

China Electric Power Research Institute
Quality Inspection and Test Center for Electric
Equipment of Power Industry



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检测
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EETC2015BL037J



Test Report

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1 Client

Shanghai Chardon electric Ltd.

2 Sample Description

Name: Separable Connectors 26kV/66kV Coupling(Rear)T-Body Surge Arrester

Type: 26-RDTA66/26-FDTA66 $\Phi 32\text{mm} \times 31\text{mm}$

Manufacturer: Shanghai Chardon electric Ltd.

Sample No./Details: complete arresters: 7 (A1~A7) resistors: 9 (R1~R9)
sections of arrester: 6 (S1~S6) housings: 3 (H1~H3)

3 Standards/Specifications

GB11032-2010 Metal-oxide surge arresters without gaps for a.c. systems

4 Test Category

Type Test

5 Test Date

01/12/2014~06/02/2015

6 Conclusion

The Separable connectors 26kV/66kV coupling(rear)T-body surge arrester without gaps for 20kV a.c. systems of 26-RDTA66/26-FDTA66 have successfully passed the type test specified in GB11032-2010.

Note 1: In the event of any difference in meanings of the text, the Chinese report shall take precedence over the English version.

Note 2: Since the date of issuance, the routine test which concerns about the related content must be done every three years in order to extend the validity of this report.

Tested by: 阮克 索锦树 李菊霞

Checked by: 李平

Verified by: 李平

Approved by: 李平

Date of issue: 2015.09.29

7 Inspection Items and Results

No.	Items	Requirements	Results	Evaluation	
1	DC reference voltage	$37.0\text{kV} \leq U_{\text{mADC}} \leq 38.5\text{kV}$	37.9kV~38.0kV	PASS	
2	Leakage current at 0.75 DC reference voltage test	$I_{\text{L}}(0.75U_{\text{mADC}}) \leq 50\mu\text{A}$	3.0 μA ~4.0 μA	PASS	
3	Power-frequency reference voltage test	$U_{1\text{mAAC}} \geq 26.0\text{kVr.m.s.}$	29.0kVr.m.s.~29.1kVr.m.s.	PASS	
4	Continuous current test	total current $I_{\text{x}} \leq 500\mu\text{A}$ resistive current $I_{\text{R}} \leq 200\mu\text{A}$	$I_{\text{x}} = 266\mu\text{A} \sim 275\mu\text{A}$ $I_{\text{R}} = 54\mu\text{A} \sim 56\mu\text{A}$	PASS	
5	Internal partial discharge test	$1.05U_{\text{c}}, \text{PD} \leq 10\text{pC}$	PD=2.0pC~3.0pC	PASS	
6	Seal leak rate test	Put the samples into the boiling water with 0.1%NaCl for 42h: change rate of $U_{1\text{mA}}\text{-DC} \leq 5\%$ change of leakage current $I_{\text{L}} \leq 20\mu\text{A}$ partial discharge $\text{PD} \leq 10\text{pC}$	$\Delta U_{1\text{mA}} \cdot \text{DC} = -0.26\% \sim -0.00\%$ $\Delta I_{\text{L}} = 0.0\mu\text{A} \sim +1.0\mu\text{A}$ PD=4.0pC	PASS	
7	Bending moment	Bending load $\geq 180\text{N}$ for 60s ~ 90s, and meet the evaluation requirements.	200N, 60s	PASS	
8	Insulation withstand tests on the arrester housing	Power-frequency voltage: Dry $\geq 54\text{kVr.m.s.}$, for 1min. lightning impulse voltage : 125kVp, the positive and negative 15 times respectively.	Power-frequency voltage (dry) 56.2kVr.m.s., 1min. Lightning impulse voltage 125.8kVp~128.7kVp, the positive and negative 15 times respectively.	PASS	
9	Residual voltage test	lighting impulse current	$\leq 66\text{kV}$	65.5kV	PASS
		steep impulse current	$\leq 74\text{kV}$	70.6kV	
		switching impulse current	$\leq 56\text{kV}$	53.6kV	
10	Long duration current impulse withstand test	2000 μs , 150A, 18 times	2149 μs , 157A~168A	PASS	
11	Operating duty test	115°C, 1000h	$P_{2\text{ct}} < 1.1 P_{3\text{ct}}, P_{2\text{ct}} < P_{1\text{ct}}$	PASS	
		4/10 μs , 65kA high-current impulse, 2 times	65.2kA~66.7kA		
12	Power-frequency voltage versus time characteristics test	Supply the Power-frequency voltage versus time characteristics for the range of voltage from 1.10U _R to 0.85U _R , the range of time from 10s to 24h: for 1.10U _R , the time is 10s; for 0.85U _R , the time is 24h.	1.10U _R 10s 1.00U _R 2h 0.85U _R 24h	PASS	

