



TRABB DENEY LABORATUVARI
DENEY RAPORU
TESTING REPORT

AB-0538-T
2XTR 190801
01-2020

Müşterinin adı/adresi Customer name/address	: ABB Power Grids Turkey Elektrik Sanayi A. S.. Satış ve Pazarlama Müdürlüğü 34870 Kartal / İstanbul
Deneysel talep numarası Test order no.	: 2XTR 190801
Numunenin tanımı Sample description	: 16 / 21 MVA ; 132 / 30 kV ; YNd11 ; 50 Hz Güç transformatörü - Power transformer
Numunenin kabul tarihi The date of receipt of test item	: 06.12.2019
Deneysel standartları Test standarts	: IEC 60076-1
Testin yapıldığı tarih Date of test	: 06.12.2019 + 06.01.2020
Raporun sayfa sayısı Number of pages of the report	: 56 +1

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The test and/or measurement results, the uncertainties (if applicable) with confidence probability and test methods are given on the following pages which are part of this report.

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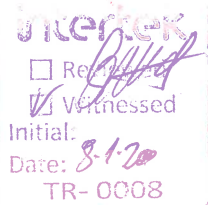


Tarih
Date

06.01.2020

Raporu hazırlayan
Prepared by
Nurettin EKSEN

Kontrol Eden ve Onaylayan
Checked and Approved By
Yusuf ÇOLUK



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(*) The marked tests are not included in the Scope of the Accreditation.



ABB Power Grids Turkey Elektrik Sanayi A. S.

TRANSFORMER TEST REPORT

Serial number : 2XTR 190801
 Customer : ESAABB - ALFANAR
 Standard : IEC 60076-1
 Transformer : 16 / 21 MVA ; 132 / 30 kV ; YNd11 ; 50 Hz

İstanbul , 06.01.2020

Senior Test Technician

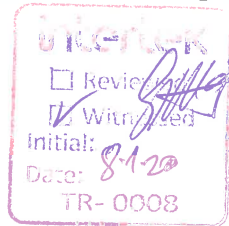
Nurettin EKSEN

Manager, Testing Laboratory

Yusuf ÇOLUK

The below undersigned party/ parties attended the factory acceptance tests as observer.

INTERTEK TPI Inspector



Güven GİZDEN

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(*) The marked tests are not included in the Scope of the Accreditation.

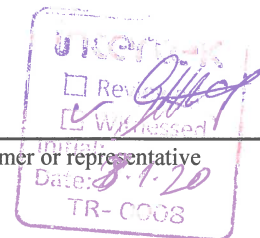
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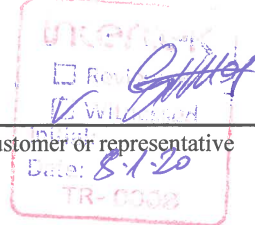
Data of the transformer

Rated power	[HV]	: 16 / 21	MVA
	[LV]	: 16 / 21	MVA
	[TV]*	: - / -	MVA
Rated voltage	[HV]	: $132 \begin{matrix} + 10 \\ - 10 \end{matrix} \times 1.5 \%$	kV
	[LV]	: 30.00	kV
	[TV]*	: -	kV
Rated current	[HV]	: 70.0 / 91.9	A
	[LV]	: 307.9 / 404.1	A
Number of phase / Frequency		: 3 / 50	Hz
Vector group		: YNd11	
Insulation level of windings	[HV]	: LI / AC 650 / 95	kV
	[HVN]	: LI / AC 250 / 95	kV
	[LV]	: LI / AC 170 / 70	kV
Temperature rise [Oil/Winding/Hot spot]		: 58 / 63 / 76	K
Type of cooling		: ONAN / ONAF	
Type of tap changer		: On load tap changer [UCLRN 750 / 900 / III]	
Type of fan		: FC100-NDL.7M.A7	
Bushings	[HV]	: GSA O-O 170-2000 ;	[HVN] : GSA O-O 245.0
	[LV]	: 24kV8000	
Current transformers		: see page 5 of 56	
Dimensions and weights :			
Length	: 6903 mm	Active part	: 17400 kg
Width	: 4233 mm	Oil	: 12800 kg
Height	: 5498 mm	Total	: 44000 kg
Transport dimensions [LxWxH]		: 4800 x 2400 x 3000 mm	
Transport weights		: 24400 kg [Without oil]	
Type of insulating oil		: NYNAS Nytro Taurus	

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Manager, Testing Laboratory

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CURRENT TRANSFORMERS

CT NO	LOCATION	TERMINALS	RATIO (A)	BURDEN (VA)	CLASS	PURPOSE
T001	IU	1S1-1S2	200/5	10	0.2S<F S10	
T002	IU	2S1-2S2	200/5	30	5P20	
T003	IW	1S1-1S2	200/5	10	0.2S<F S10	
T004	IW	2S1-2S2	200/5	30	5P20	
T005	IW	3S1-3S2	108.1/2	15	3F S10	Thermal Image
T006	IW	1S1-1S2	200/5	10	0.2S<F S10	
T007	IW	2S1-2S2	200/5	30	5P20	
T008	PV	S1-S2	404.1/2	15	3F S10	Thermal Image

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Summary of test results

Load loss and short circuit impedance voltage at 75 °C

Reference power [MVA]	Tap position No	Voltages [kV]	Load losses [kW]	Guaranteed [kW]	Short circuit imp. voltage [%]	Guaranteed [%]
16	1	151.8 / 30.0	71.877	- + - %	10.11	- ± - %
	11	132.0 / 30.0	74.291	- + - %	9.42	- ± - %
	21	112.2 / 30.0	98.325	- + - %	9.35	- ± - %
21	1	151.8 / 30.0	123.820	- + - %	13.26	- ± - %
	11	132.0 / 30.0	127.978	130 + 5 %	12.37	12.50 + 7.5 %
	21	112.2 / 30.0	169.381	- + - %	12.27	- ± - %

Zero sequence impedance

Reference power [MVA]	Tap position No	Supplied winding	Open circuit winding	Short circuit winding	Calculated	
					Z Ω / phase	Zo [%]
21	1	HV	LV	-	137.12	12.50
	11	HV	LV	-	97.45	11.75
	21	HV	LV	-	70.83	11.82

No-load loss and no-load current

Reference power [MVA]	Ur [%]	Losses [kW]	Guaranteed [kW]	Currents [%]	Guaranteed [%]
21	90	7.769	- + - %	0.047	- + - %
	100	10.106	10.5 + 5 %	0.064	- + - %
	110	14.558	- + - %	0.258	- + - %

Temperature rise test

Cooling condition	Top oil temperature rise [K]	The average winding temperature rise		Hot - spot temperature rise		Guaranteed		
		HV-winding [K]	LV-winding [K]	HV-winding [K]	LV-winding [K]	Top oil temp. rise [K]	Winding temp. rise [K]	Hot-spot temp. rise [K]
	ONAN	52.8	57.6	55.8	61.7	59.8	58	63
ONAF	45.5	44.7	42.0	54.3	51.3			

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Dokuman No : 9CJL9-083

Tarih/Rev No : 01.06.11/00

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Summary of test results

Sound level

Cooling condition	Average sound pressure level		Average sound power level			
	Measured	Guaranteed	Calculated	Guaranteed		
	[dBA]	[dBA]	[dBA]	[dBA]		
ONAN	58.1	76	79.7	-		
ONAN	57.3	71	80.5	-		

Efficiency

Reference power [MVA]	Tap position No	cos ϕ	Load factor and efficiencies [%]			
			1/4	2/4	3/4	4/4
			21	1	0.80	99.58
1.00	99.66	99.61			99.50	99.37
11	0.80	99.57		99.50	99.35	99.18
	1.00	99.66		99.60	99.48	99.35
21	0.80	99.51		99.38	99.17	98.94
	1.00	99.61		99.50	99.34	99.15

Voltage regulation

Reference power [MVA]	Tap position No	COS ϕ	Load factor and voltage regulation [%]			
			1/4	2/4	3/4	4/4
			21	1	0.80	2.14
1.00	0.20	0.51			0.94	1.47
11	0.80	2.00		4.06	6.18	8.35
	1.00	0.20		0.50	0.89	1.37
21	0.80	2.03		4.11	6.24	8.44
	1.00	0.25		0.59	1.03	1.56

X / R Ratio

Reference power [MVA]	Tap position No	X / R Ratio			
		Ux %	Ur %	X / R	Guaranteed
21.0	1	13.251	0.590	22	-
	11	12.353	0.609	20	-
	21	12.247	0.807	15	-

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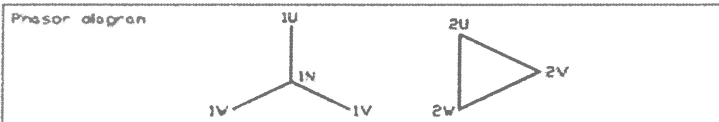
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Name Plate



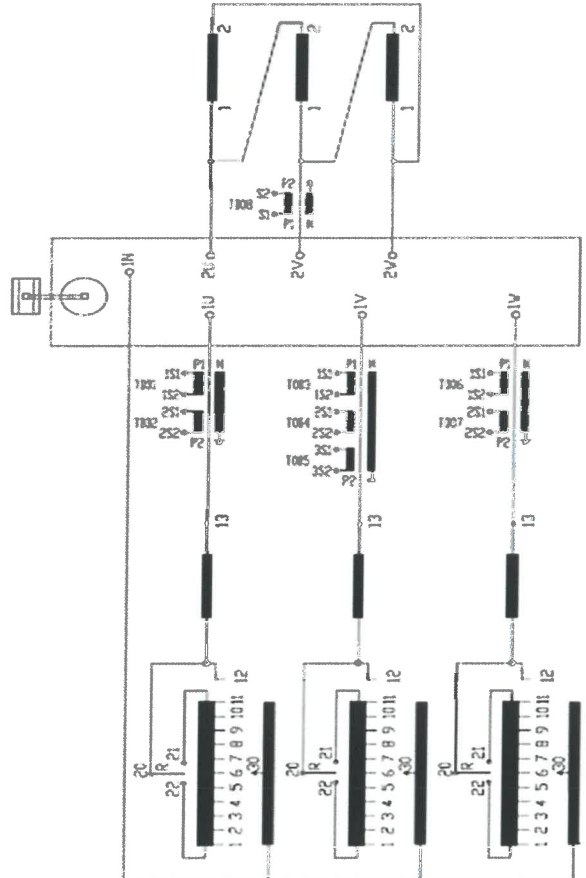
Three-phase Power Transformer, 50 Hz
Standard IEC 60076
Type No: 2XTR190800
Manufacturer's Serial No:

Terminal	Temperature rise (K) (Oil/Winding)	Class of cooling	Rating (MVA)	Current (A)	Voltage (kV)	Insulation level (kV)
1U-1V-1W	58/63	ONAN	16	60.9	151.8	Un145/L1:650/AV:95
				700	132.0	
				82.3	112.2	
				79.9	151.8	
				91.9	132.0	
2U-2V-2W	58/63	ONAN	16	307.9	-	Un52/L1:250/AV:95
				404.1	30	Un36/L1:170/AV:70



