

Test Document

Report No.: HBA 09420 P

Copy No.: 0

Contents: 13 Sheets

Test object: Metal oxide surge arresters, nominal discharge current 10 kA and 20 kA

Type: 3EP2 ...-1..2.-.... 3EP2 ...-1..3.-....
3EP2 ...-2..2.-.... 3EP2 ...-2..3.-....
3EP2 ...-3..3.-.... 3EP2 ...-3..4.-....
3EP2 ...-4..5.-....

Manufacturer: Siemens AG, PTD H 46

Client: Siemens AG, PTD H 43

Date of test: August 2003

Testing station: Siemens AG, Arrester Test Laboratory, PTD H 42, High Voltage Test Laboratory
PTD HTTP

Applied test specifications:

IEC 60099-4 Ed. 1.2 (2001)

IEC Publ. 60060-1, (1989)

IEEE C62.11-1999

Tests Performed:

Type test:

- Insulation withstand tests on the arrester housing (part of type test)

Test Result:

The test object has passed the test stated above without any objection. The results obtained and the performance proved of the test object comply with the requirements of the specifications mentioned above.

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Göhler
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High Voltage Surge arresters



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High Voltage Surge arresters

Berlin, April 19, 2004

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3 Technical data of the arresters

3.1 Type 3EP2 ...-1..2.-....

Maximum rated voltage	240 kV
Maximum continuous operating voltage	192 kV
Nominal discharge current	10 kA
Long duration current impulse capability	500 A / 2 ms
Line discharge class	2
Thermal energy discharge capability	5 kJ / kV_{rated}
Single impulse energy discharge capability (>4 ms)	2.6 kJ / kV_{rated}
High current impulse capability	100 kA

3.2 Type 3EP2 ...-1..3.-....

Maximum rated voltage	240 kV
Maximum continuous operating voltage	192 kV
Nominal discharge current	10 kA
Long duration current impulse capability	500 A / 2 ms
Line discharge class	3
Thermal energy discharge capability	5.5 kJ / kV_{rated}
Single impulse energy discharge capability (>4 ms)	3 kJ / kV_{rated}
High current impulse capability	100 kA

3.3 Type 3EP2 ...-2..2.-....

Maximum rated voltage	360 kV
Maximum continuous operating voltage	288 kV
Nominal discharge current	10 kA
Long duration current impulse capability	850 A / 2 ms
Line discharge class	2
Energy discharge capability	5 kJ / kV_{rated}
Single impulse discharge capability	3.8 kJ / kV_{rated}
High current impulse capability	100 kA

3.4 Type 3EP2 ...-2..3.-....

Maximum rated voltage	360 kV
Maximum continuous operating voltage	288 kV
Nominal discharge current	10 kA
Long duration current impulse capability	850 A / 2 ms
Line discharge class	3
Energy discharge capability	8 kJ / kV_{rated}
Single impulse discharge capability	4 kJ / kV_{rated}
High current impulse capability	100 kA

3.5 Type 3EP2 ...-3..3.-....

Maximum rated voltage	396 kV
Maximum continuous operating voltage	301 kV
Nominal discharge current	20 kA
Long duration current impulse capability	1200 A / 2 ms
Line discharge class	3
Energy discharge capability	8 kJ / kV _{rated}
Single impulse discharge capability	5.3 kJ / kV _{rated}
High current impulse capability	100 kA

