TEST REPORT

CEPRI-EETC02-2023-0051(E)

Client： Xi ’an Tiangong Electric Co.,Ltd

Object： Metal Oxide Varistor

Type： Φ42mm×23.5mm

Test Category： Characteristics test

POWER INDUSTRY QUALITY INSPECTION AND TEST CENTER FOR ELECTRIC EQUIPMENT

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Catalogue

Test Report	Power Industry Quality Inspection and Test Center for Electric Equipment		CEPRI-EETC02-2023-0051(E) Total 12 Page 2
Client	Xi ’an Tiangong Electric Co.,Ltd	Manufacturer	Xi ’an Tiangong Electric Co.,Ltd
Object	Metal Oxide Varistor	Type	Φ42mm×23.5mm
Sampling procedure	By the client delivery	Serial No.	19 resistors (301～319)
Test Category	Characteristics test	Date	2023.02.13~2023.03.31
Requirements	1. GB/T 11032-2020 Metal-oxide surge arresters without gaps for a.c. systems 2.IEC 60099-4 Edition 3.0 (2014-06) Metal-oxide surge arresters without gaps for a.c. systems		
Conclusion	The metal oxide Varistor(Φ42mm×23.5mm)has passed the type test specified in GB/T 11032-2020 and IEC 60099-4 Edition 3.0 (2014-06).		
Note	Note :See appendix A for sample instruction.		
Tested by: 梁菊霞		**陈立**	
Checked by: 王陆璐		**Verified by: 左中秋**	
Approved by: 王保山		**Date of issue:** 2023-04-12	

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Test Results

No.	Item	Requirements		Results	Evaluation
1	Residual voltage test	Lightning impulse	$\leqslant 9.15\pm 0.5kV_p$	$9.56kV_p$~$9.60kV_p$	Data only
		Switching impulse	Data only	See the text for details	
		Steep current impulse	Data only	See the text for details	
2	High current impulse withstand test	4/10μs、 100 kA 、2times		97.6kA～99.6kA	Pass
3	Repetitive charge transfer rating withstand test	Q_{rs} = 0.5C		0.550 C ~0.579C	Pass
4	Test to verify long term stability under continuous operating voltage	Charge ability 85%, 115℃,1000h.		$P_{max}\leqslant 1.3P_{min}$, $P_{all.max}\leqslant 1.1P_{start}$.	Pass

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Content:

1 Residual voltage test

1.1 Lightning impulse residual voltage test

Samples				301	302	303
Resistor	U_{2mAAC}	Measured value	kV	3.86	3.85	3.85
		Specified value	kV_p	⩾3.66		
	8/20μs, 5kA		kV_p	8.85	8.83	8.81
	8/20μs, 10kA		kV_p	9.60	9.56	9.58
	8/20μs, 20kA		kV_p	10.67	10.63	10.65
	Specified value		kV_p	⩽9.15±0.5		

Note 1：Shunt 0.025 V/A，divider K_d=206.8

Note 2：According to the determined residual pressure, draw the residual voltage and current curve, in the curve corresponding to the nominal discharge current read residual voltage, defined as the lightning protection lightning protection level.

1.2 Switching impulse residual voltage test

Samples			301	302	303
Resistor	U_{2mAAC}	kV	3.86	3.85	3.85
	Residual voltage at 250A	kV_p	7.11	7.07	6.99
	Residual voltage at 500A	kV_p	7.32	7.28	7.21
	Residual voltage at 1000A	kV_p	7.61	7.57	7.50

Note：Shunt 0.025 V/A，divider K_d=206.8

1.3 Steep current impulse residual voltage test

Samples			301	302	303
Resistor	U_{2mAAC}	kV	3.86	3.85	3.85
	8/20μs, 10kA	kV_p	10.52	10.50	10.52

Note1：Shunt 0.0267 V/A, divider K_d=59.8。

Note 2： If U_{res2}/ U_{res1} is less than 2%, there is no need to correct Inductive effect.

Data only. Test waveform is shown in figure C.1 ~ figure C.3.