Connection Y Δ Vector Group YNd11

TERMINAL	CONNECTION	VOLTAGE (V)	CURRENT (A)		ON-LOAD TAP CHANGER			
			ONAN	ONAF	POS	IN DIRECTION (DOWN)	OUT DIRECTION (UP)	TAP SELECTOR AND DIVERter SWITCH CONNECT
1U,1V,1W	Y	151800	60.9	79.9	1			30-1
		149820	61.7	80.9	2			30-2
		147840	62.5	82.0	3			30-3
		145860	63.3	83.1	4			30-4
		143880	64.2	84.3	5			30-5
		141900	65.1	85.4	6			30-6
		139920	66.0	86.7	7	20-21	20-21	30-7
		137940	67.0	87.9	8			30-8
		135960	67.9	89.2	9			30-9
		133980	68.9	90.5	10			30-10
		132000	70.0	91.9	11			30-11
		132000	70.0	91.9	11B			30-12
		130020	71.0	93.2	12			30-1
		128040	72.1	94.7	13			30-2
		126060	73.3	96.2	14			30-3
		124080	74.4	97.7	15			30-4
		122100	75.7	99.3	16	20-22	20-22	30-5
		120120	76.9	100.9	17			30-6
		118140	78.2	102.6	18			30-7
		116160	79.5	104.4	19			30-8
114180	80.9	106.2	20			30-9		
112200	82.3	108.1	21			30-10		
2U,2V,2W	Δ	30000	307.9	404.1	21		30-11	



CT NO	LOCATION	TERMINALS	RATIO (A)	BURDEN (VA)	CLASS	PURPOSE
T001	1U	1S1-1S2	200/5	10	0.2SFS10	
T002	1U	2S1-2S2	200/5	30	5P2C	
T003	1V	1S1-1S2	200/5	10	0.2SFS10	
T004	1V	2S1-2S2	200/5	30	5P2C	
T005	1V	3S1-3S2	108.1/2	15	3FS10	Thermal Image
T006	1W	1S1-1S2	200/5	10	0.2SFS10	
T007	1W	2S1-2S2	200/5	30	5P2C	
T008	2V	S1-S2	404.1/2	15	3FS10	Thermal Image

LOSSES	
Load Losses (kW)	
No Load Losses (kW)	
Cooling Equipment Losses (kW)	

Impedances (%) based on 21 MVA			
POS	1	1:1A,1:1B	2:
Voltage (V)	151.8/30.0	132.0/30.0	112.2/30.0
Z (%)			

MASSES
Active part : 17400 kg
Oil : 12800 kg
Winding : 4100 kg
Shipping weight of heaviest piece (without oil) : 24400 kg
Total : 44000 kg
Type of oil : NYNAS Nyrta Taurus
Material of winding : Copper
Guaranteed no load sound pressure level : 75 dB(A)
Month/Year of manufacture: /

Tank and oil conservator suitable to withstand full vacuum
Manufactured in Istanbul, Turkey

Senior Test Technician

Manager, Testing Laboratory

End user or representative

Initial: [Signature]
Date: 8.1.20



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Measurement of voltage ratio

Tap position No	Voltages [V]		Calculated ratios	Measured ratios			Ratio errors [%]		
	HV	LV		1U - 1N	1V - 1N	1W - 1N	1U - 1N	1V - 1N	1W - 1N
				2U - 2N	2V - 2N	2W - 2N	2U - 2N	2V - 2N	2W - 2N
1	151800	30000	2.921	2.922	2.921	2.922	0.01	0.00	0.03
2	149820	"	2.883	2.883	2.884	2.884	-0.02	0.02	0.01
3	147840	"	2.845	2.845	2.845	2.846	-0.01	0.01	0.01
4	145860	"	2.807	2.807	2.808	2.808	-0.02	0.02	0.02
5	143880	"	2.769	2.769	2.770	2.769	-0.02	0.02	0.02
6	141900	"	2.731	2.731	2.731	2.731	0.00	0.01	0.01
7	139920	"	2.693	2.693	2.693	2.693	0.01	0.01	0.02
8	137940	"	2.655	2.655	2.655	2.655	0.00	0.02	0.02
9	135960	"	2.617	2.616	2.617	2.617	-0.01	0.02	0.00
10	133980	"	2.578	2.578	2.579	2.579	-0.01	0.02	0.02
11	132000	"	2.540	2.540	2.541	2.541	-0.01	0.02	0.03
12	130020	"	2.502	2.502	2.502	2.503	0.00	0.01	0.02
13	128040	"	2.464	2.464	2.464	2.465	-0.01	0.01	0.02
14	126060	"	2.426	2.426	2.427	2.427	0.00	0.02	0.02
15	124080	"	2.388	2.388	2.389	2.388	0.00	0.03	0.01
16	122100	"	2.350	2.350	2.350	2.351	0.01	0.02	0.03
17	120120	"	2.312	2.312	2.312	2.312	0.00	0.02	0.02

Vector group : YNd11

Ratio error tolerans is ± 0.5 %

Note : The vector group is checked by the test system.

Measuring instrument : TTS ; Type 2285C/0 YB ; Serial Number : 148 681 ; Tettex / Switzerland

Senior Test Technician

Manager, Testing Laboratory

Customer or representative

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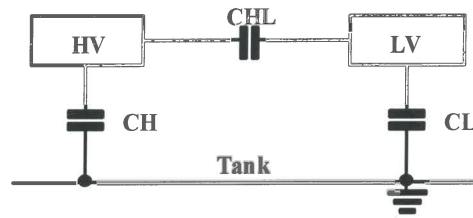
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Measurement of capacitance and dissipation factor




Transformer					Bushings					
Test kV	Measured		tan δ %		Bushing No	Test kV	Measured		tan δ %	
	Capacitance	[pF]	24.2 °C	20.0 °C			Kap.	[pF]	24.2 °C	20.0 °C
10	CHL	3683	0.15	0.14	1ZSCT25012834/03	10	C1	268.6	0.35	0.33
"	CH + CHL	6673	0.20	0.18	1ZSCT25012835/02	"	"	268.3	0.36	0.34
"	CH	2991	0.27	0.25	1ZSCT25012835/01	"	"	268.0	0.36	0.34
"	CHL	3683	0.15	0.14						
"	CHL + CL	9067	0.17	0.16						
"	CL	5384	0.18	0.17						

Measuring instrument : Automatic C and tan d bridge ; type 2818/5283 ; Seri No: 143'966 ; Tettex / Switzerland



Two windings transformer

Reviewed
 Witnessed
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Measurement of insulation resistance

	Measured values at 24.2 °C					
	HV/LV	HV/Tank	LV/Tank	-	-	-
Test voltage	5000 V	5000 V	5000 V			
Earthing duration	1 min.	1 min.	1 min.			
at 15 seconds	MΩ	35000	39500	35400		
at 30 seconds	MΩ	66000	61800	77100		
at 45 seconds	MΩ	68100	65700	91500		
at 60 seconds	MΩ	70000	67700	99200		
at 600 seconds	MΩ	155000	95700	138000		

AI = R_{60} / R_{15}	2.00	1.71	2.80			
PI = R_{600} / R_{60}	2.35	1.55	1.79			

Test voltage	Measured values at 24.2 °C					
	CL/CC	CL/Tank	CC/Tank			
2500 V						
at 60 seconds	MΩ	47400	66800	66500		

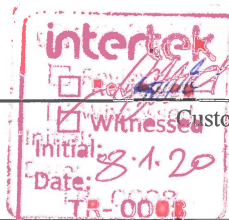
CL : Core lamination ; CC : Core clamp

AI : Absorption index ; PI : Polarization index

Measuring instrument : Megger ; S1 - 5010 ; Serial Number : 611-317/990799/1067 ; AVO / England

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Measurement of winding resistances

Tap position No	Resistances of the HV-windings [mΩ]			Average resistances [mΩ]	
	1U - 1N	1V - 1N	1W - 1N	at 23.7 °C	at 75 °C
1	2424.027	2423.296	2427.524	2424.949	2905.814
2	2380.476	2381.161	2384.918	2382.185	2854.570
3	2336.952	2337.960	2341.881	2338.931	2802.739
4	2294.574	2294.183	2299.327	2296.028	2751.328
5	2251.965	2251.814	2256.752	2253.510	2700.379
6	2209.811	2210.309	2214.737	2211.619	2650.181
7	2167.747	2167.902	2172.612	2169.420	2599.615
8	2126.101	2126.225	2131.161	2127.829	2549.775
9	2084.382	2084.690	2089.337	2086.136	2499.815
10	2043.638	2043.526	2048.713	2045.292	2450.872
11	2001.744	2000.887	2005.291	2002.641	2399.763
12	2045.856	2046.167	2050.562	2047.529	2453.552
13	2089.326	2089.207	2093.962	2090.832	2505.442
14	2131.939	2131.988	2136.518	2133.481	2556.549
15	2174.808	2174.714	2179.422	2176.315	2607.876
16	2217.006	2217.009	2221.330	2218.448	2658.365
17	2259.087	2259.059	2263.511	2260.552	2708.818
18	2301.189	2301.034	2305.276	2302.499	2759.083
19	2342.651	2342.647	2346.935	2344.078	2808.906
20	2383.960	2384.232	2388.170	2385.454	2858.487
21	2424.859	2425.010	2429.464	2426.444	2907.606

	1U - 1V	1V - 1W	1W - 1U	at 23.7 °C	at 75 °C
1	4846.529	4850.948	4850.078	4849.185	5810.775
11	3999.560	4003.953	4004.578	4002.697	4796.429
21	4846.652	4851.463	4851.135	4849.750	5811.452

Tap position No	Resistances of the LV-windings [mΩ]			Average resistances [mΩ]	
	2U - 2V	2V - 2W	2W - 2U	at 23.7 °C	at 75 °C
	201.7416	201.6743	201.4616	201.626	241.608

Measuring instrument : TTS ; Type 2285C/0 YB ; Serial Number : 148 681 ; Tettex / Switzerland

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Measurement of load loss and impedance voltage

Supplied winding	Short circuit winding	Reference power [MVA]	Tap position No	Voltages			Measured values			*Corrected values			Average temp. [°C]	Test frequency [Hz]
				HV [kV]	LV [kV]	Im [A]	Pm [kW]	Um [kV]	Im [A]	Pcorr. [kW]	Ucorr. [kV]			
HV	LV	21	1	151.8	30.0	79.757	107.260	20.101	79.757	107.566	20.130	26.60	50	
			11	132.0	30.0	89.900	106.100	15.974	89.900	110.756	16.321			
			21	112.2	30.0	100.980	127.320	12.861	100.980	145.800	13.763			

* Corrected to rated current [P(corr.) = (Irated / I measured)² * P measured and U(corr.) = (Irated / I measured) * U measured]