8. Test date

8.1~8.2 DC reference voltage test and leakage current at 0.75 DC reference voltage test

environment temperature: 12.0°C humidity: 47%

Samples	measured value kV	measured value kV	0.75 DC reference voltage kV		leakage current μA	
			measured value	specified value	measured value	specified value
A1	37.9	$37 \leq U_{1mADC} \leq 38.5$	28.5	$0.75U_{1mADC} \pm 1\%$	3	≤ 50
A2	38.0		28.5		3	
A3	38.0		28.5		4	

Note : The standards formulate the lower limits of DC reference voltage only, the upper limits were declared by the manufacturer to confirm the scale factor and protection level of the arrester.

The result fulfilled the requirements of the standards.

8.3~8.4 Power-frequency reference voltage test and Continuous current test

environment temperature: 12.0°C humidity: 47%

Samples	The power-frequency reference voltage U_{1mAAC} kV (Peak value/ $\sqrt{2}$)		I_R μA (Peak value)		I_x μA (RMS)	
	measured value	specified value	measured value	specified value	measured value	specified value
A1	29.1	≥ 26	54	≤ 200	266	≤ 500
A2	29.0		56		271	
A3	29.1		56		275	

Note : The standard stipulates that the continuous current of arrester under the continuous operating voltage declared by manufacturer.

The result fulfilled the requirements of the standards.

8.5 Internal partial discharge test

Samples	U_r	U_r duration time	$1.05U_c$	$1.05U_c$ duration time	partial discharge
	kV _{rms}	s	kV _{rms}	s	pC
A1	26	10	21.8	60	3.0
A2	26	10	21.8	60	3.0
A3	26	10	21.8	60	2.0
specified value	26	2~10	21.8	60	≤ 10

The result fulfilled the requirements of the standards.

8.6 Seal leak rate test

Samples	Boiling time	Cooling time	DC reference voltage			leakage current at 0.75U _{ImA} .DC			Partial discharge		Surface check after test
			Before	After	change rate	Before	After	change rate	Before	After	
	h	kV	%	μA			pC				
A1	42	5	37.9	37.9	0	3.0	4.0	+1.0	3.0	4.0	No visible mechanical damage
A2	42	5	38.0	37.9	-0.26	3.0	3.0	0	3.0	4.0	No visible mechanical damage
A3	42	5	38.0	38.0	0	4.0	4.0	0	2.0	4.0	No visible mechanical damage
specified value	42	≤8	≥37	≤5	≤50	≤20	≤10				Should not have visible mechanical damage

Note 1: NaCl concentration in water for 1 kg/m³.

The result fulfilled the requirements of the standards.

8.7 Bending moment

8.7.1 The test of bending moment

The test load MPSL=180N

Samples	Actual loading	Time	Maximum deflection	Residual deflection	Housing height	deflection rate	force/deflection curve	Sample check
	N							
A1	200	60	5.8	3.0	345	0.87	no mutation	No mechanical damage
specified value	180	60~90	/	/	/	≤5	Should not have mutation	Should not have mechanical damage

8.7.2 Water immersion test

Samples	U _{ImA} .DC			leakage current			Partial discharge	
	kV			μA			pC	
	Before	After	change rate %	Before	After	change rate	Before	After
A1	37.9	37.9	0	3.0	4.0	+1.0	3.0	4.0
specified value	≥25		≤5	≤50		≤5	≤10	

The result fulfilled the requirements of the standards.

8.8 Insulation withstand tests on the arrester housing

8.8.1 Power-frequency voltage test.

altitude: $\leq 1000\text{m}$

Sample	specified value	atmospheric correction factor	altitude correction factor	corrected value	applied voltage	Withstand time	Test result
	kV_{rms}	K_t	K_a	kV_{rms}	kV_{rms}	s	
H1~H3	54 (dry)	1.000	1.000	54.0	56.2	60	Passed

8.8.2 Lightning impulse voltage test

altitude: $\leq 1000\text{m}$

Sample	specified value		atmospheric correction factor	altitude correction factor	corrected value	applied voltage	Withstand time	Test result
	kV		K_t	K_a	kV_p	kV_p		
H1~H3	(+)	125	1.000	1.000	125.0	125.8~128.7	15	Passed
	(-)	125	1.000	1.000	125.0	126.2~128.3	15	Passed

The result fulfilled the requirements of the standards.