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2 High current impulse withstand test

Environment temperature：13.0℃ humidity: 71%

Samples		304	305	306	Specified value
U_{1mADC} （Positive +）	kV	5.26	5.25	5.28	/
U_{1mADC} （Negative -）	kV	5.26	5.28	5.28	/
8/20μs U_{10kAp} before	kV_p	9.56	9.52	9.57	/
1st impulse	kA	98.8	98.8	99.6	100kA，The interval should allow the samples to cool to ambient temperature
2nd impulse		98.4	97.6	99.6	
U_{1mADC} （Positive +）	kV	5.25	5.22	5.22	/
Change rate（Positive +）	%	-0.19	-0.57	-1.14	/
U_{1mADC} （Negative -）	kV	4.82	4.86	4.85	/
Change rate（Negative -）	%	-8.37	-7.95	-8.14	/
Visual inspection		No puncture, flashover or cracking.			No puncture, flashover or cracking.

Note：Shunt 0.001V/A。

Fulfilled the requirements. Test waveform is shown in figure C.4.

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3 Repetitive charge transfer rating withstand test

Environment temperature: 11.0℃ humidity: 69%

Samples		310	311	312	313	314	315	316	317	318	319
Before test	U_{2mAAC}, kV	3.85	3.84	3.82	3.83	3.82	3.85	3.83	3.82	3.85	3.84
	8/20μsU_{10kA}, kV	9.54	9.51	9.52	9.51	9.50	9.52	9.51	9.48	9.53	9.51
Q_{rs}， C		Q_{rs} (Claimed repetitive charge transfer rating) ×1.1=0.44									
1st	Q_{rs}， C	0.558	0.578	0.570	0.562	0.568	0.558	0.562	0.568	0.564	0.568
2nd	Q_{rs}， C	0.558	0.567	0.575	0.572	0.579	0.561	0.555	0.555	0.575	0.556
3rd	Q_{rs}， C	0.575	0.552	0.568	0.570	0.569	0.563	0.552	0.553	0.569	0.572
4th	Q_{rs}， C	0.566	0.572	0.562	0.566	0.564	0.554	0.562	0.567	0.563	0.568
5th	Q_{rs}， C	0.562	0.557	0.561	0.560	0.562	0.568	0.567	0.562	0.560	0.567
6th	Q_{rs}， C	0.560	0.555	0.553	0.568	0.568	0.561	0.576	0.557	0.568	0.555
7th	Q_{rs}， C	0.568	0.565	0.556	0.564	0.563	0.565	0.558	0.553	0.553	0.559
8th	Q_{rs}， C	0.553	0.563	0.552	0.557	0.577	0.561	0.552	0.550	0.557	0.554
9th	Q_{rs}， C	0.557	0.553	0.560	0.553	0.567	0.573	0.557	0.557	0.577	0.551
10th	Q_{rs}， C	0.577	0.560	0.563	0.575	0.575	0.561	0.555	0.555	0.575	0.556
11th	Q_{rs}， C	0.575	0.552	0.558	0.575	0.568	0.563	0.552	0.552	0.566	0.566
12th	Q_{rs}， C	0.566	0.572	0.557	0.566	0.562	0.554	0.562	0.562	0.559	0.560
13th	Q_{rs}， C	0.564	0.557	0.561	0.564	0.568	0.564	0.558	0.560	0.567	0.567
14th	Q_{rs}， C	0.557	0.568	0.568	0.560	0.567	0.567	0.567	0.568	0.561	0.555
15th	Q_{rs}， C	0.552	0.553	0.553	0.568	0.563	0.562	0.563	0.567	0.572	0.559
16th	Q_{rs}， C	0.561	0.557	0.557	0.563	0.559	0.565	0.555	0.563	0.563	0.555
17th	Q_{rs}， C	0.570	0.575	0.577	0.557	0.565	0.562	0.569	0.565	0.560	0.551
18th	Q_{rs}， C	0.562	0.567	0.567	0.564	0.558	0.572	0.578	0.562	0.562	0.565
19th	Q_{rs}， C	0.572	0.563	0.563	0.575	0.571	0.568	0.570	0.552	0.556	0.576
20th	Q_{rs}， C	0.557	0.561	0.565	0.572	0.569	0.562	0.567	0.568	0.558	0.570
Test evaluation	U_{2mAAC}, kV	3.89	3.83	3.88	3.84	3.89	3.85	3.86	3.82	3.86	3.87
	Change rate, %	+1.04	-0.26	+1.57	+0.26	+1.83	0	+0.78	0	+0.26	+0.78
	8/20μs U_{10kA}, kV	9.73	9.71	9.70	9.68	9.70	9.74	9.72	9.69	9.72	9.70
	Change rate, %	+1.99	+2.10	+1.89	+1.79	+2.11	+2.31	+2.21	+2.22	+1.99	+2.00
	One 8/20 current impulse, kA	6.92kA (0.5kA/cm^2=0.5×3.14×(4.2/2)^2=6.92kA which is lower than 2 times I_n)									
		7.25	7.36	7.28	7.52	7.18	7.16	7.05	7.18	7.29	7.15
	Visual inspection	All the samples have no puncture, flashover or cracking.									

