TRANSFORMER

Type: TRP 60000-145/E
Serial No. : ET0817 - 463829

ROUTINE TESTS:	TEST REPORT No.:	Page :	STANDARD
Measurement of voltage ratio and check of phase displacement	463829	2, 2a / 8	IEC 60076-1 (11.3)
Measurement of winding resistance	463829	2, 2a, 3 / 8	IEC 60076-1 (11.2)
Measurement of short-circuit impedance and load losses	463829	4, 4a, 5 / 8	IEC 60076-1 (11.4)
Measurement of no-load loss and current	463829	6 / 8	IEC 60076-1 (11.5)
Insulation resistance measurement of the windings	463829	7 / 8	IEC 60076-1 (11.1.2)
Applied voltage test (AV)	463829	7 / 8	IEC 60076-3 (10)
Line terminal AC withstand test (LTAC)	463829	7 / 8	IEC 60076-3 (12)
Test on on-load tap-changer	463829	7 / 8	IEC 60076-1 (11.7)
Test on marshalling kiosk, wirings and protective devices	463829	7 / 8	
Check of core and frame insulation	463829	7 / 8	IEC 60076-1 (11.12)
Induced voltage test with partial discharge measurement (IVPD)	463829	8 / 8	IEC 60076-3 (11.3)
Lightning impulse test (LI + LIC)	U2734	---	IEC 60076-3 (13.2; 13.3)
Measurement of dielectric strenght of oil	210/18	---	IEC 60156
Leak testing with pressure	OL463829	---	IEC 60076-1 (11.8)
Test of bushing current transformer	463829	7 / 8	
Measurement of dissipation factor (tanδ) of the insulation system capacitances	K1089	---	IEC 60076-1 (11.1.2)
Measurement of zero-sequence impedance	463829	4 / 8	IEC 60076-1 (11.6)
Chromatographic analysis of gases dissolved in oil	18/270, 18/271, 18/272	---	IEC 61181 (Tbl.A.1)

TYPE AND SPECIAL TESTS:			
Frequency response measurement	F454	---	IEC 60076-18
Temperature-rise test	Z1200	---	IEC 60076-2
Determination of sound levels	B1921	---	IEC 60076-10
Measurement of magnetizing current at 400 V and 50 Hz	463829	6 / 8	
Tank vacuum deflection test	V463829	---	IEC 60076-1 (11.9)
Tank pressure deflection test	P463829	---	IEC 60076-1 (11.10)

ALL SPECIFIED TESTS AND MEASUREMENTS WERE PERFORMED.
TRANSFORMER PASSED THE TESTS AND MEASUREMENTS MET SPECIFIED TOLERANCES.

The test was carried out in the presence of :

KONČAR Distributivni i specijalni transformatori d.d. Zagreb

Tested by :	Approved by :	Date and stamp :	ISPITNA STANICA TESTING STATION 4
V. Gojević, dipl.ing.	Vedran Maljković, dipl.ing.	07.06.2018.	

TRANSFORMER

Serial No. : ET0817 - 463829

RATING PLATE

CE KONČAR D&ST

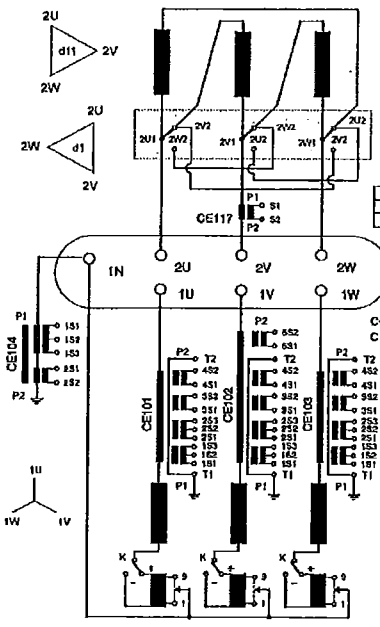
THREE PHASE TRANSFORMER

Type	TRP60000-145/E	No.	ET0817-463829	Year of Manufacture	2018.
Rated Frequency	50 Hz	Number of Phases	3	Standard	IEC 60076
HV: Um145/LI550/SI460/AC230 HV-N:-/LI-/AC95 LV: Um36/LI170/AC70				Vector Group Symbol	YNd11(d1)
				Type of Cooling	ONAN/ONAF(65/100%)
				Rated Power	60000 kVA

Position	H.V.	L.V.	H.V.	L.V.		Imp. Voltage
1	145226	33000 V	238.5	1049.7 A		20,27(20,26) %
7	132000		262.4			19,28(19,28) %
19	105547		328.2			18,40(18,40) %

Network Short-circuit Power	5700 MVA	Max. Duration of Short-circuit	3 s		
PEI 0,99812 pu	k_{PEI} 0,30329 pu	P_0 17,08 kW	P_{C0} 0 kW		
Mass of the Active Part	55.3 t	Mass of the Conductor	18.9 t	P_k	185,68 (184,97) kW
Conductor Material	COPPER	Core Material	GOES		
Average Winding Temp. Rise	65 K	Top Oil Temp. Rise	60 K	Untanking Mass	58.2 t
Transformer Transportation Mass	68.0 t	Mass/Volume of Oil	21.5 t / 24160 l	Transf. Mass	85.5 t
Cooling Plant Mass	11.0 t	Transformer / Cooling Bank Saund power level (L_{WA})	60,5 / 75,8 dB(A)		

Insulating oil: Inhibited oil according to IEC60296



Connection L.V. Winding	Vector Group Symbol
2U1 - 2V2 2V1 - 2W2 2W1 - 2U2	YNd11
2U1 - 2W2 2V1 - 2U2 2W1 - 2V2	YNd1

Winding	ONAN	ONAF
L.V. (K)		
H.V. (K)		

Pos. of O.L.T.C.	H.V. WINDING Voltage (V)	H.V. WINDING Current (A)	L.V. WINDING Voltage (V)	L.V. WINDING Current (A)	Rated Power (kVA)
1	145226	238.5			
2	143022	242.2			
3	140818	246.0			
4	138613	249.9			
5	136409	254.0			
6	134204	258.1			
7	132000	262.4	33000	1049.7	60000
8	129796	266.9			
9	127591	271.5			
10	125387	276.3			
11	123182	281.2			
12	120978	286.3			
13	118774	291.7			
14	116569	297.2			
15	114365	302.9			
16	112160	308.9			
17	109956	315.0			
18	107752	321.5			
19	105547	328.2			

Current transformers:
CE101=CE103= 1S1-1S2-1S3: 600-1200/1A; cl.PX/Ek≥800V; Ie@400V≤40mA; Rct@75°C≤3Ω *
2S1-2S2-2S3: 600-1000/1A; cl.PX/Ek≥600V; Ie@300V≤30mA; Rct@75°C≤3Ω *
3S1-3S2: 300/1A; 5P20; 30VA
4S1-4S2: 400/1A; cl.PX/Ek≥400V; Ie@200V≤50mA; Rct@75°C≤4Ω

CE102= 1S1-1S2-1S3: 600-1200/1.5A; cl.PX/Ek≥800V; IE@400V≤40mA; Rct@75°C≤3Ω *
2S1-2S2-2S3: 500-1000/1A; cl.PX/Ek≥600V; Ie@300V≤30mA; Rct@75°C≤3Ω *
3S1-3S2: 300/1A; 5P20; 30VA
4S1-4S2: 400/1A; cl.PX/Ek≥400V; Ie@200V≤50mA; Rct@75°C≤4Ω *
5S1-5S2: 340/1.5A; cl.3Fs5; 10VA

CE117= 1060/1.5A; cl3Fs5; 10VA

CE104= 1S1-1S2-1S3: 600-1200/1A; PX; Ek≥100(Rct+15)V; Ie≤40mA@; Ek/2; Rct≤3Ω *
2S1-2S2: 400/1A; PX; Ek≥20(Rct+16); Ie≤50mA@; Ek/2; Rct≤4Ω

* Characteristics are referring to high ratio

MADE BY KONČAR D&ST IN ZAGREB,CROATIA

Note : **Transformer is delivered in vector group YNd1.**

KONČAR D&ST

TRANSFORMER TEST REPORT

Serial No. : 463829

CUSTOMER :

1. 0. RATING VALUES

Transformer type :	TRP 60000-145/E		Tap-changer type :	VMIII500Y-72,5/B-10191W	
Serial No. :	463829		Serial No. :	1942810	
Winding :	H.V.	L.V.			
Insulation level :	HV: LI550 AC230, HV-N: LI-/AC95	LI170 AC70		Part No. :	ET0817
Rated power (kVA)	60000	60000		Transformer transport mass (t)	68,0
Rated voltage - tap 1 (V)	145226			Mass of oil (t)	21,5
Rated voltage - tap 7 (V)	132000	33000		Transformer mass (t)	85,5
Rated voltage - tap 10 (V)	125387			Frequency (Hz)	50,0
Rated voltage - tap 19 (V)	105547			Vector group :	YNd11
Rated current - tap 1 (A)	238,5			Type of cooling :	ONAN / ONAF
Rated current - tap 7 (A)	262,4	1049,7		Tested in acc. :	IEC 60076
Rated current - tap 10 (A)	276,3				
Rated current - tap 19 (A)	328,2				

2. 0. TEST RESULTS

2. 1. 1. Impedance voltage at 60 MVA and temperature 75°C

Winding :	H.V. / L.V.				
Tap position	1	7	10	19	
Rated (%)	----	----	----	----	
Guaranteed (%)	18 - 21	18 - 21	18 - 21	18 - 21	
Measured (%)	20,27	19,28	18,88	18,40	

2. 1. 2. Load losses at 60 MVA and 75°C

Rated (kW)	----	195,00	----	----	
Guaranteed (kW)	----	195,00	----	----	
Measured (kW)	184,49	185,68	186,77	262,87	

2. 3. No - load losses and no-load current

	No-load losses			No-load current at rated voltage and 60MVA	
Voltage (%)	90,0	100,0	110,1	Rated (%)	0,080
Rated (kW)	----	17,50	----	Guaranteed (30% tol.) (%)	0,104
Guaranteed (kW)	----	17,50	----	Measured (A)	0,330
Measured (kW)	12,46	17,08	21,45	Measured (%)	0,031

2. 4. Total losses at 60 MVA (load losses + no-load losses)

Tap position	1	7	10	19	
Rated (kW)	----	212,50	----	----	
Guaranteed (kW)	----	212,50	----	----	
Measured (kW)	201,57	202,76	203,85	279,95	

2. 5. Efficiency at 60 MVA

Winding H.V. / L.V. at tap position 7

Load (%)	25	50	75	100	125
Measured PF=1.0 (%)	99,81	99,79	99,73	99,66	99,59
Guaranteed (%)	-----	-----	-----	-----	-----
Measured PF=0.8 (%)	99,76	99,74	99,66	99,58	99,49
Guaranteed (%)	-----	-----	-----	-----	-----

2. 6. Regulation

			Load (%)	100	125
Guaranted PF=1.0 (%)	-----	-----	Measured (%)	2,17	2,71
Guaranted PF=0.8 (%)	-----	-----	Measured (%)	12,98	16,23

KONČAR D&ST

TRANSFORMER TEST REPORT

Serial No. : 463829

CUSTOMER :

1. 0. RATING VALUES

Transformer type :	TRP 60000-145/E		Tap-changer type :	VMIII500Y-72,5/B-10191W	
Serial No. :	463829		Serial No. :	1942810	
Winding :	H.V.	L.V.			
Insulation level :	HV: LI550 AC230, HV-N: LI-/AC95	LI170 AC70		Part No. :	ET0817
Rated power (kVA)	60000	60000		Transformer transport mass (t)	68,0
Rated voltage - tap 1 (V)	145226			Mass of oil (t)	21,5
Rated voltage - tap 7 (V)	132000	33000		Transformer mass (t)	85,5
Rated voltage - tap 10 (V)	125387			Frequency (Hz)	50,0
Rated voltage - tap 19 (V)	105547			Vector group :	YNd1
Rated current - tap 1 (A)	238,5			Type of cooling :	ONAN / ONAF
Rated current - tap 7 (A)	262,4	1049,7		Tested in acc. :	IEC 60076
Rated current - tap 10 (A)	276,3				
Rated current - tap 19 (A)	328,2				

2. 0. TEST RESULTS

2. 1. 1. Impedance voltage at 60 MVA and temperature 75°C

Winding :	H.V. / L.V.				
Tap position	1	7	10	19	
Rated (%)	----	----	----	----	
Guaranteed (%)	18 - 21	18 - 21	18 - 21	18 - 21	
Measured (%)	20,26	19,28	18,87	18,40	

2. 1. 2. Load losses at 60 MVA and 75°C

Rated (kW)	----	195,00	----	----	
Guaranteed (kW)	----	195,00	----	----	
Measured (kW)	183,83	184,97	185,96	262,24	

2. 3. No - load losses and no-load current

	No-load losses			No-load current at rated voltage and 60MVA	
Voltage (%)	90,0	100,0	110,1	Rated (%)	0,080
Rated (kW)	----	17,50	----	Guaranteed (30% tol.) (%)	0,104
Guaranteed (kW)	----	17,50	----	Measured (A)	0,330
Measured (kW)	12,46	17,08	21,45	Measured (%)	0,031

2. 4. Total losses at 60 MVA (load losses + no-load losses)

Tap position	1	7	10	19	
Rated (kW)	----	212,50	----	----	
Guaranteed (kW)	----	212,50	----	----	
Measured (kW)	200,91	202,05	203,04	279,32	

2. 5. Efficiency at 60 MVA

Winding H.V. / L.V. at tap position 7

Load (%)	25	50	75	100	125
Measured PF=1.0 (%)	99,81	99,79	99,73	99,66	99,59
Guaranteed (%)	-----	-----	-----	-----	-----
Measured PF=0.8 (%)	99,76	99,74	99,66	99,58	99,49
Guaranteed (%)	-----	-----	-----	-----	-----

2. 6. Regulation

			Load (%)	100	125
Guaranted PF=1.0 (%)	-----	-----	Measured (%)	2,17	2,71
Guaranted PF=0.8 (%)	-----	-----	Measured (%)	12,98	16,23

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TRANSFORMER TEST REPORT

Serial No. : 463829

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TRANSFORMER TYPE : TRP 60000-145/E

Part No. : ET0817

3. 0. Measurement of voltage ratio and check of phase displacement (measured by Tettex 2796)

Tap position	Phase 1U error (%)	Phase 1V error (%)	Phase 1W error (%)	Voltage (V)	Calculated ratio
1	-0,38	-0,37	-0,36	145226	4,401
2	-0,35	-0,35	-0,34	143022	4,334
3	-0,32	-0,32	-0,31	140818	4,267
4	-0,30	-0,29	-0,28	138613	4,200
5	-0,26	-0,26	-0,25	136409	4,134
6	-0,23	-0,23	-0,22	134204	4,067
7	-0,20	-0,20	-0,19	132000 / 33000	4,000
8	-0,17	-0,17	-0,16	129798	3,933
9	-0,14	-0,13	-0,13	127591	3,866
10	-0,10	-0,10	-0,09	125387	4,000
11	-0,03	-0,03	-0,02	123182	3,733
12	0,01	0,01	0,02	120978	3,666
13	0,05	0,05	0,06	118774	3,599
14	0,10	0,10	0,11	116569	3,532
15	0,15	0,15	0,15	114365	3,466
16	0,19	0,19	0,20	112160	3,399
17	0,23	0,23	0,24	109956	3,332
18	0,28	0,28	0,29	107752	3,265
19	0,33	0,33	0,34	105547	3,198
(H.V. / L.V.)	Vector group is :	YNd11			

3. 1. Measurement of winding resistance (Ω) (measurement at temperature 27°C)

Winding H.V. - tap position	1U - 1V	1U - 1W	1V - 1W		
1	0,888	0,889	0,889		
7	0,770	0,770	0,771		
10	0,709	0,709	0,709		
19	0,888	0,888	0,889		
Winding L.V.	2U - 2V	2U - 2W	2V - 2W		
in connection d11	0,0294	0,0295	0,0294		

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TRANSFORMER TEST REPORT

Serial No. : 463829

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TRANSFORMER TYPE : TRP 60000-145/E

Part No. : ET0817

3. 0.	Measurement of voltage ratio and check of phase displacement				(measured by Tettex 2796)
Tap position	Phase 1U error (%)	Phase 1V error (%)	Phase 1W error (%)	Voltage (V)	Calculated ratio
1	-0,37	-0,36	-0,36	145226	4,401
2	-0,34	-0,33	-0,33	143022	4,334
3	-0,31	-0,31	-0,30	140818	4,267
4	-0,29	-0,28	-0,28	138613	4,200
5	-0,26	-0,25	-0,25	136409	4,134
6	-0,23	-0,22	-0,22	134204	4,067
7	-0,19	-0,19	-0,19	132000 / 33000	4,000
8	-0,16	-0,16	-0,15	129798	3,933
9	-0,13	-0,12	-0,12	127591	3,866
10	-0,08	-0,07	-0,07	125387	4,000
11	-0,04	-0,03	-0,03	123182	3,733
12	0,00	0,00	0,01	120978	3,666
13	0,04	0,04	0,05	118774	3,599
14	0,10	0,10	0,10	116569	3,532
15	0,14	0,14	0,15	114365	3,466
16	0,18	0,19	0,19	112160	3,399
17	0,23	0,23	0,24	109956	3,332
18	0,28	0,28	0,28	107752	3,265
19	0,33	0,33	0,33	105547	3,198
(H.V. / L.V.)	Vector group is :	YNd1			

3. 1.	Measurement of winding resistance (Ω)			(measurement at temperature 27°C)	
Winding H.V. - tap position	1U - 1V	1U - 1W	1V - 1W		
1	0,888	0,889	0,889		
7	0,770	0,770	0,771		
10	0,709	0,709	0,709		
19	0,888	0,888	0,889		
Winding L.V.	2U - 2V	2U - 2W	2V - 2W		
in connection d1	0,0294	0,0293	0,0293		

KONČAR D&ST

TRANSFORMER TEST REPORT

Serial No. : 463829

TRANSFORMER TYPE : TRP 60000-145/E

Part No. : ET0817

3. 1. **Measurement of winding resistance (Ω)** **(measurement at temperature 27°C)**

Winding H.V. - tap position	1U - 1N	1V - 1N	1W - 1N		
1	0,444	0,445	0,445		
2	0,434	0,435	0,435		
3	0,425	0,425	0,425		
4	0,415	0,415	0,416		
5	0,405	0,405	0,406		
6	0,395	0,395	0,396		
7	0,385	0,386	0,386		
8	0,375	0,376	0,376		
9	0,366	0,366	0,366		
10	0,355	0,355	0,355		
11	0,366	0,366	0,367		
12	0,375	0,376	0,376		
13	0,385	0,386	0,386		
14	0,395	0,395	0,396		
15	0,405	0,405	0,406		
16	0,414	0,415	0,416		
17	0,425	0,425	0,425		
18	0,435	0,435	0,435		
19	0,444	0,444	0,445		

KONČAR D&ST

TRANSFORMER TEST REPORT

Serial No. : 463829

TRANSFORMER TYPE : TRP 60000-145/E

Part No. : ET0817

2. 1. Measurement of short-circuit impedance and load losses (L.V. in connection d11)

Combination		H.V. / L.V.	H.V. / L.V.	H.V. / L.V.	H.V. / L.V.	
Tap position		**1**	**7**	**10**	**19**	
Temperature	**(°C)**	**27**	**27**	**27**	**27**	
Frequency	**(Hz)**	**50**	**50**	**50**	**50**	
Measured voltage	(u-v)	17170	15650	13893	11193	
	(u-w)	17194	15667	13910	11203	
	(v-w)	17166	15649	13893	11195	
Average		17177	15655	13899	11197	
Constant		1	1	1	1	
VOLTAGE	**(V)**	**17177**	**15655**	**13899**	**11197**	
Measured current	(u)	139,3	161,4	162,3	189,2	
	(v)	138,8	160,9	161,8	188,8	
	(w)	139,6	161,8	162,6	189,6	
Average		139,2	161,4	162,2	189,2	
Constant		1	1	1	1	
CURRENT	**(A)**	**139,2**	**161,4**	**162,2**	**189,2**	
Measured power	(u)	14780	17630	16740	24500	
	(v)	22060	24160	21960	28010	
	(w)	20560	21930	19560	25310	
Total		57400	63720	58260	77820	
Constant		1	1	1	1	
LOAD LOSSES	(W)	57400	63720	58260	77820	
Calculated to	(kVA)	**60000**	**60000**	**60000**	**60000**	
	(A)	**238,5**	**262,4**	**276,3**	**328,2**	
LOAD LOSSES	**(W)**	**168504**	**168421**	**169056**	**234167**	
I2 R losses	(W)	124472	128208	129837	192178	
Stray losses	(W)	44032	40213	39219	41989	
Impedance voltage	**(V)**	**29430,4**	**25451,5**	**23676,3**	**19423,1**	
	(%)	**20,265**	**19,281**	**18,883**	**18,402**	
Temperature	**(°C)**	**75**	**75**	**75**	**75**	
I2 R losses	(W)	147276	151696	153624	227386	
Stray losses	(W)	37214	33986	33146	35487	
LOAD LOSSES	**(W)**	**184490**	**185682**	**186770**	**262873**	
Impedance voltage	**(V)**	**29430,0**	**25450,9**	**23676,8**	**19423,8**	
	(%)	**20,265**	**19,281**	**18,883**	**18,403**	
Ur	**(%)**	**0,307**	**0,309**	**0,311**	**0,438**	
Ux	**(%)**	**20,263**	**19,279**	**18,880**	**18,398**	

2. 2. Measurement of zero-sequence impedance (L.V. in connection d11)

Winding H.V. - tap position	Voltage (V)	Current (A)	Impedance (Ω)	Imped. (Ω / phase)	
1	1585,1	70,85	22,37	67,11	
7	1227,2	69,61	17,63	52,89	
10	1106,4	70,95	15,59	46,77	
19	870,3	80,25	10,84	32,52	

KONČAR D&ST

TRANSFORMER TEST REPORT

Serial No. : 463829

TRANSFORMER TYPE : TRP 60000-145/E

Part No. : ET0817

2.1.1. Measurement of short-circuit impedance at all taps (L.V. in connection d11)

Winding H.V. - tap position	Voltage (V)	Test current (A)	Rated voltage (V)	Rated current (A)	Losses at test current (27°C) (W)	Imp. voltage (%) at 27°C	Losses at 75°C (W)	Imp. voltage (%) at 75°C
1	14804	120,0	145226	238,5	42750	20,26	184818	20,26
2	14427	121,6	143022	242,2	42610	20,09	185170	20,09
3	14051	123,2	140818	246,0	42360	19,92	185267	19,92
4	13721	125,2	138613	249,9	42400	19,76	185517	19,76
5	13417	127,4	136409	253,9	42540	19,60	185743	19,60
6	13086	129,5	134204	258,1	42490	19,43	185800	19,43
7	12764	131,6	132000	262,4	42400	19,28	185844	19,28
8	12510	134,4	129798	266,9	42860	19,14	186437	19,14
9	12168	136,2	127591	271,5	42610	19,01	186904	19,01
10	11858	138,4	125387	276,3	42430	18,88	186852	18,88
11	11577	140,9	123182	281,2	43810	18,76	193298	18,76
12	11365	144,2	120978	286,3	45670	18,65	199827	18,65
13	11078	146,5	118774	291,7	46940	18,57	207007	18,57
14	10827	149,2	116569	297,2	48570	18,50	214738	18,50
15	10586	152,1	114365	302,9	50330	18,43	222856	18,43
16	10360	155,1	112160	308,9	52230	18,40	231698	18,40
17	10074	157,1	109956	315,0	53560	18,37	241202	18,37
18	9935	161,3	107752	321,5	56490	18,38	251716	18,38
19	9759	164,9	105547	328,2	59070	18,40	262745	18,40

KONČAR D&ST

TRANSFORMER TEST REPORT

Serial No. : 463829

TRANSFORMER TYPE : TRP 60000-145/E

Part No. : ET0817

2. 1. Measurement of short-circuit impedance and load losses (L.V. in connection d1)

Combination		H.V. / L.V.	H.V. / L.V.	H.V. / L.V.	H.V. / L.V.	
Tap position		**1**	**7**	**10**	**19**	
Temperature	**(°C)**	**27**	**27**	**27**	**27**	
Frequency	**(Hz)**	**50**	**50**	**50**	**50**	
Measured voltage	(u-v)	17197	15699	13941	11221	
	(u-w)	17214	15716	13949	11220	
	(v-w)	17193	15697	13939	11217	
Average		17201	15704	13943	11219	
Constant		1	1	1	1	
VOLTAGE	**(V)**	**17201**	**15704**	**13943**	**11219**	
Measured current	(u)	139,4	161,9	162,8	189,6	
	(v)	138,9	161,4	162,3	189,3	
	(w)	139,8	162,3	163,2	189,9	
Average		139,4	161,9	162,8	189,6	
Constant		1	1	1	1	
CURRENT	**(A)**	**139,4**	**161,9**	**162,8**	**189,6**	
Measured power	(u)	14520	17630	16510	23600	
	(v)	22080	24350	22010	27820	
	(w)	20720	21840	19860	26500	
Total		57320	63820	58380	77920	
Constant		1	1	1	1	
LOAD LOSSES	(W)	57320	63820	58380	77920	
Calculated to	(kVA)	**60000**	**60000**	**60000**	**60000**	
	(A)	**238,5**	**262,4**	**276,3**	**328,2**	
LOAD LOSSES	**(W)**	**167787**	**167645**	**168158**	**233480**	
I2 R losses	(W)	124306	128043	129672	192013	
Stray losses	(W)	43481	39602	38486	41467	
Impedance voltage	**(V)**	**29429,3**	**25452,3**	**23663,7**	**19420,2**	
	(%)	**20,264**	**19,282**	**18,873**	**18,400**	
Temperature	**(°C)**	**75**	**75**	**75**	**75**	
I2 R losses	(W)	147080	151501	153429	227191	
Stray losses	(W)	36748	33470	32527	35046	
LOAD LOSSES	**(W)**	**183828**	**184971**	**185956**	**262237**	
Impedance voltage	**(V)**	**29428,6**	**25452,2**	**23664,3**	**19421,7**	
	(%)	**20,264**	**19,282**	**18,873**	**18,401**	
Ur	**(%)**	**0,306**	**0,308**	**0,310**	**0,437**	
Ux	**(%)**	**20,262**	**19,280**	**18,870**	**18,396**	

KONČAR D&ST

TRANSFORMER TEST REPORT

Serial No. : 463829

Page : 6 / 8

TRANSFORMER TYPE : TRP 60000-145/E

Part No. : ET0817

2. 3. Measurement of no-load loss and current (L.V. in connection d11)

Voltage	**(%)**	**90,0**	**100,0**	**110,1**		
RMS measured vltg.	(u-v)	29714	33042	36375		
	(u-w)	29728	33055	36385		
	(v-w)	29710	33029	36351		
Average		29717	33042	36370		
RMS VOLTAGE	**(V)**	**29717**	**33042**	**36370**		
Mean measured vltg.	(u-v)	29680	33008	36343		
	(u-w)	29696	33023	36354		
	(v-w)	29679	32989	36301		
Average		29685	33007	36333		
MEAN VOLTAGE	**(V)**	**29685**	**33007**	**36333**		
Form factor		1,111	1,111	1,111		
Measured current	(u)	0,196	0,229	0,310		
	(v)	0,302	0,364	0,494		
	(w)	0,332	0,396	0,539		
Average		0,277	0,330	0,448		
CURRENT	**(A)**	**0,277**	**0,330**	**0,448**		
Measured power	(u)	3242	3907	4557		
	(v)	4620	6201	8359		
	(w)	4614	6991	8555		
Total		12476	17099	21471		
LOSSES	(W)	12476	17099	21471		
Correction	(W)	-13	-18	-22		
LOSSES	**(W)**	**12463**	**17081**	**21449**		

Measuring equipement : YOKOGAWA Power Analyser WT3000

NOTE : **MEASUREMENT AT FREQUENCY YNd11 (Hz) ON WINDING : L.V.**

The power was corrected to the sine - wave voltage basis: $P_o = P_{measured} * (1 + (U_{mean} - U_{rms}) / U_{mean})$.