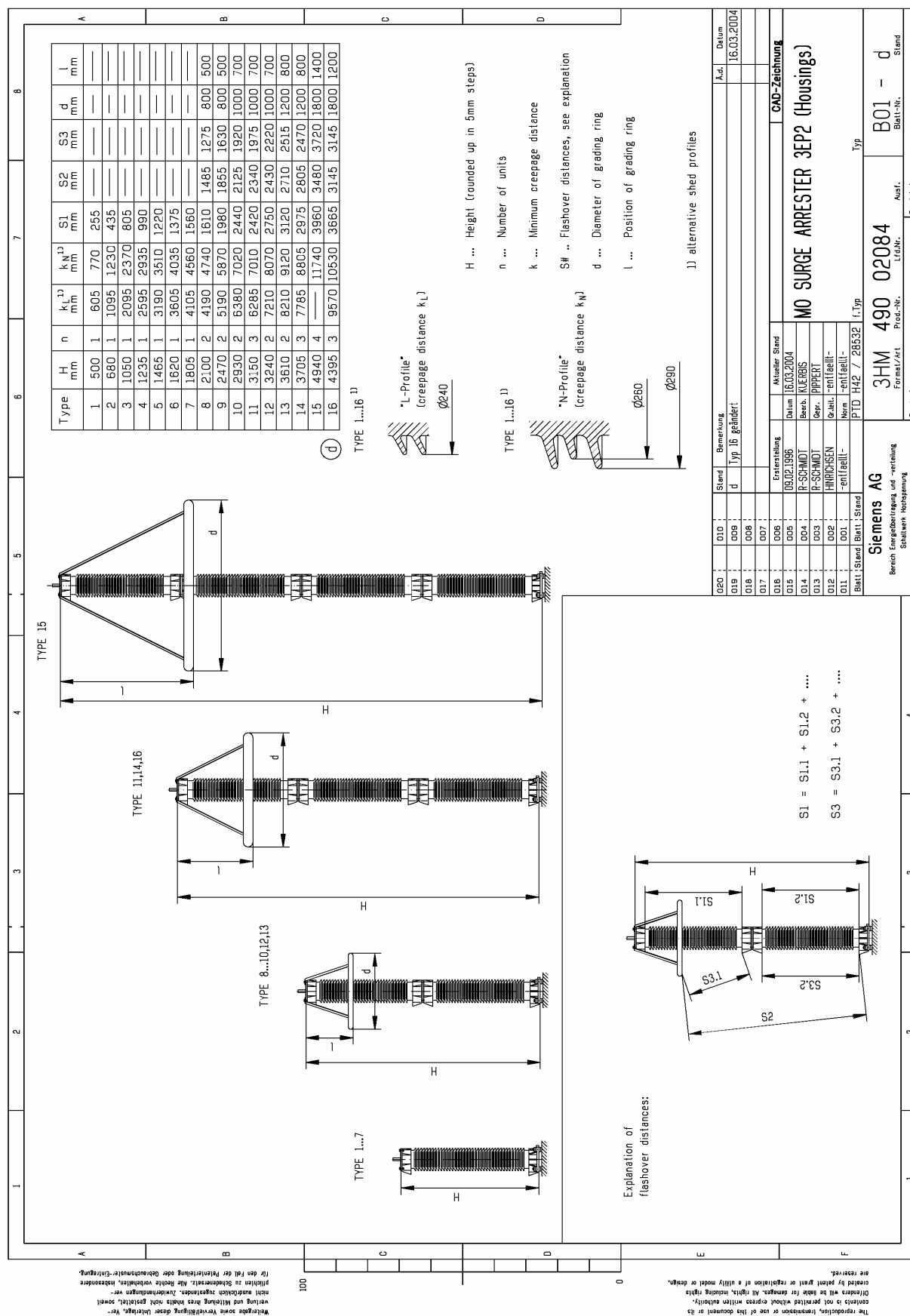
3.6 Type 3EP2 ...-3..4.-....

Maximum rated voltage	468 kV
Maximum continuous operating voltage	374 kV
Nominal discharge current	20 kA
Long duration current impulse capability	1200 A / 2 ms
Line discharge class	4
Energy discharge capability	10 kJ / kV _{rated}
Single impulse discharge capability	5.6 kJ / kV _{rated}
High current impulse capability	100 kA

3.7 Type 3EP2 ...-4..5.-....

Maximum rated voltage	468 kV
Maximum continuous operating voltage	374 kV
Nominal discharge current	20 kA
Long duration current impulse capability	1600 A / 2 ms
Line discharge class	5
Energy discharge capability	13 kJ / kV _{rated}
Single impulse discharge capability	7.8 kJ / kV _{rated}
High current impulse capability	150 kA

4 Dimensional drawing



5 Insulation withstand tests

The insulation withstand voltages of all arrester housings are given in the table below.

