring frequency	Permissible RIV level	Switching device	Voltage applied to	Earth connected to	Test result
9.4 kV	1 MHz	250 μV	Close	Aa	BbCcF	less than 1 μV
				Bb	AaCcF	less than 1 μV
				Cc	AaBbF	less than 1 μV
			Open (Grounded)	A	aBbCcF	less than 1 μV
				B	AabCcF	less than 1 μV
				C	AaBbcF	less than 1 μV
				a	ABbCcF	less than 1 μV
				b	AaBCcF	less than 1 μV
				c	AaBbCF	less than 1 μV
			Open (Ungrounded)	A	F	less than 1 μV
				B	F	less than 1 μV
				C	F	less than 1 μV
				a	F	less than 1 μV
				b	F	less than 1 μV
				c	F	less than 1 μV

* A, B, C : Source side terminal, a, b, c : Load side terminal, F : Tank
* Background noise : 1 μV
* Atmospheric conditions : 19 ℃, 56 % RH, 1 010 hPa

6 Temperature rise test

Test current		630 A		
Test frequency		60 Hz		
Ambient temperature		28.9 ℃		
Test duration		6 h		
Electrical connections		Copper conductor cable (300 mm^2)		
Items		Limit of temperature rise	Temperature rise	
1	Temporary connection (1 m apart from source terminal (A))	(No. 2) ± 5 K	36.8 K	
2	Source side terminal (A)	65 K	38.2 K	
3	Insulation surface (A)	40 K	12.1 K	
4	VI terminal (A)	65 K	26.3 K	
5	Load side terminal (A)	65 K	35.5 K	
6	Source side terminal (B)	65 K	35.7 K	
7	Insulation surface (B)	40 K	10.2 K	
8	VI terminal (B)	65 K	25.4 K	
9	Load side terminal (B)	65 K	35.1 K	
10	Source side terminal (C)	65 K	37.6 K	
11	Insulation surface (C)	40 K	11.6 K	
12	VI terminal (C)	65 K	28.2 K	
13	Load side terminal (C)	65 K	34.5 K	
14	Ambient temperature	(10 ~ 40) ℃	29.2 ℃	28.9 ℃
15	Ambient temperature	(10 ~ 40) ℃	29.6 ℃	
16	Ambient temperature	(10 ~ 40) ℃	27.8 ℃	

7 Time-current test

7.1 Phase

(Tolerance : ±10 %)

Setting value A	Applied curve	Applied value A	Specified time ms	Test results ms		
				Phase A	Phase B	Phase C
50 (minimum)	IEC-SI	75 (150 %)	17.19	16.86	16.79	16.87
		150 (300 %)	6.302	6.252	6.243	6.253
		250 (500 %)	4.280	4.250	4.247	4.248
		500 (1000 %)	2.970	2.950	2.949	2.948
	IEC-VI	75 (150 %)	27.00	26.36	26.21	26.29
		150 (300 %)	6.750	6.673	6.655	6.660
		250 (500 %)	3.370	3.340	3.331	3.338
		500 (1 000 %)	1.500	1.483	1.480	1.482
	IEC-EI	75 (150 %)	64.00	62.41	61.79	62.13
		150 (300 %)	10.00	9.841	9.794	9.822
		250 (500 %)	3.330	3.276	3.267	3.275
		500 (1000 %)	0.800	0.792	0.788	0.792
280 (midium)	IEC-SI	420 (150 %)	17.19	16.87	16.78	16.85
		840 (300 %)	6.302	6.251	6.240	6.250
		1 400 (500 %)	4.280	4.251	4.247	4.250
		2 800 (1 000 %)	2.970	2.956	2.955	2.958
	IEC-VI	420 (150 %)	27.00	26.40	26.24	26.33
		840 (300 %)	6.750	6.671	6.650	6.661
		1 400 (500 %)	3.370	3.336	3.329	3.336
		2 800 (1 000 %)	1.500	1.487	1.487	1.488
	IEC-EI	420 (150 %)	64.00	62.25	61.82	62.12
		840 (300 %)	10.00	9.831	9.780	9.815
		1 400 (500 %)	3.330	3.279	3.260	3.270
		2 800 (1 000 %)	0.800	0.799	0.799	0.798
630 (maximum)	IEC-SI	945 (150 %)	17.19	16.89	16.80	16.87
		1 890 (300 %)	6.302	6.248	6.235	6.245
		3 150 (500 %)	4.280	4.260	4.258	4.263
		6 300 (1 000 %)	2.970	2.961	2.961	2.961
	IEC-VI	945 (150 %)	27.00	26.42	26.27	26.37
		1 890 (300 %)	6.750	6.661	6.640	6.655
		3 150 (500 %)	3.370	3.354	3.353	3.355
		6 300 (1 000 %)	1.500	1.496	1.492	1.495
	IEC-EI	945 (150 %)	64.00	62.36	61.91	62.22
		1 890 (300 %)	10.00	9.812	9.767	9.794
		3 150 (500 %)	3.330	3.301	3.301	3.307
		6 300 (1 000 %)	0.800	0.803	0.803	0.802