2. 3. 1. Measurement of magnetizing current at 400 V and 50 Hz

Winding H.V. - tap position	**Phase 1U (m A)**	**Phase 1V (m A)**	**Phase 1W (m A)**		
1	0,9	0,6	1,4		
7	1,1	0,7	1,5		
10	1,2	0,7	1,6		
19	1,7	1,1	2,1		

KONČAR D&ST

TRANSFORMER TEST REPORT

Serial No. : 463829

TRANSFORMER TYPE : TRP 60000-145/E

Part No. : ET0817

3. 2. Insulation resistance measurement of the windings (MΩ) (measured at 2500 VDC and temperature 27°C)

Between	R 15 "	R 60 "	R 60 " / R 15 "
H.V. - (L.V. + core + core clamp + earth)	18000	22200	1,23
L.V. - (H.V. + core + core clamp + earth)	11500	15100	1,31

Check of core and frame insulation (measured at 5000V DC and temperature 27°C)

Between	R 15 "	R 60 "	R 60 " / R 15 "
core - (H.V. + L.V. + core clamp + earth)	4640	8040	1,73
core clamp - (H.V. + L.V. + core + earth)	4010	7280	1,82

3. 3. Dielectric test of the transformer

Lightning impulse test (LI + LIC) Test report No.: U2734

	Between	Test voltage (kV)	Frequency (Hz)	Duration (sec)
Applied voltage test (AV)	H.V. - (L.V. + core + core clamp + earth)	95	50	60
	L.V. - (H.V. + core + core clamp + earth)	70	50	60
	core - (H.V. + L.V. + core clamp + earth)	5	50	60
	core clamp - (H.V. + L.V. + core + earth)	5	50	60
Line terminal AC withstand test (LTAC)	1U	230	200	30
	1V	230	200	30
	1W	230	200	30

NOTE : Winding H.V. - tap position 1.

3. 5. Test on on-load tap-changer - Operation test

Tap changer was tested in accordance with : IEC 60076 - 1 (clause 11.7) :

a) with de-energized transformer tap-changer is tested at 100% of supplay voltage 8 cycles and at 85% of supplay voltage one cycle.

b) with energized transformer at rated voltage and frequency at no-load condition tap-changer is tested 1 cycle.

c) with one winding short-circuited, at rated current 10 cycles of tap-change operation two steps on each side from the middle tapping.

3. 6 Test on marshalling kiosk and protective devices

Functionally test of the auxiliary box has been done in accordance with drawing No.: CS4835.

a) all wirings and devices in auxiliary cabinet are properly connected and checked:

b) operation of the Buchholz relay device -CF050,

c) operation of the OLTC protection relay device -CF061,

d) operation of the pressure relief device of the tank -CP081,

e) operation of the pressure relief device of the OLTC -CP101,

f) operation of the oil level indicator device of the tank -CL060,

g) operation of the oil level indicator device ofthe OLTC -CL064,

h) operation of the rubber bag rupture detection device -CF045,

i) correct indication of PT100 for OLTC temperature -CT030,

j) operation of the oil temperature indicator OTI -CT031,

k) operation of the winding temperature indicator WTI "phase 1V"- CT033,

l) operation of the winding temperature indicator WTI "phase 2V"- CT035,

m) correct indication of the A-meters P1 (for phase 1V) and P2 (for phase 2V),

n) operation of fans and all devices connected to the fans.

3. 7. Test of bushing current transformer

CE101=CE103

CE101, phase 1U;	1S1-1S2-1S3: 600-1200/1A; cl.PX
Ser. No.: 91005706	2S1-2S2-2S3: 500-1000/1A; cl.PX
CE103, phase 1W;	3S1-3S2: 300/1A; 5P20: 30VA
Ser. No.: 91005708	4S1-4S2: 400/1A; cl.PX

CE104

CE101, phase 1N	1S1-1S2-1S3: 600-1200/1A; cl.PX
	2S1-2S2: 400/1A; cl.PX
	3S1-3S2: 300/1A; 5P20: 30VA

CE102

CE102, phase 1V;	1S1-1S2-1S3: 600-1200/1A; cl.PX
Ser. No.: 91005707,	2S1-2S2-2S3: 500-1000/1A; cl.PX
91005709	3S1-3S2: 300/1A; 5P20: 30VA
	4S1-4S2: 400/1A; cl.PX
	5S1-5S2: 340/1,5A; cl.3Fs5; 10VA

CE117

CE117, phase 2V;	S1-S2: 1060/1,5A; cl.3Fs5; 10VA
Ser. No.: 91005710	

Ratio and polarity are checked on current transformer. Current transformer is checked with 2kV AC for 1min. and test loops with 5kV AC for 1min.

KONČAR D&ST

TRANSFORMER TEST REPORT

Serial No. : 463829

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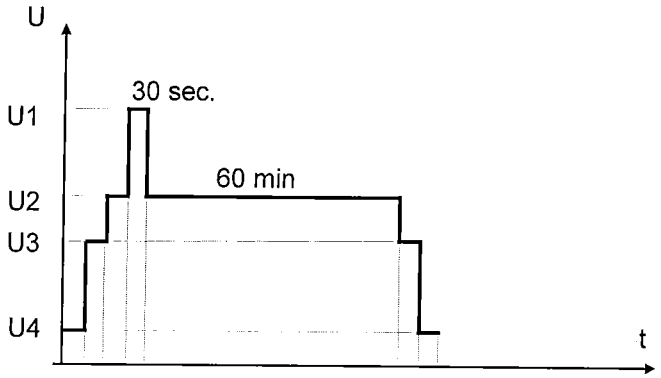
TRANSFORMER TYPE : TRP 60000-145/E

Part No. : ET0817

3. 4. Induced voltage test with partial discharge measurement (IVPD)

3. 4. 1. Test sequence and levels



Standard:	IEC 60076-3
Supply	three-phase
Supplied terminals	2U - 2V - 2W
Tap position	7
Supply frequency (Hz)	200
U4 (kV)	52,8
U3 (kV)	158,4
U2 (kV)	208,6
U1 (kV)	264,0
Allowed PD at voltage level (pC)	
U3	≤ 100
U2	≤ 250

3. 4. 2. Measuring equipement, calibration and background noise level

Measuring equipement:
PD detector: "Tettex" DDX9101
Calibrator: "Tettex" type 451

Calibration: Calibraton performed with 100 pC

Calibration signal	1U	1V	1W
Measured (pC)			
1U	100	5	5
1V	5	100	5
1W	5	5	100

Background noise level with source connected and voltage 0 (V): < 10 pC

3. 4. 3. Test and PD measurement

Voltage level	Duration (min)	Measured on phase (pC) 1U	1V	1W
U4	1,0	10	10	10
U3	1,0	10	10	10
U2	5,0	10	10	10
U1	0,5	----	----	----
U2	5,0	10	10	10
U2	5,0	10	10	10
U2	5,0	10	10	10
U2	5,0	10	10	10
U2	5,0	10	10	10
U2	5,0	10	10	10
U2	5,0	10	15	10
U2	5,0	10	15	10
U2	5,0	10	15	10
U2	5,0	10	15	10
U2	5,0	10	15	10
U2	5,0	10	15	10
U3	1,0	10	15	10
U4	1,0	10	15	10

3. 4. 4. Results

No collapse of voltage observed.

Measured level of PD is lower than in IEC 60076 - 3 specified.

TRANSFORMER PASSED IVPD TEST.

KONČAR - DISTRIBUTIVNI I SPECIJALNI TRANSFORMATORI d.d.
Address: Josipa Mokrovića 8, P.O. Box 100, HR-10090 Zagreb, Croatia
Telephone: (+385 1) 3783 777, Fax: (+385 1) 3794 051
E-mail: info@koncar-dst.hr, Internet: www.koncar-dst.hr

ISPITNI IZVJEŠTAJ br. / TEST REPORT No. 210/18

according to HRN EN 10 204 2.2.

FIZIKALNO - KEMIJSKA ANALIZA TRANSFORMATORSKOG ULJA
PHYSICO-CHEMICAL ANALYSIS OF TRANSFORMER OIL

PODACI O UZORKU I TRANSFORMATORU / *SAMPLE AND TRANSFORMER IDENTIFICATION:*

Naručitelj / *Ordered by*: **SCOTLAND**
Tip transformatora / *Transformer type*: **TRP 60000-145/E**
Tvornički broj / *Serial No.*: **463829**
Vrsta ulja / *Type of oil:* **HYVOLT III**
Datum uzorkovanja / *Date of sampling*: **06.06.2018.**
Napomena / *Note* :

VRSTA ISPITIVANJA TYPE OF TEST	MJERNA JEDINICA / UNIT	GRANIČNA VRIJEDNOST / LIMITS	REZULTATI RESULTS
Sadržaj vode / *Water content*	mg/kg	<10	6
Probojni napon / *Breakdown voltage*	kV	>60	70

INTERPRETACIJA REZULTATA / *INTERPRETATION OF RESULTS:*
Transformer oil complay with requirements of IEC 60422/13 Table3., for new mineral insulating oils in transformers prior to energization.

VRSTA ISPITIVANJA / TYPE OF TEST	MJERNA METODA / TEST METHOD	UREĐAJ / INSTRUMENT
Boja / *Colour*	DIN 51581	
Sadržaj vlage / *Water content*	IEC 60156	Mettler Toledo DL32
Prob. napon / *Breakdown voltage*	ISO 2719	OTS100AF, Megger
Faktor diel. gubitka / *DD factor*	IEC 60247	Dieltest DTL, Baur
Spec. otpor / *Spec. resistant*	IEC 60248	Dieltest DTL, Baur

Datum / *Date*:	Ispitao / *Tested by*:	Odobrio / *Approved of:*
07.06.2018.	*Ivanka Radić, MSc.Chem.E.*	*Renata Jurišić, MSc.Chem.E.*

Laboratorij Ulazne kontrole / Laboratory of Incoming Control : tel. +385 1 3783 829 , e-mail: ivanka.radic@koncar-dst.hr

KONČAR D&ST	**Izvještaj o ispitivanju nepropusnosti** **Oil leakage test report**	Ispitni izvještaj br.: Test report No.: OL463829

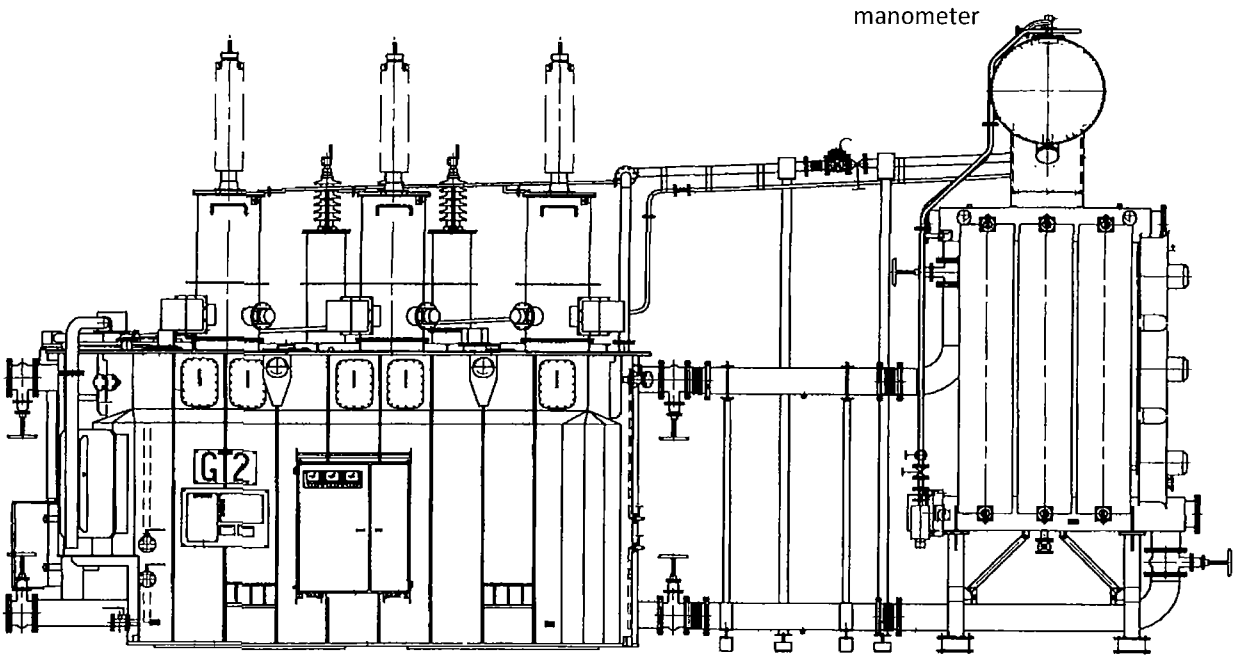
Tip transformatora: TRP 60000-145/E
Transformer type: ET0817

Tvornički broj:
Serial number(s): 463829

Uvjeti ispitivanja / Testing conditions

Ispitno sredstvo Testing media	Transformatorsko ulje Transformer oil	
Temperatura ispitnog sredstva Temperature of testing media	20°C	
Tlak Pressure	35 kN/m2	on the top of the transformer na vrhu transformatora
Trajanje ispitivanja Duration	24h	Begin: 28.06.2018. Finish: 29.06.2018.

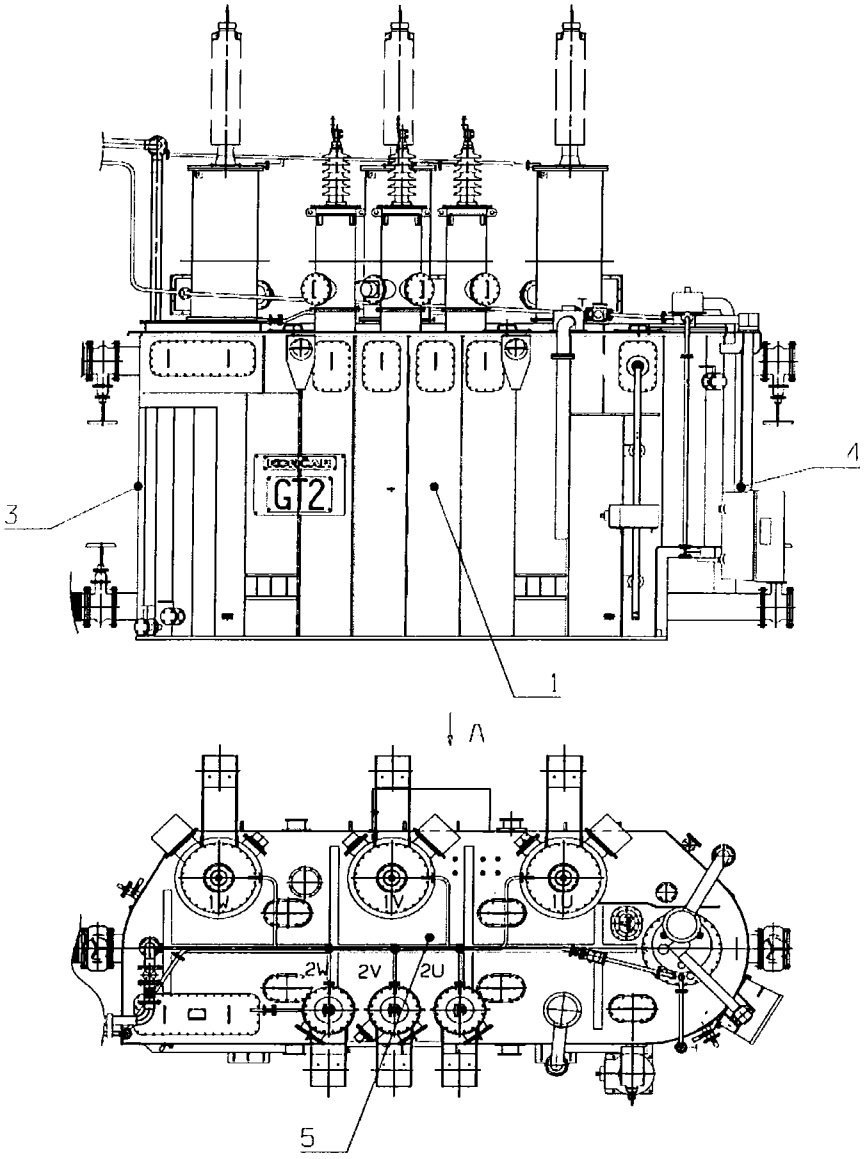
Shema ispitivanja - Way of testing (scheme)

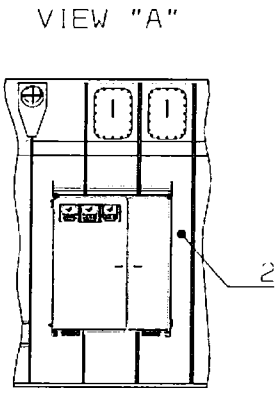


Rezultat testa : Nema curenja
Test result : No leakage

Datum/Date: 29.06.2018. QI-04	Ispitivanje proveo / Testing performed by :Davor Kovač

TRP 60000-145/E





Point location	Point no.	Elastic (mm)	Permanent (mm)
HV side	1	9	1
LV side	2	8	1
COVER	3	2	0

1 mbar, 30 min

				Checked	Approved	TANK VACUUM DEFLECTION TEST	
			01-04	Kovač	Ing.Maljković		
Rev.	Rev. No.	Date	Name	27.06.2018.			
KONČAR - DISTRIBUTIVNI I SPECIJALNI TRANSFORMATORI d.d. Mokrovićeva 8, P.O.Box 6062, HR-10090 Zagreb, Hrvatska Telefon (+385 1) 3783 732 Fax (+385 1) 3794 050 E-mail: dist.a@koncar.tel.hr				KONČAR D&ST		Doc. No. V463829	Rev.
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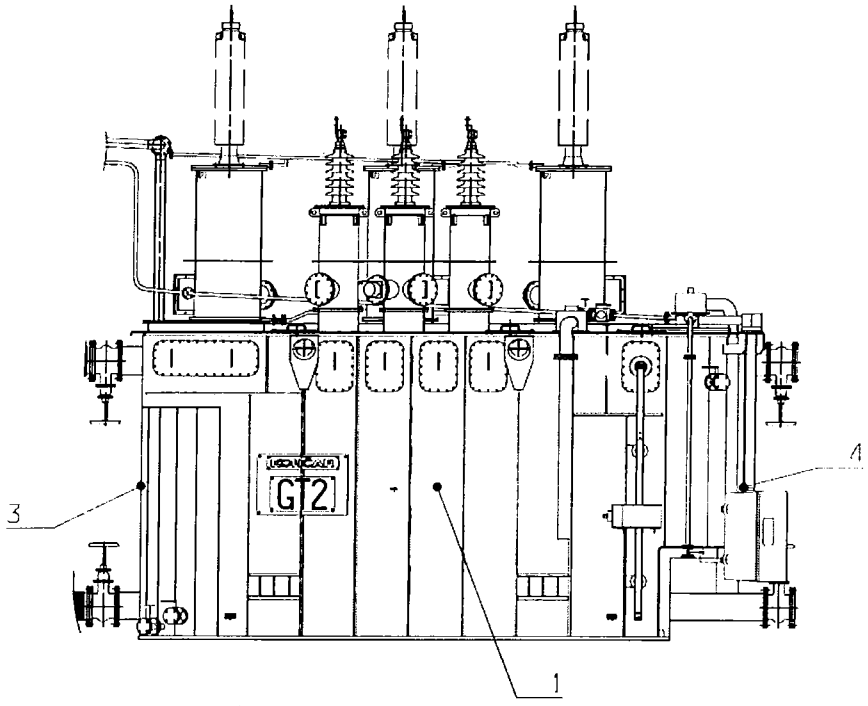
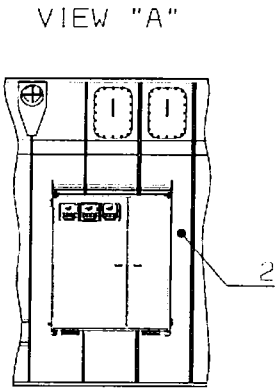
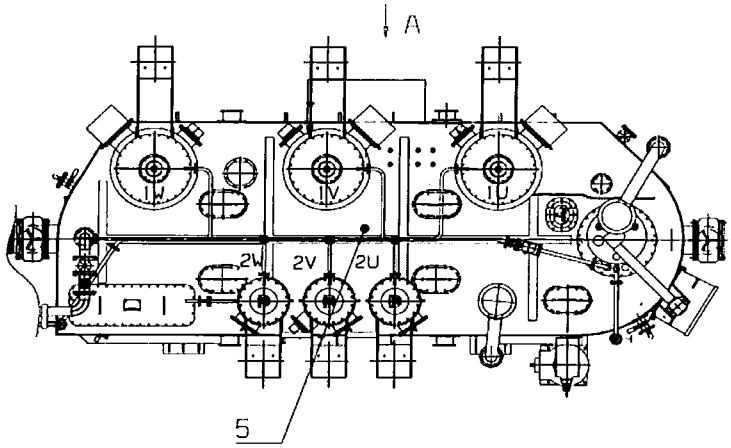
TRP 60000-145/E







Point location	Point no.	Elastic (mm)	Permanent (mm)
HV side	1	9	1
LV side	2	9	1
COVER	3	2	0

0,35 bar, 24 hours

				Checked	Approved	TANK PRESSURE DEFLECTION TEST	
			QI-04	Kovač	Ing.Maljković		
Rev.	Rev. No.	Date	Name	28.06.2018.			
KONČAR - DISTRIBUTIVNI I SPECIJALNI TRANSFORMATORI d.d. Mokrovićeva 8, P.O.Box 6062, HR-10090 Zagreb, Hrvatska Telefon (+385 1) 3783 732 Fax (+385 1) 3794 050 E-mail: dist.a@koncar.tel.hr				KONČAR D&ST		Doc. No. P463829	Rev.
						Scale:	Sheet / Sheets

KONČAR D&ST

IMPULSE TEST REPORT

Test report no. U2734

Transformer type		Serial number		
TRP 60000-145/E		ET0817 - 463829		
H.V. winding		L.V. winding		
Tap position	Voltage (V)	Voltage (V)		
1	145226	-		
7	132000	33000(33000)		
19	105547	-		
Connection symbol	**YNd11(d1)**			

1. Specified test voltages Standard: IEC 60076 - 3

Terminals	Full wave		Chopped wave	
	kV	Wave shape (μs)	kV	Time to chopping (μs)
1U, 1V, 1W	550	1,2/50	605	3,3
2U, 2V, 2W	170	1,2/50	187	3,5
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

2. Measurements

Voltage was measured with capacitive voltage divider HIGH VOLT SMC670/1200 and measuring device for recording impulse voltage and current HIGH VOLT MIAS 100-14/4B in accordance with IEC 60060 - 2.

3. Result

By comparing the voltage and current records it has been proved that the transformer withstood the test.

4. Remarks

a) Voltage and current wave records are stored by Manufacturer in files: 463829

KONČAR Distributivni i specijalni transformatori d.d. Zagreb
ISPITNA STANICA TESTING STATION 4

Tested by: Darko Bistrički, dipl.ing.

Approved by: Vedran Maljković, dipl.ing.

Date and stamp: 07.06.2018.