Reference power [MVA]	Tap position No	Voltages			Load losses at 75 °C				Short circuit impedance voltage at 75 °C			
		HV [kV]	LV [kV]	Im [A]	Σ I ² *R [kW]	Other losses [kW]	Load losses [kW]	Guaranteed [kW]	Tolerance [%]	Measured [%]	Guaranteed [%]	Tolerance
16	1	151.8	30.0	79.757	66.640	5.238	71.877	-	-	10.11	-	-
	11	132.0	30.0	89.900	69.598	4.694	74.291	-	-	9.42	-	7.5
	21	112.2	30.0	100.980	93.451	4.874	98.325	-	-	9.35	-	-
21	1	151.8	30.0	79.757	114.797	9.023	123.820	-	-	13.26	-	-
	11	132.0	30.0	89.900	119.893	8.086	127.978	130	5	12.37	12.5	7.5
	21	112.2	30.0	100.980	160.985	8.396	169.381	-	-	12.27	-	-

Measuring instrument : Loss Measurement System LMS 1000/100 , No : 4809 , MI / Canada

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Measurement of zero sequence impedance

Reference power [MVA]	Tap position No	Supplied winding	Open circuit winding	Short circuit winding	Measured		Calculated		Figure No
					Voltage [V]	Current [A]	Z Ω / phase	Zo [%]	
21	1	HV	LV	-	1098.8	24.04	137.12	12.50	1
	11	HV	LV	-	891.90	27.46	97.451	11.75	
	21	HV	LV	-	775.16	32.83	70.832	11.82	

Measuring instrument : Loss Measurement System LMS 1000/100 , No : 4809 , MI / Canada

Note :

The Z and Zo are calculated according to following formulae.

$$Z = 3 * U / I$$

$$Zo = Z * Ir * 100 / Ur$$

Where :

- Z : zero-sequence impedance..... [Ω / phase]
- Zo : zero-sequence impedance..... [%]
- U : measured voltage..... [Volt]
- I : measured current..... [Amper]
- Ir : rated current per phase of the excited windings..... [Amper]
- Ur : rated phase to neutral voltage of the excited windings..... [Volt]

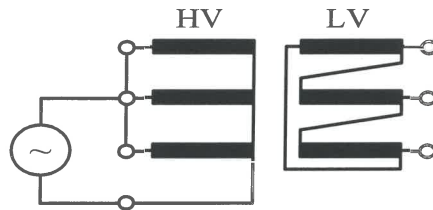


Figure : 1

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Measurement of no-load loss and no-load current

Ur [%]	Measured values			No-load loss			No-load current			
	Pm [kW]	kV		Im [A]	Corrected [kW]	Guar. [kW]	Tol. [%]	Measur. [%]	Guar. [%]	Tol. [%]
		[kVrms]	[kVmean]							
90	7.784	27.052	27.000	0.1901	7.769	-	-	0.047	-	-
100	10.137	30.092	30.000	0.2569	10.106	10.5	5	0.064	-	-
110	14.649	33.206	33.000	1.0415	14.558	-	-	0.258	-	-

Note : The no-load losses are corrected according to (1)

$$P_o = P_m * (1+d) \dots\dots\dots (1)$$

$$d = [(U_{avg} - U_{rms}) / U_{avg}]$$



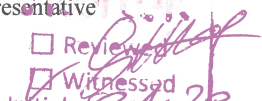
Measurement of harmonics on no-load current

Phase	At 100 %Ur			
	3rd harmonics [%]	5th harmonics [%]	7th harmonics [%]	9th harmonics [%]
	X1	23.5	49.3	26.4
X2	31.0	54.3	31.7	3.3
X3	12.7	42.6	23.4	2.2

Measurement of the power taken by the fan and oil pump motors

Number of fans	Number of pump	Supply voltage [V]	Measured current [A]	Measured losses [kW]	Guaranteed losses [kW]
1	-	400	4.390	2.219	-

Measuring instrument : Loss Measurement System LMS 1000/100 , No : 4809 , MI / Canada

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Impulse voltage test - Lightning impulse test

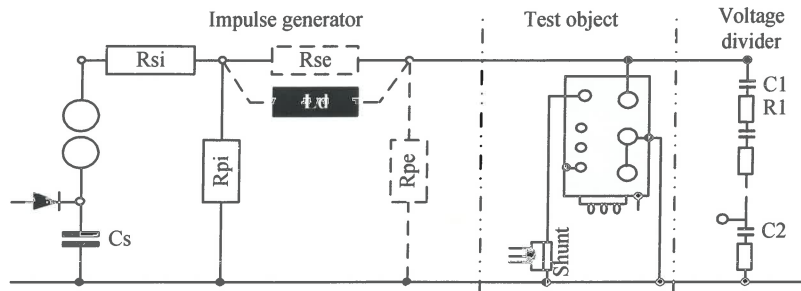
Test voltage [Full Wave]	Wave form [T ₁ / T ₂]	Polarity	Standard
650 kV [Tolerance : ± 3 %]	1.2 ± 0.36 / 50 ± 10 μs	[-] negative	60076-3

Test circuit	Phase	Phase	Phase						
Impulse on	1U	1V	1W						
Earthed via shunt	1N	1N	1N						
Earthed directly	1V, 1W, 2U, 2V, 2W tank	1U, 1W, 2U, 2V, 2W tank	1U, 1V, 2U, 2V, 2W tank						
Tap Position No	1	11	21						
Wave shape	See voltage curve	See voltage curve	See voltage curve						
Test sequence	Osc. No	Applied voltage		Osc. No	Applied voltage		Osc. No	Applied voltage	
		kV _[peak]	[%]		kV _[peak]	[%]		kV _[peak]	[%]
RFW	1	391.0	60.2	7	389.1	59.9	13	389.5	59.9
FW	2	647.6	99.6	8	651.2	100.2	14	651.7	100.3
CW	3	714.7	109.9	9	713.4	109.8	15	713.3	109.7
CW	4	713.1	109.7	10	714.8	110.0	16	714.5	109.9
FW	5	650.9	100.1	11	649.6	99.9	17	650.8	100.1
FW	6	650.7	100.1	12	651.5	100.2	18	650.4	100.1

Measuring instrument : HIAS 743 ,Serial No : 081 628-02 ; Haefely / Switzerland

RFW : Reduced full wave

FW : Full wave



Per stage values of the impulse generator

Series stage	Parallel stage	Cs [nF]	Rsi [Ω]	Rpi [Ω]	Rse [Ω]	Rpe [Ω]	Ld [μH]	Shunt [Ω]	Voltage divider ratio
4	2	500	76	154	-	-	-	0.5	866.2

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Impulse voltage test - Lightning impulse test

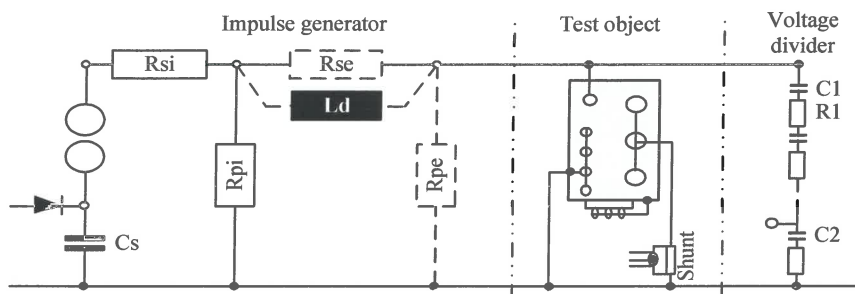
Test voltage [Full Wave]	Wave form [T ₁ / T ₂]	Polarity	Standard
250 kV [Tolerance : ± 3 %]	max. 13 / 50 ± 10 μs	[-] negative	60076-3

Test circuit	Phase		
Impulse on	1N		
Earthed via shunt	1U, 1V, 1W		
Earthed directly	2U, 2V, 2W tank		
Tap Position No	1		
Wave shape	See voltage curve		
Test sequence	Osc. No	Applied voltage	
		kV _[peak]	[%]
RFW	19	150.4	60.2
FW	20	250.1	100.1
FW	21	249.8	99.9
FW	22	250.1	100.0

Measuring instrument : HIAS 743 ,Serial No : 081 628-02 ; Haefely / Switzerland

RFW : Reduced full wave

FW : Full wave



Per stage values of the impulse generator

Series stage	Parallel stage	Cs [nF]	Rsi [Ω]	Rpi [Ω]	Rse [Ω]	Rpe [Ω]	Ld [μH]	Shunt [Ω]	Voltage divider ratio
4	2	500	76	154	-	-	-	0.5	866.2

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Impulse voltage test - Lightning impulse test

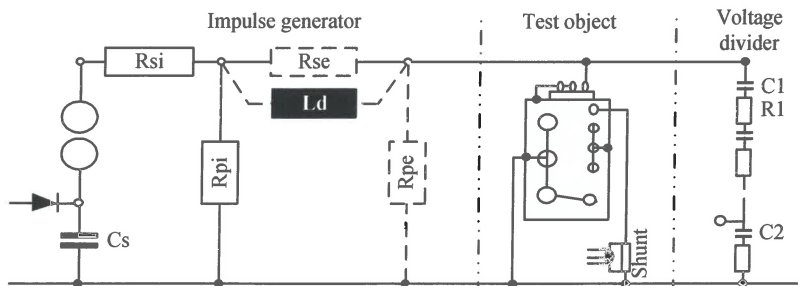
Test voltage [Full Wave]	Wave form [T ₁ / T ₂]	Polarity	Standard
170 kV [Tolerance : ± 3 %]	1.2 ± 0.36 / 50 ± 10 μs	[-] negative	60076-3

Test circuit	Phase		Phase		Phase				
Impulse on	2U		2V		2W				
Earthed via shunt	2W		2U		2V				
Earthed directly	1U, 1V, 1W, 1N, 2V tank		1U, 1V, 1W, 1N, 2W tank		1U, 1V, 1W, 1N, 2U tank				
Tap Position No	1		1		1				
Wave shape	See voltage curve		See voltage curve		See voltage curve				
Test sequence	Osc. No	Applied voltage		Osc. No	Applied voltage		Osc. No	Applied voltage	
		kV _[peak]	[%]		kV _[peak]	[%]		kV _[peak]	[%]
RFW	23	101.9	59.9	29	101.8	59.9	35	101.9	60.0
FW	24	170.1	100.0	30	170.3	100.2	36	169.8	99.9
CW	25	182.0	107.1	31	182.4	107.3	37	182.8	107.6
CW	26	181.9	107.0	32	182.1	107.1	38	182.2	107.2
FW	27	170.2	100.1	33	170.0	100.0	39	169.8	99.9
FW	28	169.9	99.9	34	170.5	100.3	40	170.1	100.1

Measuring instrument : HIAS 743 ,Serial No : 081 628-02 ; Haefely / Switzerland

RFW : Reduced full wave

FW : Full wave



Per stage values of the impulse generator

Series stage	Parallel stage	Cs [nF]	Rsi [Ω]	Rpi [Ω]	Rse [Ω]	Rpe [Ω]	Ld [μH]	Shunt [Ω]	Voltage divider ratio
1	2	500	-	176	70	200	400	0.5	866.2