8.9 Residual voltage test

8.9.1 Lightning impulse residual voltage test

Samples		R1	R2	R3	
$U_{1\text{mADC}}$	kV	6.75	6.75	6.73	
2.5kA	kV_p	10.84	10.85	10.76	
5kA	kV_p	11.33	11.35	11.28	
10kA	kV_p	12.62	12.63	12.55	
$U_{5\text{kA}}/U_{1\text{mADC}}$	-	1.68	1.68	1.68	
Residual voltage converted to complete arresters, 5kA	ratio	5.70	5.70	5.72	
	measured value	kV_p	64.62	64.74	64.53
	specified value	kV_p	≤ 66	≤ 66	≤ 66

Note : shunt resistance $R_s=0.004827\Omega$, divider ratio $K_d=59.0$.

8.9.2 Switching impulse residual voltage test

Samples		R1	R2	R3	
Residual voltage of the resistors ,500A	kV_p	9.39	9.37	9.31	
Residual voltage converted to complete arresters, 500A	measured value	kV_p	53.56	53.44	53.26
	specified value	kV_p	≤ 56.0	≤ 56.0	≤ 56.0

Note : shunt resistance $R_s=0.004827\Omega$, Divider ratio $K_d=59.0$.

8.9.3 Steep current impulse residual voltage test

Samples		R1	R2	R3	
5 kA ,residual voltage of section U_{res1}	kV _p	12.57	12.59	12.51	
5 kA ,residual voltage of metal block U_{res2}	kV _p	0.29			
ratio	U_{res2}/U_{res1}	2.30%	2.30%	2.32%	
5kA ,residual voltage after correction	$U_{res1}-U_{res2}$	12.28	12.30	12.22	
Residual voltage of arrester, 5 kA	Residual voltage of arrester	kV _p	70.04	70.16	69.91
	Inductance per unit length	μH/m	1		
	Length without resistors	m	$0.262-(0.032 \times 6)=0.07$		
	inductive voltage drop	kV _p	$1 \times 0.07 \times 5 = 0.35$		
	After correction	kV _p	70.39	70.51	70.26
	specified value	kV _p	≤74.0	≤74.0	≤74.0

Note 1: shunt resistance $R_s=0.002458\Omega$, divider ratio $K_d=61.0$.

Note 2: if U_{res2}/U_{res1} less than 2%, inductive voltage drop is needless.

The result fulfilled the requirements of the standards, the test waveforms were shown in figure A.1 ~ figure A.4.

8.10 Long duration current impulse withstand test

environment temperature:12.5°C humidity: 37%

Samples		R4	R5	R6	specified value	
8/20μs I_n Residual voltage of the resistors	kV _p	11.24	11.30	11.28	/	
Current	The 1st time	A	168	157	153	150A(90%~110%)
	The 2nd time	A	157	161	161	
	The 3rd time	A	157	157	161	
	The 4th time	A	161	161	157	
	The 5th time	A	163	163	157	
	The 6th time	A	157	157	161	
	The 7th time	A	157	157	163	
	The 8th time	A	157	161	163	
	The 9th time	A	161	163	157	
	The 10th time	A	161	161	157	
	The 11th time	A	157	161	157	150A(100%~110%)

	time					
	The 12th time	A	163	163	161	
	The 13th time	A	163	161	161	
	The 14th time	A	161	157	161	
	The 15th time	A	157	157	157	
	The 16th time	A	157	161	163	
	The 17th time	A	161	161	161	
	The 18th time	A	163	168	163	
	8/20 μ s I_n Residual voltage of the resistors after test	kV _p	11.28	11.37	11.36	/
	Change rate of Residual voltage of the resistors	%	+0.36	+0.62	+0.71	≤ 5
	Examination		No breakdown or flashover or breakage		No breakdown or flashover or breakage	
Note : shunt resistance $R_s=0.004827\Omega$.						

The result fulfilled the requirements of the standards, the test waveforms were shown in figure A.5.

8.11 Operating duty test

8.11.1 Accelerated ageing test

Items	Unit	Samples		
		R7	R8	R9
U_{1mADC}	kV	6.64	6.64	6.64
U_c	kV _{rms}	4.00	4.00	4.00
Arrester voltage rate	%	85.0	85.0	85.0
Power losses P_{1ct} , 2h	mW	879	964	892
Power losses P_{2ct} , 1000+8h	mW	774	788	776
P_{3ct}	mW	727	763	752
$P_{2ct} / 1.1P_{3ct}$	-	0.97	0.94	0.94
P_{2ct} / P_{1ct}	-	0.88	0.82	0.87

Note: (1) Because $P_{2ct} < 1.1 \times P_{3ct}$, $P_{2ct} < P_{1ct}$ the following test should be performed on the new resistors.
(2) The temperature of resistors: $115 \pm 4^\circ\text{C}$.