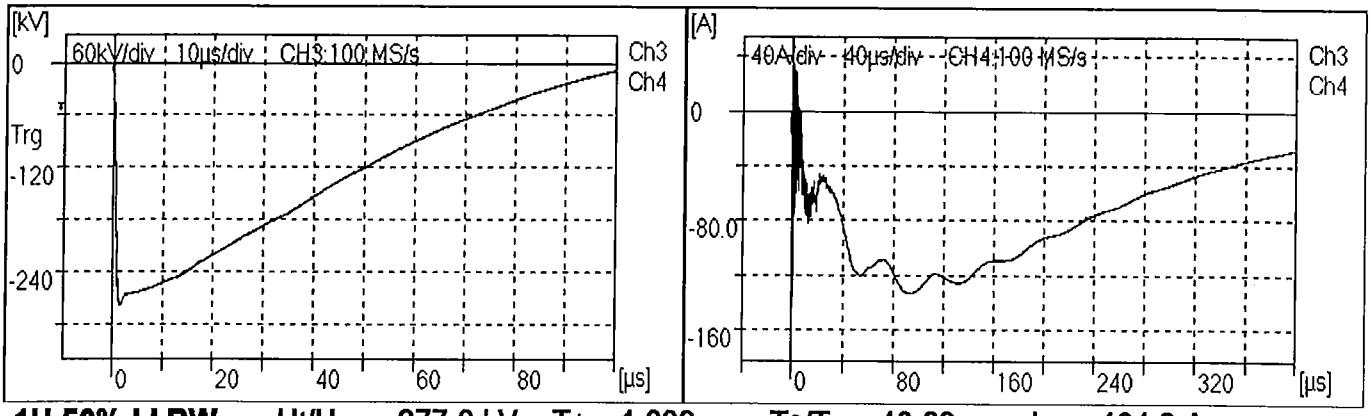
5. Testing of H.V. winding

5.1. Connection of terminals

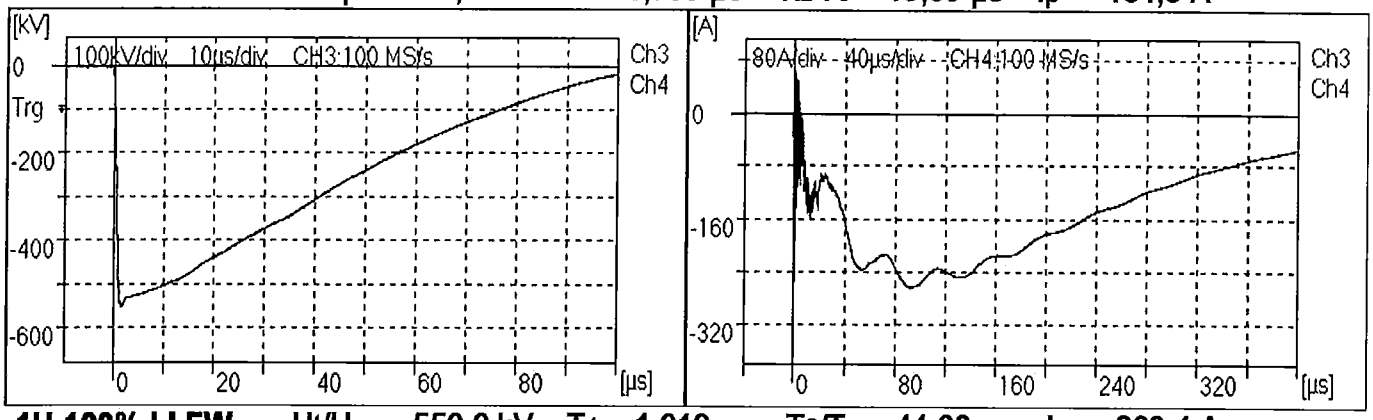
line terminal under test	connected to the impulse voltage generator
other line terminals of the winding under test	short circuited and directly earthed
neutral terminal 1N	earthed through shunt S1
2U, 2V, 2W	short circuited and directly earthed

5.2. Order of tests

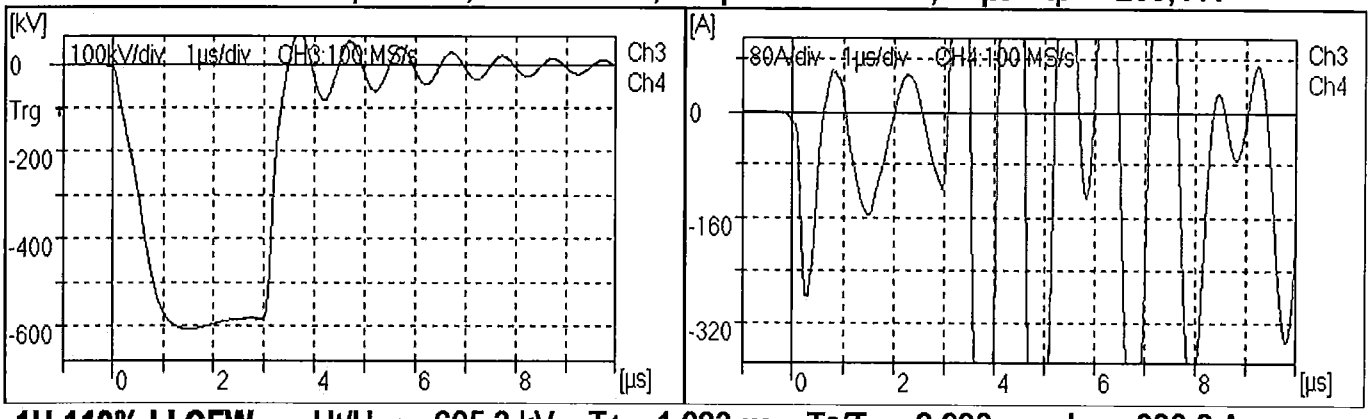
Terminal	Tap position	Description	Page
1U	19	Applied voltage and current through shunt S1 oscillograms	3 , 4
1V	7	Applied voltage and current through shunt S1 oscillograms	5 , 6
1W	1	Applied voltage and current through shunt S1 oscillograms	7 , 8



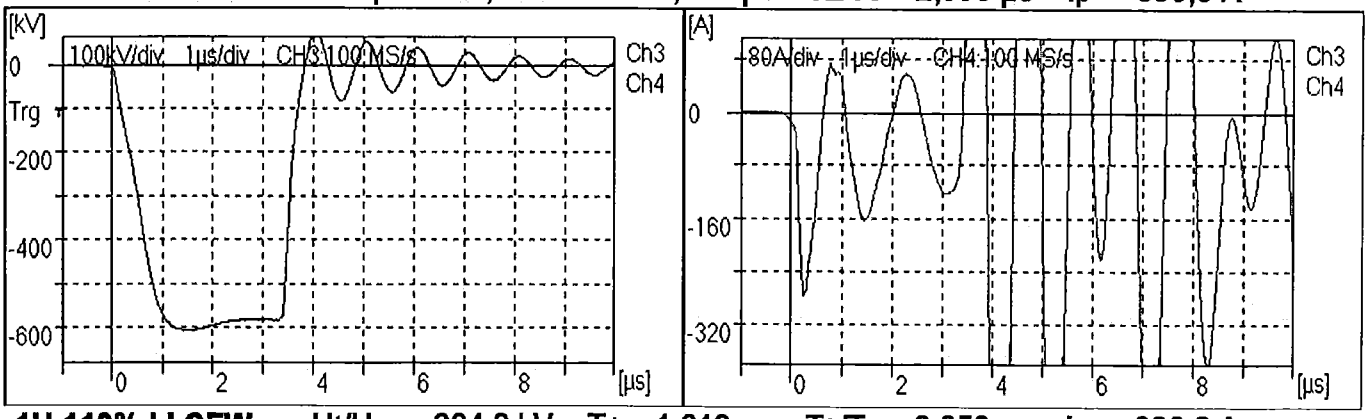
1U 50% LI RW Ut/Up = -277,0 kV T1 = 1,009 µs T2/Tc = 43,89 µs Ip = -134,8 A



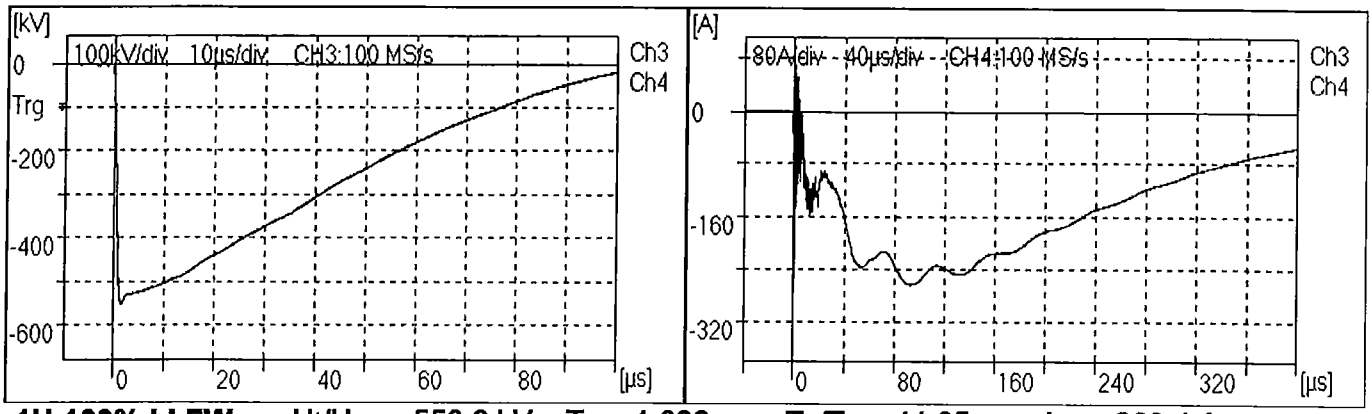
1U 100% LI FW Ut/Up = -550,0 kV T1 = 1,019 µs T2/Tc = 44,03 µs Ip = -263,4 A



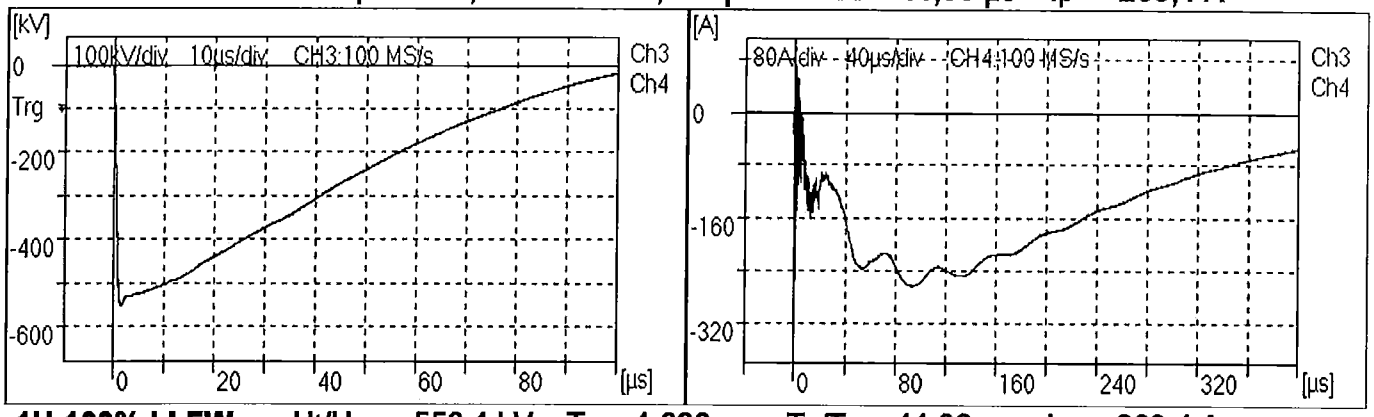
1U 110% LI CFW Ut/Up = -605,3 kV T1 = 1,023 µs T2/Tc = 2,998 µs Ip = -380,8 A



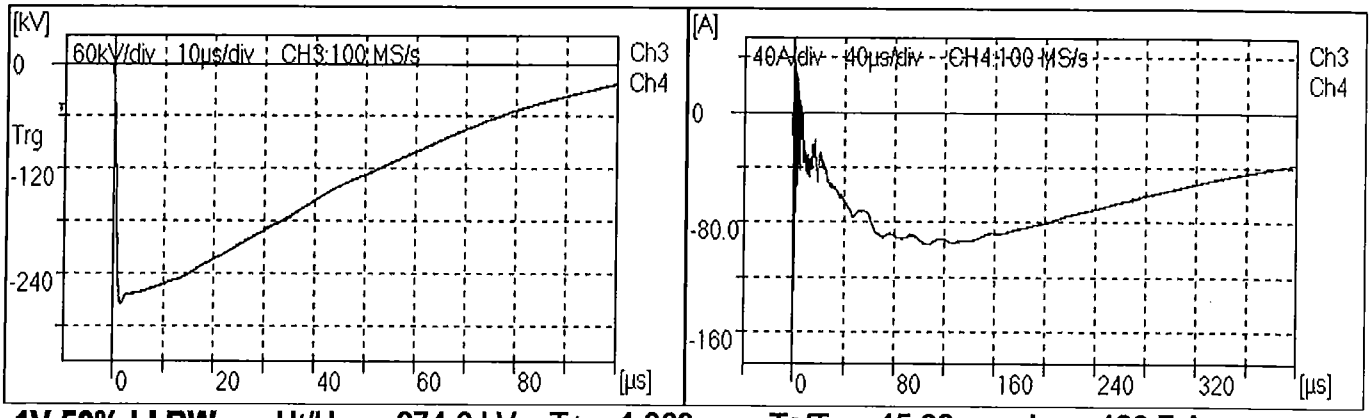
1U 110% LI CFW Ut/Up = -604,8 kV T1 = 1,019 µs T2/Tc = 3,359 µs Ip = -380,8 A



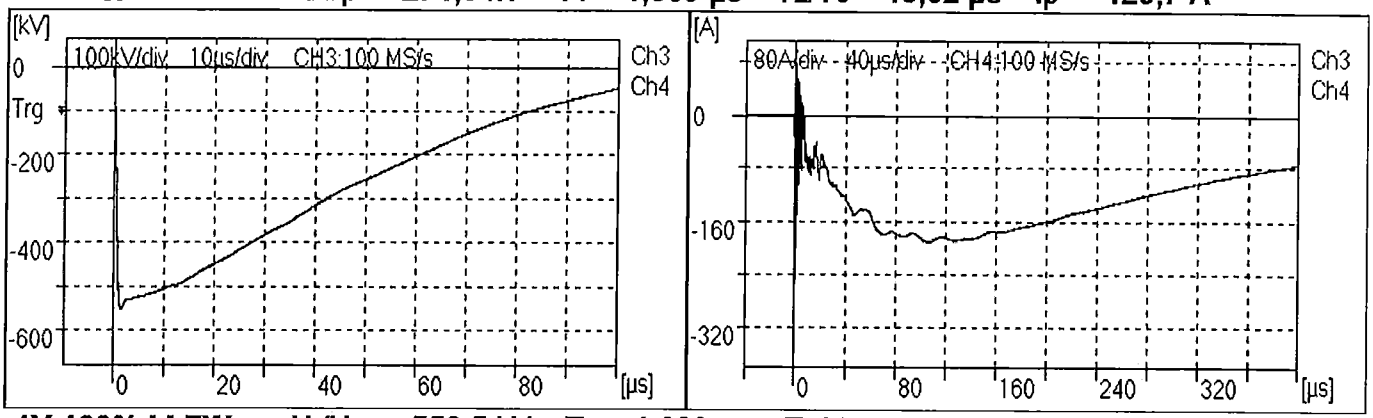
1U 100% LI FW Ut/Up = -550,2 kV T_1 = 1,022 µs T_2/T_c = 44,05 µs Ip = -263,4 A



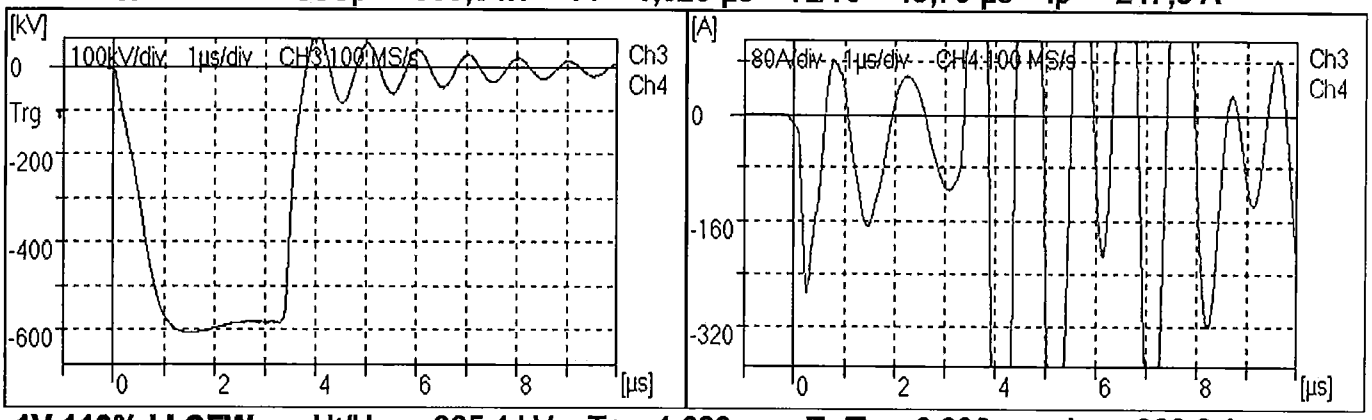
1U 100% LI FW Ut/Up = -550,1 kV T_1 = 1,020 µs T_2/T_c = 44,06 µs Ip = -263,4 A



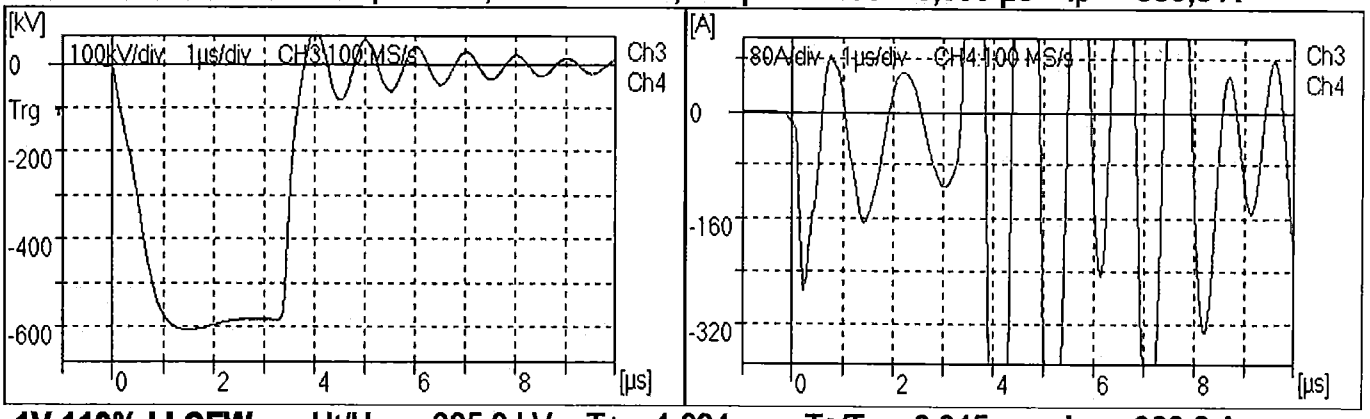
1V 50% LI RW Ut/Up = -274,6 kV T1 = 1,009 µs T2/Tc = 45,62 µs Ip = -129,7 A



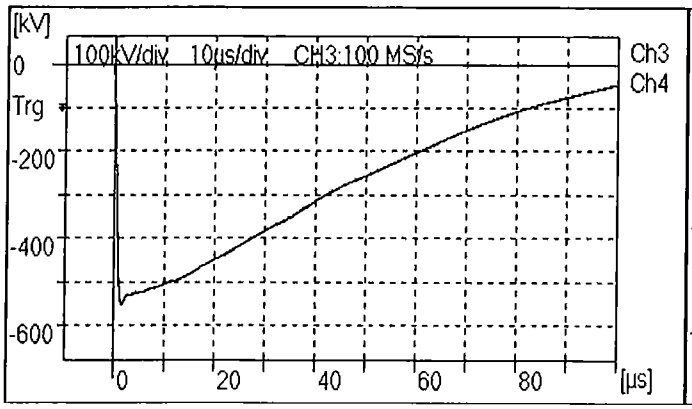
1V 100% LI FW Ut/Up = -550,5 kV T1 = 1,023 µs T2/Tc = 45,79 µs Ip = -247,8 A

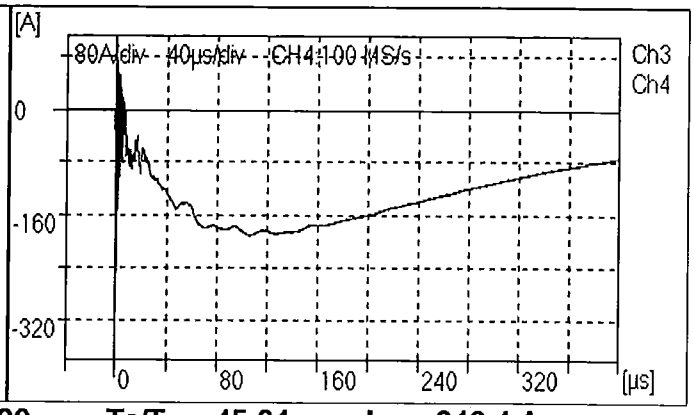


1V 110% LI CFW Ut/Up = -605,4 kV T1 = 1,023 µs T2/Tc = 3,330 µs Ip = -380,8 A

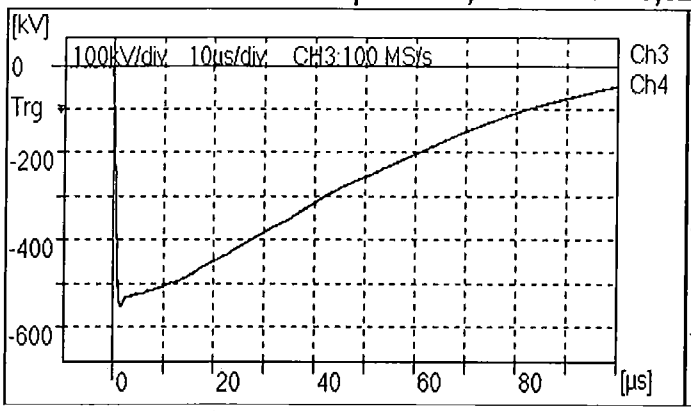


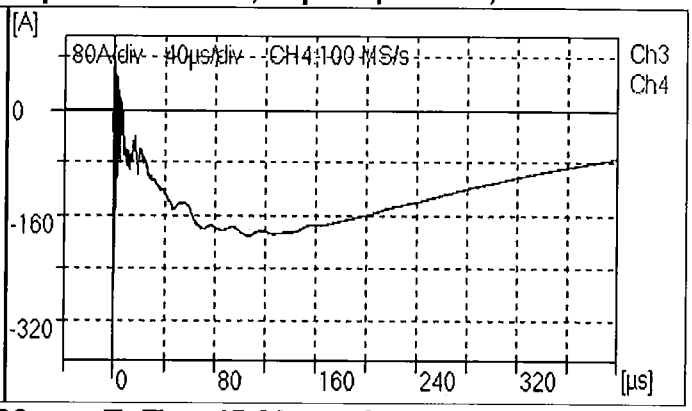
1V 110% LI CFW Ut/Up = -605,3 kV T1 = 1,024 µs T2/Tc = 3,345 µs Ip = -380,8 A



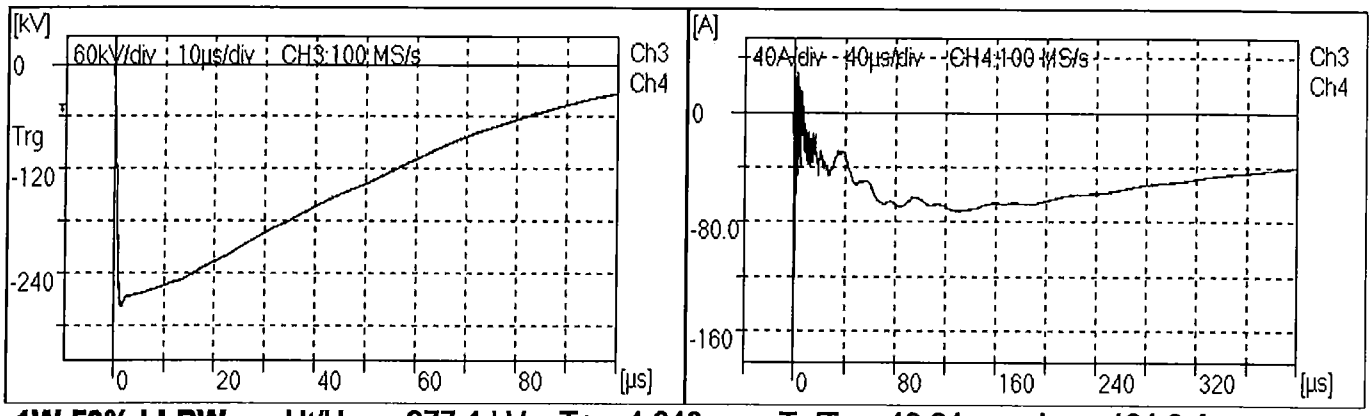


1V 100% LI FW Ut/Up = -549,8 kV T_1 = 1,020 µs T_2/T_c = 45,81 µs Ip = -246,4 A

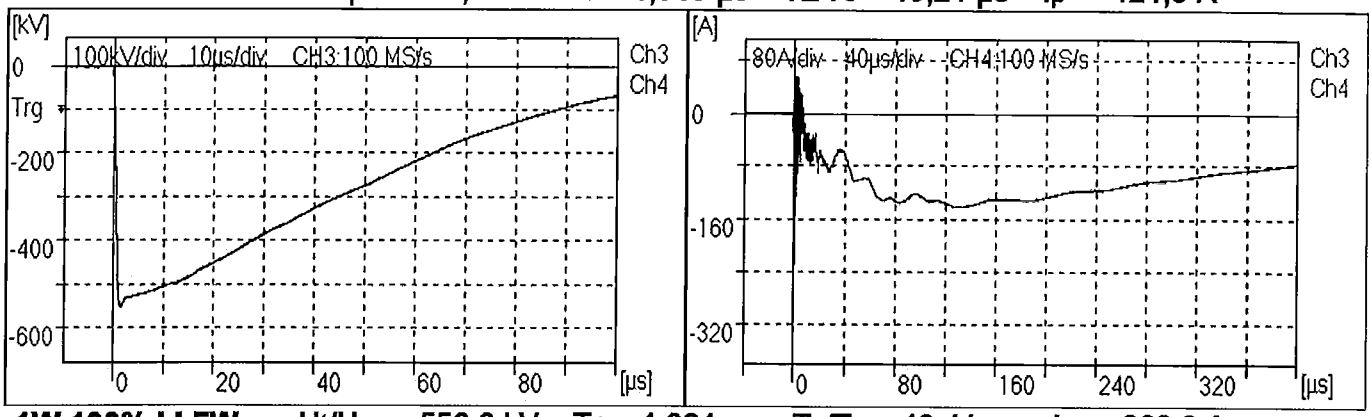




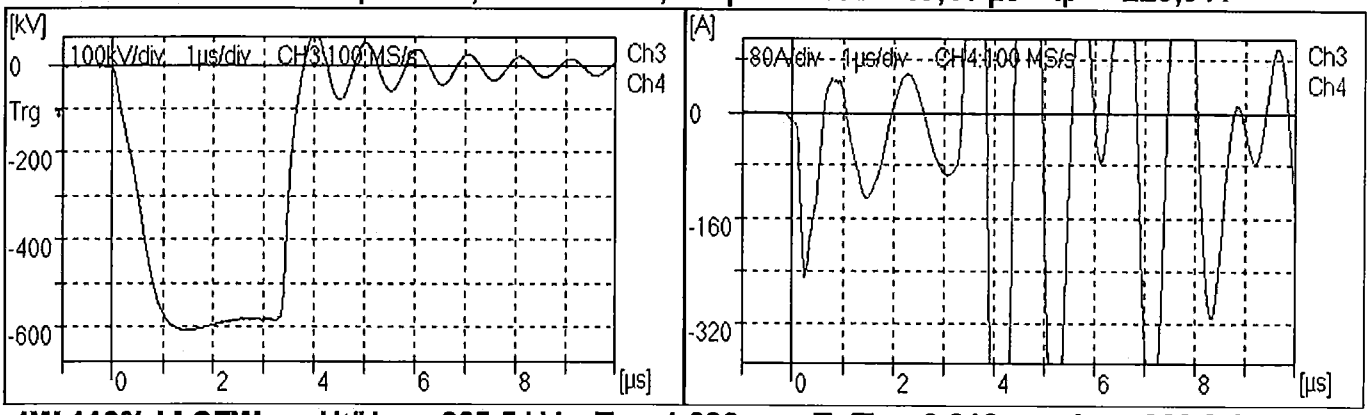
1V 100% LI FW Ut/Up = -549,7 kV T_1 = 1,022 µs T_2/T_c = 45,83 µs Ip = -247,8 A