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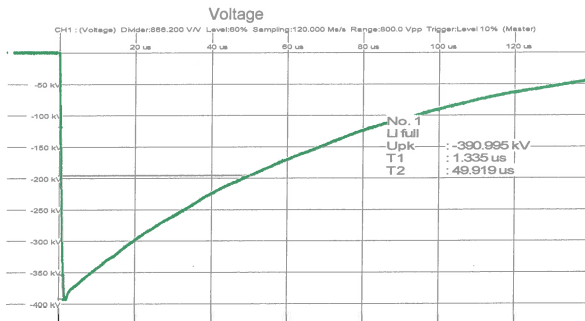
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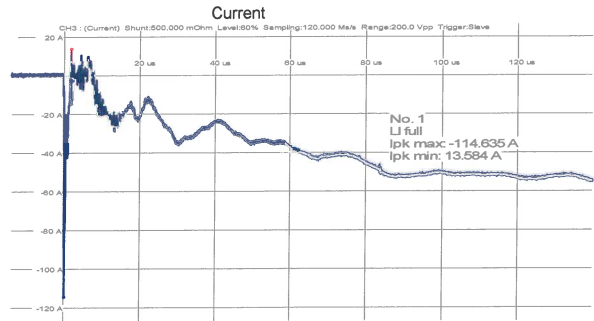
Lightning impulse test

1U TAP 1



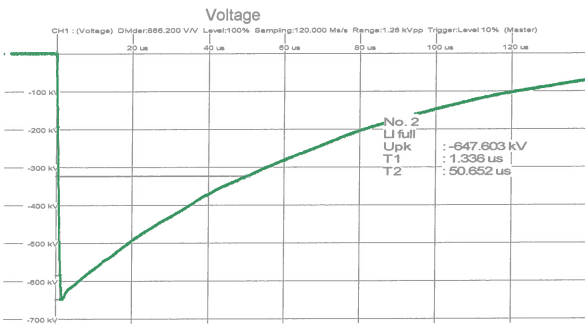
No. 1 LI full Upk: -390.995 kV T1: 1.335 us T2: 49.919 us

1U TAP 1



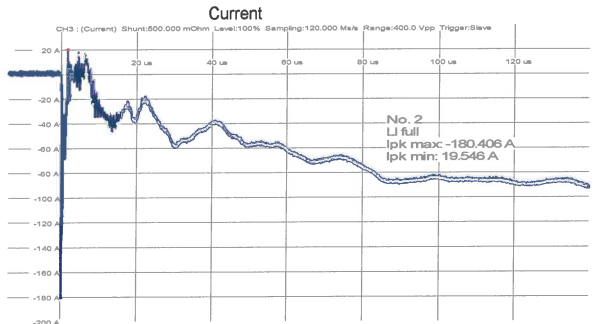
No. 1 LI full Ipk max: -114.635 A Ipk min: 13.584 A

1U TAP 1



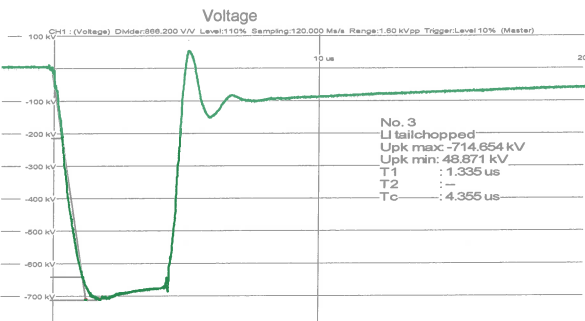
No. 2 LI full Upk: -647.603 kV T1: 1.336 us T2: 50.652 us

1U TAP 1



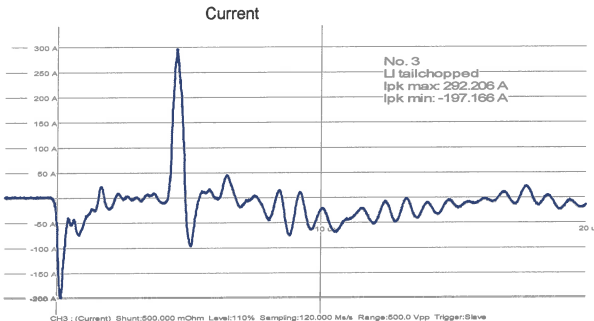
No. 2 LI full Ipk max: -180.406 A Ipk min: 19.546 A

1U TAP 1



No. 3 LI tailchopped Upk max: -714.654 kV Upk min: 48.871 kV T1: 1.335 us T

1U TAP 1



No. 3 LI tailchopped Ipk max: 292.206 A Ipk min: -197.166 A

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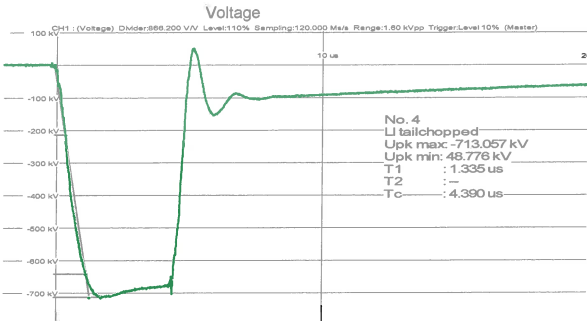
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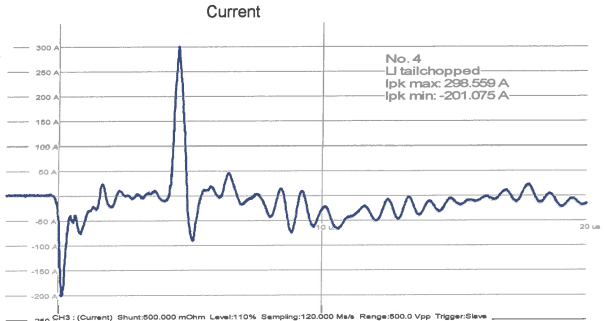
Lightning impulse test

1U TAP 1



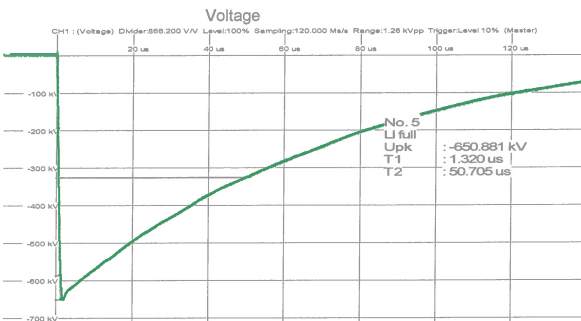
No. 4 LI tailchopped Upk max: -713.057 kV Upk min: 48.776 kV T1: 1.335 us T

1U TAP 1



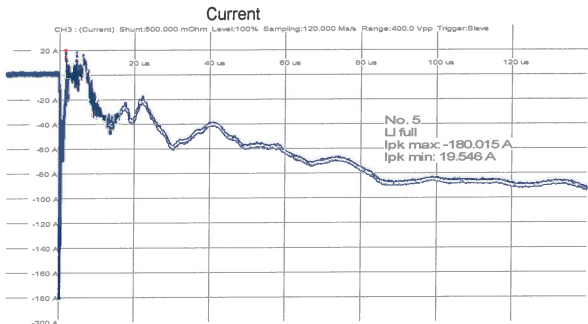
No. 4 LI tailchopped Ipk max: 298.559 A Ipk min: -201.075 A

1U TAP 1



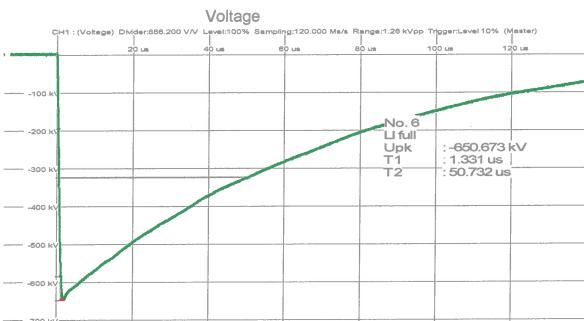
No. 5 LI full Upk: -650.881 kV T1: 1.320 us T2: 50.705 us

1U TAP 1



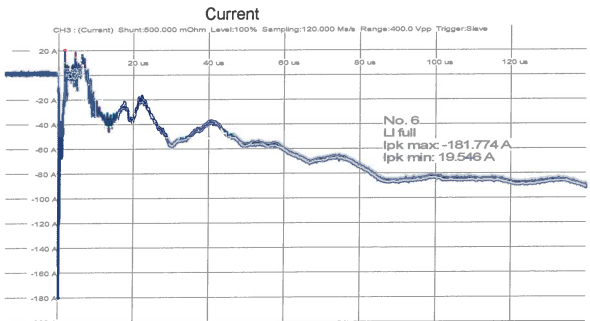
No. 5 LI full Ipk max: -180.015 A Ipk min: 19.546 A

1U TAP 1



No. 6 LI full Upk: -650.673 kV T1: 1.331 us T2: 50.732 us

1U TAP 1



No. 6 LI full Ipk max: -181.774 A Ipk min: 19.546 A

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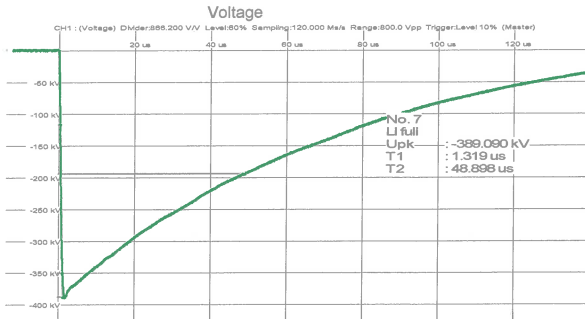
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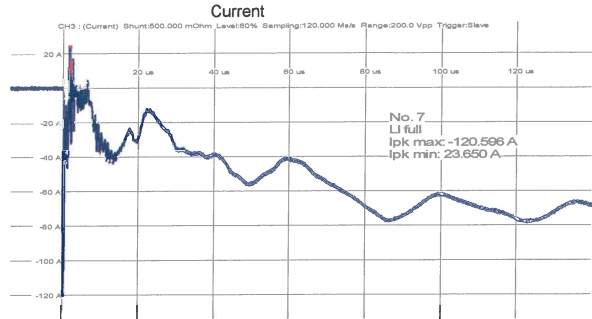
Lightning impulse test

1V TAP 11



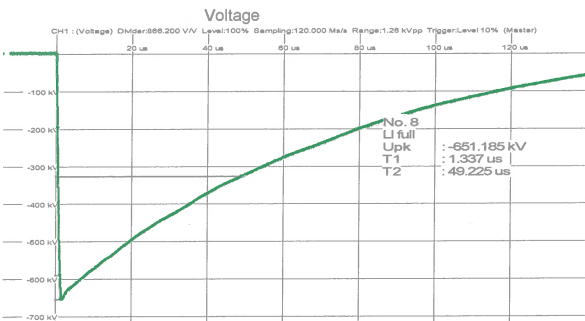
No. 7 LI full Upk: -389.090 kV T1: 1.319 us T2: 48.898 us