8.11.2 High-current impulse operating duty test parameter

Samples		S1	S2	S3
U_{1mADC}	kV	6.68	6.69	6.69
U_r	kV_{rms}	4.69	4.70	4.70
U_c	kV_{rms}	3.76	3.76	3.76
K_d	-	1.0	1.0	1.0
U_r^*	kV_{rms}	4.69	4.70	4.70
U_c^*	kV_{rms}	3.76	3.76	3.76
$1.20 \times U_c^*$	kV_{rms}	4.51	4.51	4.51

8.11.3 High-current impulse operating duty test

environment temperature: 6.5°C humidity: 53%

Samples		S1	S2	S3	specified value	
8/20 μ s	U_{5kA} before test	kV_p	11.25	11.32	11.34	/
Conditioning test	$1.20 \times U_c^*$	kV_{rms}	4.51	4.51	4.51	$1.20 \times U_c^*$
	Trigger degree	°	54.5	54.2	60.6	$60^\circ \pm 15^\circ$ (before peak value)
	The 1st group	kA	4.92~5.11	4.88~5.13	4.96~5.10	Times of 5kA, 8/20 μ s 4 groups of 5 times
	The 2nd group		5.02~5.13	4.90~5.14	4.93~5.11	
	The 3rd group		4.97~5.08	4.97~5.10	4.96~5.12	
The 4th group	4.96~5.13		4.98~5.12	4.94~5.11		
High-current impulse	1 st impulse	kA	65.6	65.4	65.2	Between two impulse, cooled samples to ambient temperature
	2 nd impulse	kA	66.1	66.5	66.7	
Applied voltage after 2 nd impulse	Time	ms	80	78	82	within 100ms
	U_r^*	kV_{rms}	4.69	4.70	4.70	$peak/\sqrt{2}$
	Duration	s	10	10	10	10
	U_c^*	kV_{rms}	3.76	3.76	3.76	-
	Duration	min	30	30	30	30
Power loss within 30 min	0min	mW	263	247	269	In the last 15 min power loss should reduce Steadily
	5min		212	196	207	
	10min		184	169	177	
	15min		157	133	143	
	20min		122	107	119	
	25min		95	86	88	

	30min		71	63	65	
8/20 μ s U_{5kA} after		kV _p	11.29	11.37	11.41	-
8/20 μ s U_{5kA} change rate		%	+0.36	+0.44	+0.62	≤ 5
Visual inspection		-	No puncture, flashover, cracking or other significant damage			No puncture, flashover, cracking or other significant damage

The result fulfilled the requirements of the standards.

8.12 Power frequency voltage versus time characteristics test

8.12.1 Power frequency voltage versus time characteristics test parameter

Samples			S4	S5	S6
U_{1mADC}		kV	6.70	6.71	6.71
U_r		kV _{rms}	4.71	4.72	4.72
U_c		kV _{rms}	3.77	3.77	3.77
K_{α}		-	1.00	1.00	1.00
U_r^*		kV _{rms}	4.71	4.72	4.72
U_c^*		kV _{rms}	3.77	3.77	3.77

8.12.2 Power frequency voltage versus time characteristics test

environment temperature: 7.0°C humidity: 45%

Samples			S4	S5	S6	specified value
8/20 μ s U_{5kA} before		kV	11.28	11.32	11.34	/
High-current impulse		kA	65.6	66.5	66.1	preheated samples to 60°C \pm 3°C
Applied voltage after high-current impulse	Time	ms	80	80	82	within 100ms
	U_r	kV _{rms}	4.00	4.72	5.19	peak/ $\sqrt{2}$
	Times of U_r^*	-	0.85	1.00	1.10	-
	Duration	s	24 h	2 h	10 s	-
	U_c	kV _{rms}	3.77	3.77	3.77	-
	Duration	min	30	30	30	30
Power loss within 30 min	0min	W	129	215	866	In the last 15 min power loss should reduce Steadily
	5min		98	186	637	
	10min		76	164	329	
	15min		63	137	254	
	20min		52	108	198	
	25min		47	88	166	
	30min		43	67	141	

8/20 μ s U_{SkA} after	kV _p	11.32	11.38	11.45	-
8/20 μ s U_{SkA} change rate	%	+0.35	+0.53	+0.97	≤ 5
Visual inspection	-	No puncture, flashover, cracking or other significant damage			No puncture, flashover, cracking or other significant damage

The result fulfilled the requirements of the standards.