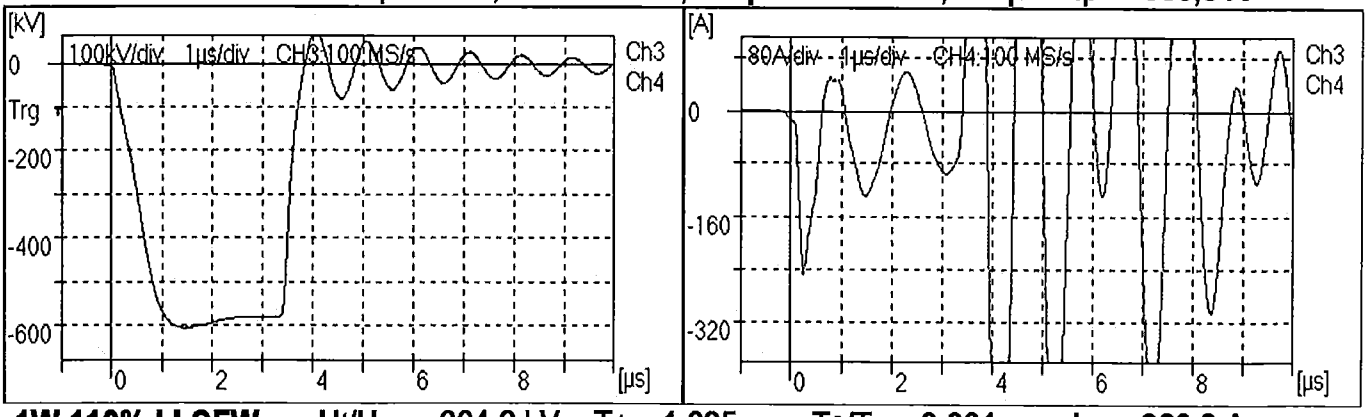
1W 50% LI RW Ut/Up = -277,1 kV T1 = 1,013 µs T2/Tc = 49,21 µs Ip = -121,3 A



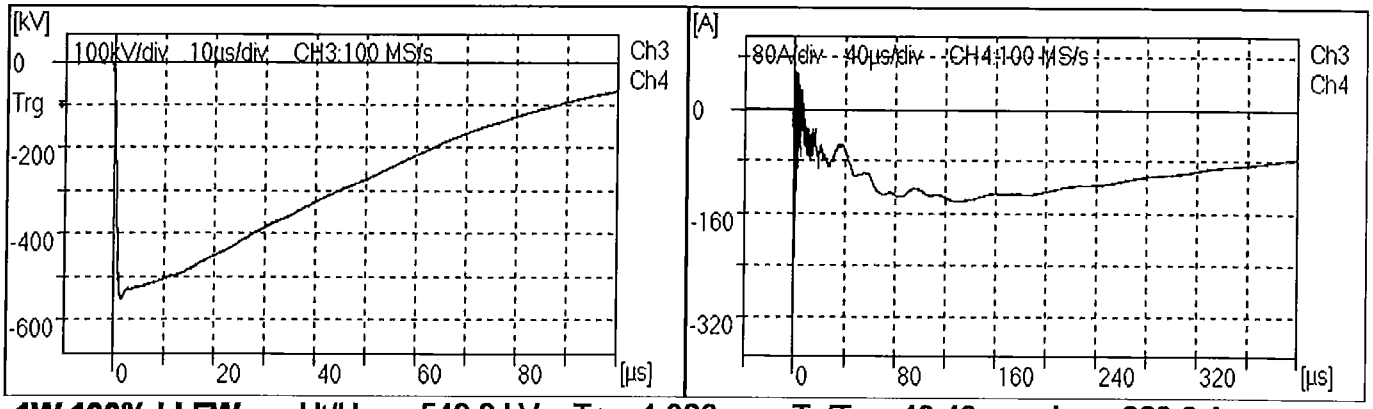
1W 100% LI FW Ut/Up = -550,0 kV T1 = 1,021 µs T2/Tc = 49,41 µs Ip = -228,9 A



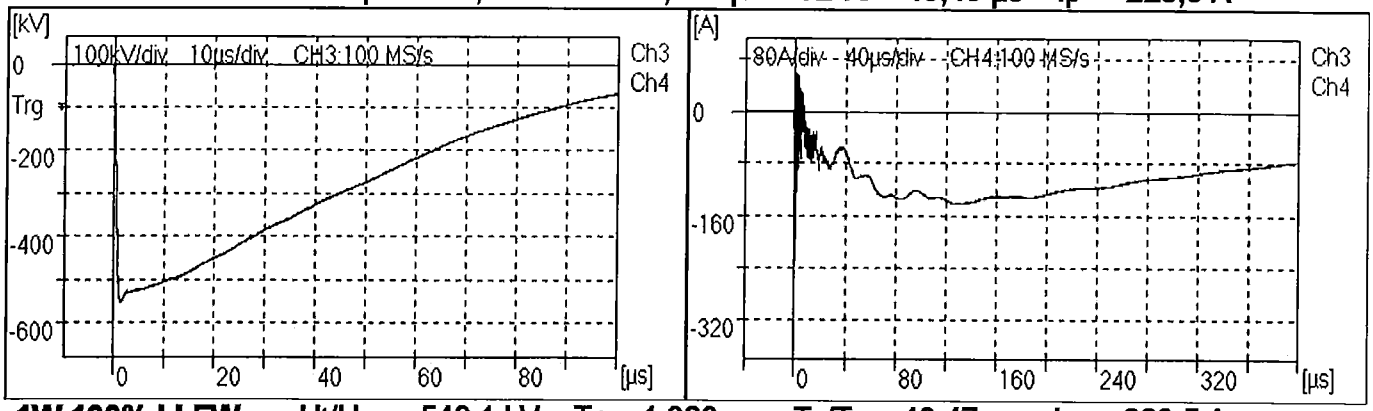
1W 110% LI CFW Ut/Up = -605,5 kV T1 = 1,026 µs T2/Tc = 3,316 µs Ip = -380,8 A



1W 110% LI CFW Ut/Up = -604,2 kV T1 = 1,025 µs T2/Tc = 3,361 µs Ip = -380,8 A



1W 100% LI FW Ut/Up = -549,8 kV T_1 = 1,026 µs T_2/T_c = 49,40 µs Ip = -228,9 A



1W 100% LI FW Ut/Up = -549,1 kV T_1 = 1,020 µs T_2/T_c = 49,47 µs Ip = -228,5 A

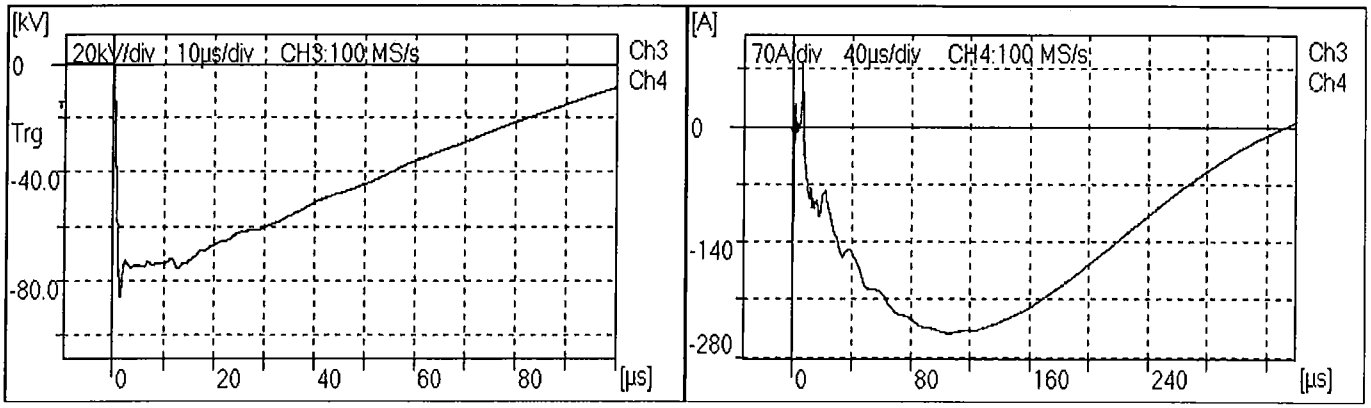
6. Testing of L.V. winding

6.1. Connection of terminals

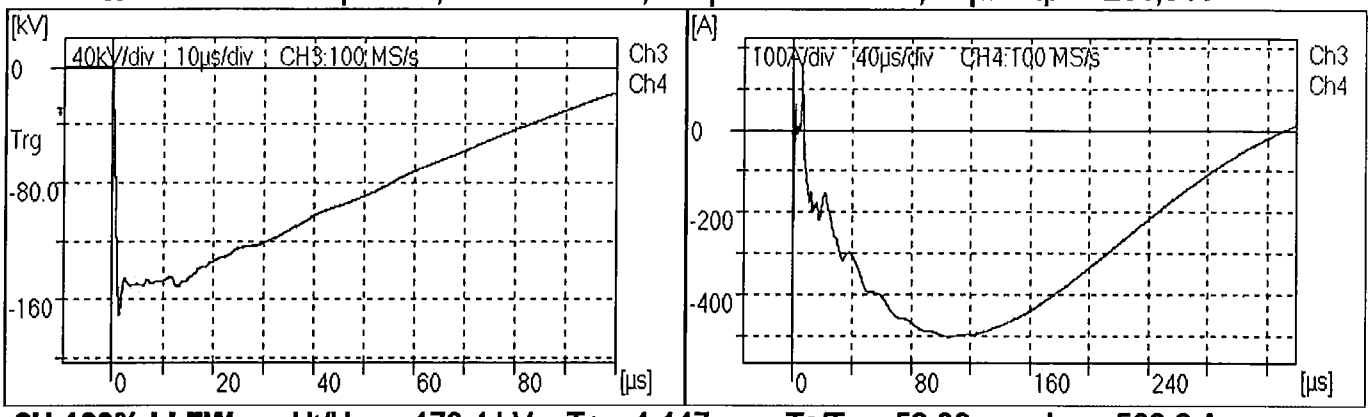
line terminal under test	connected to the impulse voltage generator
other line terminals of the winding under test	earthed through shunt S1
1U, 1V, 1W, 1N	short circuited and directly earthed

6.2. Order of tests

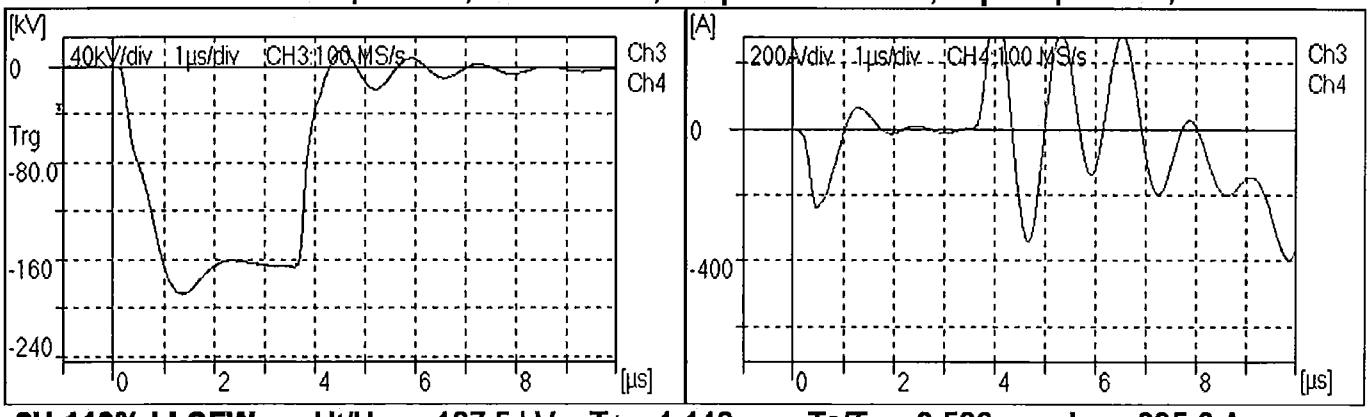
Terminal	Tap position	Description	Page
2U	-	Applied voltage and current through shunt S1 oscillograms	10 , 11
2V	-	Applied voltage and current through shunt S1 oscillograms	12 , 13
2W	-	Applied voltage and current through shunt S1 oscillograms	14 , 15



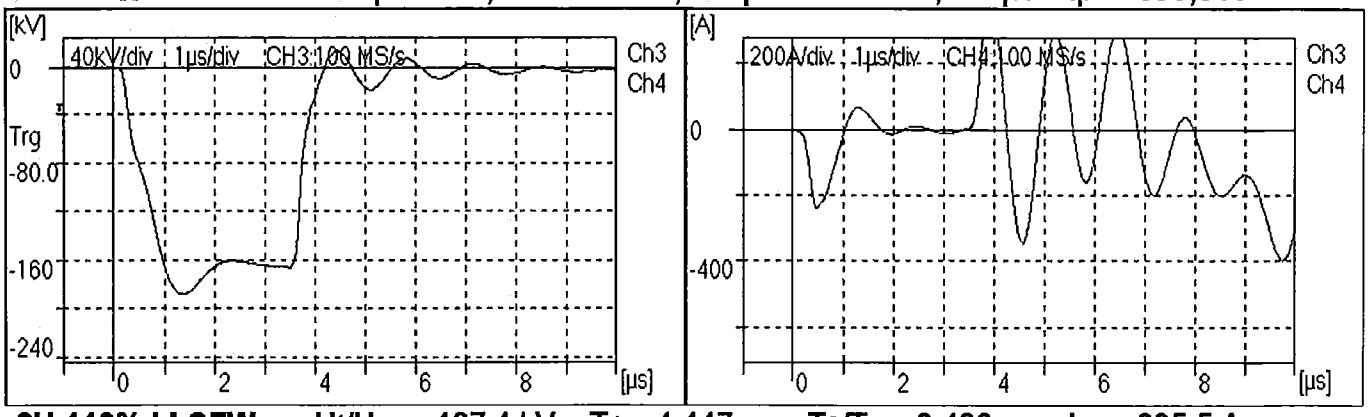
2U 50% LI RW Ut/Up = -85,07 kV T1 = 1,149 µs T2/Tc = 52,28 µs Ip = -251,3 A



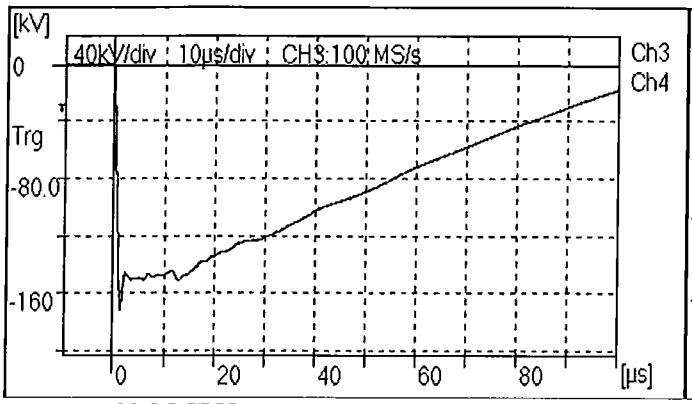
2U 100% LI FW Ut/Up = -170,4 kV T1 = 1,147 µs T2/Tc = 52,39 µs Ip = -502,2 A

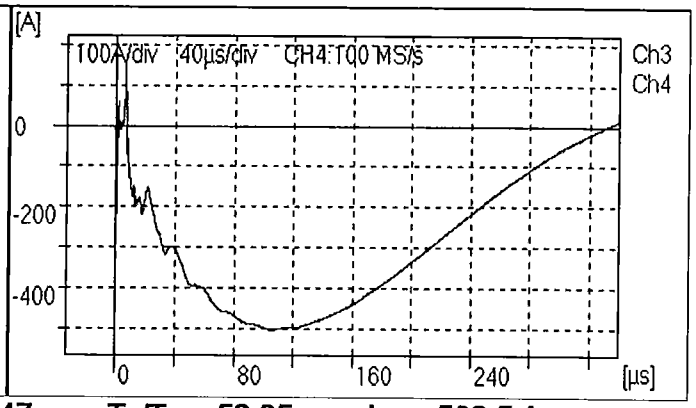


2U 110% LI CFW Ut/Up = -187,5 kV T1 = 1,148 µs T2/Tc = 3,586 µs Ip = -395,0 A

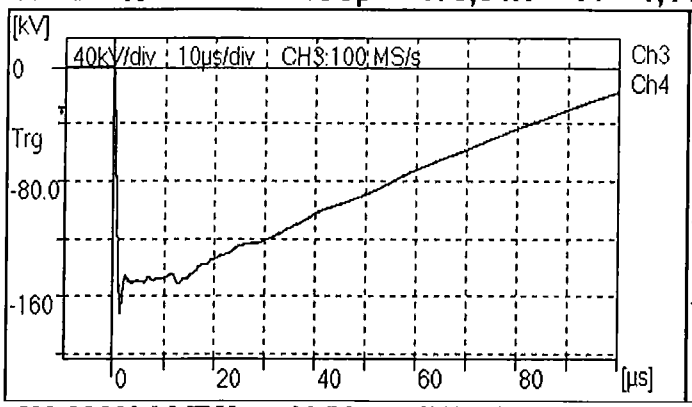


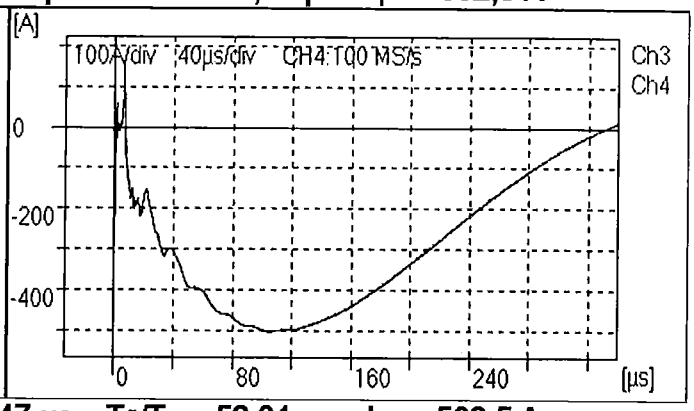
2U 110% LI CFW Ut/Up = -187,4 kV T1 = 1,147 µs T2/Tc = 3,480 µs Ip = -395,5 A



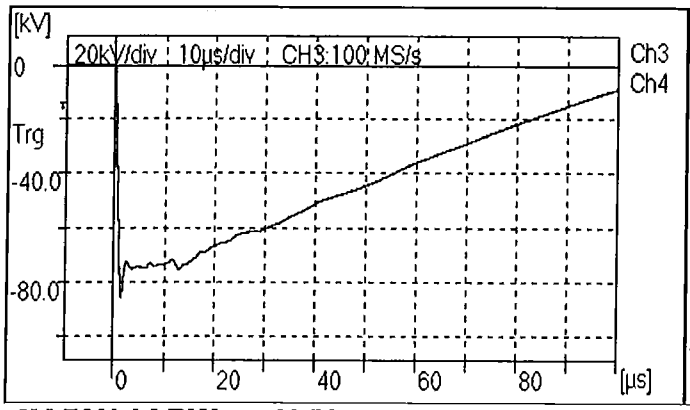


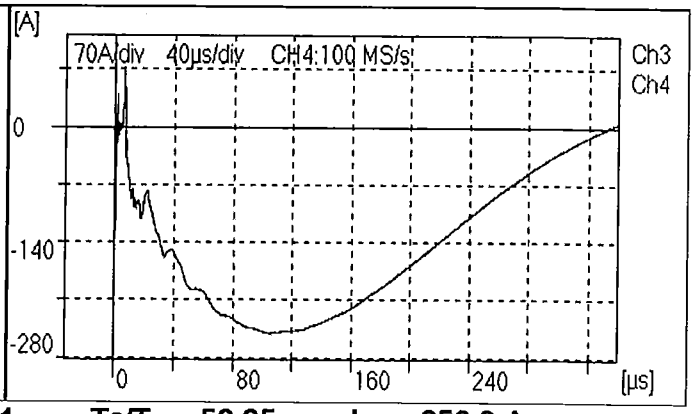
2U 100% LI FW Ut/Up = -170,5 kV T_1 = 1,147 µs T_2/T_c = 52,35 µs Ip = -502,5 A



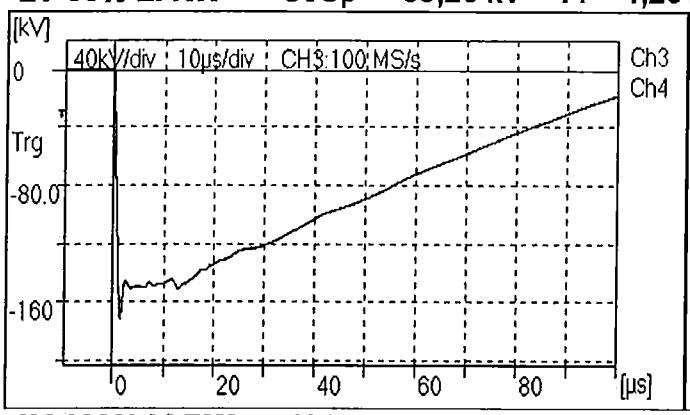


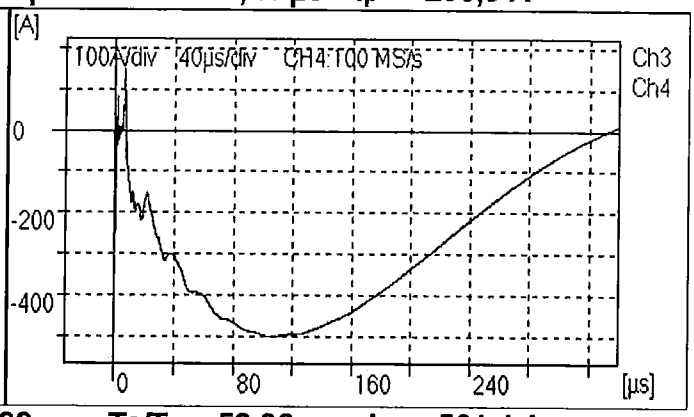
2U 100% LI FW Ut/Up = -170,6 kV T_1 = 1,147 µs T_2/T_c = 52,31 µs Ip = -502,5 A



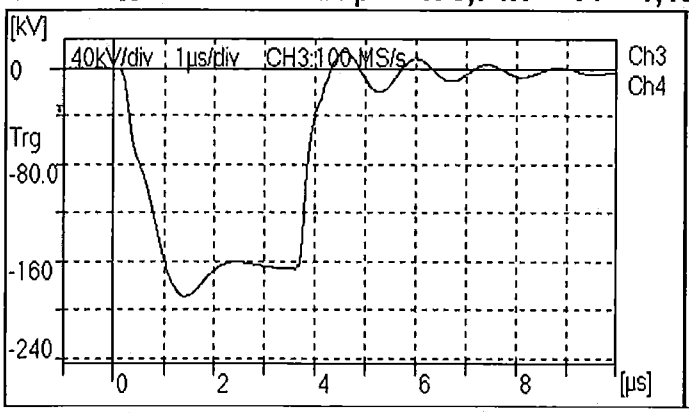


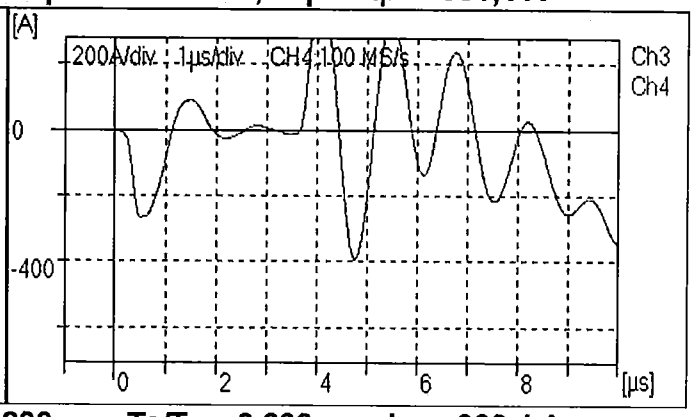
2V 50% LI RW Ut/Up = -85,20 kV T1 = 1,201 µs T2/Tc = 52,25 µs Ip = -250,9 A