1V TAP 11



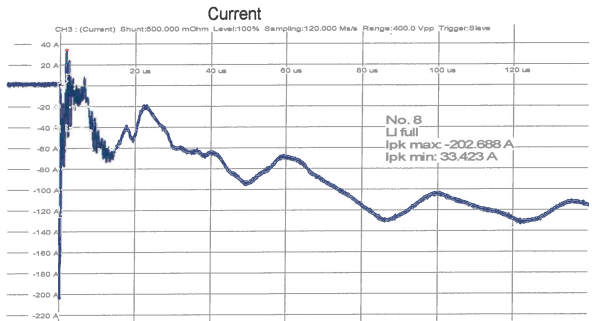
No. 7 LI full Ipk max: -120.596 A Ipk min: 23.650 A

1V TAP 11



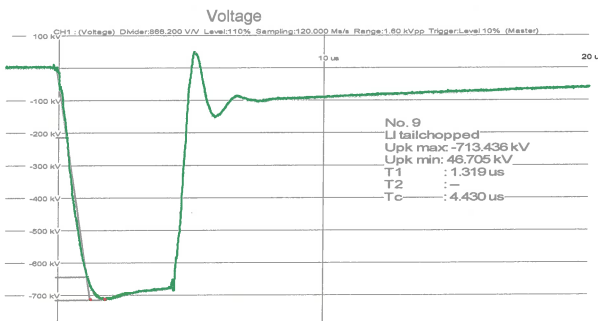
No. 8 LI full Upk: -651.185 kV T1: 1.337 us T2: 49.225 us

1V TAP 11



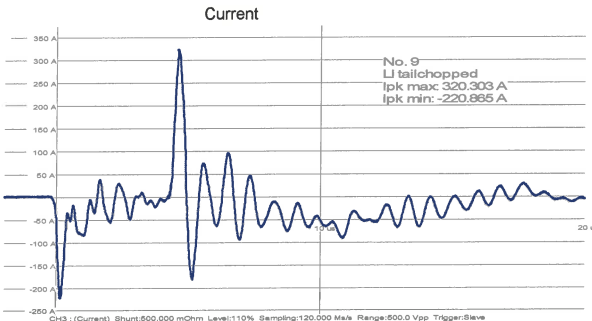
No. 8 LI full Ipk max: -202.688 A Ipk min: 33.423 A

1V TAP 11



No. 9 LI tailchopped Upk max: -713.436 kV Upk min: 46.705 kV T1: 1.319 us T

1V TAP 11



No. 9 LI tailchopped Ipk max: 320.303 A Ipk min: -220.865 A

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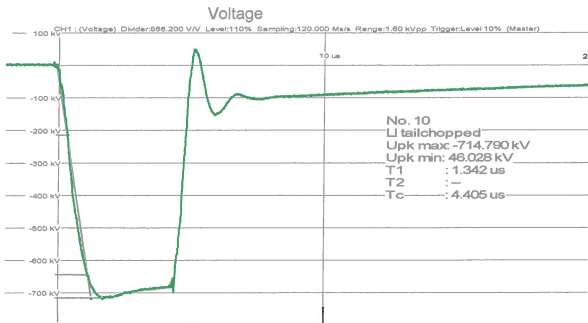
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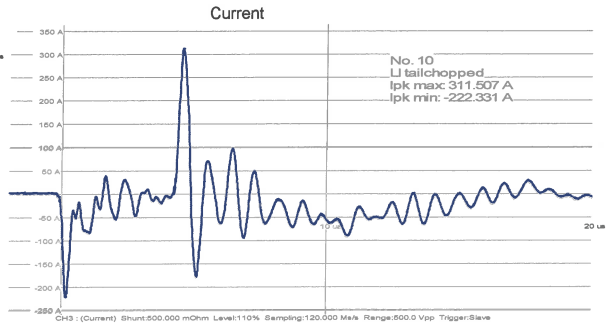
Lightning impulse test

1V TAP 11



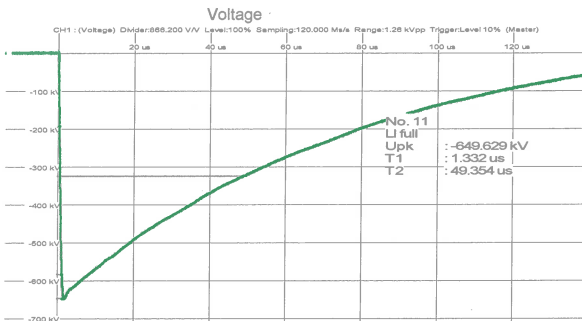
No. 10 LI tailchopped Upk max: -714.790 kV Upk min: 46.028 kV T1: 1.342 us

1V TAP 11



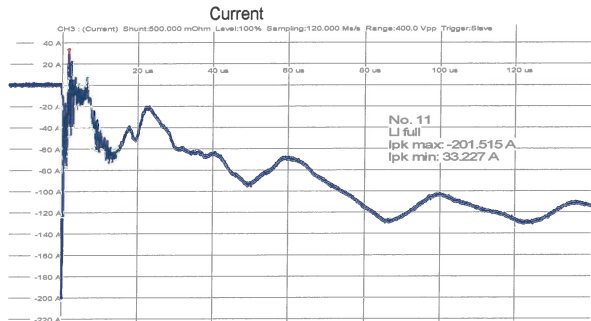
No. 10 LI tailchopped Ipk max: 311.507 A Ipk min: -222.331 A

1V TAP 11



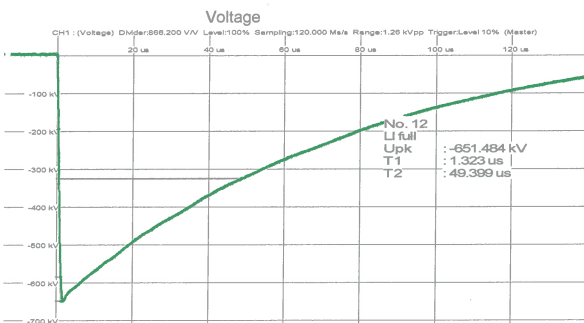
No. 11 LI full Upk: -649.629 kV T1: 1.332 us T2: 49.354 us

1V TAP 11



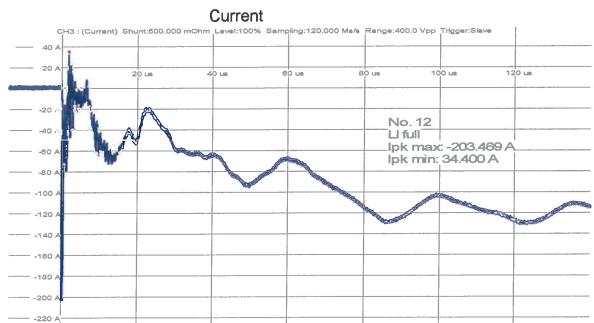
No. 11 LI full Ipk max: -201.515 A Ipk min: 33.227 A

1V TAP 11



No. 12 LI full Upk: -651.484 kV T1: 1.323 us T2: 49.399 us

1V TAP 11



No. 12 LI full Ipk max: -203.469 A Ipk min: 34.400 A

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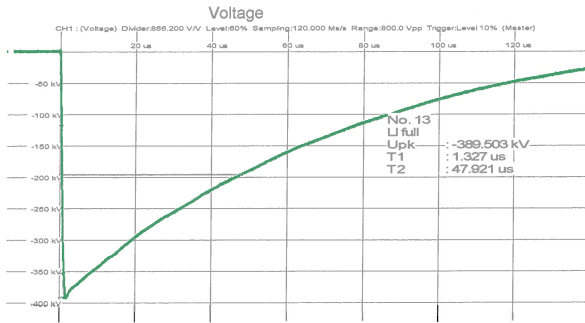
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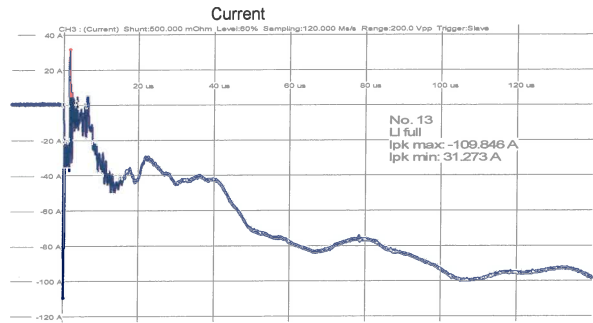
Lightning impulse test

1W TAP 21



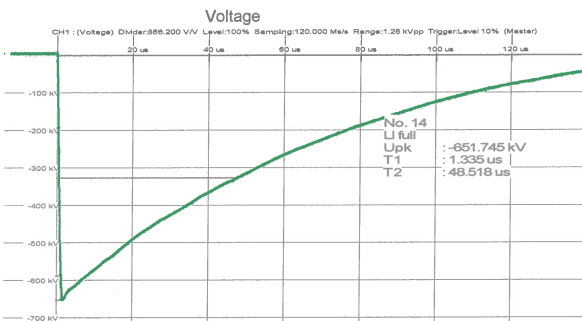
No. 13 LI full Upk: -389.503 kV T1: 1.327 us T2: 47.921 us

1W TAP 21



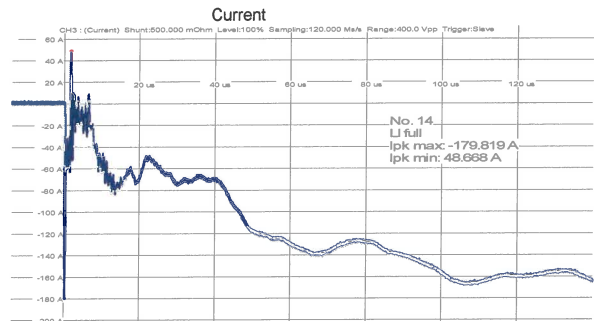
No. 13 LI full Ipk max: -109.846 A Ipk min: 31.273 A

1W TAP 21



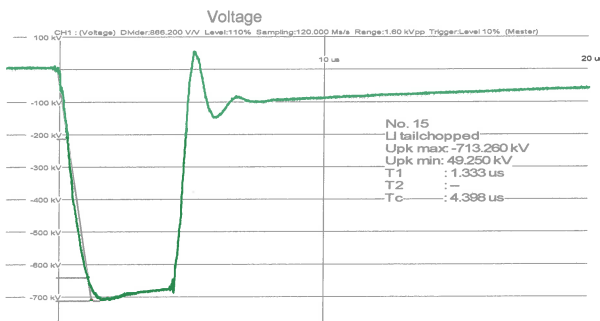
No. 14 LI full Upk: -651.745 kV T1: 1.335 us T2: 48.518 us