Housing type ¹⁾	Insulation withstand level of arrester housing				
	Power-frequency voltage 50 Hz, 1 min / kV		Lightning impulse Voltage / kV	Switching impulse Voltage / kV	
	dry	wet		dry	wet
1	71	56	148	122	102
2	116	96	252	204	174
3	217	177	467	362	322
4	268	218	574	446	396
5	328	268	708	558	488
6	383	303	798	620	550
7	423	343	905	724	624
8	350	270	700	540	460
9	430	350	900	680	600
10	480	400	1050	780	700
11	480	400	1050	780	700
12	560	480	1200	900	800
13	630	550	1350	1000	900
14	600	530	1300	1000	900
15	800	750	1800	1175	1175
16	750	680	1700	1100	1050

1) acc. to drawing 3 HM 490 02084 (see sheet no. 5)

A dielectric test, consisting of a power-frequency voltage test and a switching impulse voltage test, each under dry and wet conditions, and a standard lightning impulse voltage test (test circuits see sheet-nos. 12 and 13) was performed according to IEC 60060-1 (1989) on three arrester housings (internal parts removed):

- Type 7 (highest specific voltage stress, one unit and longest arrester unit)
- Type 9 (highest specific voltage stress, multi unit)
- Type 15 (longest arrester)

The arresters were assembled on a support of 2.2 m height.

5.1 Test Result

Atmospheric conditions for Type 7 and 9:

T = 23 °C

p = 1016 mbar

RH = 63 % (h= 13.1 g/m³)

Atmospheric conditions for Type 15:

T = 22 °C

p = 1012 mbar

RH = 61 % (h= 11.9 g/m³)

k_1 = air density correction factor

k_2 = humidity correction factor

$k_t = k_1 \cdot k_2$ correction factor

	Housing type	Condition	k_1	k_2	k_t
Lightning impulse voltage	7	dry	0.9928	1.0194	1.0121
	9	dry	0.9928	1.0216	1.0143
	15	dry	0.9922	1.0102	1.0024
Switching impulse voltage	7	dry	0.9928	1.0216	1.0143
		wet	0.9947	-	0.9947
	9	dry	0.9939	1.0182	1.0120
		wet	0.9958	-	0.9958
	15	dry	0.9963	1.0048	1.0011
		wet	0.9963	-	0.9963
Power-frequency voltage	7	dry	0.9980	1.0070	1.0050
		wet	0.9987	-	0.9987
	9	dry	0.9982	1.0066	1.0047
		wet	0.9988	-	0.9988
	15	dry	0.9984	1.0024	1.0009
		wet	0.9986	-	0.9986