Note：Shunt 0.0019V/A.

Fulfilled the requirements, the test waveforms were shown in fig C.5.

4 Test to verify long term stability under continuous operating voltage

Samples	307	308	309
U_{1mADC}, kV	5.24	5.23	5.23
U_{ct}, kV_{rms}	3.33	3.33	3.33
Charge rate,%	90.0	90.1	90.1
U_{2mAAC}, before test	3.88	3.89	3.89
U_{2mAAC}, after test	4.01	4.02	4.00
Change rate, %	+3.35	+3.34	+2.83
Power losses P_{start}, 3h, W	0.879	0.953	0.804
Power losses P_{100h}, W	0.760	0.844	0.707
Power losses P_{200h}, W	0.748	0.832	0.710
Power losses P_{300h}, W	0.738	0.825	0.695
Power losses P_{400h}, W	0.813	0.905	0.785
Power losses P_{500h}, W	0.736	0.817	0.689
Power losses P_{600h}, W	0.704	0.781	0.663
Power losses P_{700h}, W	0.766	0.847	0.718
Power losses P_{800h}, W	0.747	0.826	0.700
Power losses P_{900h}, W	0.774	0.853	0.720
Power losses P_{end}, 1000+8h,W	0.737	0.815	0.696
P_{min}, W	0.704	0.781	0.663
Any increase of power losses from P_{min} during the remaining test period, P_{max}	0.774	0.853	0.720
$P_{all.max}$, W	0.879	0.953	0.804
P_{max} / $1.3P_{min}$	0.846	0.840	0.835
$P_{all.max}$ /1.1 P_{start}	0.909	0.909	0.909

Because $P_{max} \leqslant 1.3P_{min}$， $P_{all.max} \leqslant 1.1P_{start}$, the samples fulfilled the requirements.

Note：The temperature of blocks:115±4℃.

Fulfilled the requirements, the accelerated ageing curves were shown in fig 1.

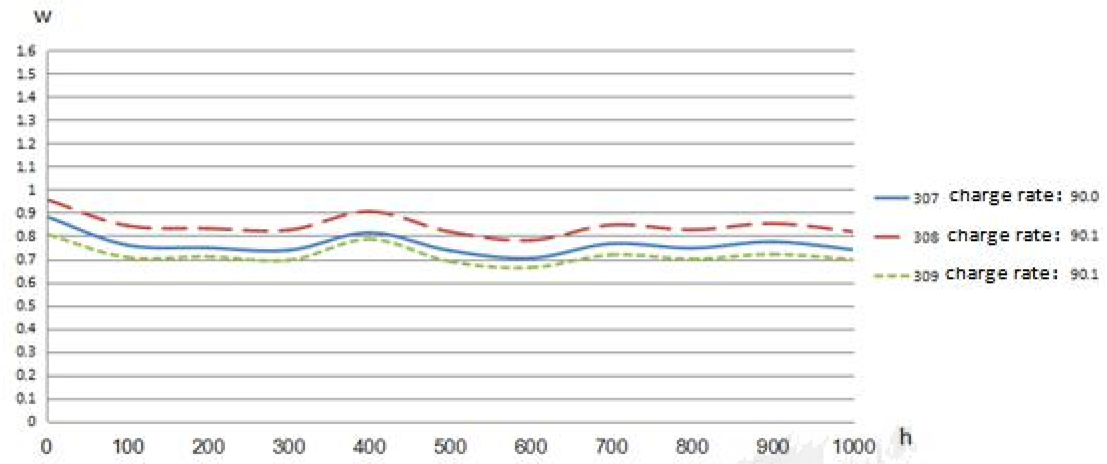

Fig 1 The Accelerated ageing curve of samples

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Appendix A: Sample instruction