7.2 Ground

(Tolerance : ±10 %)

Setting value A	Applied curve	Applied value A	Specified time ms	Test results ms
20 Minimum	IEC-SI	30 (150 %)	17.19	16.74
		60 (300 %)	6.302	6.232
		100 (500 %)	4.280	4.241
		200 (1 000 %)	2.970	2.947
	IEC-VI	30 (150 %)	27.00	26.14
		60 (300 %)	6.750	6.644
		100 (500 %)	3.370	3.325
		200 (1 000 %)	1.500	1.475
	IEC-EI	30 (150 %)	64.00	61.41
		60 (300 %)	10.00	9.773
		100 (500 %)	3.330	3.257
		200 (1 000 %)	0.808	0.789
140 Medium	IEC-SI	210 (150 %)	17.19	16.74
		420 (300 %)	6.302	6.226
		700 (500 %)	4.280	4.239
		1 400 (1 000 %)	2.970	2.946
	IEC-VI	210 (150 %)	27.00	26.13
		420 (300 %)	6.750	6.626
		700 (500 %)	3.370	3.320
		1 400 (1 000 %)	1.500	1.477
	IEC-EI	210 (150 %)	64.00	61.56
		420 (300 %)	10.00	9.740
		700 (500 %)	3.330	3.253
		1 400 (1 000 %)	0.808	0.786
300 Maximum	IEC-SI	450 (150 %)	17.19	16.72
		900 (300 %)	6.302	6.230
		1 500 (500 %)	4.280	4.238
		3 000 (1 000 %)	2.970	2.953
	IEC-VI	450 (150 %)	27.00	26.09
		900 (300 %)	6.750	6.632
		1 500 (500 %)	3.370	3.322
		3 000 (1 000 %)	1.500	1.487
	IEC-EI	450 (150 %)	64.00	61.44
		900 (300 %)	10.00	9.752
		1 500 (500 %)	3.330	3.252
		3 000 (1 000 %)	0.808	0.797

8 Mechanical duty test

Test method and requirement	Test result
The recloser shall be subjected to a minimum of 2 000 close open operations without maintenance. After operations, the following items (8.1, 8.2 and 8.3) shall be verified.	10 000 operations (Refer to the test result of 8.1, 8.2 and 8.3)

8.1 Terminal to terminal resistance

Requirement	Conditions	Test result μΩ		
		Phase A	Phase B	Phase C
The measured resistance shall not have increased by more than 50 % or 100 μΩ, whichever is greater	Before mechanical duty test	50.7	43.8	48.8
	After 2 000 operations	50.3	43.7	50.9
	After 10 000 operations	48.0	45.4	52.2
* Measurement was made with d.c. 100 A				