5.1.1 Table of withstand voltage values

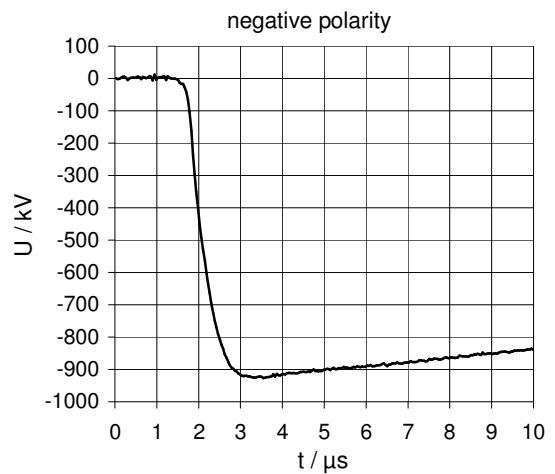
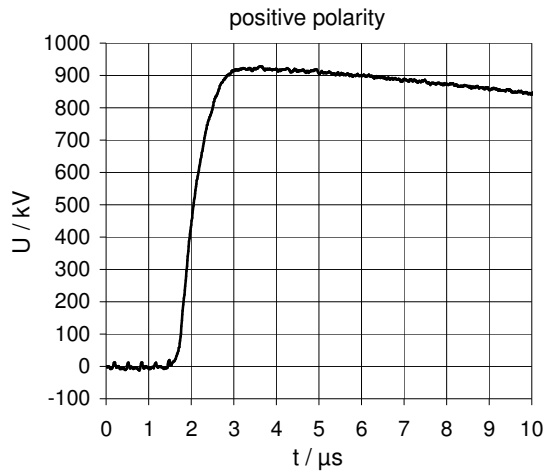
	Housing Type	Condition	Polarity	Required voltage / kV	Corrected voltage / kV	Applied voltage / kV	Test result
Lightning impulse voltage 1.2/50 μ s	7	dry	positive negative	905 905	916 916	920 920	imp / flash 15 / 0 15 / 0
	9	dry	positive negative	900 900	913 913	914 914	15 / 0 15 / 0
	15	dry	positive negative	1800 1800	1804 1804	1805 1805	15 / 0 15 / 0
Switching impulse voltage 250/2500 μ s	7	dry	positive negative	724 724	734 734	735 735	imp / flash 15 / 0 15 / 0
		wet *)	positive negative	624 624	621 621	625 625	15 / 0 15 / 0
	9	dry	positive negative	680 680	688 688	690 690	15 / 0 15 / 0
		wet *)	positive negative	600 600	599 599	600 600	15 / 0 15 / 0
	15	dry	positive negative	1175 1175	1176 1176	1178 1178	15 / 0 15 / 0
		wet *)	positive negative	1175 1175	1171 1171	1172 1172	15 / 0 15 / 0
Power-frequency voltage 50 Hz	7	dry wet *)		423 343	425 343	425 344	1 min no flash
	9	dry wet *)		430 350	432 350	432 350	1 min no flash
	15	dry wet *)		800 750	801 749	802 750	1 min no flash

*) Resistivity of water: 102 μ S/cm (98 Ω m)
Precipitation rate vertical / horizontal: 1.5...1.8 mm/min

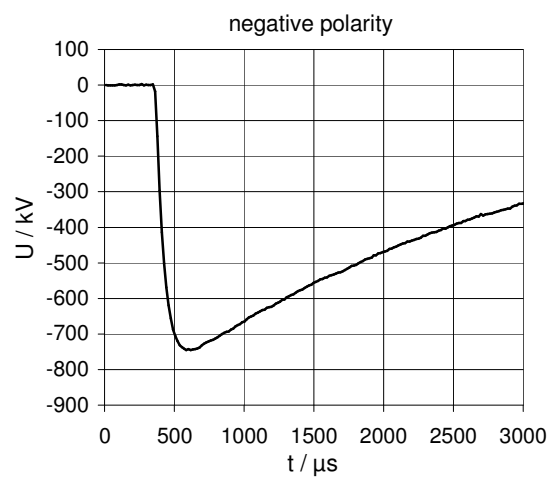
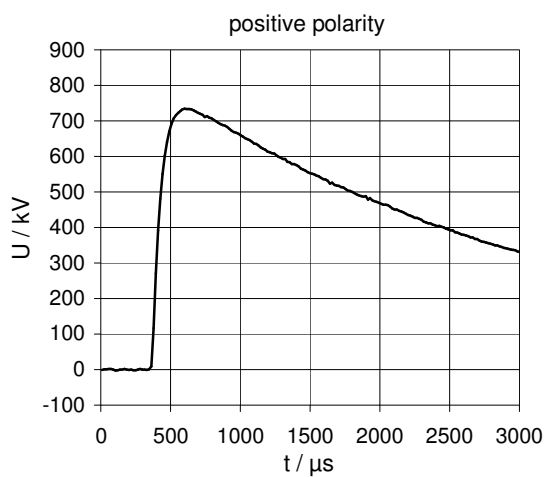
The test samples have passed the test without any flashover (oscillograms see sheet nos. 9 to 11).