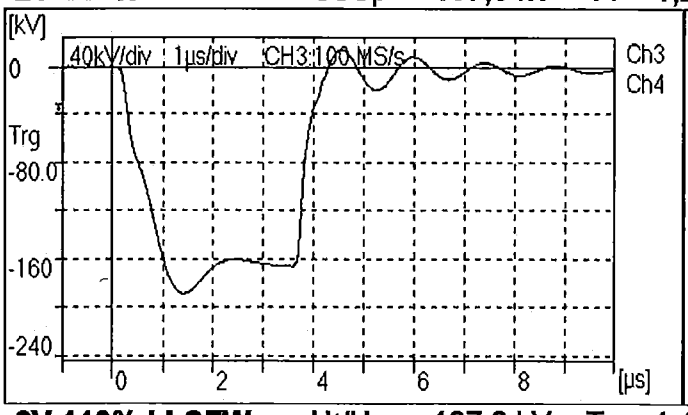


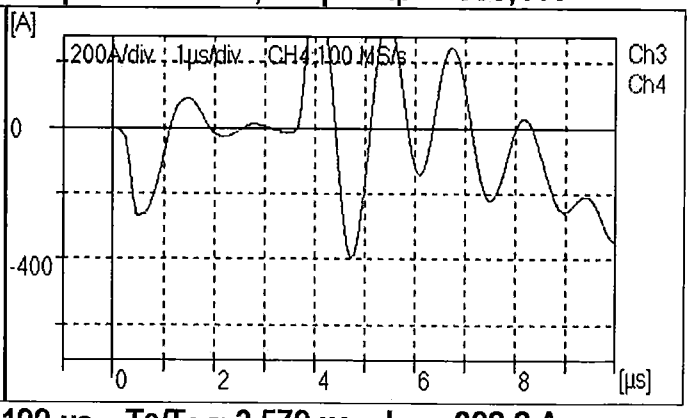
2V 100% LI RW Ut/Up = -170,7 kV T1 = 1,199 µs T2/Tc = 52,36 µs Ip = -501,4 A



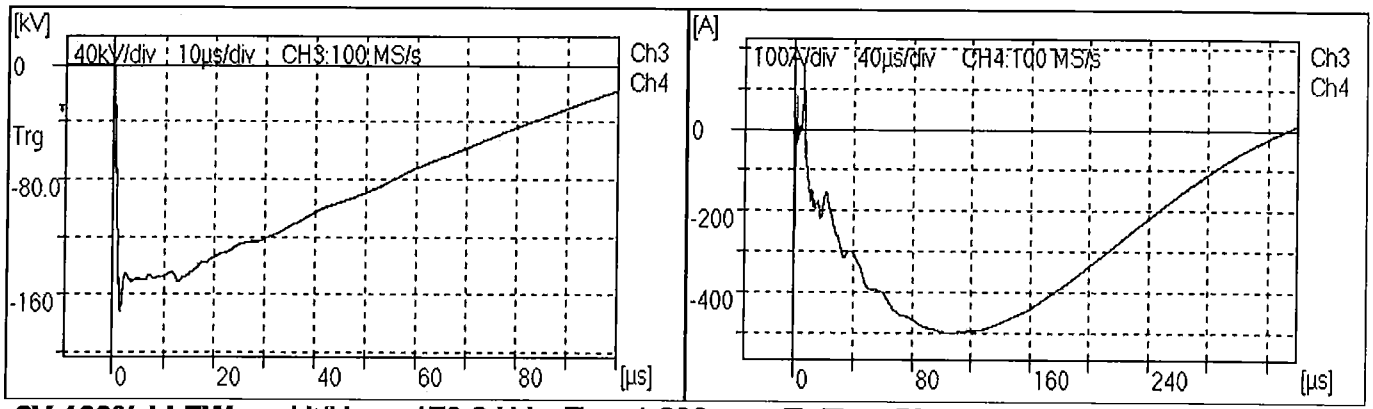


2V 110% LI CFW Ut/Up = -187,8 kV T1 = 1,200 µs T2/Tc = 3,660 µs Ip = -390,4 A

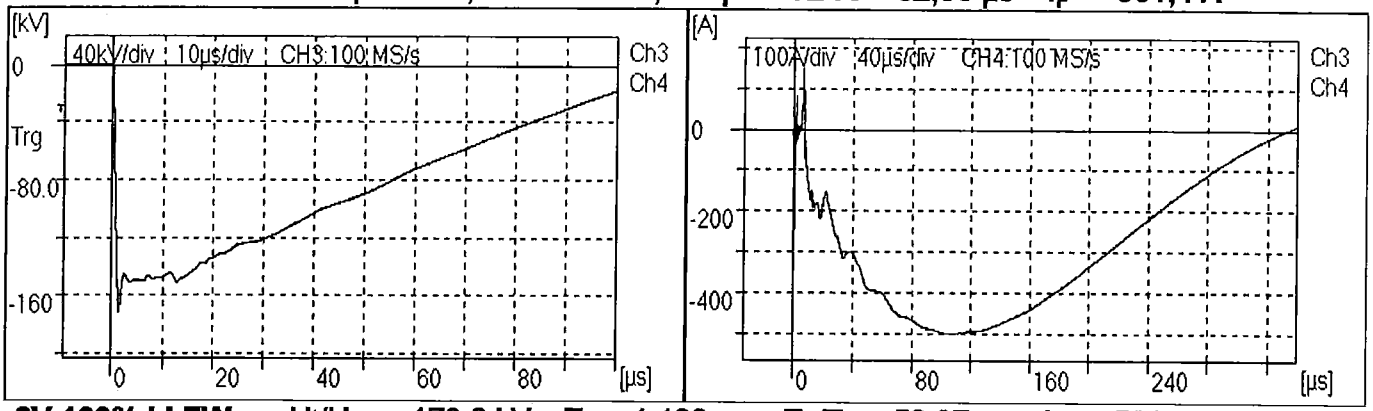




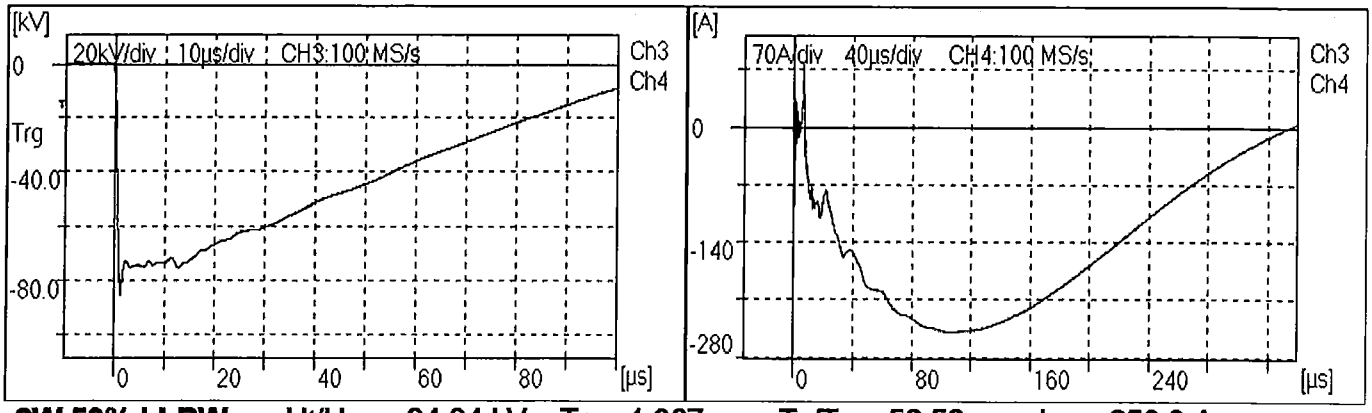
2V 110% LI CFW Ut/Up = -187,8 kV T1 = 1,199 µs T2/Tc = 3,579 µs Ip = -392,2 A



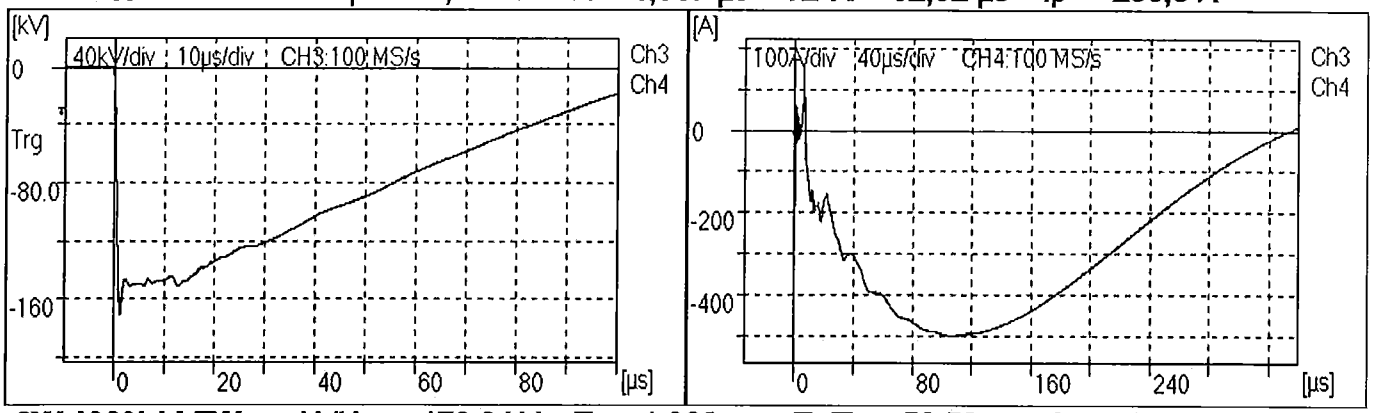
2V 100% LI FW Ut/Up = -170,8 kV T_1 = 1,200 µs T_2/T_c = 52,36 µs Ip = -501,4 A



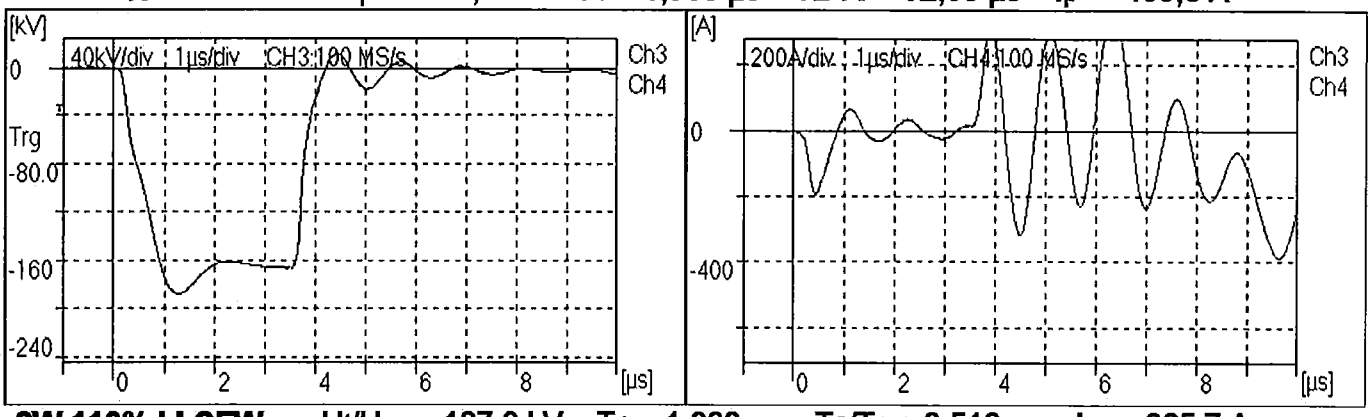
2V 100% LI FW Ut/Up = -170,8 kV T_1 = 1,199 µs T_2/T_c = 52,37 µs Ip = -501,5 A



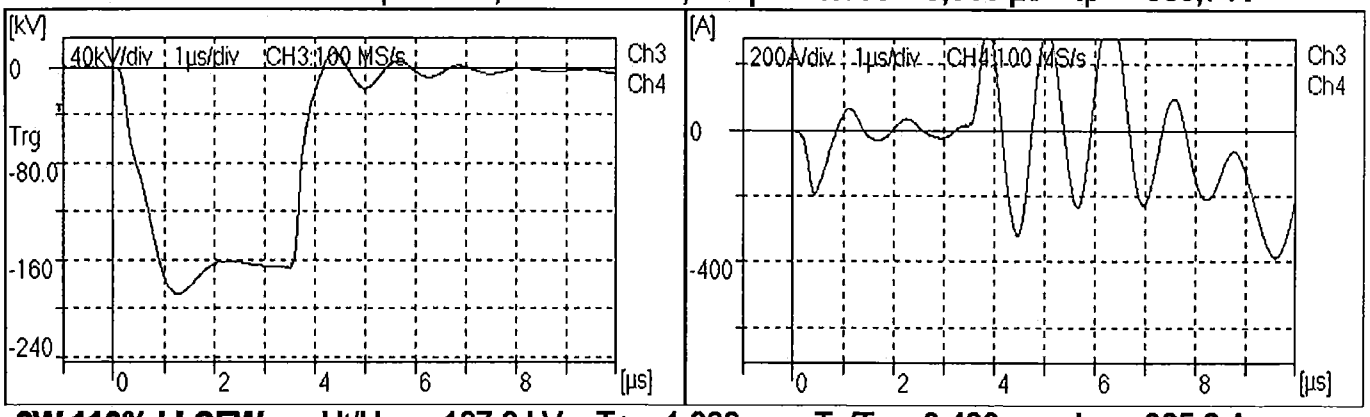
2W 50% LI RW Ut/Up = -84,84 kV T1 = 1,067 µs T2/Tc = 52,52 µs Ip = -250,3 A



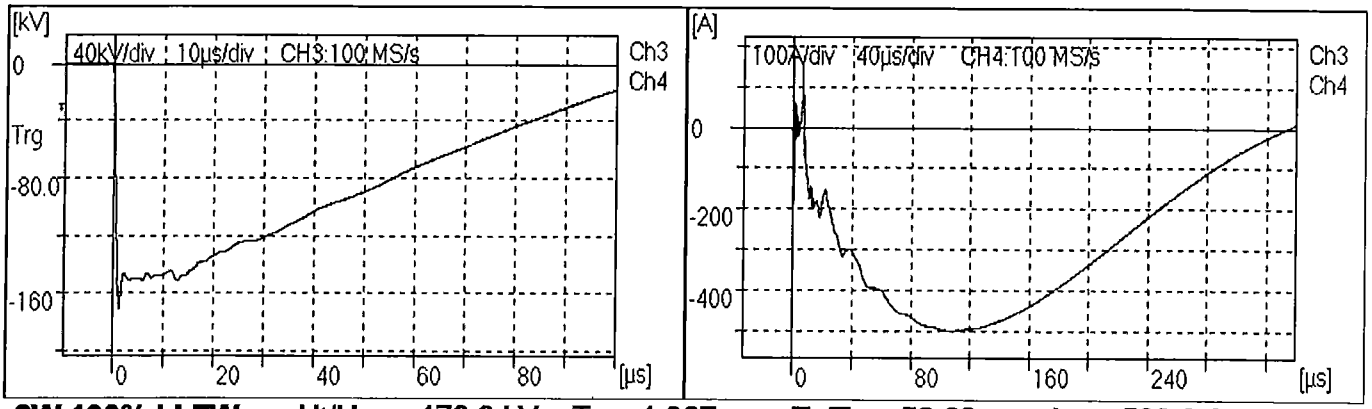
2W 100% LI FW Ut/Up = -170,0 kV T1 = 1,068 µs T2/Tc = 52,58 µs Ip = -499,8 A



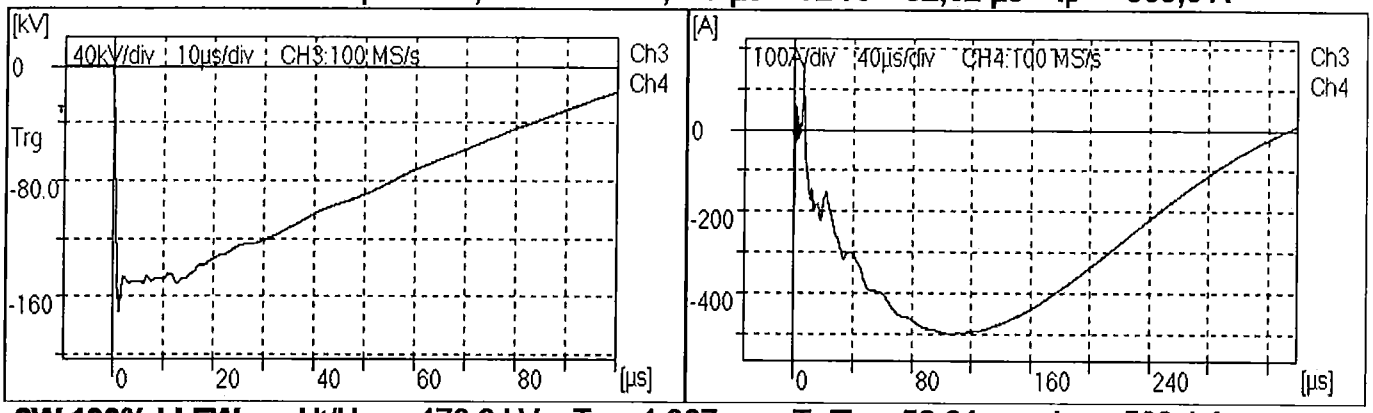
2W 110% LI CFW Ut/Up = -187,0 kV T1 = 1,068 µs T2/Tc = 3,516 µs Ip = -385,7 A



2W 110% LI CFW Ut/Up = -187,0 kV T1 = 1,068 µs T2/Tc = 3,480 µs Ip = -385,2 A

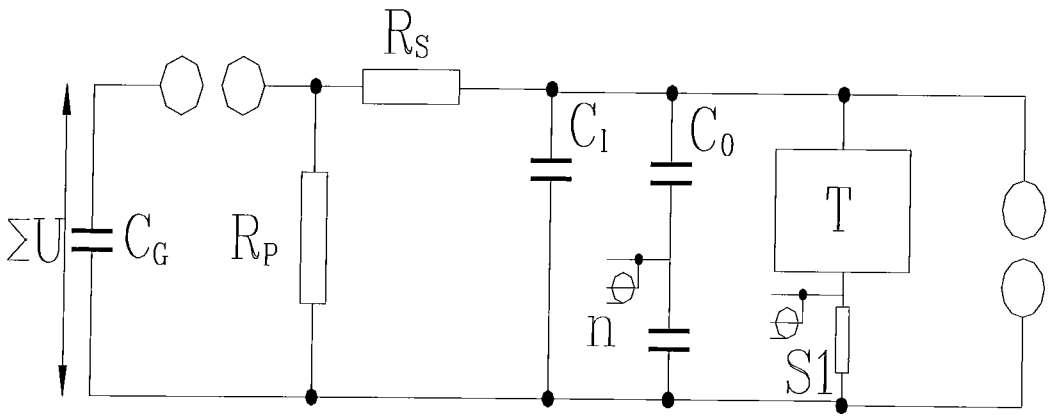


2W 100% LI FW Ut/Up = -170,0 kV T_1 = 1,067 µs T_2/T_c = 52,62 µs Ip = -500,0 A



2W 100% LI FW Ut/Up = -170,0 kV T_1 = 1,067 µs T_2/T_c = 52,64 µs Ip = -500,1 A

7.1 Equivalent lightning impulse circuit



7.2 Impulse circuit ´s constants

	H.V. winding	L.V. Winding		
C_G (pF)	166667	166666,6667		
R_S (Ω)	140,4	60		
R_P (Ω)	396	237		
C_0 (pF)	670	670		
C_1 (pF)	-	-		
S1 (Ω)	0,5	0,5		

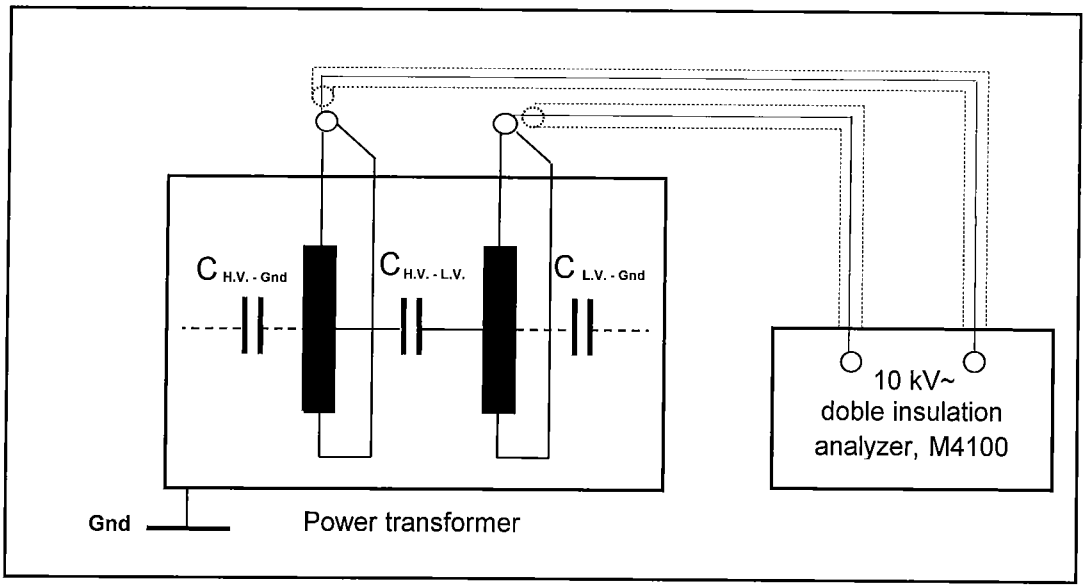
KONČAR D&ST

MEASUREMENT OF CAPACITANCES AND DISSIPATION FACTOR OF WINDINGS

Test report No :	K1089
Page :	1 / 1

1 . 0 .	RATING VALUES		
Transformer type :	TRP 60000-145/E	Vector Group :	YNd11(d1)
Rated power H.V. / L.V. (kVA) :	60000 / 60000	Type of cooling :	ONAN / ONAF
Rated voltage H.V. / L.V. (kV) :	132 / 33,0(33,0)	Frequency (Hz) :	50
Serial No. :	ET0817 - 463829	Tested in accordance :	IEC 60076-1

2 . 0 . TEST CIRCUIT



3 . 0 . TEST RESULTS

Measured combination	H.V. - Gnd	H.V. - L.V.	L.V. - Gnd	H.V. - (L.V. + Gnd)	L.V. - (H.V. + Gnd)	
Measured at oil temperature 27 °C						
tanδ (%)	0,211	0,169	0,276	0,182	0,228	
C (pF)	4773,1	8107,6	9928,3	12877,6	18032,3	
Ut (kV)	10	10	10	10	10	
Corrected values to 20 °C						
tanδ (%)	0,183	0,147	0,240	0,158	0,198	

NOTE: During the test winding L.V. was in connection d11.

Tested by : Vedran Gojević, dipl.ing.

Approved by : Vedran Maljković, dipl.ing.

KONČAR Distributivni i specijalni transformatori d.d. Zagreb

ISPITNA STANICA TESTING STATION 4

Date and stamp : 06.06.2018.

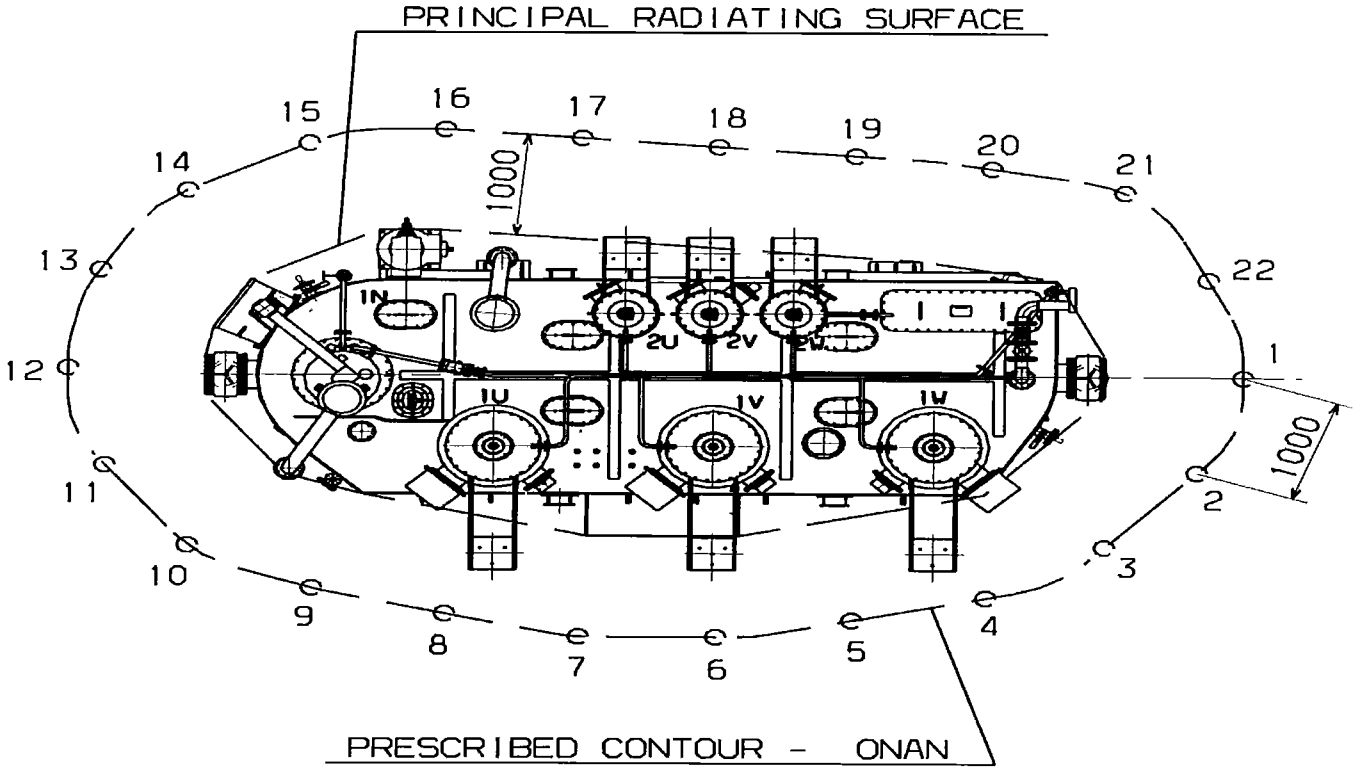
KONČAR D&ST

REPORT OF SOUND LEVEL MEASUREMENT

Test report No B1921

Page : 1

1 . 0	RATING VALUES		
Transformer type :	TRP 60000-145/E	Connections :	YNd11(d1)
Rated power (kVA)	60000	Type of cooling :	ONAN
Rated voltage (kV)	132 / 33,0(33,0)	Frequency (Hz) :	50
Serial No. :	ET0817 - 463829	Tested in acc. :	IEC 60076-10



Test conditions :		Guaranted dB(A)	Measured dB(A)
Type of cooling : ONAN, measured at 100% Ur	Sound intensity level - (LiA) - ONAN at 100% Ur	---	40,5
Distance of measurement contour : X = 1m	Sound power level - (LwA) - ONAN at 100% Ur	77,0	60,5
Lenght of prescribed contour : Lm= 22m			

Distance between measurement points : D = 1m	Instrument Type: Brüel & Kjaer 2260 Investigator
Height of the transformer : h = 3,06m	**Test result : P A S S E D**

Note: Measured with walk-around method

The test was carried out in the presence of:

Tested by : D. Bistrički, dipl.ing.