8.2 Power frequency voltage dry withstand test

Test voltage	Test duration	Test frequency	Conditions	Switching device	Voltage application	Test result
50 kV	60 s	60 Hz	After mechanical duty test (2 000 operations)	Close	AaBbCc-F	Withstood
					Bb-AaCcF	Withstood
				Open	ABC-abcF	Withstood
					abc-ABCF	Withstood
					B-AabCcF	Withstood
					b-AaBCcF	Withstood
			After mechanical duty test (10 000 operations)	Close	AaBbCc-F	Withstood
					Bb-AaCcF	Withstood
				Open	ABC-abcF	Withstood
					abc-ABCF	Withstood
					B-AabCcF	Withstood
					b-AaBCcF	Withstood
* A, B, C : Source side terminal, a, b, c : Load side terminal, F : Tank * Atmospheric conditions : 24 ℃, 63 % RH, 1 009 hPa (after mechanical duty test (2 000 operations)) : 24 ℃, 69 % RH, 1 009 hPa (before mechanical duty test (10 000 operations))						

8.3 Primary contact speed

Requirement	Conditions	Test result m/s	
		Closing speed	Opening speed
Primary contact speed shall be essentially the same as before the start of the mechanical duty test	Before mechanical duty test	0.75	1.23
	After 2 000 operations	0.73	1.21
	After 10 000 operations	0.73	1.20
* Refer to the Osc. ET(04~06)			

9 Review of test results

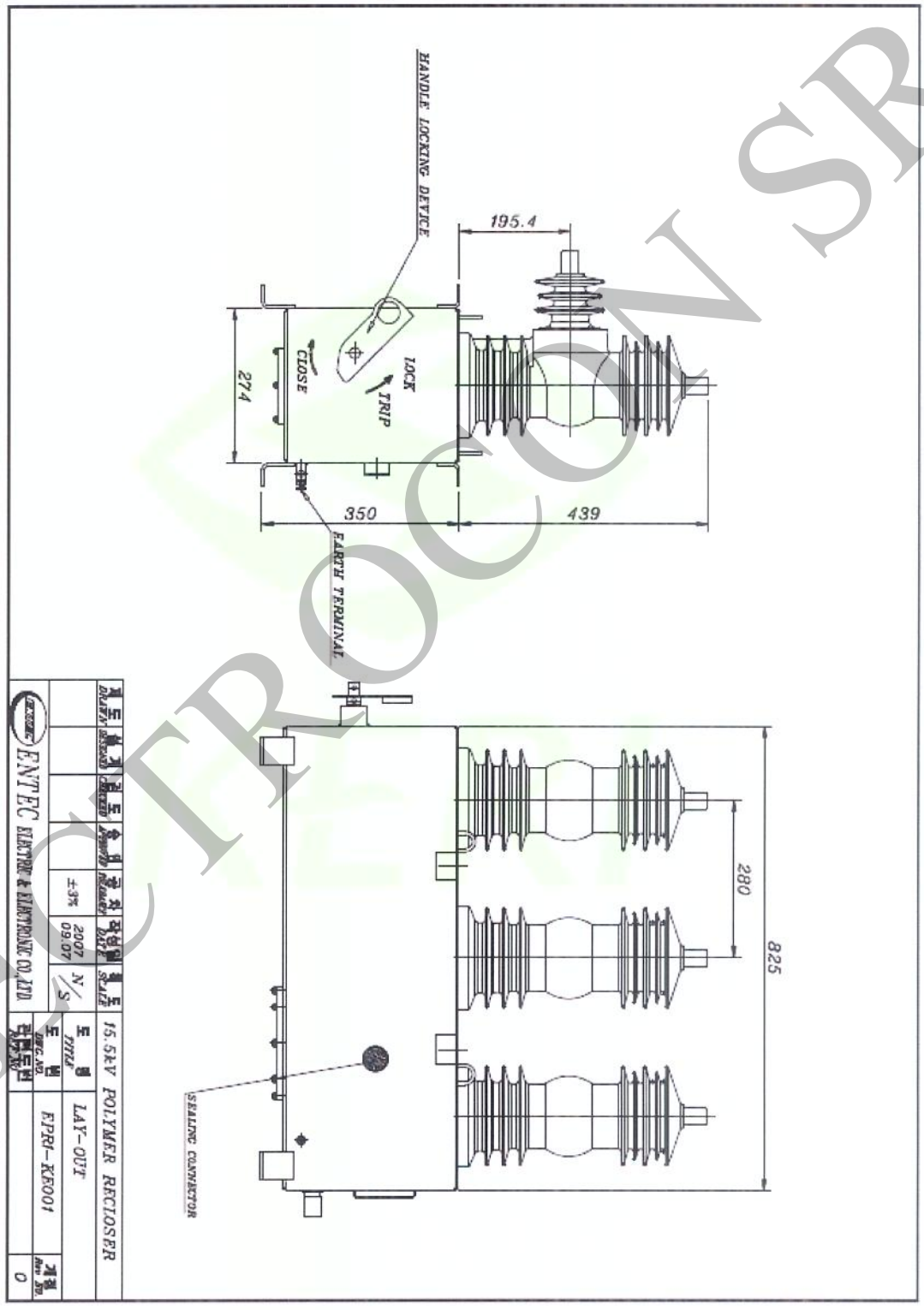
9.1 The tests were carried out for the test object submitted by the manufacturer in accordance with IEEE Std C37.60 : 2003 and applicant's specification.