5.1.2 Oscillograms

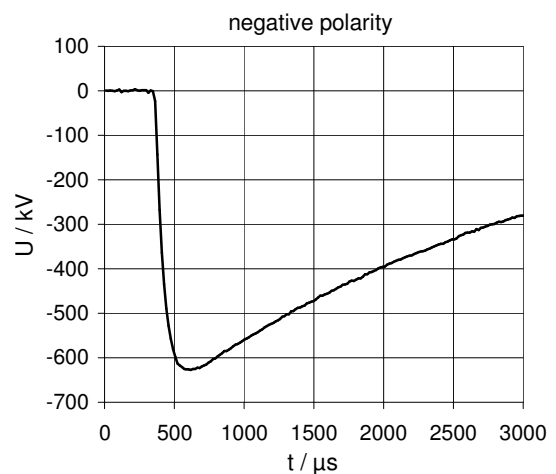
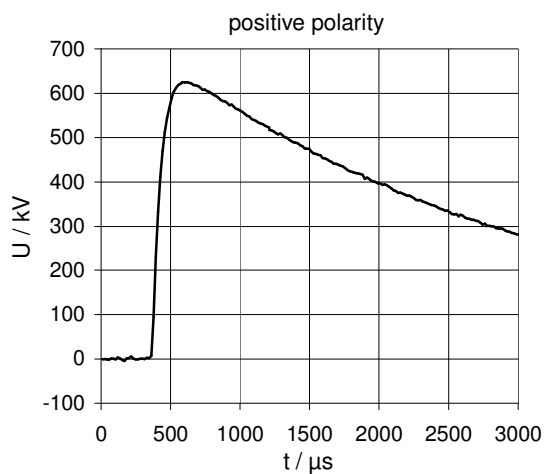
5.1.2.1 Housing type 7, Lightning impulse voltage



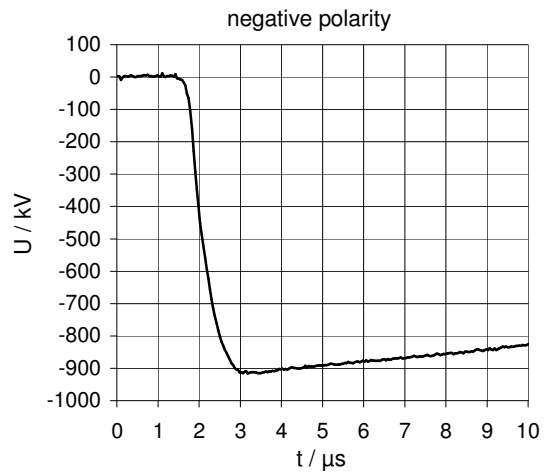
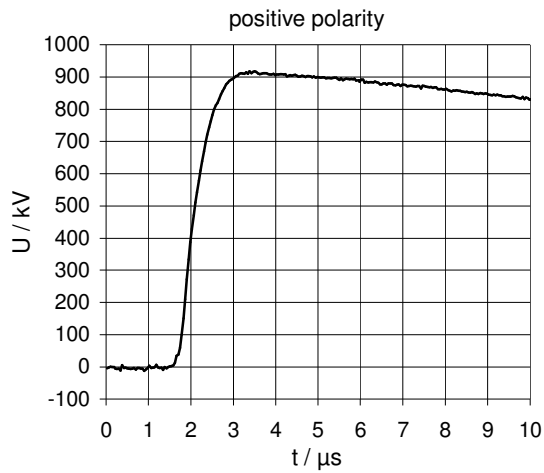
5.1.2.2 Housing type 7, Switching impulse voltage - dry



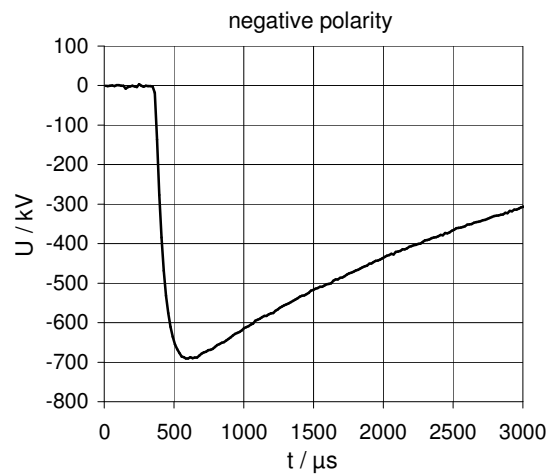
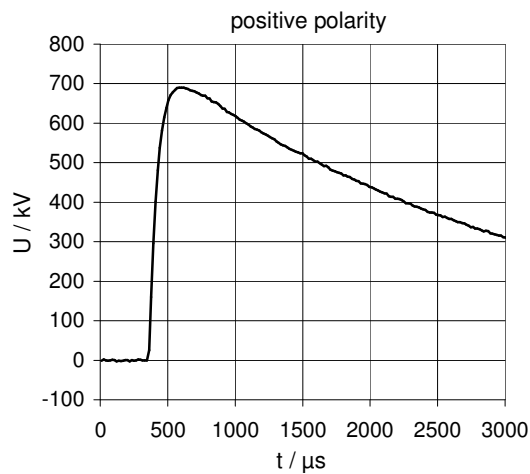
5.1.2.3 Housing type 7, Switching impulse voltage - wet