Appendix A: The typical test waveform



Fig A.1 Sample R1, 8/20 μ s, 5kA, $R_s=0.004827\Omega$ K=59

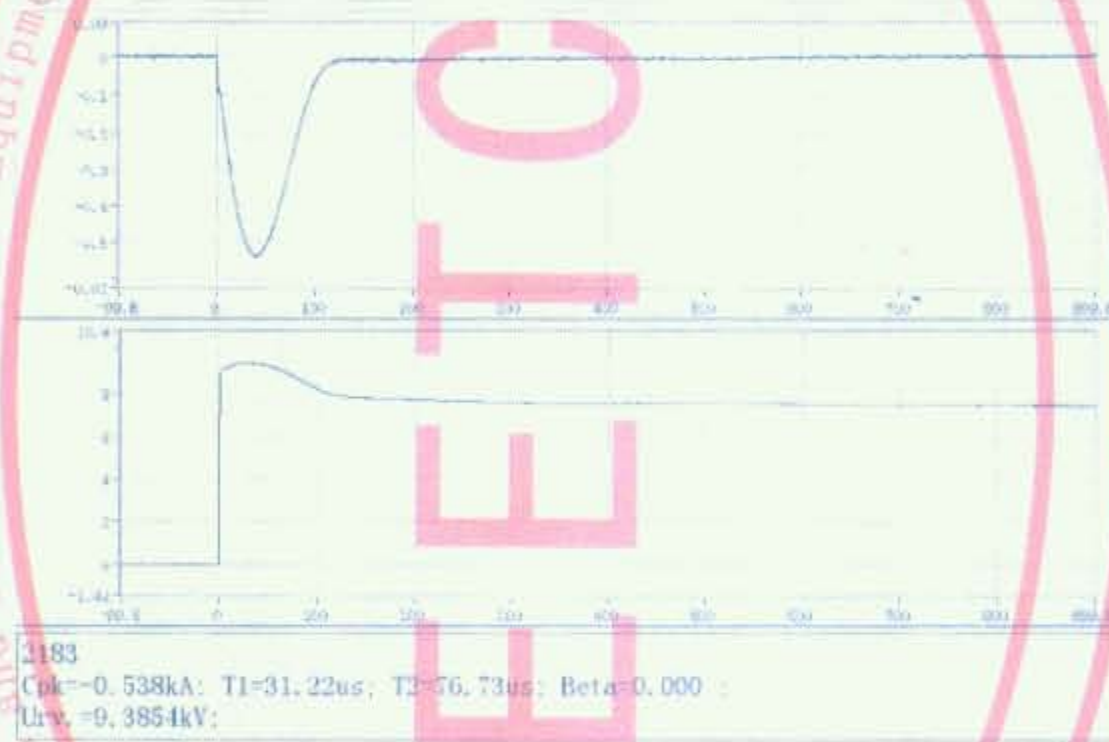


Fig A.2 Sample R1, 30/80 μ s, 5kA, $R_s=0.004827\Omega$ K=59

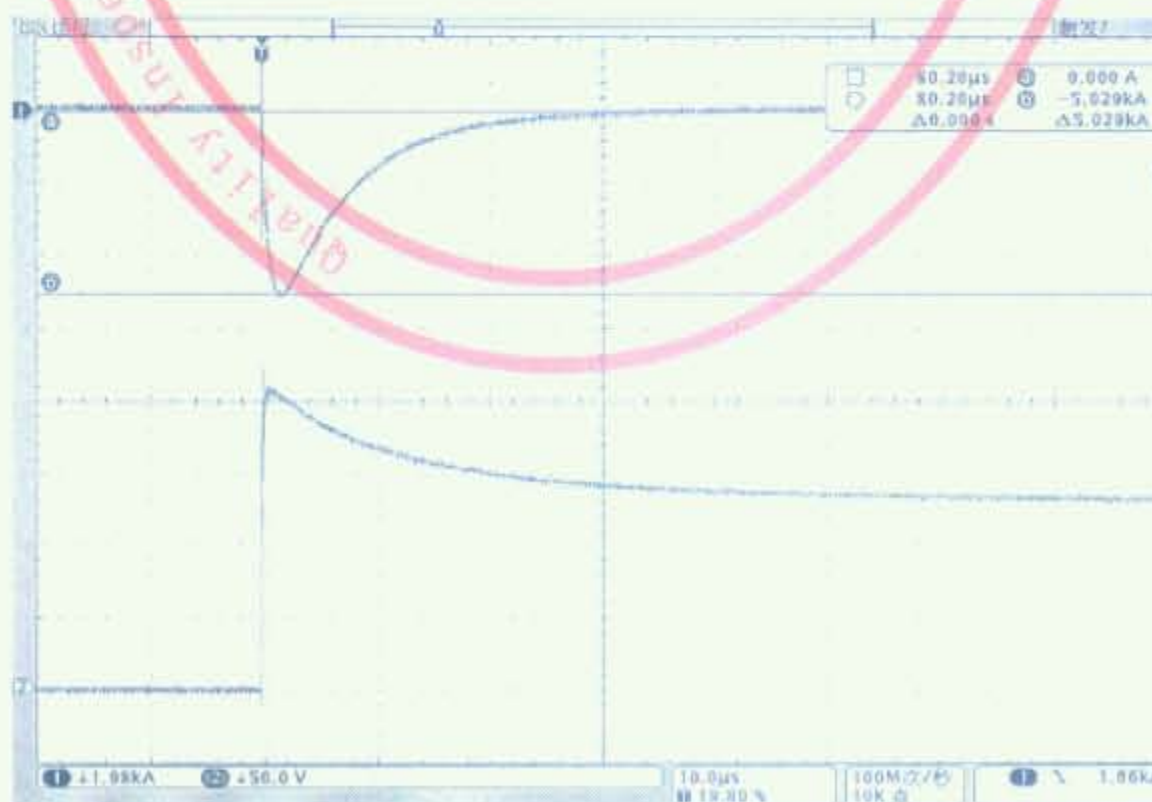


Fig A.3 Sample R1, 1/5 μ s, 5kA, $R_s=0.002458\Omega$ K=61

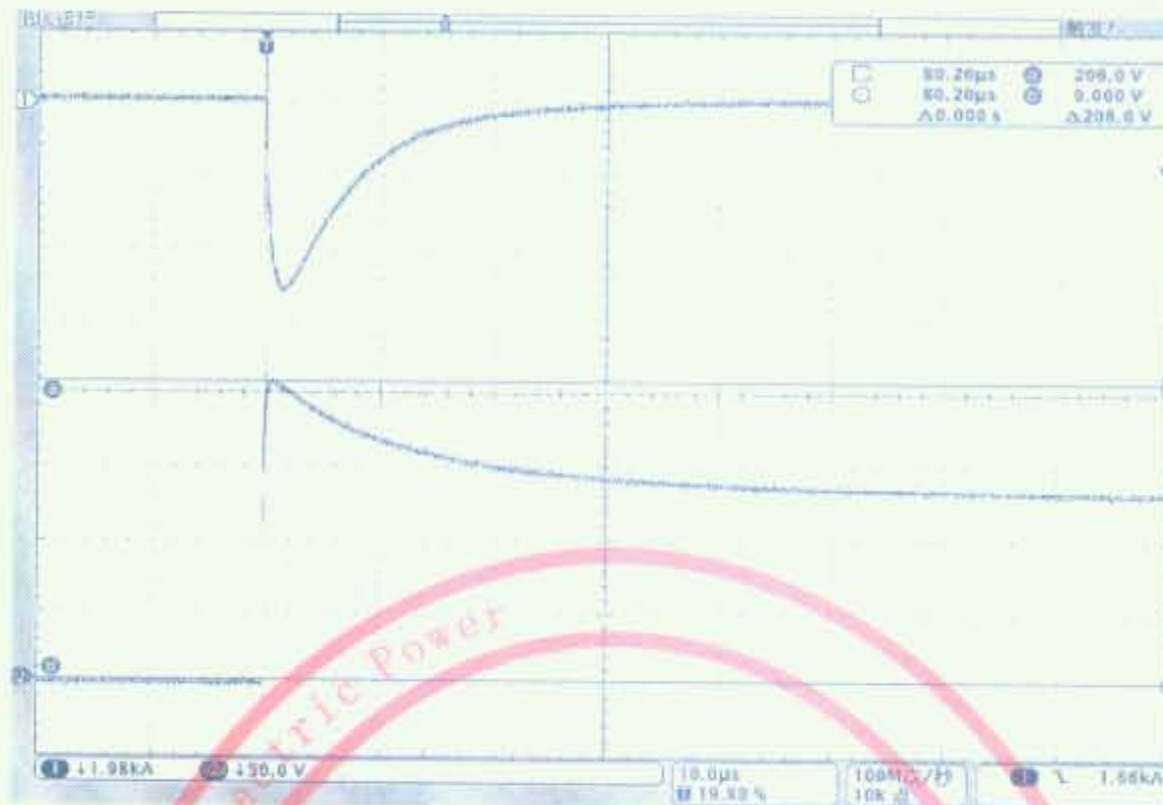


Fig A.4 Sample R1, 1/5μs, 5kA, $R_c=0.002458\Omega$ K=61

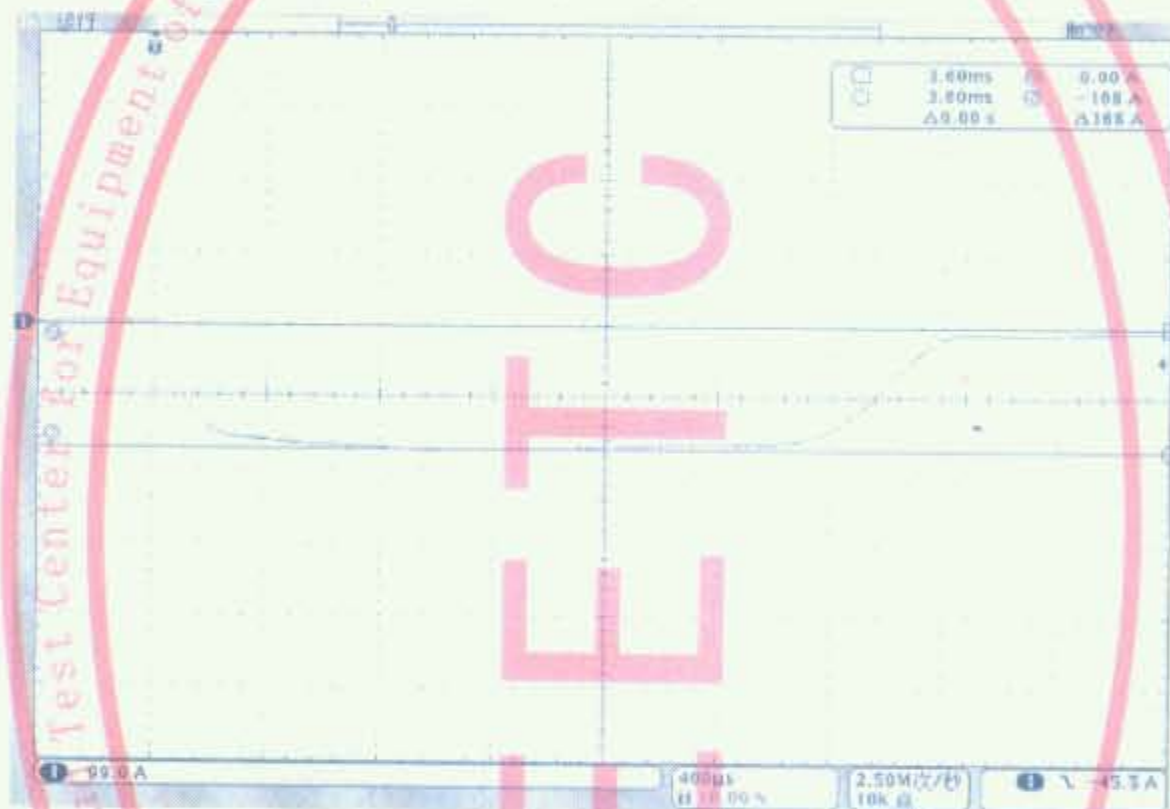


Fig A.5 the 1st time of Sample R4 2ms, 150A, $R_s=0.05046\Omega$

Appendix B: Main performance parameters of arresterRated voltage U_r : 26 kVContinuous operating voltage U_c : 20.8kVNominal discharge current I_n : 5 kALightning impulse residual voltage U_{res} : ≤ 66 kV**Appendix C: Main test device**

NO.	Device name	Device NO.	Measurement	Uncertainty /Accuracy	Calibration institution	Expiration date