9.2 In time-current tests, the measured time is contact parting time. The end.

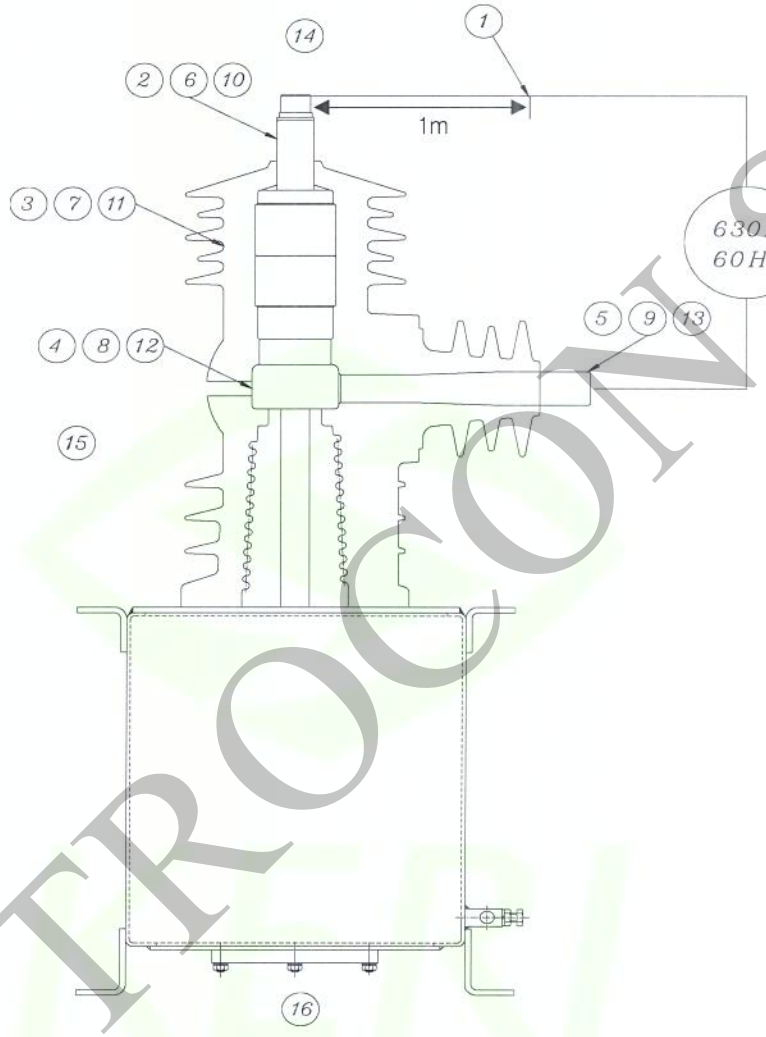
Test object : Photo. ET01

Test object : Solid insulated Automatic circuit Recloser
Ratings : 3 phases 15.5 kV 630 A 16 kA 3 s 60 Hz
Manufacturer : ENTEC Electric & Electronic Co.,Ltd