1W TAP 21



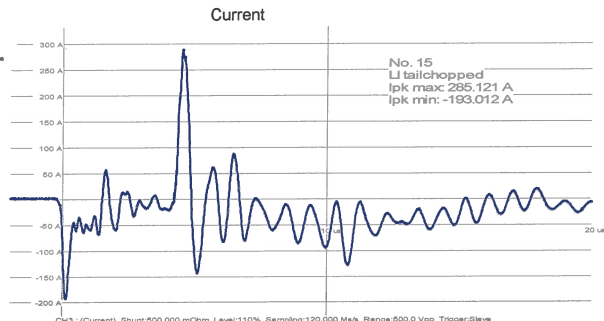
No. 14 LI full Ipk max: -179.819 A Ipk min: 48.668 A

1W TAP 21



No. 15 LI tailchopped Upk max: -713.260 kV Upk min: 49.250 kV T1: 1.333 us

1W TAP 21



No. 15 LI tailchopped Ipk max: 285.121 A Ipk min: -193.012 A

Senior Test Technician

Manager, Testing laboratory

intertek

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 Date: 8.1.20
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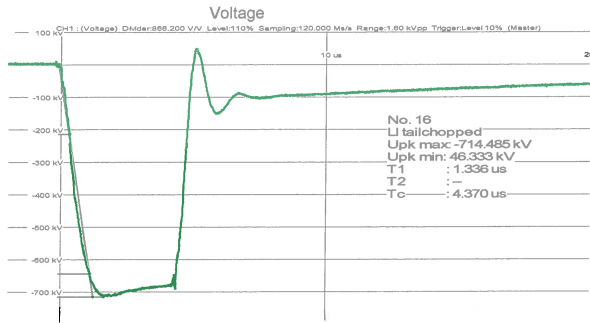
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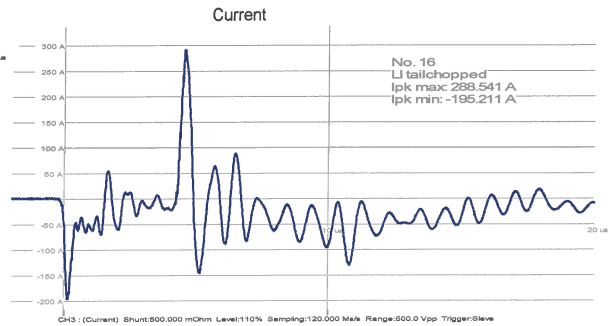
Lightning impulse test

1W TAP 21



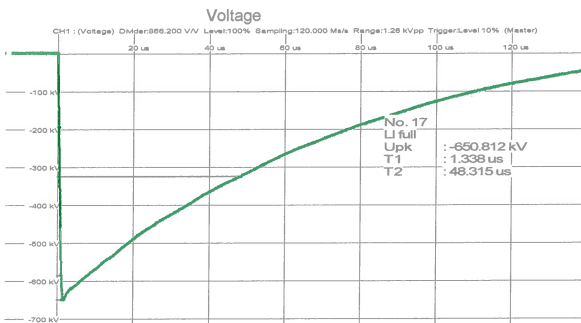
No. 16 LI tailchopped Upk max: -714.485 kV Upk min: 46.333 kV T1: 1.336 us

1W TAP 21



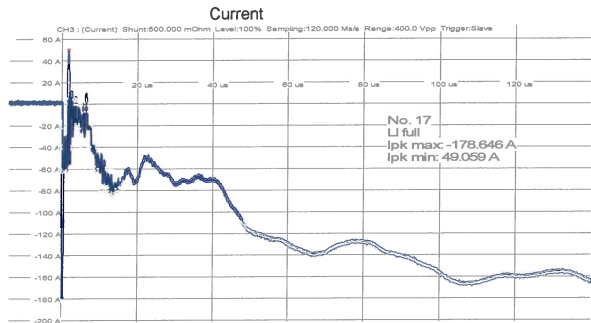
No. 16 LI tailchopped Ipk max: 288.541 A Ipk min: -195.211 A

1W TAP 21



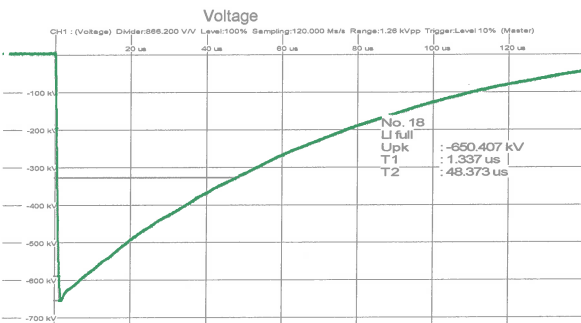
No. 17 LI full Upk: -650.812 kV T1: 1.338 us T2: 48.315 us

1W TAP 21



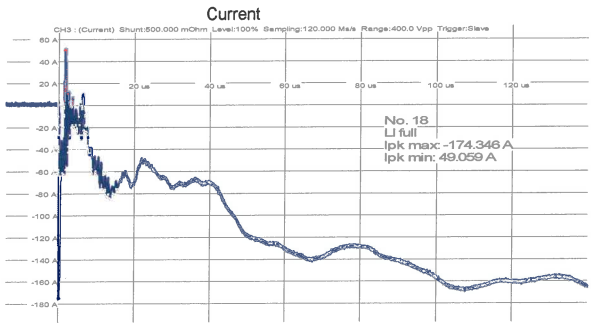
No. 17 LI full Ipk max: -178.646 A Ipk min: 49.059 A

1W TAP 21



No. 18 LI full Upk: -650.407 kV T1: 1.337 us T2: 48.373 us

1W TAP 21



No. 18 LI full Ipk max: -174.346 A Ipk min: 49.059 A

Senior Test Technician

Manager, Testing laboratory

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Date: 8.1.20

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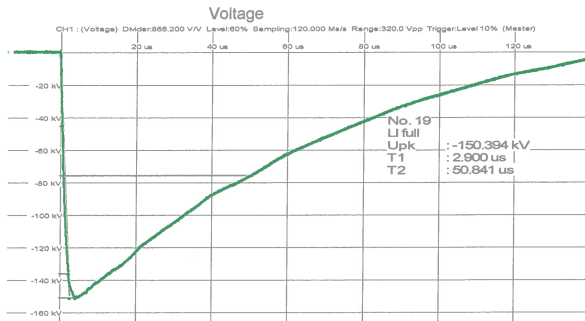
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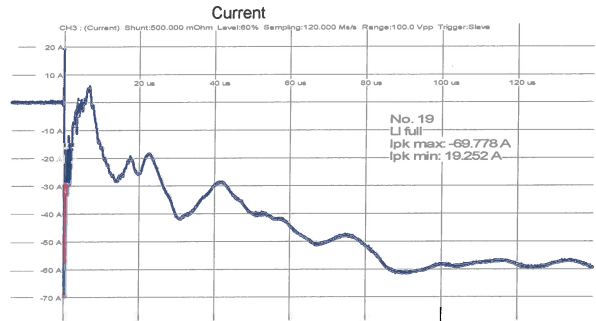
Lightning impulse test

1N TAP 1



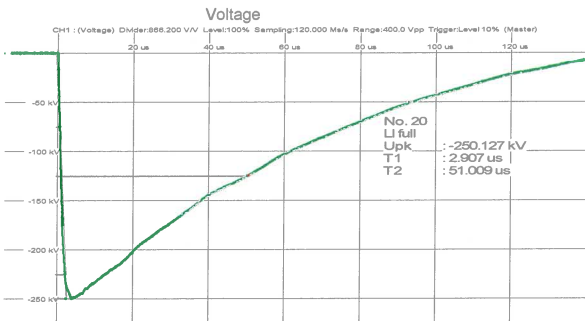
No. 19 LI full Upk: -150.394 kV T1: 2.900 us T2: 50.841 us

1N TAP 1



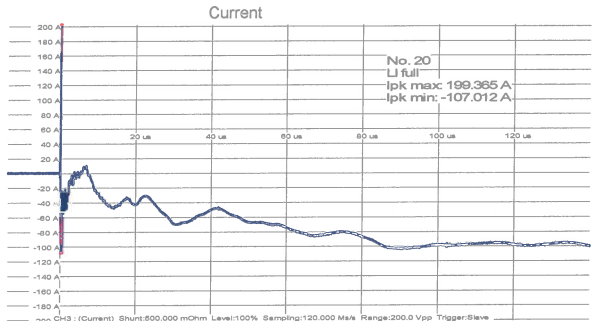
No. 19 LI full Ipk max: -69.778 A Ipk min: 19.252 A

1N TAP 1



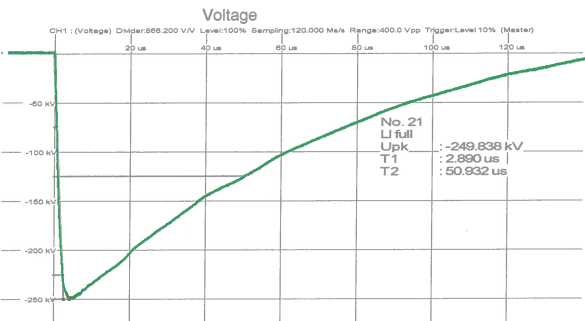
No. 20 LI full Upk: -250.127 kV T1: 2.907 us T2: 51.009 us

1N TAP 1



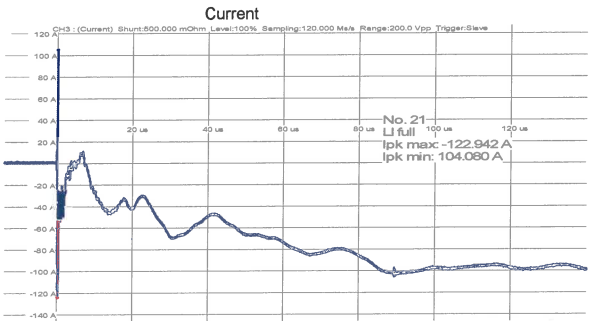
No. 20 LI full Ipk max: 199.365 A Ipk min: -107.012 A

1N TAP 1



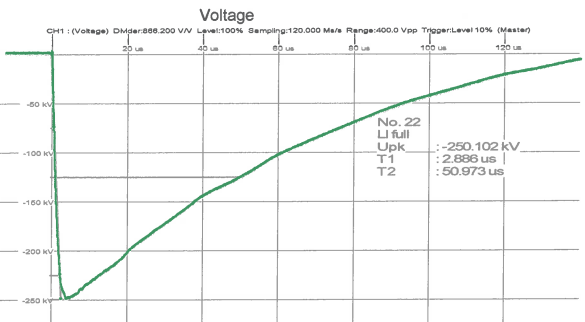
No. 21 LI full Upk: -249.838 kV T1: 2.890 us T2: 50.932 us