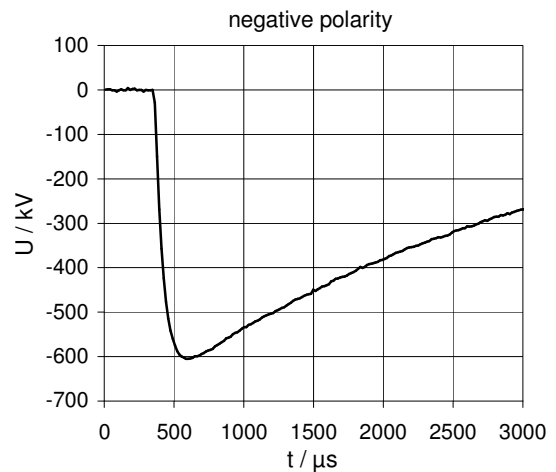
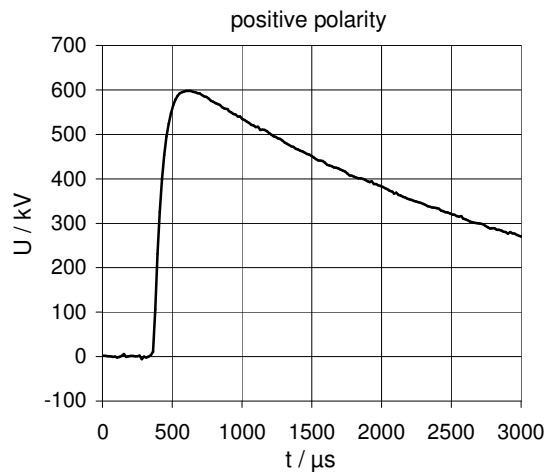
5.1.2.4 Housing type 9, Lightning impulse voltage



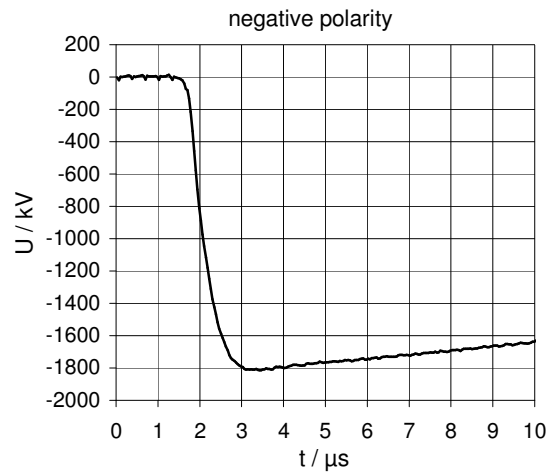
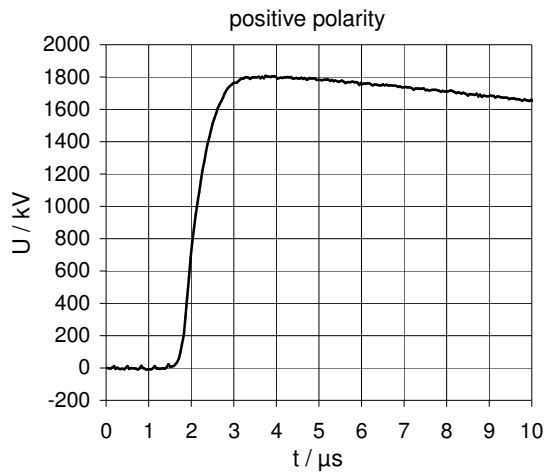
5.1.2.5 Housing type 9, Switching impulse voltage - dry