Sample instruction:

1) 19 resistors, number EETC02-23/01/20-0051-301~ EETC02-23/01/20-0051-319， short for 301~319 in report.

Appendix B: Main test device

NO.	Device name	Device NO.	Measurement	Uncertainty /Accuracy	Calibration institution	Expiration date
1	impulse current generator	EETC02-0003	8/20 μs 40 kA 4/10 μs 130 kA	U_{rel}=0.015 k=2	National center for high voltage measurement	2023-06-23
2	impulse current generator	EETC02-0005	8/20 μs 40 kA 30 kV 4/10 μs 2 kA 30 kV	U_{rel}=0.015 k=2 U_{rel}=0.018 k=2	National center for high voltage measurement	2023-06-29
3	Steep current impulse generator	EETC02-0004	8/20 μs 40 kA 30 kV 30/80 μs 2 kA 30 kV	U_{rel}=0.015 k=2 U_{rel}=0.018 k=2	National center for high voltage measurement	2023-06-29
4	DC reference voltage tester	EETC02-0049	DC 0~9 kV	U_{rel}=0.008 k=2	Hubei province meteorological metrological verification station	2023-07-12
5	Accelerated aging device for MO resistor	EETC02-0036	115℃	U_{rel} =0.3℃k=2	Hubei province meteorological metrological verification station	2023-08-03
			0~10kV	U_{rel}=0.013 k=2	National center for high voltage measurement	2024-03-08

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Appendix C The typical test waveform

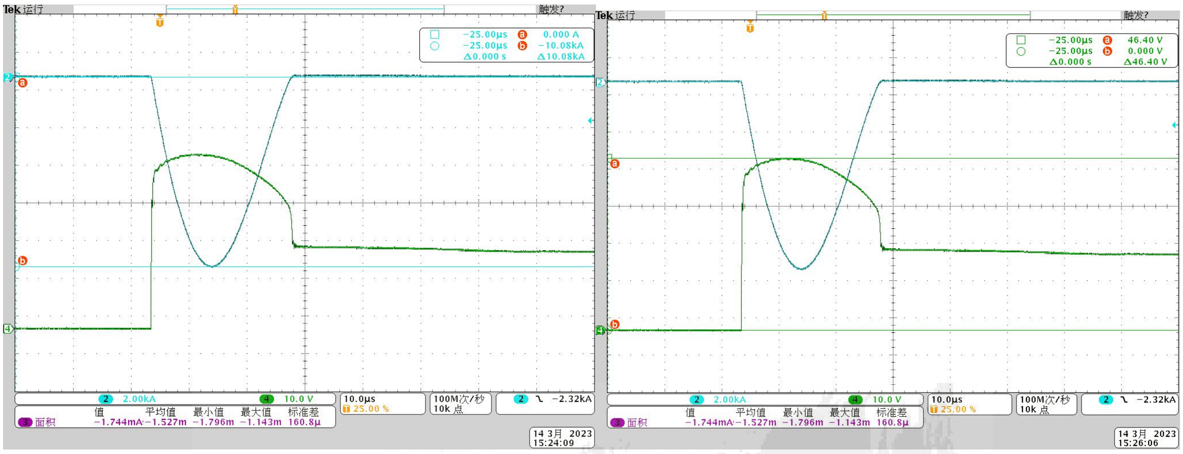

Fig C.1 Lightning impulse current and residual voltage waveform (sample 301, shunt 0.025V/A, divider K_d=206.8)