1N TAP 1



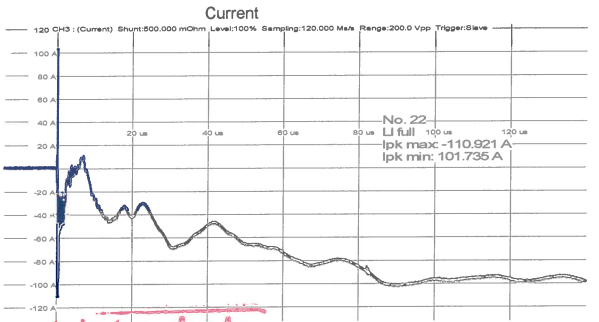
No. 21 LI full Ipk max: -122.942 A Ipk min: 104.080 A

1N TAP 1



No. 22 LI full Upk: -250.102 kV T1: 2.886 us T2: 50.973 us

1N TAP 1



No. 22 LI full Ipk max: -110.921 A Ipk min: 101.735 A

Senior Test Technician

Manager, Testing laboratory

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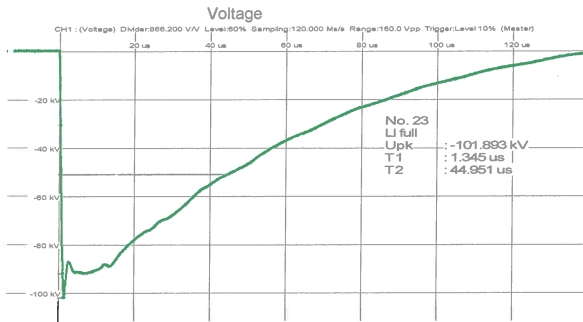
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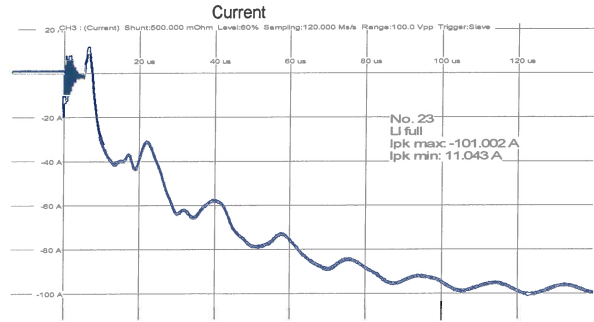
Lightning impulse test

2U TAP 1



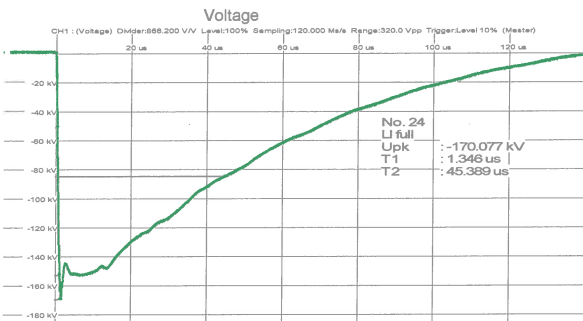
No. 23 LI full Upk: -101.893 kV T1: 1.345 us T2: 44.951 us

2U TAP 1



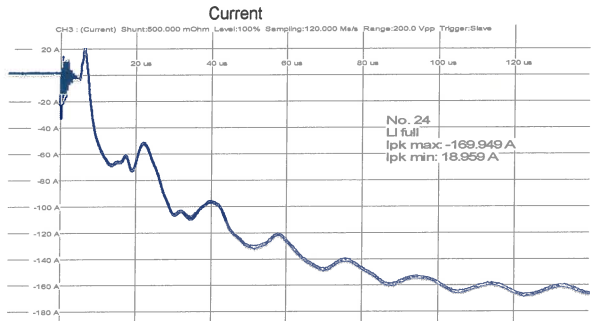
No. 23 LI full Ipk max: -101.002 A Ipk min: 11.043 A

2U TAP 1



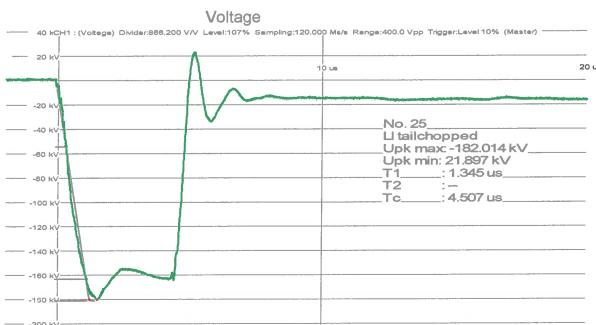
No. 24 LI full Upk: -170.077 kV T1: 1.346 us T2: 45.389 us

2U TAP 1



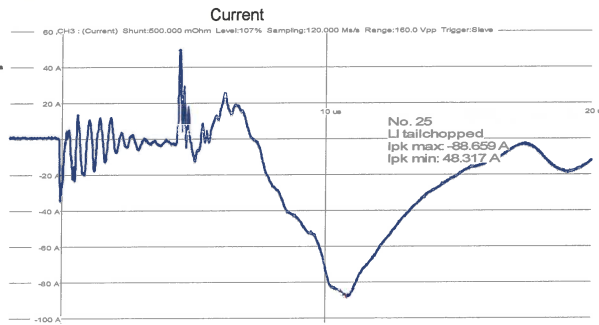
No. 24 LI full Ipk max: -169.949 A Ipk min: 18.959 A

2U TAP 1



No. 25 LI tailchopped Upk max: -182.014 kV Upk min: 21.897 kV T1: 1.345 us

2U TAP 1



No. 25 LI tailchopped Ipk max: -88.659 A Ipk min: 48.317 A

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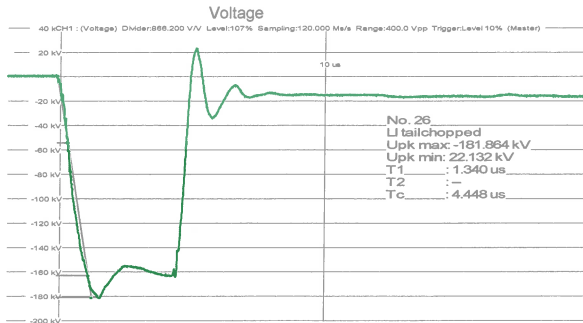
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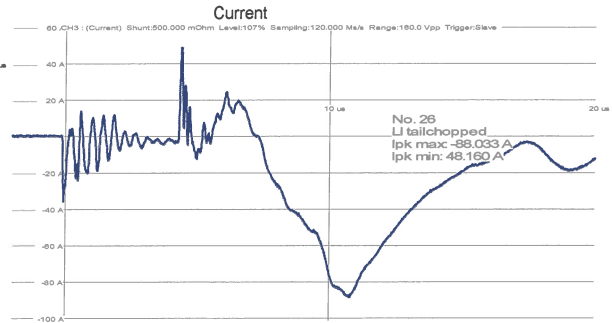
Lightning impulse test

2U TAP 1



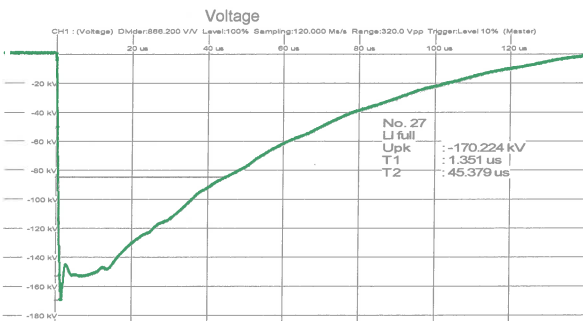
No. 26 LI tailchopped Upk max: -181.864 kV Upk min: 22.132 kV T1: 1.340 us

2U TAP 1



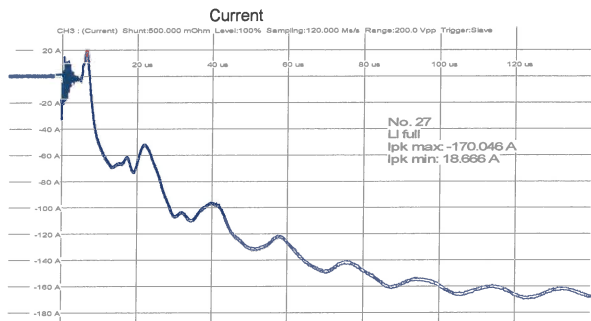
No. 26 LI tailchopped Ipk max: -88.033 A Ipk min: 48.160 A

2U TAP 1



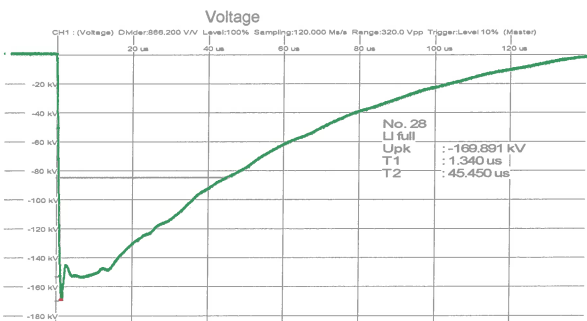
No. 27 LI full Upk: -170.224 kV T1: 1.351 us T2: 45.379 us

2U TAP 1



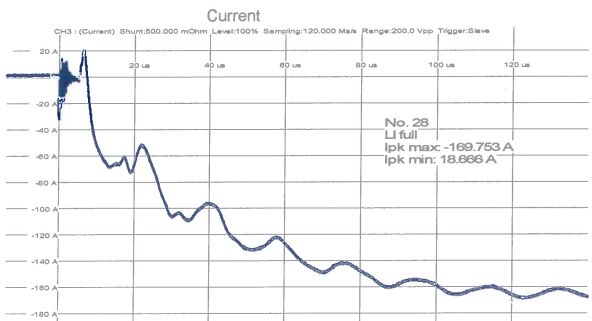
No. 27 LI full Ipk max: -170.046 A Ipk min: 18.666 A

2U TAP 1



No. 28 LI full Upk: -169.891 kV T1: 1.340 us T2: 45.450 us

2U TAP 1



No. 28 LI full Ipk max: -169.753 A Ipk min: 18.666 A

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Date: 8-1-20

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Senior Test Technician

Manager, Testing Laboratory



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Serial No : 2XTR 190801

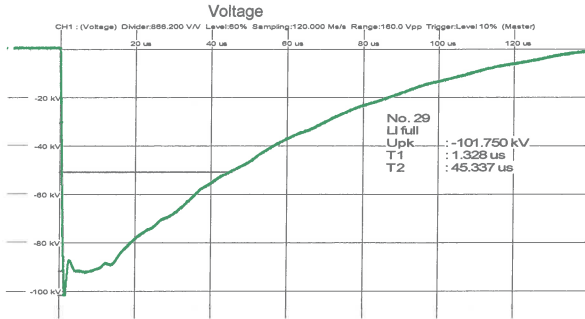
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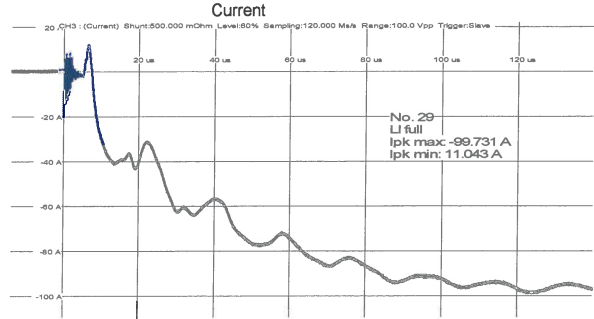
Lightning impulse test