Approved by : Vedran Maljković, dipl.ing.

KONČAR Distributivni i specijalni transformatori d.d. Zagreb

ISPITNA STANICA TESTING STATION 4

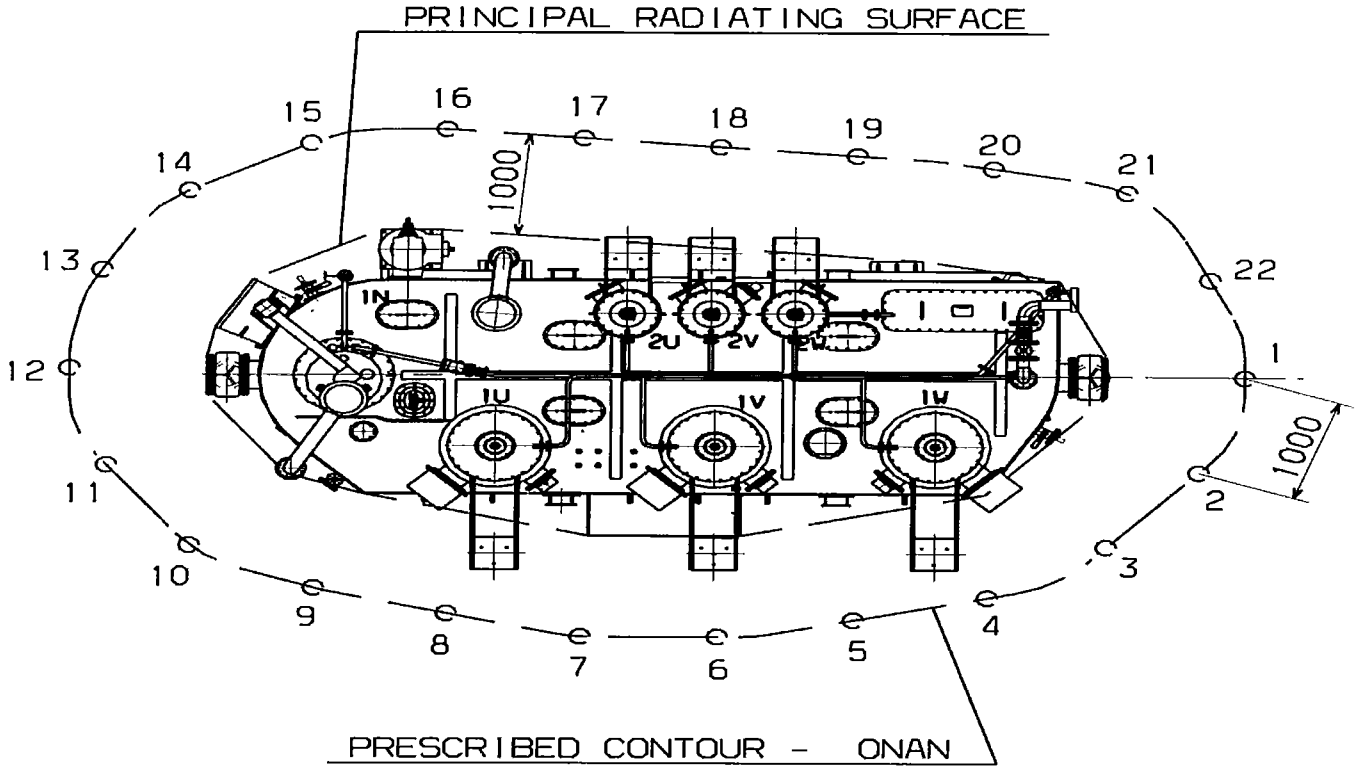
Date of measurement: 06.06.2018.

KONČAR D&ST

REPORT OF SOUND LEVEL MEASUREMENT

Test report No	B1921
Page :	2

1.0	RATING VALUES		
Transformer type :	TRP 60000-145/E	Connections :	YNd11(d1)
Rated power (kVA)	60000	Type of cooling :	ONAN
Rated voltage (kV)	132 / 33,0(33,0)	Frequency (Hz) :	50
Serial No. :	ET0817 - 463829	Tested in acc. :	IEC 60076-10



Test conditions :		Guaranted dB(A)	Measured dB(A)
Type of cooling : ONAN, measured at 90% Ur	Sound intensity level - (LiA) - ONAN at 90% Ur	---	34,3
Distance of measurement contour : X = 1m	Sound power level - (LwA) - ONAN at 90% Ur	---	54,3
Lenght of prescribed contour : Lm= 22m			
Type of cooling : ONAN, measured at 110% Ur	Sound intensity level - (LiA) - ONAN at 110% Ur	----	46,3
Distance of measurement contour : X = 1m	Sound power level - (LwA) - ONAN at 110% Ur	----	66,3
Lenght of prescribed contour : Lm= 22m			

Distance between measurement points : D = 1m	Instrument Type: Brüel & Kjaer 2260 Investigator
Height of the transformer : h = 3,06m	**Test result : P A S S E D**

Note: Measured with walk-around method

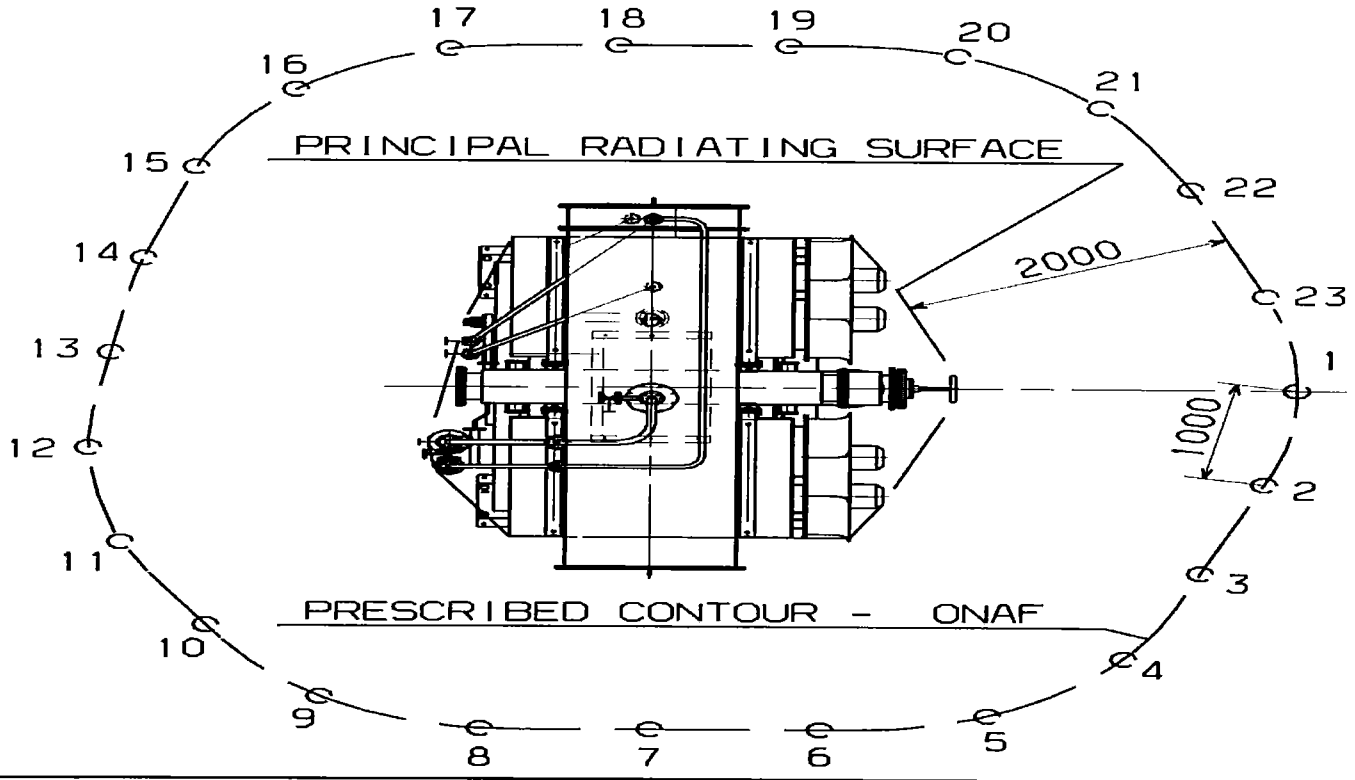
KONČAR D&ST

REPORT OF SOUND LEVEL MEASUREMENT

Test report No B1921

Page : 3

1.0	RATING VALUES		
Transformer type :	TRP 60000-145/E	Connections :	YNd11(d1)
Rated power (kVA)	60000	Type of cooling :	ONAF
Rated voltage (kV)	132 / 33,0(33,0)	Frequency (Hz) :	50
Serial No. :	ET0817 - 463829	Tested in acc. :	IEC 60076-10



Test conditions : Measurement of the cooling bank		Guaranted dB(A)	Measured dB(A)
Type of cooling : ONAF	Sound intensity level - (LiA)	---	53,6
Distance of measurement contour : X = 2m	Sound power level - (LwA)	77,0	75,8
Lenght of prescribed contour : Lm= 23m			

Distance between measurement points : D = 1m	Instrument Type: Brüel & Kjaer 2260 Investigator
Height of the cooling bank : h = 4,75m	**Test result : P A S S E D**

KONCAR - DISTRIBUTION & SPECIAL TRANSFORMERS
ZAGREB, CROATIA

TEMPERATURE RISE TEST REPORT

(TYPE TEST)

TRANSFORMER TYPE :	**TRP 60000-145/E**
SERIAL No. :	**ET0817- 463829**
RATED VOLTAGE (kV):	**132,0 / 33,0(33,0)**
VECTOR GROUP :	**YNd11(d1)**
RATED FREQUENCY :	**50**
COOLING METHOD :	**ONAF / ONAN**
TEST METHOD :	**SHORT - CIRCUIT METHOD**
TAP POSITION :	**19**

MEASURED VALUES :

		ONAF	ONAN
RATED POWER :	(MVA)	*60,0*	*39,0*
TOP OIL TEMPERATURE RISE :	(K)	45,2	42,0
WINDING H.V. TEMPERATURE RISE :	(K)	53,5	44,2
WINDING L.V. TEMPERATURE RISE :	(K)	50,3	41,5

SPECIFIED TEMPERATURE RISE LIMITS :

FOR OIL (K) :	**≤ 60**
FOR WINDINGS (K) :	**≤ 65**
WINDING 'HOT - SPOT' (K) :	**≤ 78**

APPLIED STANDARD : **IEC 60076-2**

TEST RESULT : **PASSED**

Note: During the test, transformer is checked with thermo-camera and all temperatures are in normal limits.

Checked by :
V. Gojević,dipl.ing.

KONČAR
Distributivni i specijalni transformatori d.d.
Zagreb
ISPITNA STANICA TESTING STATION 4

ZAGREB, 08.06.2018.

Approved by :
V. Maljković,dipl.ing.

TEST RESULTS

TRANSFORMER TYPE : **TRP 60000-145/E**
SERIAL No. : **ET0817- 463829**

COOLING METHOD : **ONAF**

TEST METHOD : **SHORT - CIRCUIT METHOD**

TAP POSITION : **19**

RATED POWER (MVA) : **60,0**

Oil temperature rises (steady state)	(k W)	Test losses 279,950	**Total losses 279,950**
TOP OIL TEMPERATURE RISE	(K)	45,2	***45,2***
EXIT OF COOLER	(K)	19,1	**19,1**
AVERAGE	(K)	32,2	**32,2**

Winding temperature rises		**H.V.**	**L.V.**
TEMPERATURE AT THE BEGINING	(°C)	25,8	25,8
WINDING RESISTANCE AT BEGINING	(Ω)	0,443877	0,029486
WINDING RESISTANCE AT THE END	(Ω)	0,537809	0,035359
AVERAGE OIL TEMP. AT SHUTDOWN	(°C)	59,6	59,6
WINDING TEMP. AT SHUTDOWN	(°C)	80,9	77,7
TEST CURRENT (I t)	(A)	328,2	1049,7
AVERAGE WINDING TO AVERAGE OIL TEMPERATURE RISE AT It	(K)	21,4	18,1
RATED CURRENT (I r)	(A)	328,2	1049,7
AVERAGE WINDING TO AVERAGE OIL TEMPERATURE RISE AT Ir	(K)	21,4	18,1
AVERAGE WINDING TEMPERATURE RISE	(K)	***53,5***	***50,3***
WINDING HOT-SPOT TO TOP OIL TEMPERATURE RISE	(K)	**18,3**	**13,9**
WINDING HOT-SPOT TEMPERATURE RISE	(K)	***63,5***	***59,1***

The readings of optical sensors are taken at the end of 1 hour period at ONAF rated current :

Top oil (°C)	Sensors - Winding 1 (°C)						Sensors - Winding 2 (°C)			
	1U/1		1V/2	1V/3	1V/4	1W/1	2U/1	2V/1	2V/2	2W/1
72,5	90,8		88,1	79,7	89,2	89,6	85,4	82,6	83,3	86,4

Hot-spot winding to top oil temperature rise at I_{rated} (K)									
1U/1 - Top oil		1V/2 - Top oil	1V/3 - Top oil	1V/4 - Top oil	1W/1 - Top oil	2U/1 - Top oil	2V/1 - Top oil	2V/2 - Top oil	2W/1 - Top oil
18,3		15,6	7,2	16,7	17,1	12,9	10,1	10,8	13,9

Top oil temperature rise (K)
45,2

Winding 1 - Hot-spot temperature rise (K)						Winding 2 - Hot-spot temperature rise (K)			
63,5		60,8	52,4	61,9	62,3	58,1	55,3	56,0	59,1

TEST RESULTS

TRANSFORMER TYPE : **TRP 60000-145/E**
SERIAL No. : **ET0817- 463829**

COOLING METHOD : **ONAN**
TEST METHOD : **SHORT - CIRCUIT METHOD**
TAP POSITION : **19**
RATED POWER (MVA) : **39,0**

Oil temperature rises (steady state)		Test losses	**Total losses**
	(k W)	128,120	**128,120**
TOP OIL TEMPERATURE RISE	(K)	42,0	***42,0***
EXIT OF COOLER	(K)	22,8	**22,8**
AVERAGE	(K)	32,4	**32,4**

Winding temperature rises		**H.V.**	**L.V.**
TEMPERATURE AT THE BEGINING	(°C)	25,8	25,8
WINDING RESISTANCE AT BEGINING	(Ω)	0,443877	0,029486
WINDING RESISTANCE AT THE END	(Ω)	0,515378	0,033935
AVERAGE OIL TEMP. AT SHUTDOWN	(°C)	56,0	56,0
WINDING TEMP. AT SHUTDOWN	(°C)	67,8	65,1
TEST CURRENT (I t)	(A)	213,3	682,3
AVERAGE WINDING TO AVERAGE OIL TEMPERATURE RISE AT It	(K)	11,7	9,1
RATED CURRENT (I r)	(A)	213,3	682,3
AVERAGE WINDING TO AVERAGE OIL TEMPERATURE RISE AT Ir	(K)	11,7	9,1
AVERAGE WINDING TEMPERATURE RISE	(K)	***44,2***	***41,5***
WINDING HOT-SPOT TO TOP OIL TEMPERATURE RISE	(K)	**11,1**	**7,4**
WINDING HOT-SPOT TEMPERATURE RISE	(K)	***53,1***	***49,4***

The readings of optical sensors are taken at the end of 1 hour period at ONAN rated current :

Top oil (°C)	Sensors - Winding 1 (°C)						Sensors - Winding 2 (°C)			
	1U/1		1V/2	1V/3	1V/4	1W/1	2U/1	2V/1	2V/2	2W/1
64,7	75,8		73,8	69,0	73,8	74,5	72,1	71,0	71,1	71,8

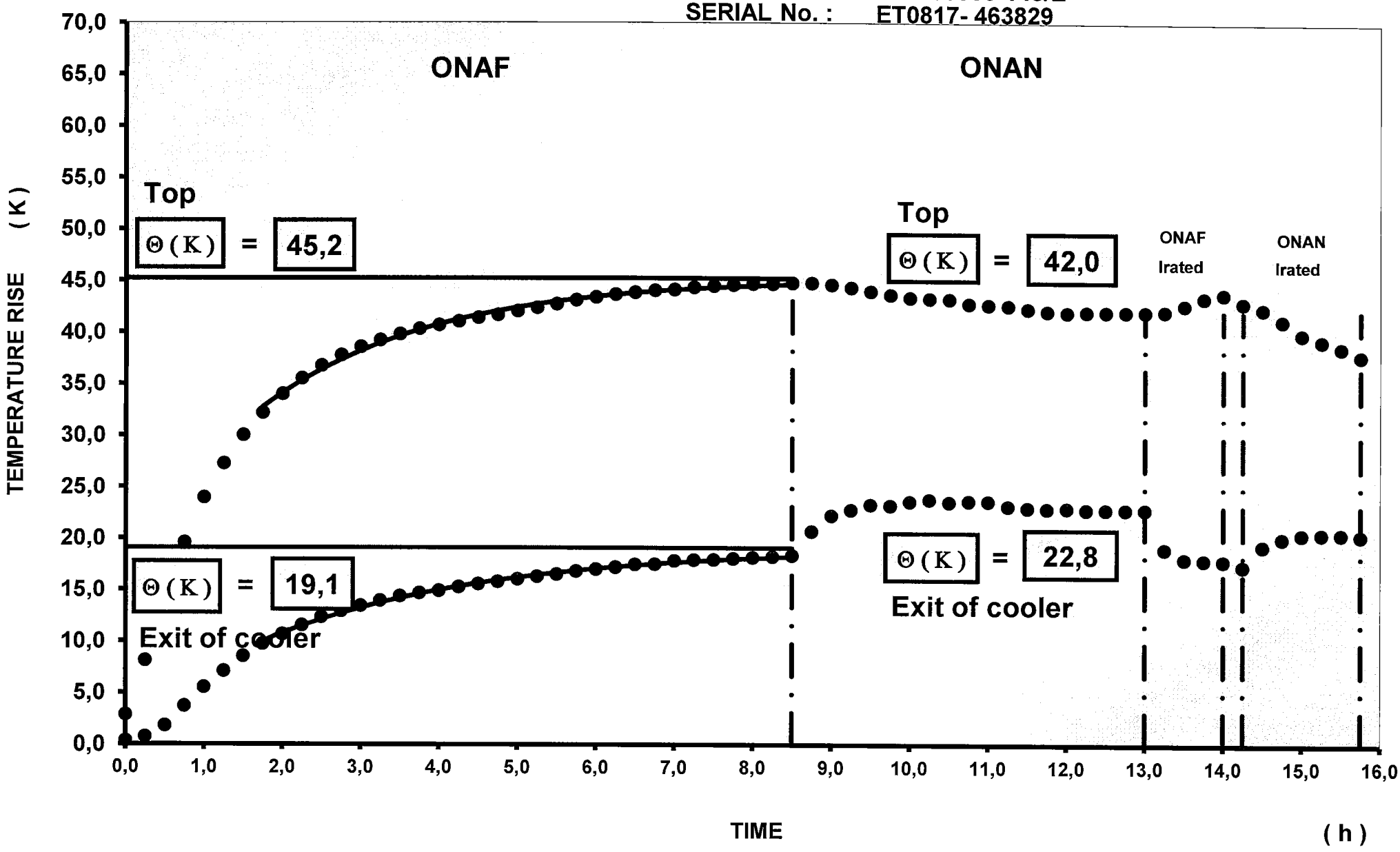
Hot-spot winding to top oil temperature rise at I_{rated} (K)									
1U/1 - Top oil		1V/2 - Top oil	1V/3 - Top oil	1V/4 - Top oil	1W/1 - Top oil	2U/1 - Top oil	2V/1 - Top oil	2V/2 - Top oil	2W/1 - Top oil
11,1		9,1	4,3	9,1	9,8	7,4	6,3	6,4	7,1

Top oil temperature rise (K)
42,0

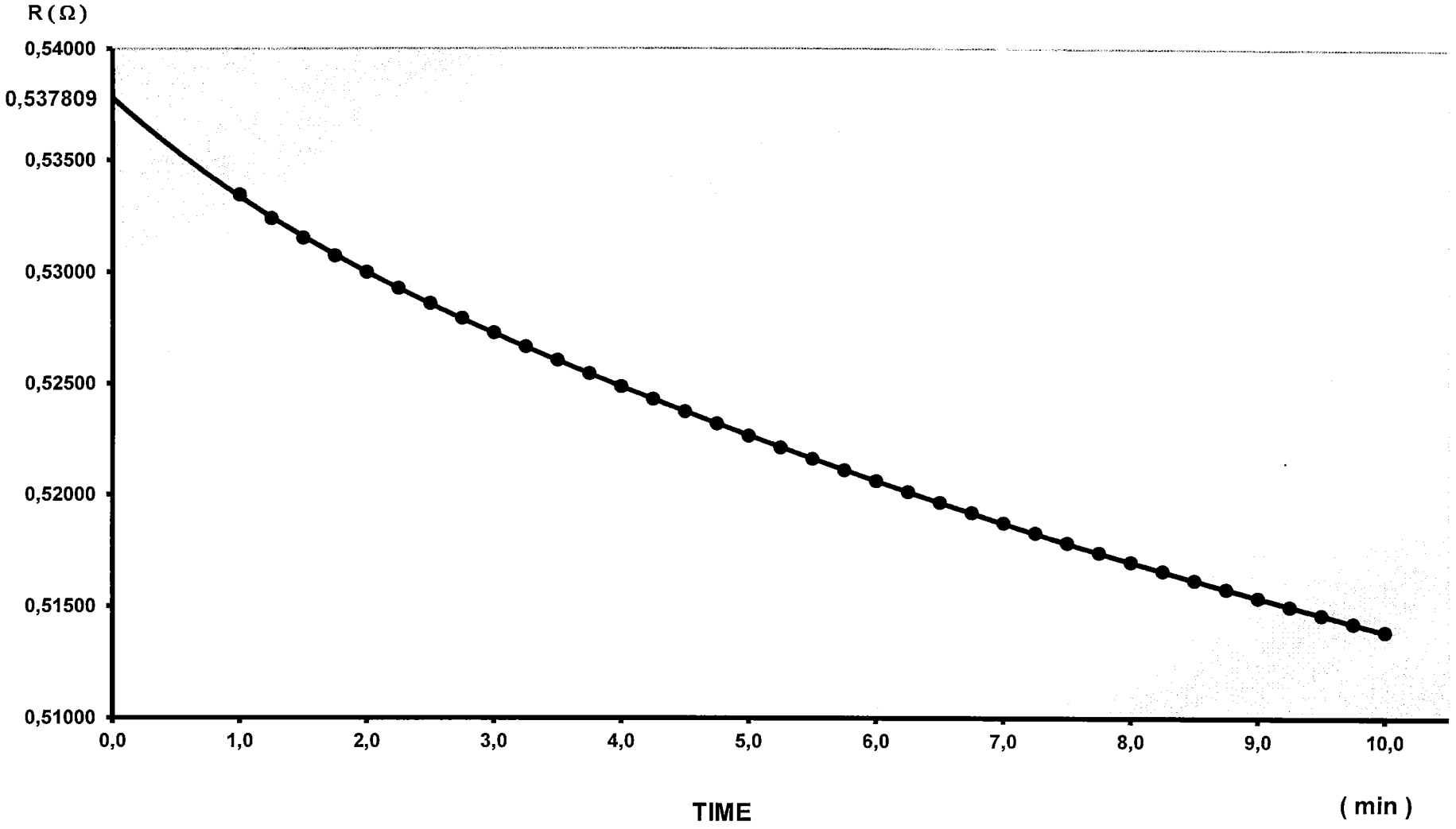
Winding 1 - Hot-spot temperature rise (K)						Winding 2 - Hot-spot temperature rise (K)			
53,1		51,1	46,3	51,1	51,8	49,4	48,3	48,4	49,1