Solid insulated Automatic circuit Recloser : Dwg. ET01

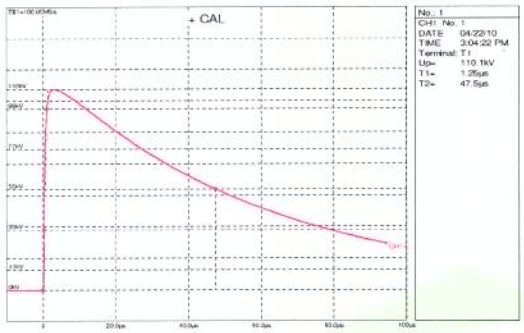
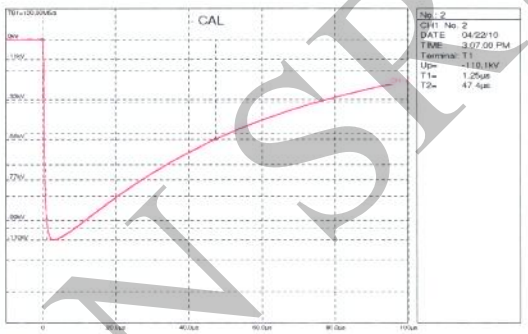


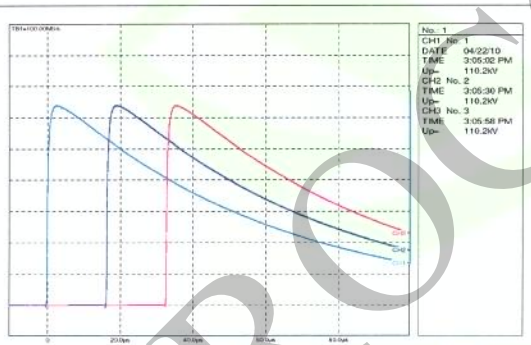
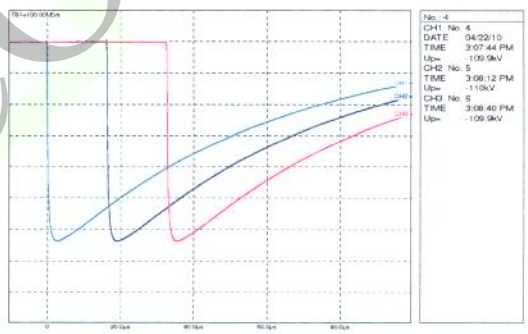
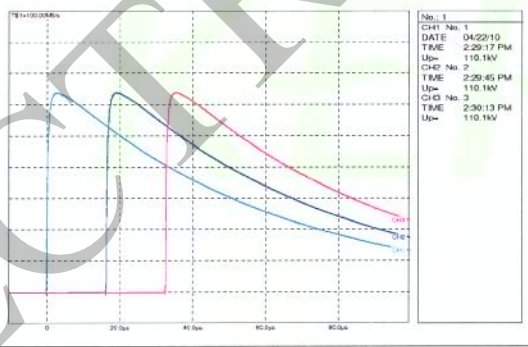
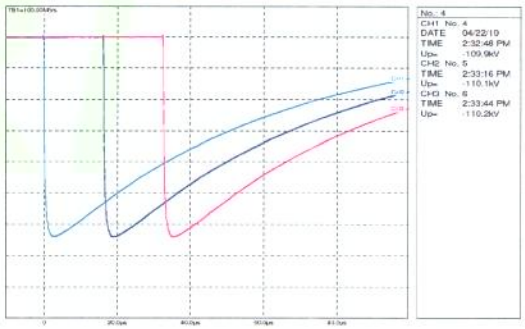
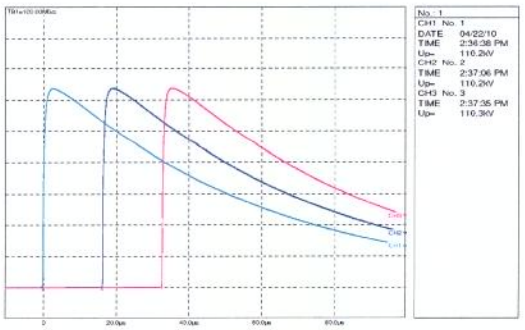
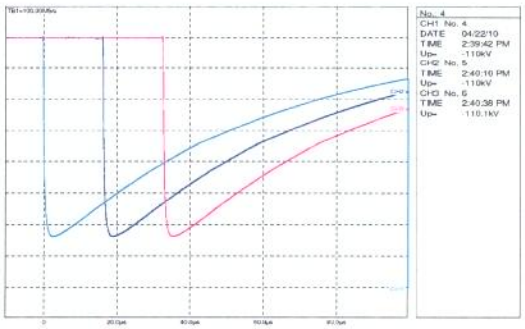
Measured position in temperature rise test : Attach. ET01