1	400 kV DC High Voltage generator	BL008	0-400 kV	/	National center for high voltage measurement	2016-04-30
2	300 kV AC High Voltage generator	BL010	0-300 kV	/	/	/
	Digital high-voltage table	BLW072	0-300 kV	1%	National center for high voltage measurement	2015-09-26
3	8/20 μ s impulse current generator	BL002	0-40 kA	/	/	/
	CASI-50shunt	BLW040	0-60 kA	1%	The fifth (xi'an) measurement and test center of mechanical industry	2016-07-01
	PDR-50 voltage divider	BLW049	0-50 kV	1%	National center for high voltage measurement	2016-02-17
4	1/5 μ s steep impulse current generator	BL004	0-20 kA	/	/	/
	PDR-20 voltage divider	BLW047	0-20 kV	1%	National center for high voltage measurement	2016-02-17
5	4/10 μ s high current Impulse generator	BL003	0-150 kA	/	/	/
	CASI-150 shunt	BLW045	0-150 kA	1%	The fifth (xi'an) measurement and test center of mechanical industry	2016-07-01
6	Long duration (rectangular) current impulse generator	BL001	0-3000 A	/	/	/
	CASI-3 shunt	BLW038	0-3000 A	1%	The fifth (xi'an) measurement and test center of mechanical industry	2016-02-16
	FYC-30kV weak damping voltage divider	BLW074	0-30 kV	1%	National center for high voltage measurement	2016-06-12
7	Aneroid barometer	BLW023	2 级	/	The meteorological metrological verification station of Hubei province	2015-08-19
8	MOA-II DC reference voltage detector	BLW002	0-10 kV	3%	National center for high voltage measurement	2016-03-11
9	DMI Digital voltage table	BLW018	0-1600V	1%	National center for high voltage measurement	2015-10-26
10	RCD-4 resistance current tester	BLW003	0-10mA	3%	National center for high voltage measurement	2016-02-18