OIL TEMPERATURE RISE

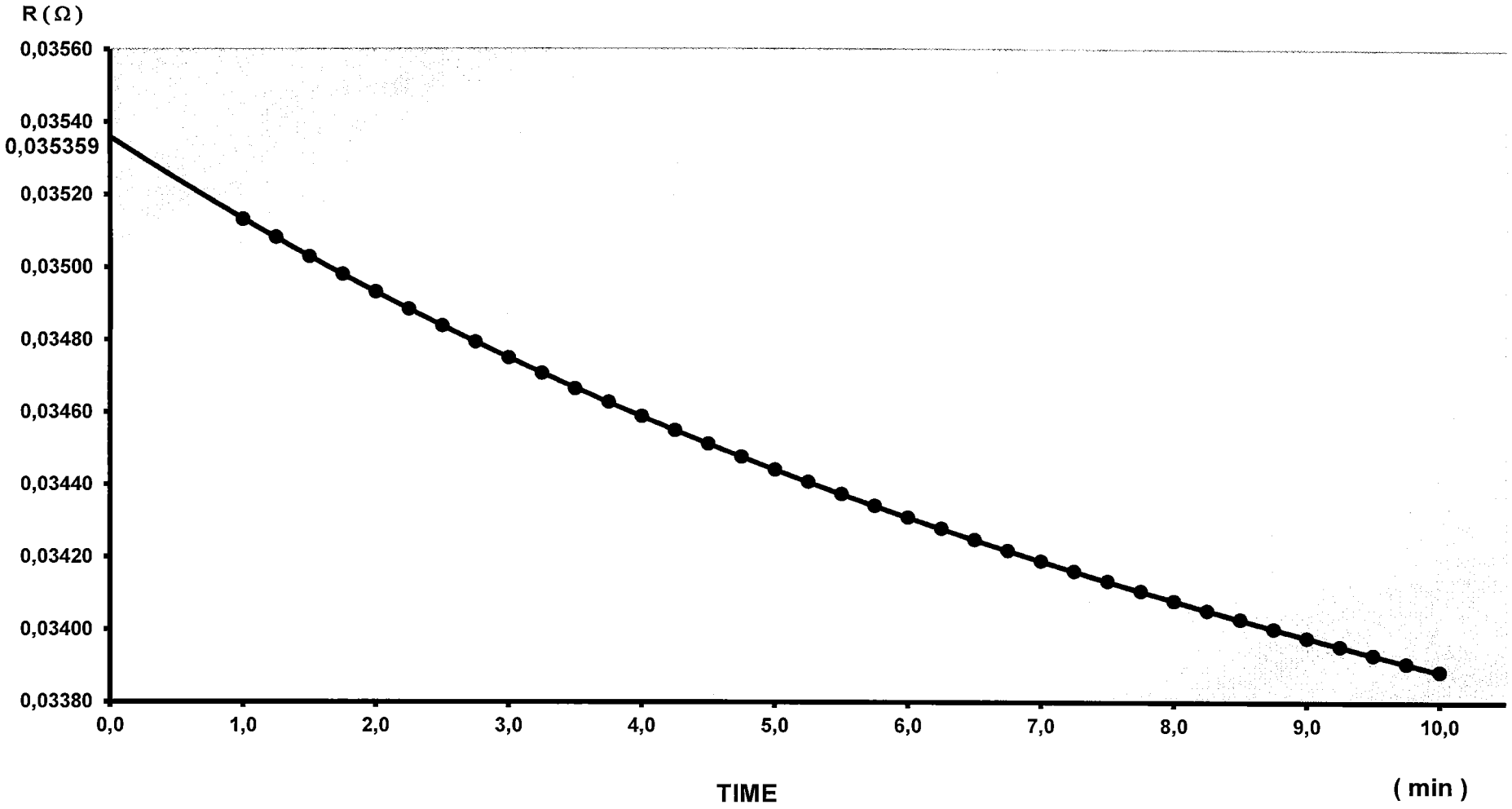
TRANSFORMER TYPE : TRP 60000-145/E
SERIAL No. : ET0817- 463829

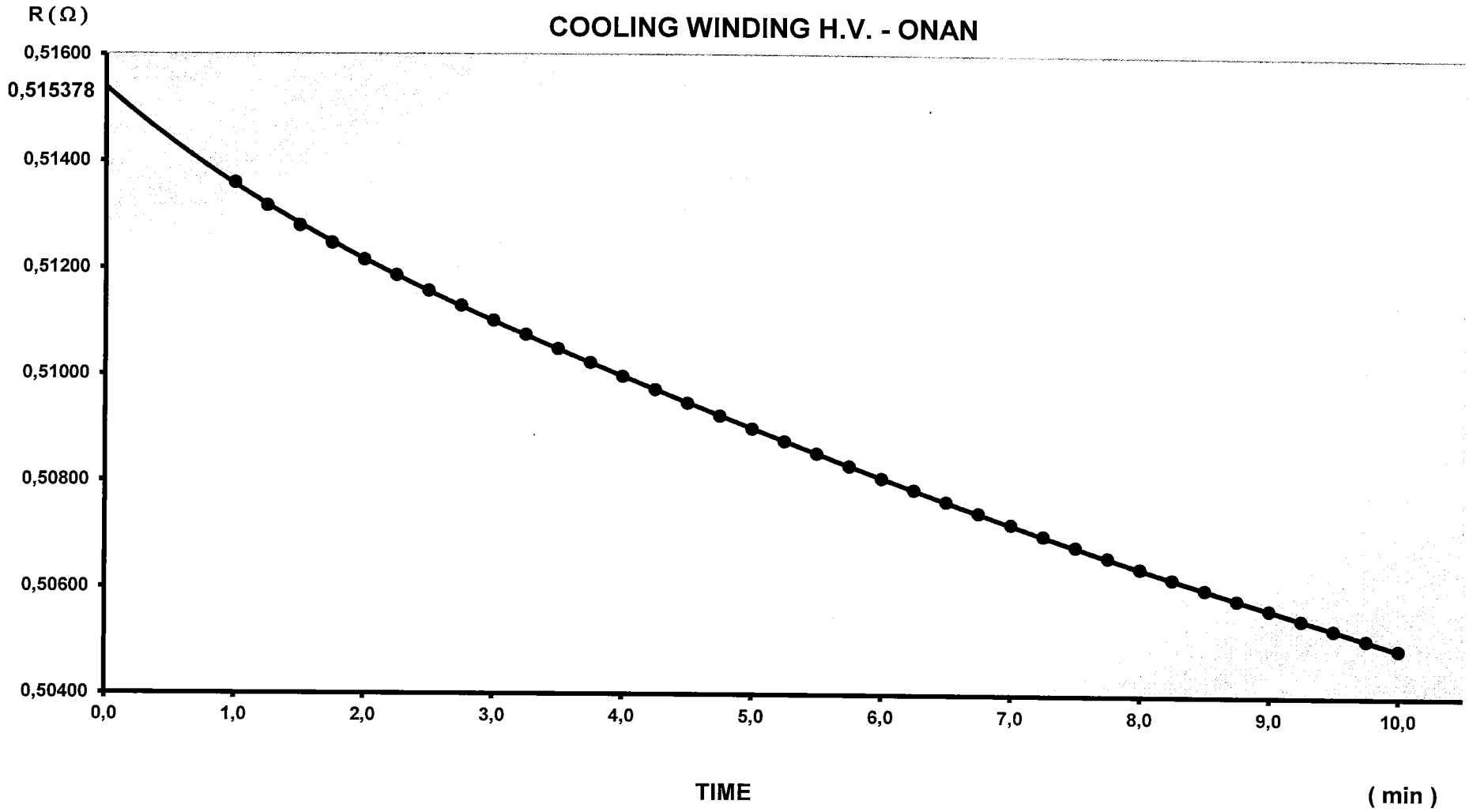


COOLING WINDING H.V.- ONAF

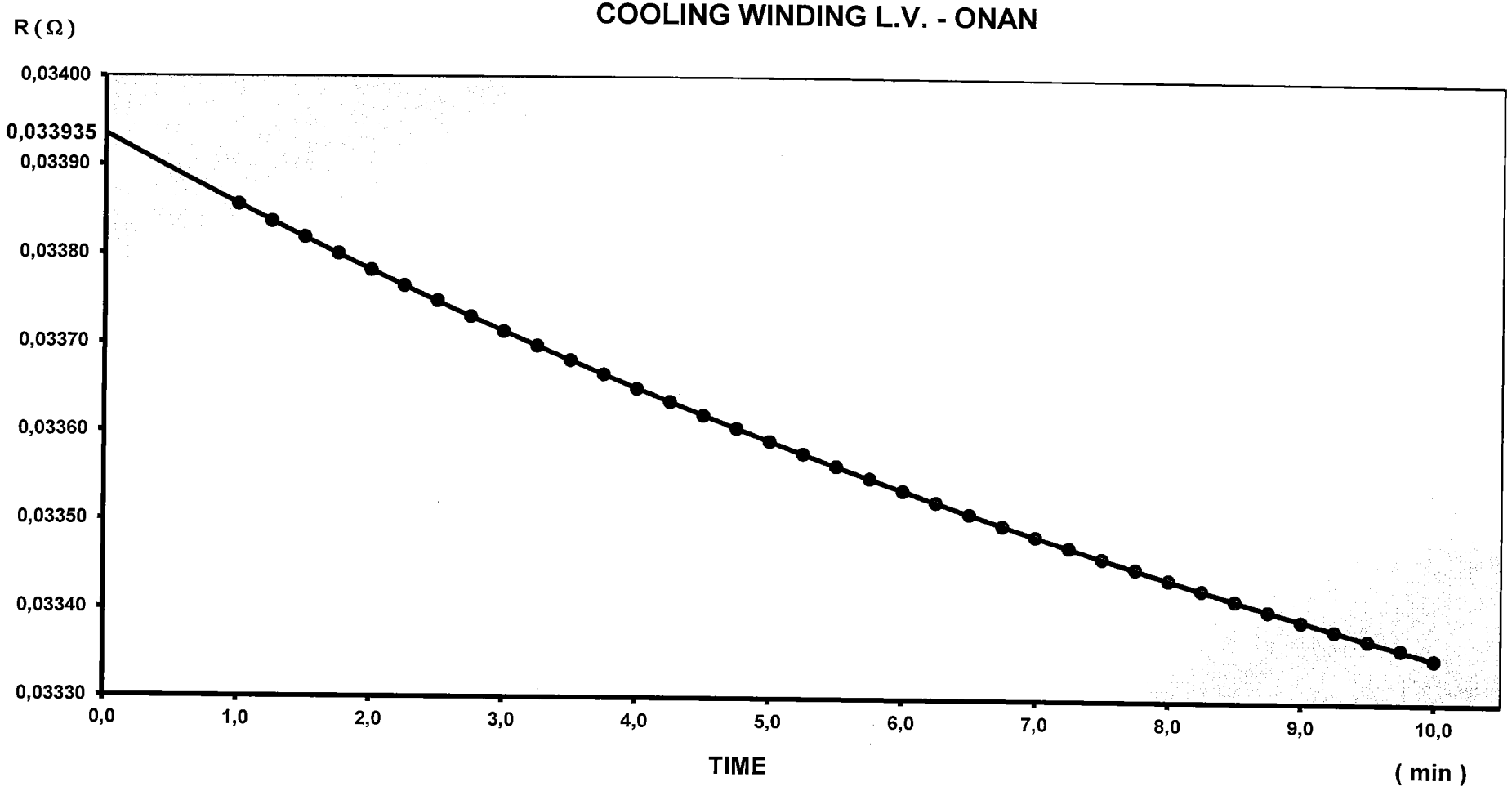


COOLING WINDING L.V. - ONAF




COOLING WINDING H.V. - ONAN
R (Ω)
0,51600
0,515378
0,51400
0,51200
0,51000
0,50800
0,50600
0,50400
0,0
1,0
2,0
3,0
4,0
5,0
6,0
7,0
8,0
9,0
10,0
TIME
(min)

COOLING WINDING L.V. - ONAN



TEST REPORT

acc.to: HRN EN10204 2.2

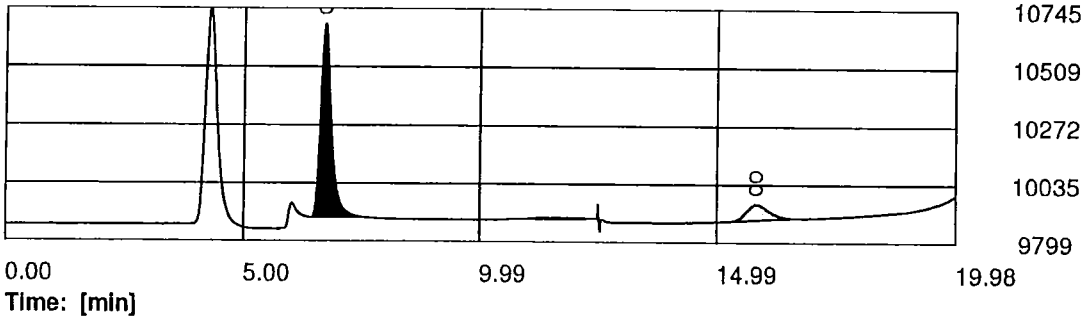
No.: 18/270

Date: 07.06.2018

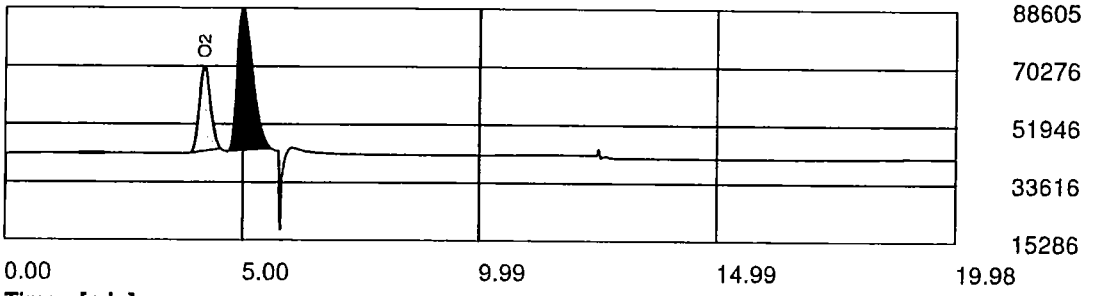
CHROMATOGRAPHIC ANALYSIS OF GASES DISSOLVED IN OIL

Transformer data:	TRP 60000-145/E; ET0817; fac.no.463829; SCOTLAND
Instrument data:	TOGA GC, full vacum degassing, Energy support
Test method:	IEC 60567, IEC 60599, IEC 61181
Note:	before all factory acceptance tests

FID channel: [µV]



TCD channel: [µV]



Component		Ref. value ppm	Meas. value ppm	Nom. value ppm	Exceed. nom. val. %
Hydrogen	H_2	-	-	15.0	-
Methane	CH_4	-	-	5.0	-
Ethine	C_2H_2	-	-	1.0	-
Ethene	C_2H_4	-	-	2.0	-
Ethane	C_2H_6	-	-	5.0	-
Carbon monoxide	CO	-	3.6	80.0	-
Carbon dioxide	CO_2	-	19.0	200	-
Nitrogen	N_2	-	5590	-	-
Oxygen	O_2	-	1783	-	-
Total gas	TG	-	7396	-	-

INTERPRETATION OF TEST RESULTS: All gas concentrations are low and according with typical manufacturer's gas values acc. QA-RU-15-00-05

Tested by: Ivanka Radić, MSc.Chem.E.
Vlatka Šerkinić, mag.ing.oecoing.

Approved by: Renata Jurišić, MSc.Chem.E.

OB-0278 2013-08-26

Končar Distribution&Special Transformers, tel. + 385 1 3783 777, fax:+ 0385 1 3794 051, e-mail: info@koncar-dst.hr, www.koncar-dst.hr
Laboratory of Incoming control, tel.+385 1 3783 829, e-mail:ivanka.radic@koncar-dst.hr

TEST REPORT

acc.to: HRN EN10204 2.2

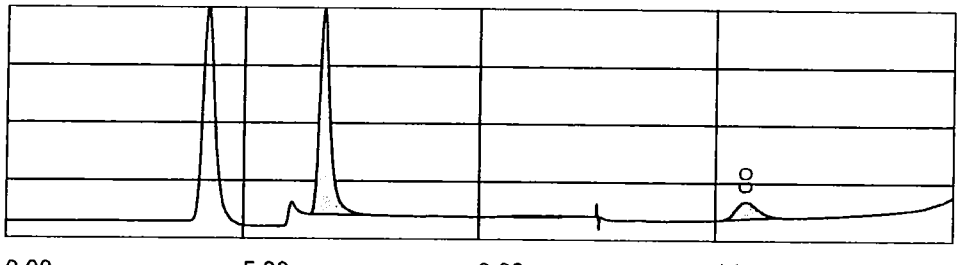
No.: 18/271

Date: 08.06.2018

CHROMATOGRAPHIC ANALYSIS OF GASES DISSOLVED IN OIL

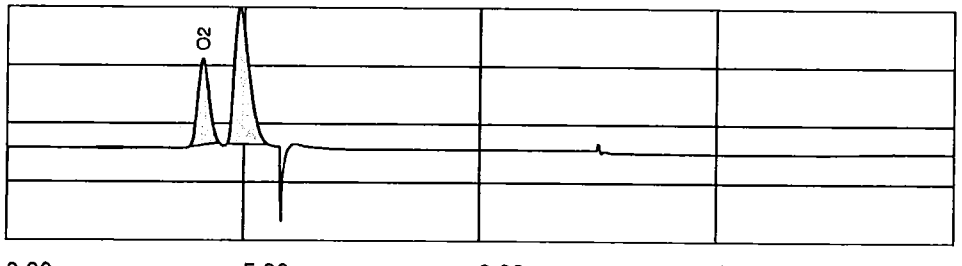
Transformer data:	TRP 60000-145/E; ET0817; fac.no.463829; SCOTLAND
Instrument data:	TOGA GC, full vacum degassing, Energy support
Test method:	IEC 60567, IEC 60599, IEC 61181
Note:	after dielectrical tests

FID channel: [µV]



Time: [min]

TCD channel: [µV]



Time: [min]

Component		Ref. value ppm	Meas. value ppm	Nom. value ppm	Exceed. nom. val. %
Hydrogen	H_2	-	-	15.0	-
Methane	CH_4	-	-	5.0	-
Ethine	C_2H_2	-	-	1.0	-
Ethene	C_2H_4	-	-	2.0	-
Ethane	C_2H_6	-	-	5.0	-
Carbon monoxide	CO	-	3.7	80.0	-
Carbon dioxide	CO_2	-	20.3	200	-
Nitrogen	N_2	-	5079	-	-
Oxygen	O_2	-	1749	-	-
Total gas	TG	-	6852	-	-

INTERPRETATION OF TEST RESULTS: All gas concentrations are low and according with typical manufacturer's gas values acc. QA-RU-15-00-05

Tested by: Ivanka Radić, MSc.Chem.E.
Vlatka Šerkinić, mag.ing.oecoing.

Approved by: Renata Jurišić, MSc.Chem.E.

Končar Distribution&Special Transformers, tel. + 385 1 3783 777, fax:+ 0385 1 3794 051, e-mail: info@koncar-dst.hr, www.koncar-dst.hr
Laboratory of Incoming control, tel.+385 1 3783 829, e-mail:ivanka.radic@koncar-dst.hr

TEST REPORT

acc.to: HRN EN10204 2.2

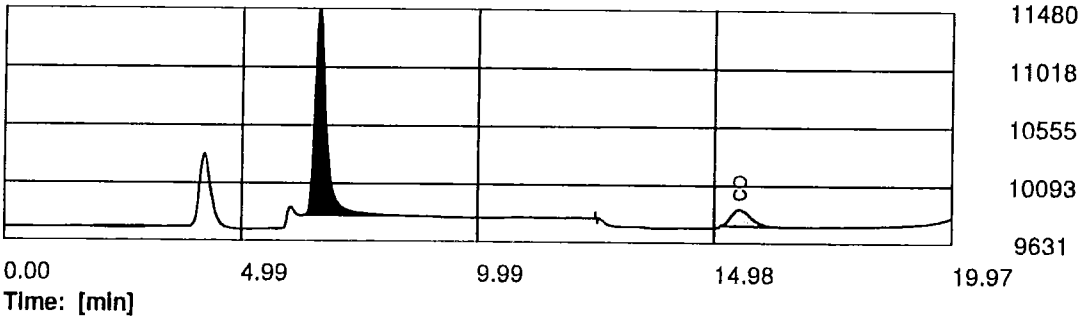
No.: 18/272

Date: 11.06.2018

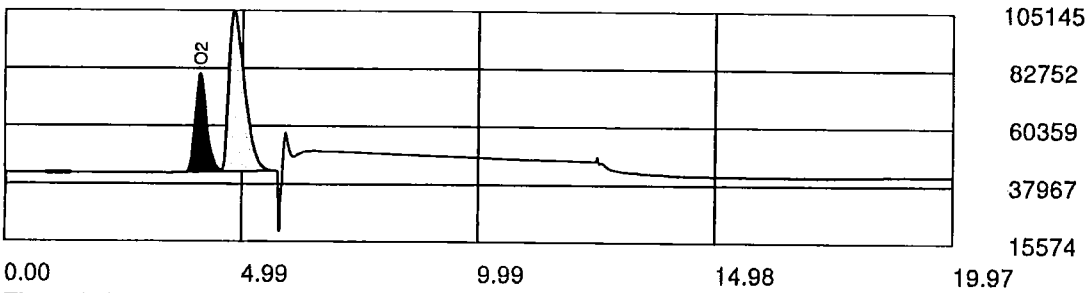
CHROMATOGRAPHIC ANALYSIS OF GASES DISSOLVED IN OIL

Transformer data:	TRP 60000-1457E; ET0817; fac.no.463829; SCOTLAND
Instrument data:	TOGA GC, full vacum degassing, Energy support
Test method:	IEC 60567, IEC 60599, IEC 61181
Note:	after all factory acceptance tests

FID channel: [µV]



TCD channel: [µV]



Component		Ref. value ppm	Meas. value ppm	Nom. value ppm	Exceed. nom. val. %
Hydrogen	H_2	-	-	15.0	-
Methane	CH_4	-	-	5.0	-
Ethine	C_2H_2	-	-	1.0	-
Ethene	C_2H_4	-	-	2.0	-
Ethane	C_2H_6	-	-	5.0	-
Carbon monoxide	CO	-	6.9	80.0	-
Carbon dioxide	CO_2	-	43.8	200	-
Nitrogen	N_2	-	8416	-	-
Oxygen	O_2	-	2697	-	-
Total gas	TG	-	11163	-	-

INTERPRETATION OF TEST RESULTS: All gas concentrations are low and according with typical manufacturer's gas values acc. QA-RU-15-00-05

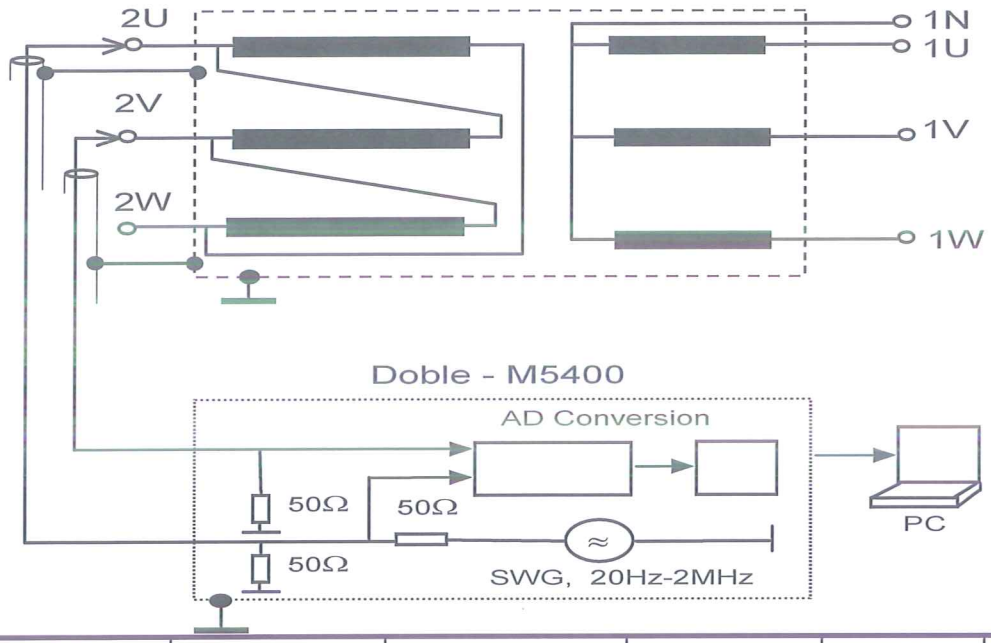
Tested by: Ivanka Radić, MSc.Chem.E.
Vlatka Šerkinić, mag.ing.oecoing.

Approved by: Renata Jurišić, MSc.Chem.E.