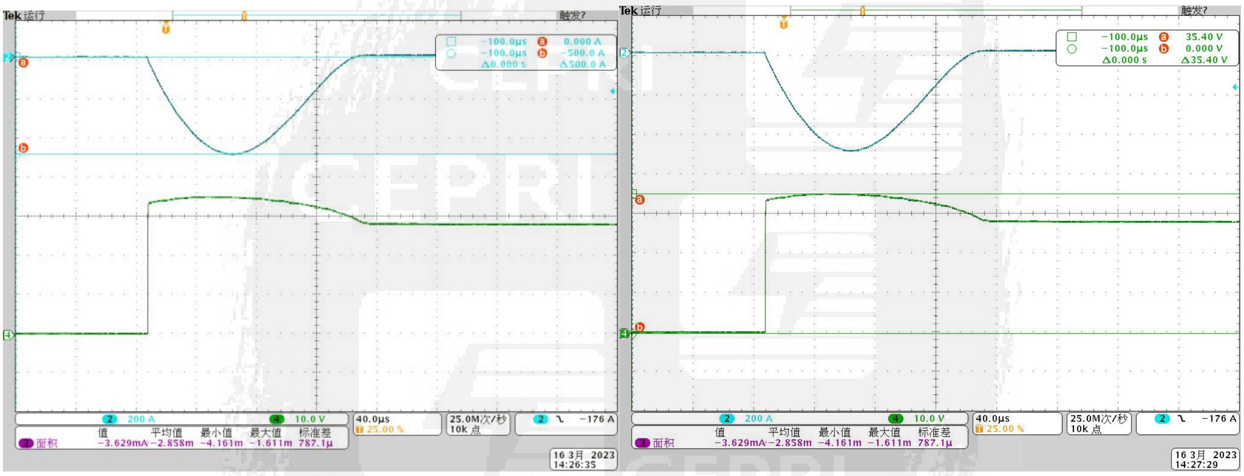

Fig C.2 Switching impulse current and residual voltage waveform (sample 301, shunt 0.025V/A, divider K_d=206.8)

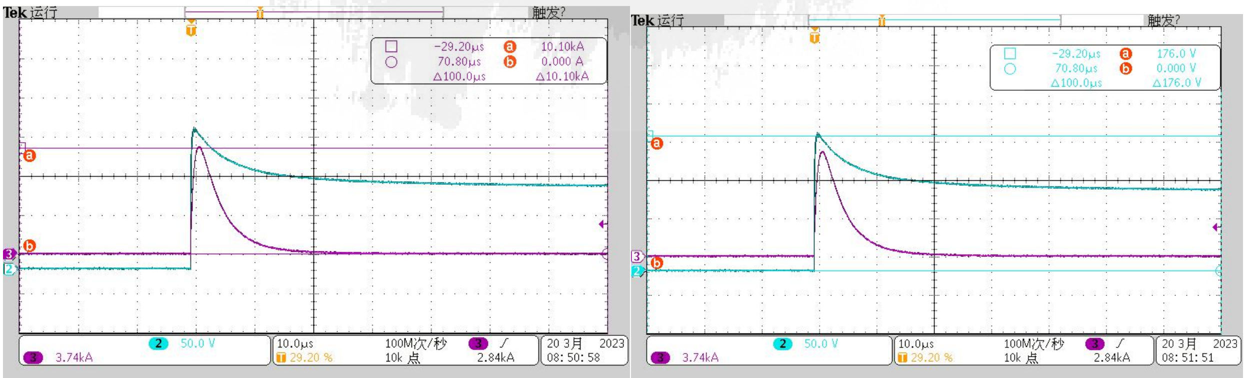

Fig C.3 Steep impulse current and residual voltage waveform (sample 301, shunt 0.0267V/A, divider K_d=59.8)