Appendix D: Visual and dimensional check



Fig D1: Outside view of 26-RDTA66/26-FDTA66

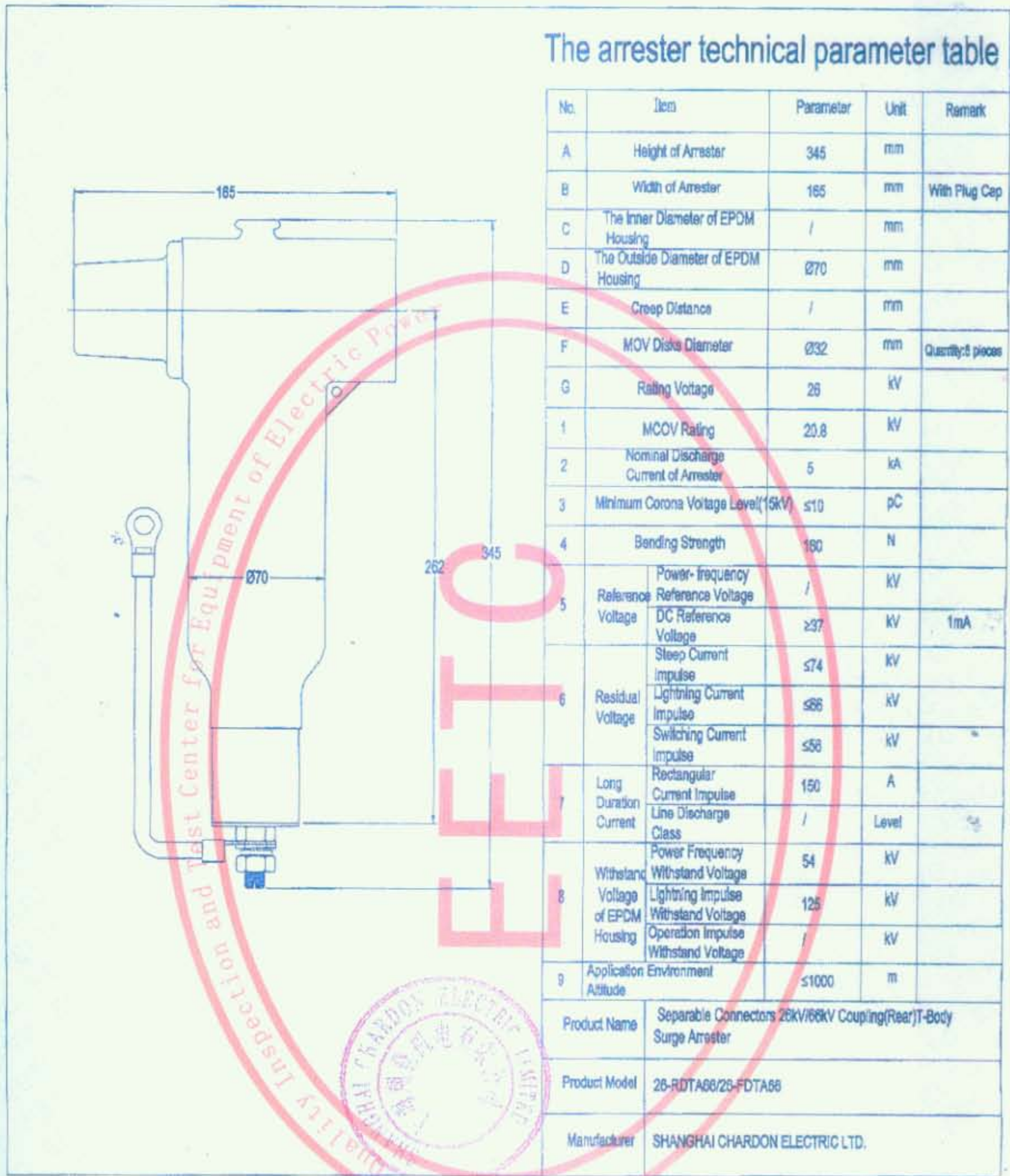


Fig 2: Dimensional drawing of 26-RDTA66/26-FDTA66