Končar Distribution&Special Transformers, tel. + 385 1 3783 777, fax:+ 0385 1 3794 051, e-mail: info@koncar-dst.hr, www.koncar-dst.hr
Laboratory of Incoming control, tel.+385 1 3783 829, e-mail:ivanka.radic@koncar-dst.hr

KONČAR D&ST	MEASUREMENT OF FREQUENCY RESPONSE	Test report No : F454 Page No. : 1

	RATING VALUES		
Transformer type :	TRP 60000-145/E	Connections :	YNd11
Rated power (kVA)	60000 / 60000	Type of cooling :	ONAN / ONAF
Rated voltage (kV)	132,0 / 33,0	Frequency (Hz) :	50
Serial No. :	ET0817 - 463829	Tested in acc. :	IEC 60076-18



Winding under test	Winding vector group	Tap positions - windings H.V. / L.V.	Voltage applied	Response	Graph №	Description
H.V.	YN	1 / -	1U	1N	1	Winding L.V. - open
			1V	1N		
			1W	1N		
H.V.	YN	10(from tap 9) / -	1U	1N	1a	Winding L.V. - open
			1V	1N		
			1W	1N		
L.V.	d11	1 / -	2U	2V	2	Winding H.V. - open
			2V	2W		
			2W	2U		

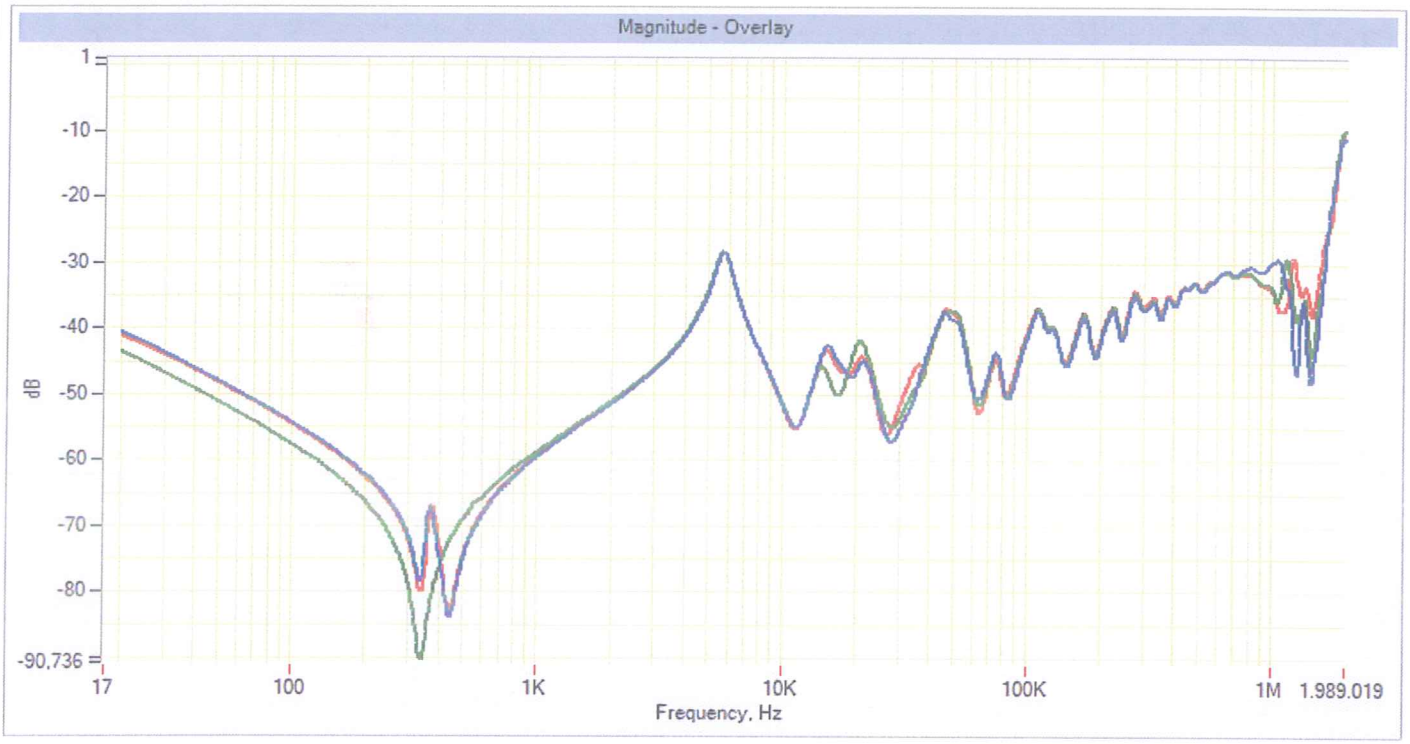
Winding L.V. in connection 'd11'.

KONČAR Distributivni i specijalni transformatori d.d. Zagreb
ISPITNA STANICA TESTING STATION 4

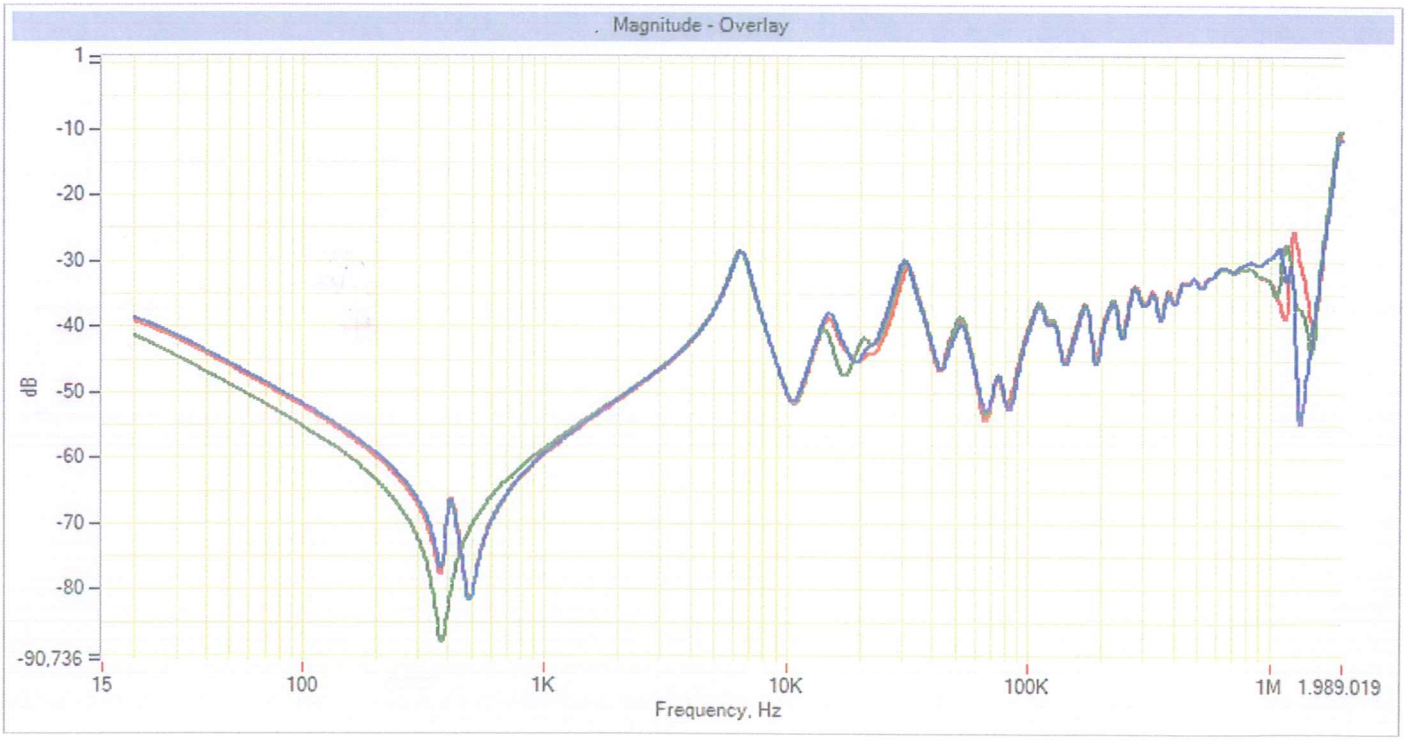
Tested by : D. Bistrički, dipl.ing.

Approved by : Vedran Maljković, dipl.ing.

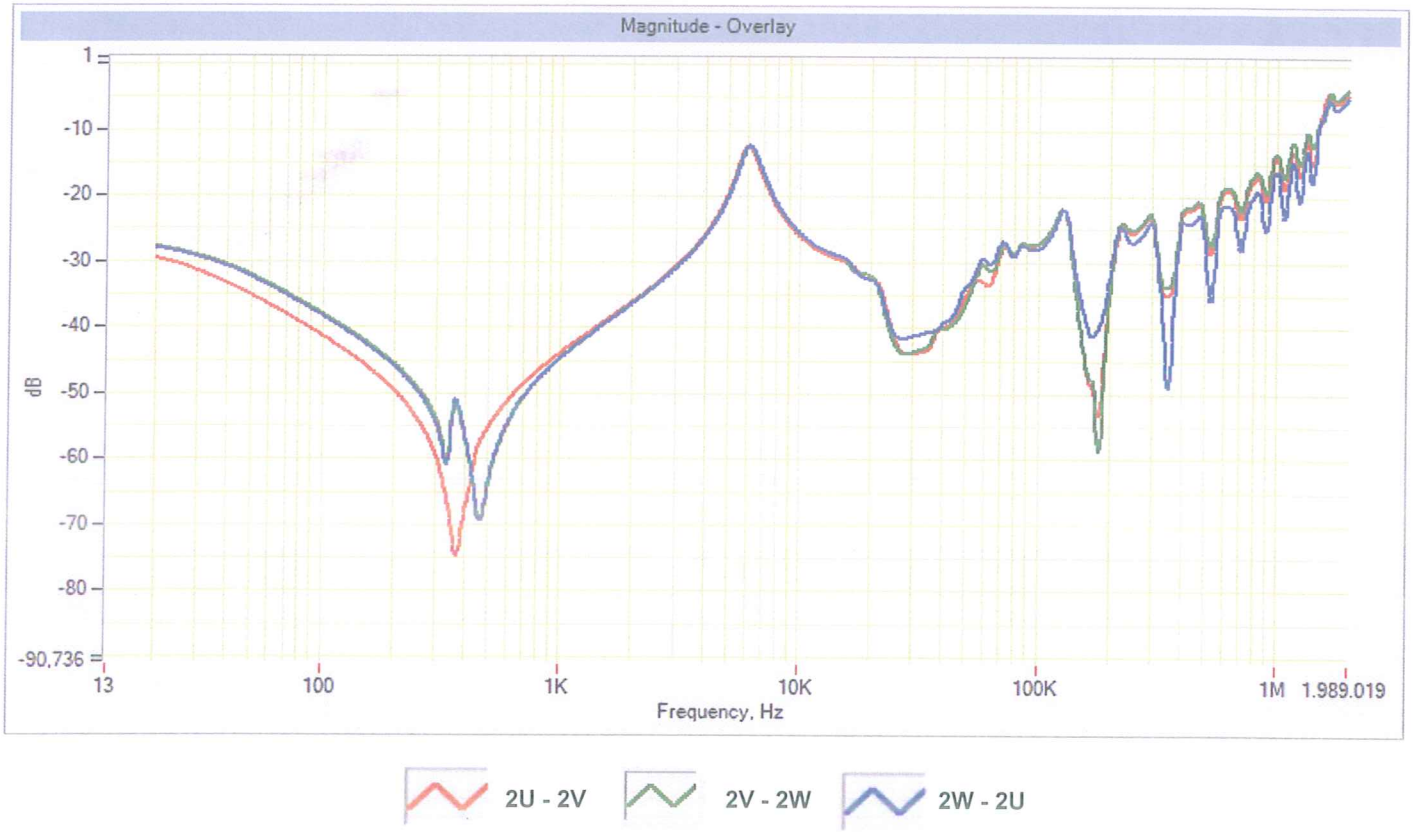
Date of measurement : 06.06.2018.



Graph 1.



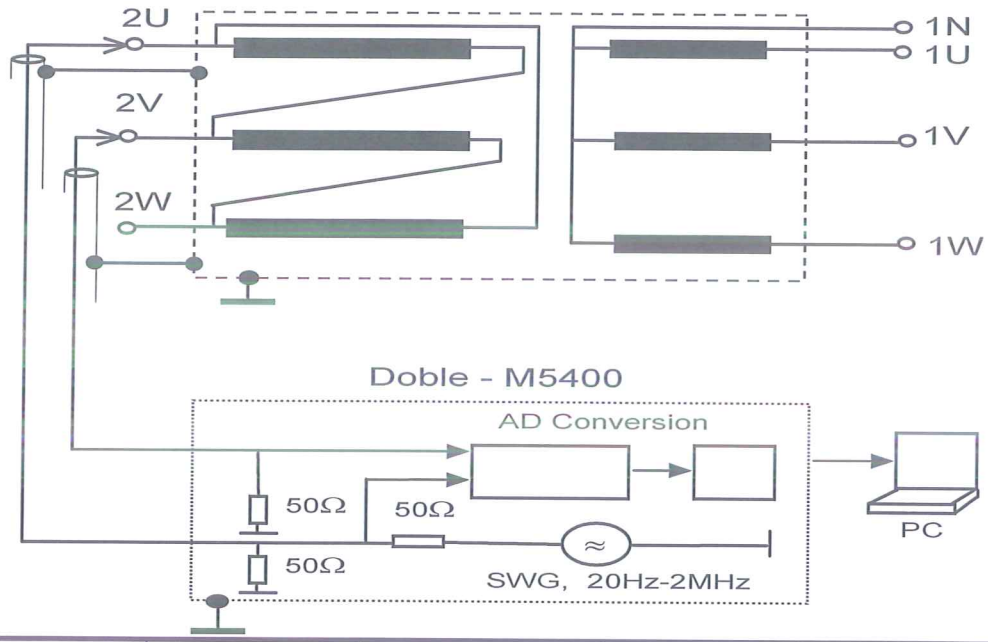
Graph 1a.


Magnitude - Overlay
1
-10
-20
-30
-40
-50
-60
-70
-80
-90,736
dB
13
100
1K
10K
100K
1M
1.989.019
Frequency, Hz
2U - 2V
2V - 2W
2W - 2U

Graph 2.

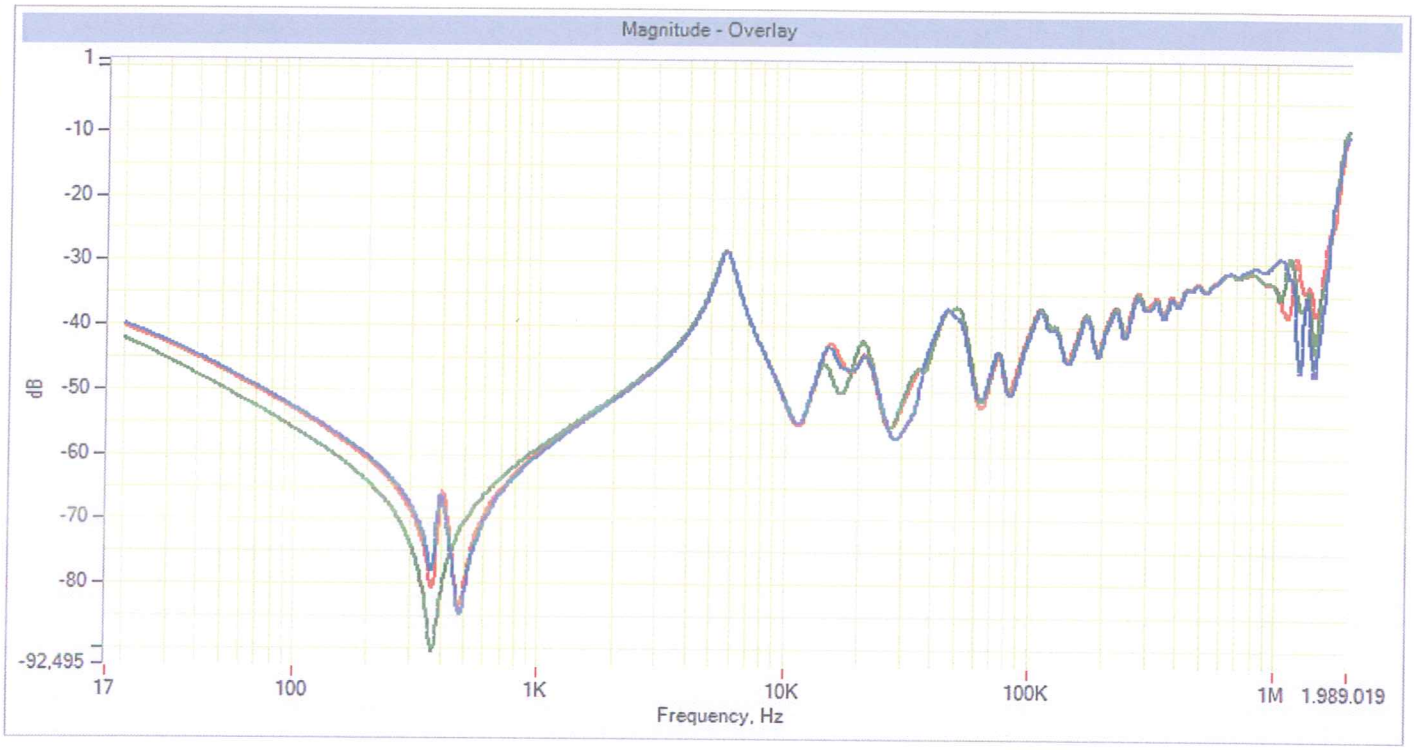
KONČAR D&ST	MEASUREMENT OF FREQUENCY RESPONSE	Test report No : F454
		Page No. : 4

	RATING VALUES		
Transformer type :	TRP 60000-145/E	Connections :	YNd1
Rated power (kVA)	60000 / 60000	Type of cooling :	ONAN / ONAF
Rated voltage (kV)	132 / 33	Frequency (Hz) :	50
Serial No. :	ET0817 - 463829	Tested in acc. :	IEC 60076-18

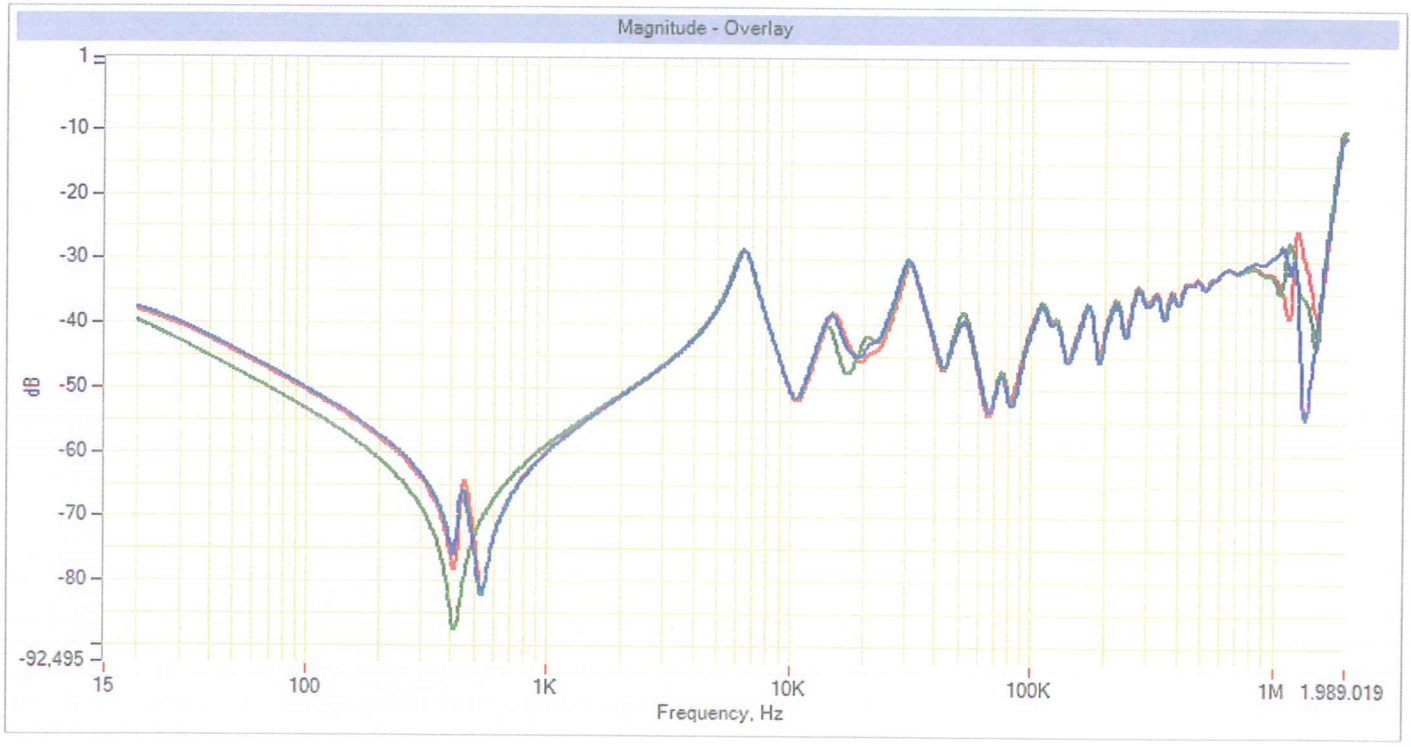


Winding under test	Winding vector group	Tap positions - windings H.V. / L.V.	Voltage applied	Response	Graph №	Description
H.V.	YN	1 / -	1U	1N	3	Winding L.V. - open
			1V	1N		
			1W	1N		
H.V.	YN	10(from tap 9) / -	1U	1N	3a	Winding L.V. - open
			1V	1N		
			1W	1N		
L.V.	d1	1 / -	2U	2V	4	Winding H.V. - open
			2V	2W		
			2W	2U		

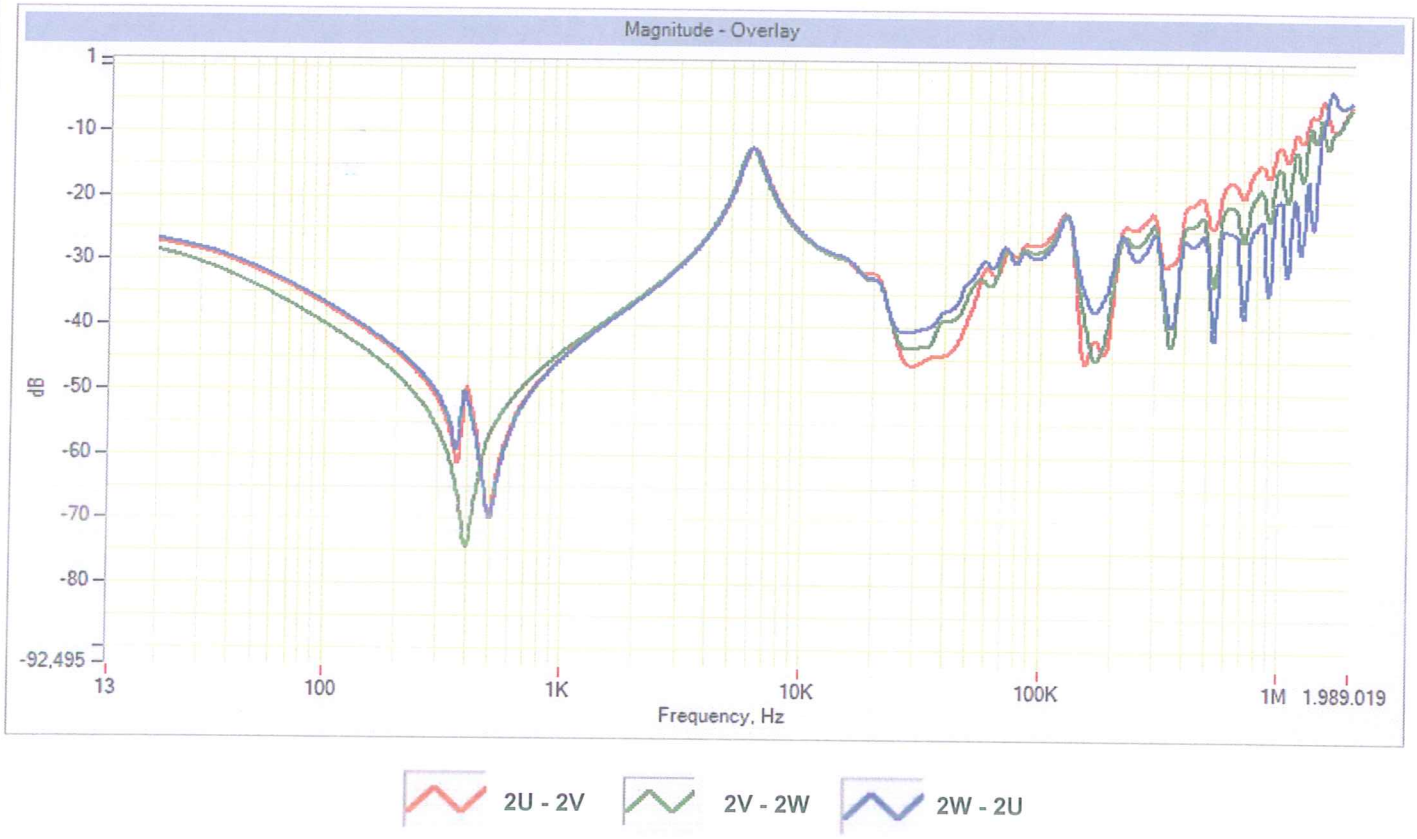
Winding L.V. in connection 'd1'.



Graph 3.



Graph 3a.


Magnitude - Overlay
1
-10
-20
-30
-40
-50
-60
-70
-80
-92,495
dB
13
100
1K
10K
100K
1M
1.989.019
Frequency, Hz
2U - 2V
2V - 2W
2W - 2U

Graph 4.

KONČAR DISTRIBUTIVNI I SPECIJALNI TRANSFORMATORI d.d.
Josipa Mokrovića 8, P.O. Box 100, HR-10090 Zagreb,
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info@koncar-dst.hr, www.koncar-dst.hr

ISO 9001
ISO 14001
OHSAS 18001
BUREAU VERITAS
Certification

EC DECLARATION OF CONFORMITY

CE

Manufacturer: **KONČAR DISTRIBUTIVNI I SPECIJALNI TRANSFORMATORI d.d.**

Address: **Josipa Mokrovića 8, P.O. Box 100, HR-10090 Zagreb**

We hereby declare that:

Description of transformer:	Three phase oil immersed transformer, rated power 60000 kVA, with ONAN / ONAF cooling, rated voltage 132 / 33 kV
Type:	TRP 60000-145/E
Part number:	ET0817
Serial number:	463829

is in conformity with the provisions of the following EC directive(s), including the latest amendments, and with national legislation implementing this/these directives:

1. Ecodesign Directive 2009/125/EC
2. Ecodesign Regulation (EU) No.548 / 2014

and that the following harmonized standards have been applied:

Ref.	***Title***	***Edition/Date***
IEC 60076-1	Power transformers – Part 1: General	Ed.3 / 04.2011.
IEC 60076-2	Power transformers – Part 2: Temperature rise for liquid immersed transformers	Ed.3 / 02.2011.
IEC 60076-3	Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air	Ed.3 / 07.2013.
IEC 60076-5	Power transformers – Part 5: Ability to withstand short circuit	Ed.3 / 02.2006.
IEC 60076-10	Power transformers – Part 10: Determination of sound levels	Ed.2 / 03.2016.
EN 50629	Energy performance of large power transformers	Ed.1 / 06.2015.

Routine test report No's	*ET0817 - 463829*

Date:	*29.06.2018.*	*Place:*	*Zagreb*
Responsible / Quality control manager	*Vedran Maljković*	*Signature:*	N. Malj