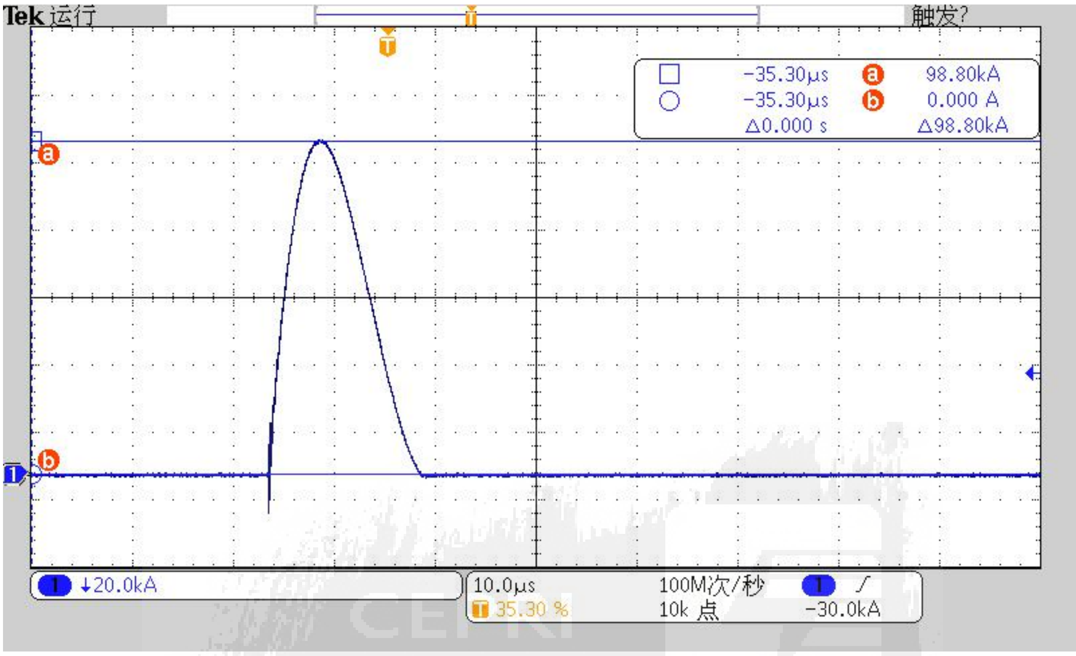

Fig C.4 Waveform of 304 conditioning test (first impulse)

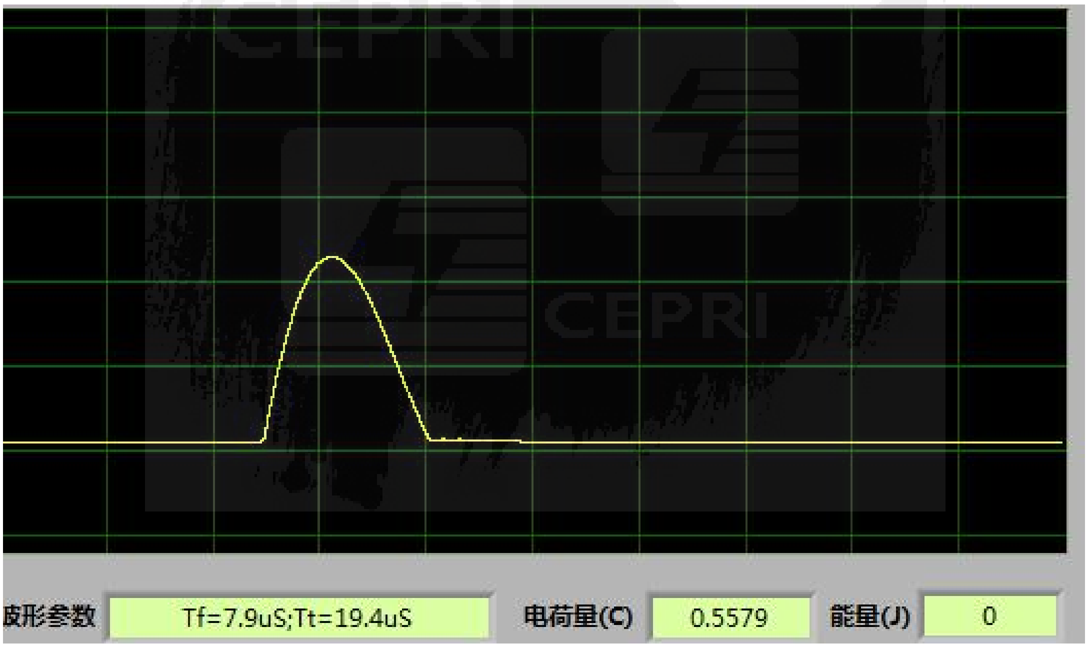

Fig C.5 The 1st time of sample 310, Repetitive charge transfer withstand, 0.0019V/A