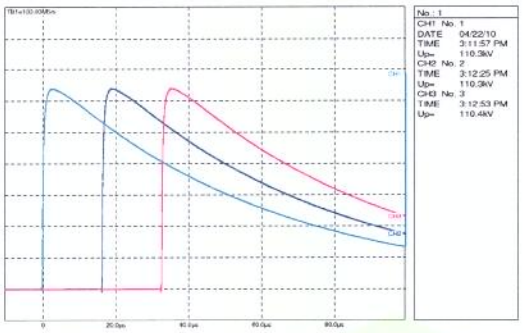
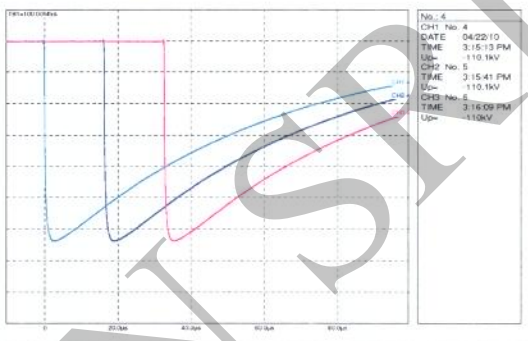
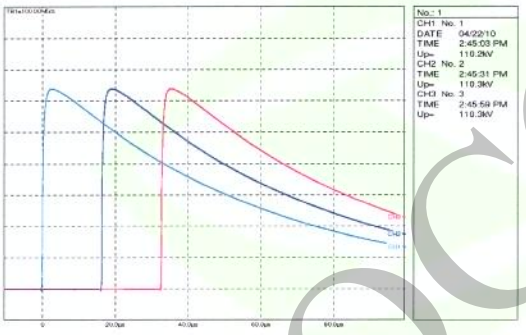
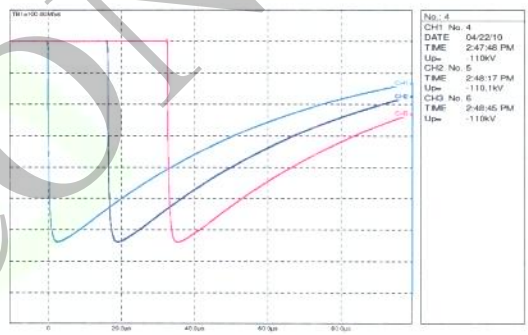
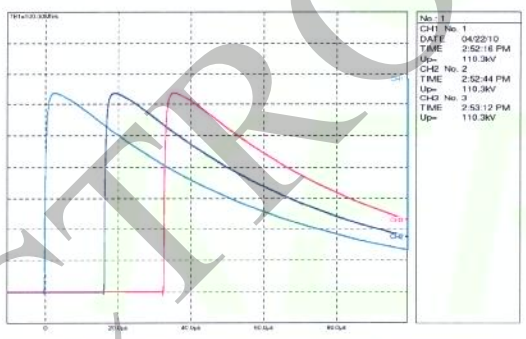
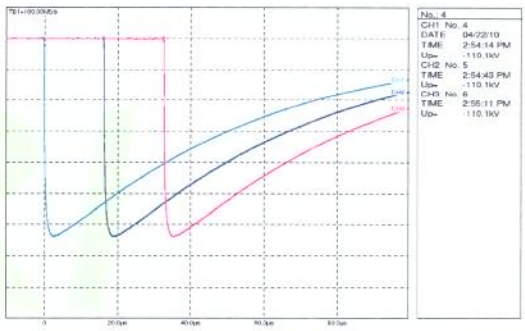
1	Temporary connection (1 m apart from source terminal (A))	9	Load side terminal (B)
2	Source side terminal (A)	10	Source side terminal (C)
3	Insulation surface (A)	11	Insulation surface (C)
4	VI terminal (A)	12	VI terminal (C)
5	Load side terminal (A)	13	Load side terminal (C)
6	Source side terminal (B)	14	Ambient temperature
7	Insulation surface (B)	15	Ambient temperature
8	VI terminal (B)	16	Ambient temperature