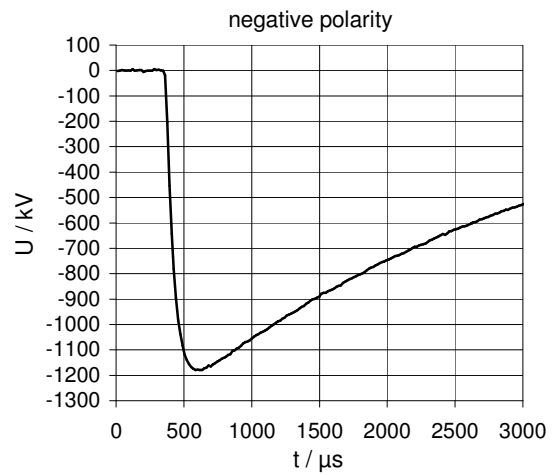
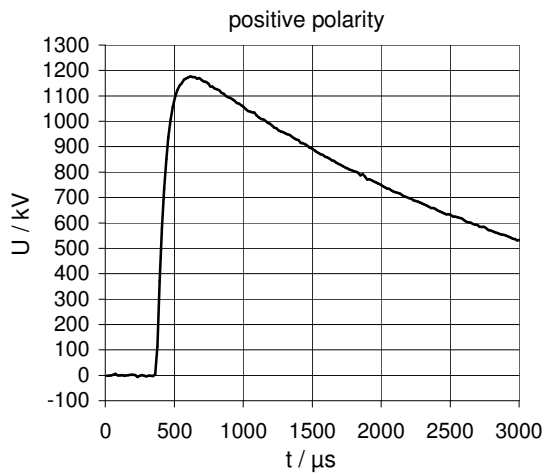
5.1.2.6 Housing type 9, Switching impulse voltage - wet



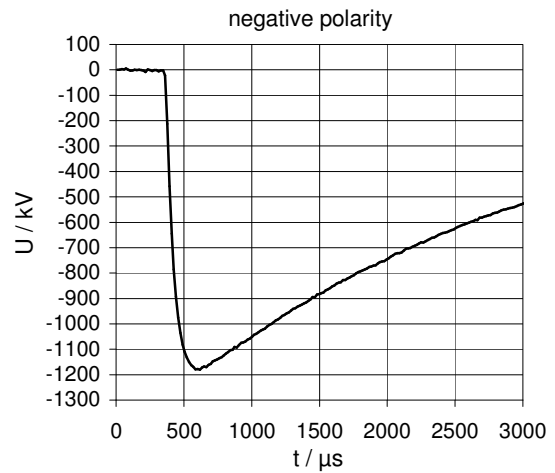
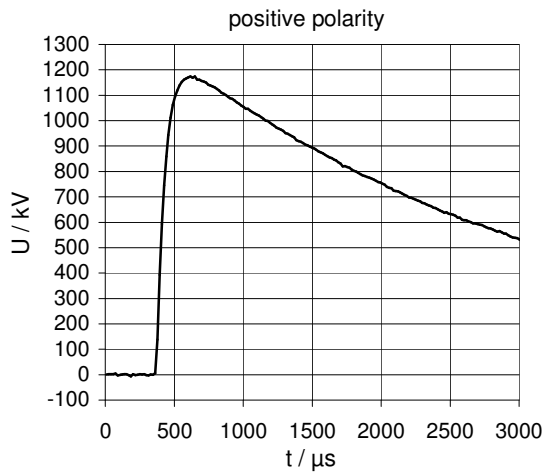
5.1.2.7 Housing type 15, Lightning impulse voltage