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Appendix D: Photos of the arrester

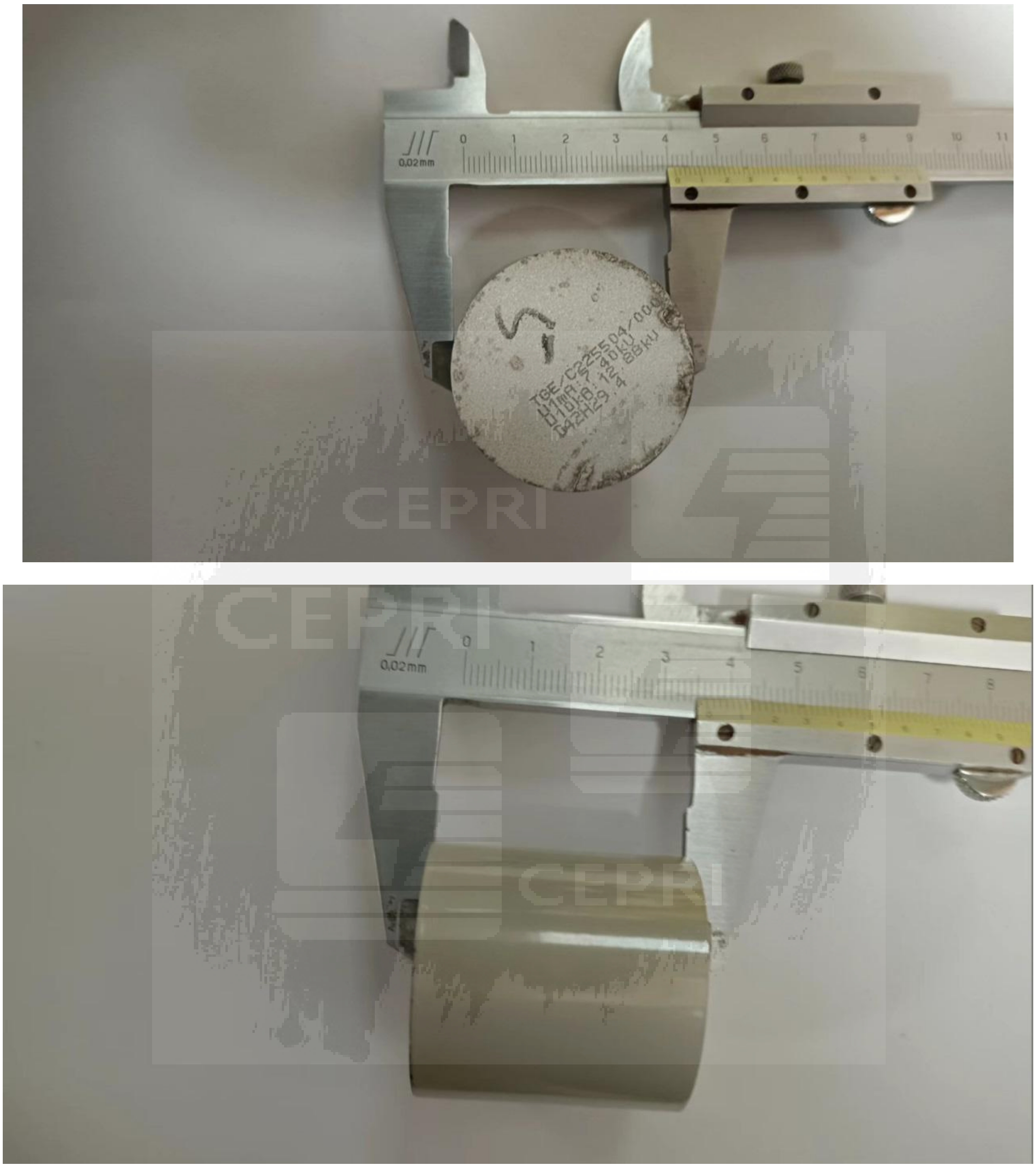

Fig D1: Outside view of MO resistor (Φ42mm×23.5mm)