Lightning impulse voltage wave : Osc. ET01

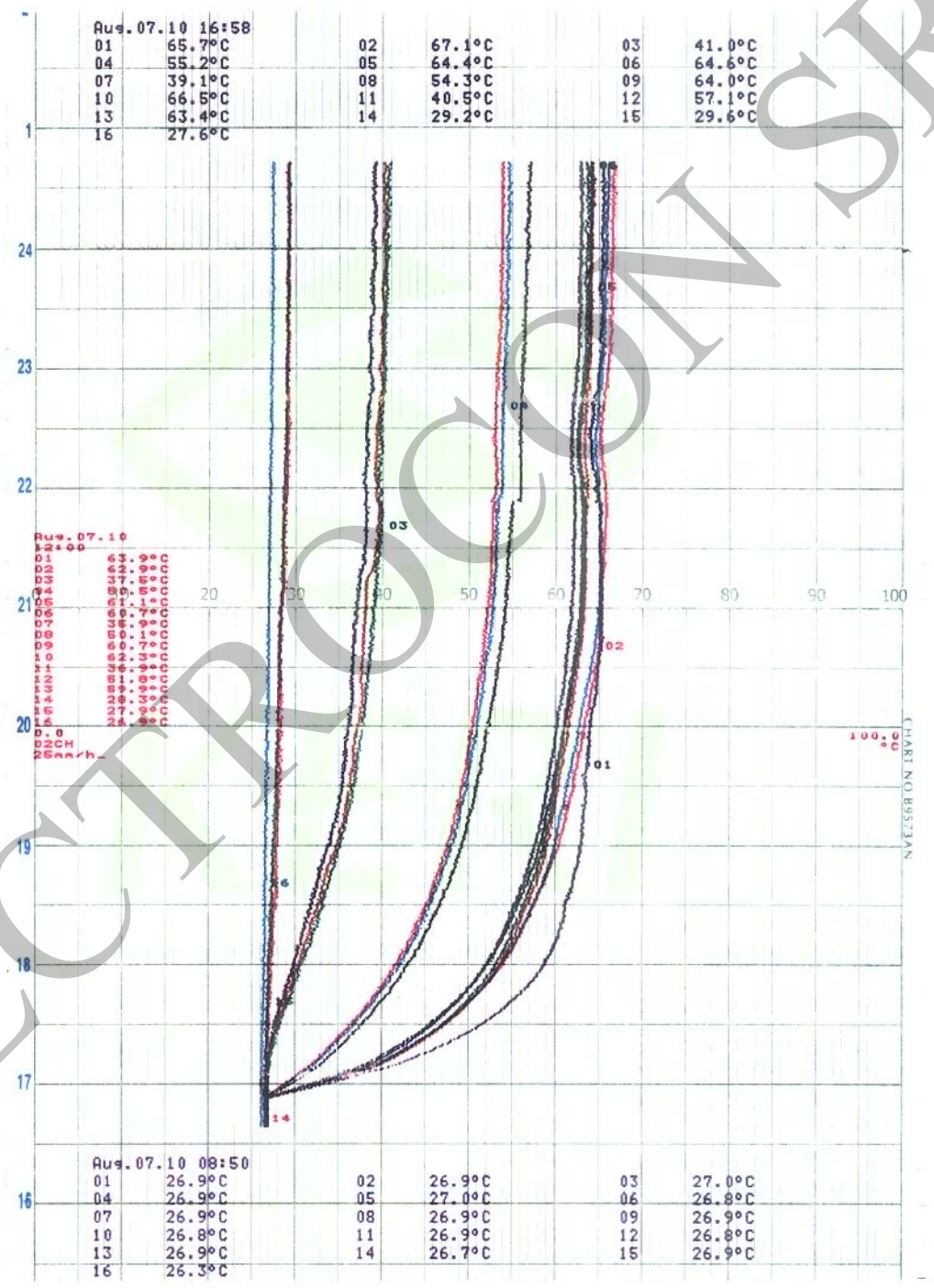
Calibration (110 kV)	
Positive (1.3×48) ㎲	Negative (1.3×47) ㎲
	