5.1.2.8 Housing type 15, Switching impulse voltage – dry



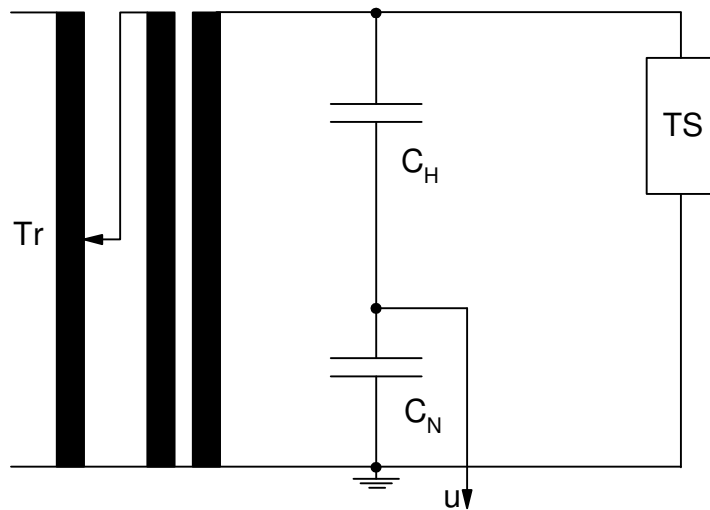
5.1.2.9 Housing type 15, Switching impulse voltage - wet



5.2 Technical data of test circuit

5.2.1 Insulation withstand test (Power-frequency voltage)

Transformer: Rated voltage	kV	1200
Rated power	kVA	1500



Tr.... Transformer
TS... Test sample

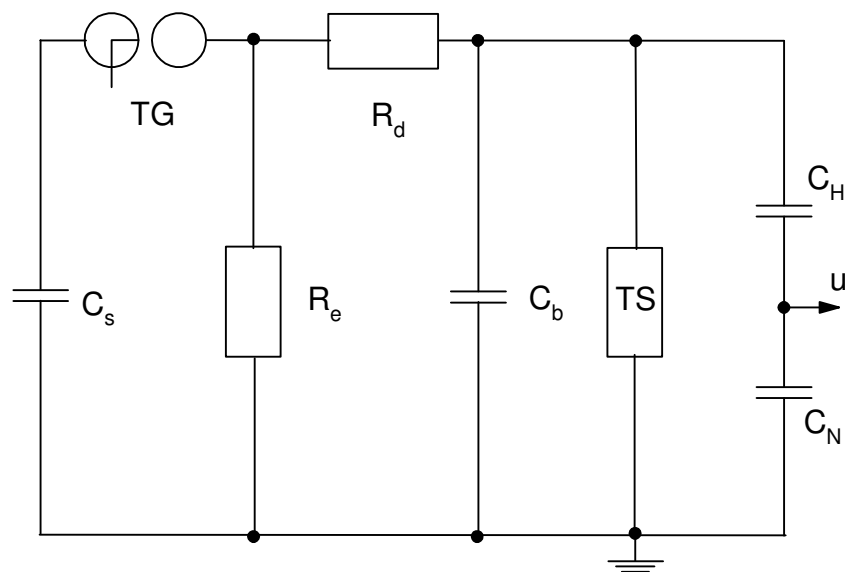
Voltage measurement: u

Capacitive divider: $C_H = 168 \text{ pF}$, $C_N = 1.3 \text{ }\mu\text{F}$
AC Peak Voltmeter Haefely type 51
Oscilloscope Tektronix type 2430

Test sample: arrester housing

5.2.2 Insulation withstand test (Lightning impulse voltage and Switching impulse voltage)

Surge circuit:	Surge capacitance	nF	44	44
	Load capacitance	nF	0.56	0.56
	Front resistance	kΩ	0.5	37
	Discharge resistance	kΩ	1.6	75
	Test wave front time	μs	1.2	250



TG... Trigger spark gap
 TS... Test sample
 Cs... Surge capacitor
 Cb... Load capacitor
 Rd... Front resistor
 Re... Discharge resistor

Voltage measurement: u

Capacitive divider: $C_H = 262 \text{ pF}$, $C_N = 489 \text{ nF}$
 Peak Voltmeter Haefely type 64 M
 Oscilloscope Tektronix type 2430

Test sample: arrester housing