Voltage applications	Positive	Negative
ABCabc-F (Close)		
ABC-abcF (Open)		
abc-ABCF (Open)		

Lightning impulse voltage wave : Osc. ET02

Voltage applications	Positive	Negative
Bb-ACacF (Close)		
B-ACabcF (Open)		
b-ABCacF (Open)		

Temperature rise test : Osc. ET03

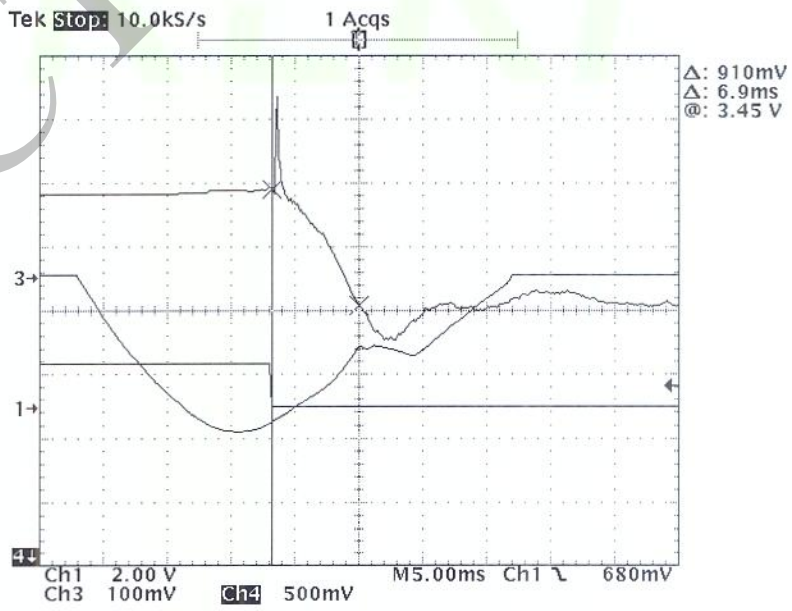


Primary contac speed (before mechanical duty test) : Osc. ET04

Closing speed : Speed based on the VI stroke of 50 % contact gap (8.5 mm x 0.5)
Opening speed : Speed based on the VI stroke of 100 % contact gap (8.5 mm)

Close Speed (8.5 mm x 0.5 / 5.7 ms= 0.75 m/s)

Open Speed (8.5 mm / 6.9 ms=1.23 m/s)



Primary contac speed (after 2 000 operations) : Osc. ET05

Closing speed : Speed based on the VI stroke of 50 % contact gap (8.5 mm x 0.5)
Opening speed : Speed based on the VI stroke of 100 % contact gap (8.5 mm)

Close Speed (8.5 mm x 0.5 / 5.8 ms = 0.73 m/s)

Open Speed (8.5 mm / 7 ms = 1.21 m/s)

Primary contac speed (after 10 000 operations) : Osc. ET06

Closing speed : Speed based on the VI stroke of 50 % contact gap (8.5 mm x 0.5)
Opening speed : Speed based on the VI stroke of 100 % contact gap (8.5 mm)

Close Speed (8.5 mm x 0.5 / 5.8 ms = 0.73 m/s)

Open Speed (8.5 mm / 7.1 ms = 1.20 m/s)