2V TAP 1



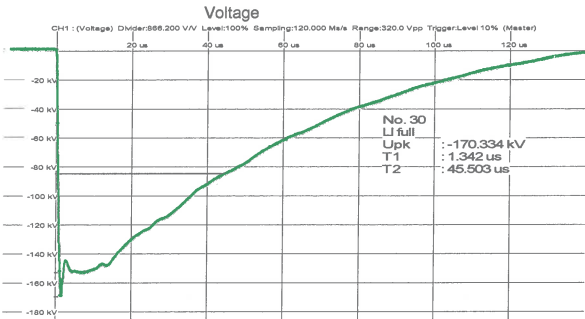
No. 29 LI full Upk: -101.750 kV T1: 1.328 us T2: 45.337 us

2V TAP 1



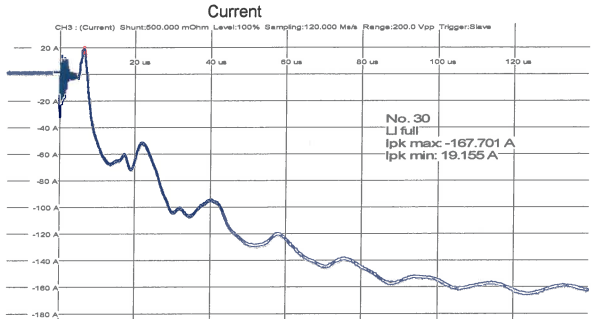
No. 29 LI full Ipk max: -99.731 A Ipk min: 11.043 A

2V TAP 1



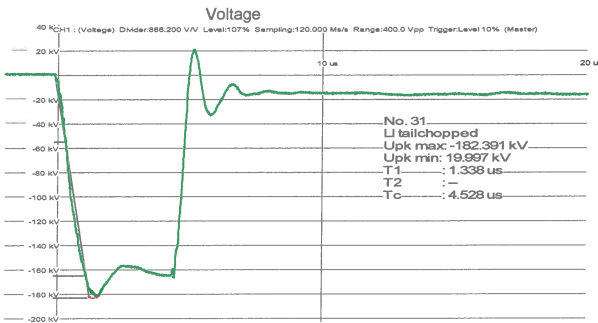
No. 30 LI full Upk: -170.334 kV T1: 1.342 us T2: 45.503 us

2V TAP 1



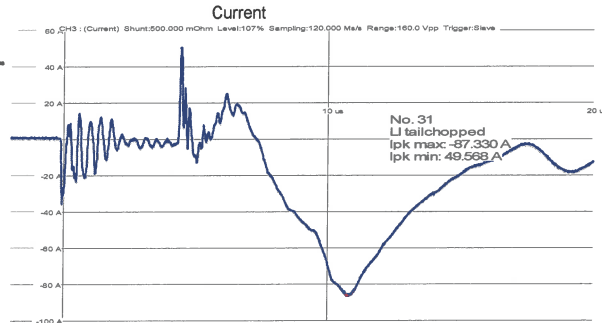
No. 30 LI full Ipk max: -167.701 A Ipk min: 19.155 A

2V TAP 1



No. 31 LI tailchopped Upk max: -182.391 kV Upk min: 19.997 kV T1: 1.338 us

2V TAP 1



No. 31 LI tailchopped Ipk max: -87.330 A Ipk min: 49.568 A

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Date: 8.1.20

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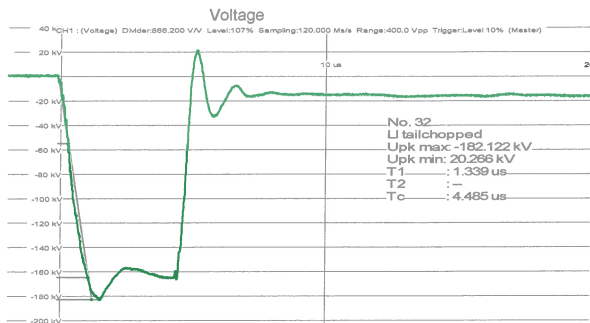
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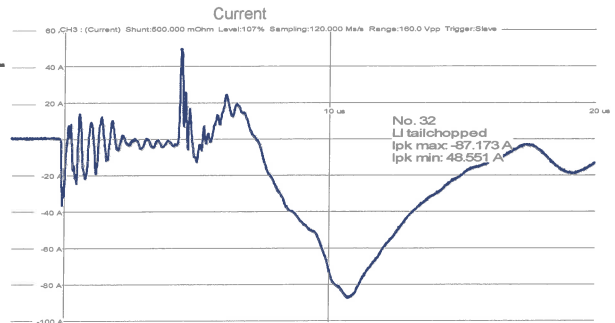
Lightning impulse test

2V TAP 1



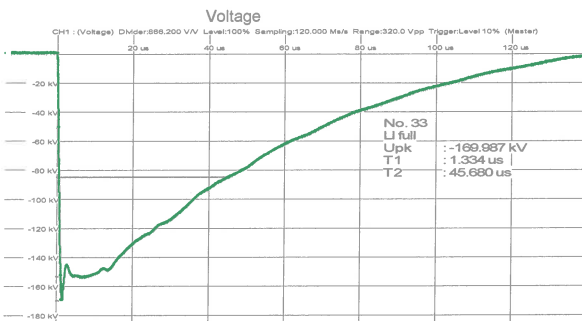
No. 32 LI tailchopped Upk max: -182.122 kV Upk min: 20.266 kV T1: 1.339 us

2V TAP 1



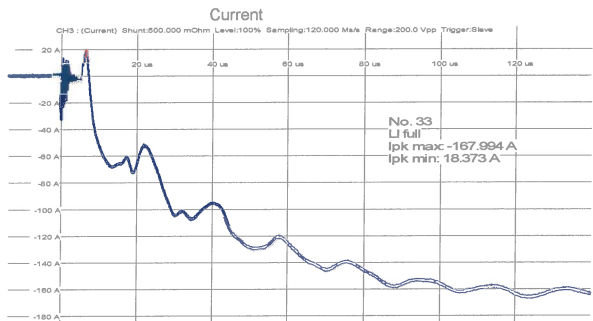
No. 32 LI tailchopped Ipk max: -87.173 A Ipk min: 48.551 A

2V TAP 1



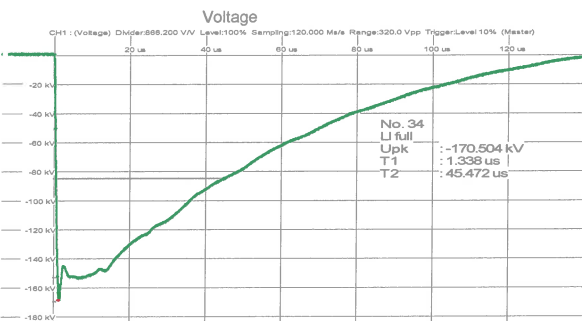
No. 33 LI full Upk: -169.987 kV T1: 1.334 us T2: 45.680 us

2V TAP 1



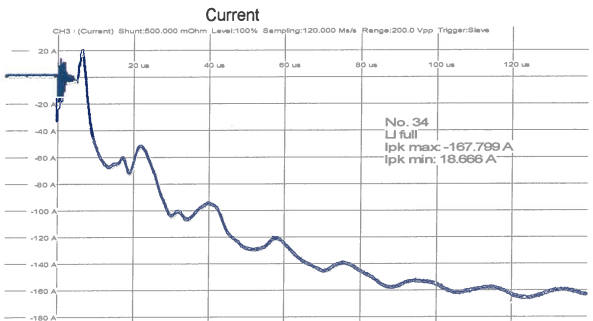
No. 33 LI full Ipk max: -167.994 A Ipk min: 18.373 A

2V TAP 1



No. 34 LI full Upk: -170.504 kV T1: 1.338 us T2: 45.472 us

2V TAP 1



No. 34 LI full Ipk max: -167.799 A Ipk min: 18.666 A

Senior Test Technician

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Date: 8.12.0

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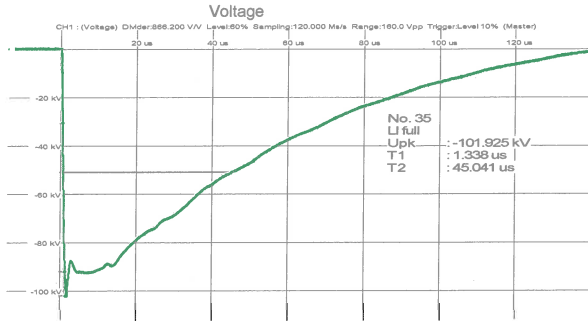
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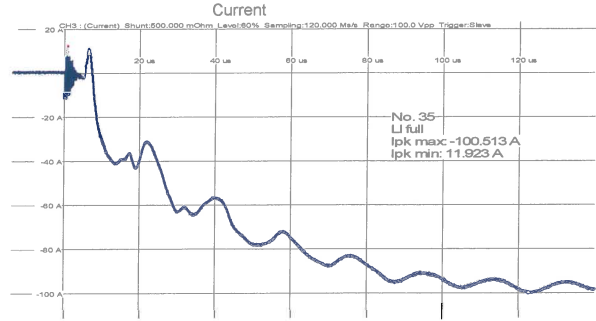
Lightning impulse test

2W TAP 1



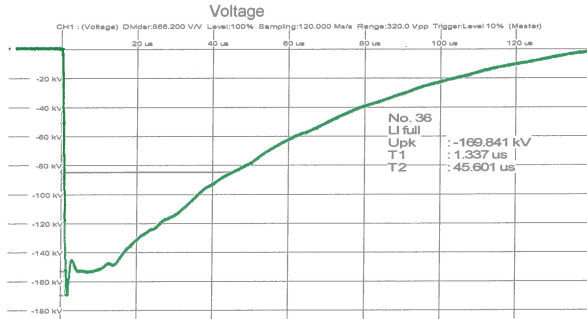
No. 35 LI full Upk: -101.925 kV T1: 1.338 us T2: 45.041 us

2W TAP 1



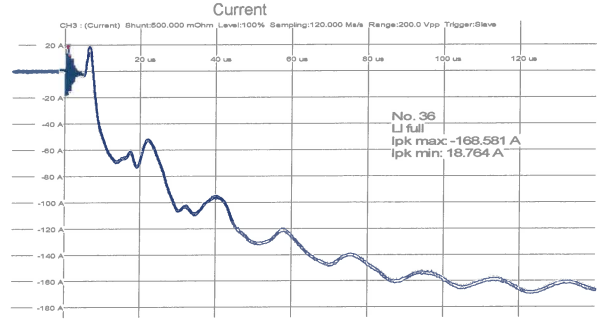
No. 35 LI full Ipk max: -100.513 A Ipk min: 11.923 A

2W TAP 1



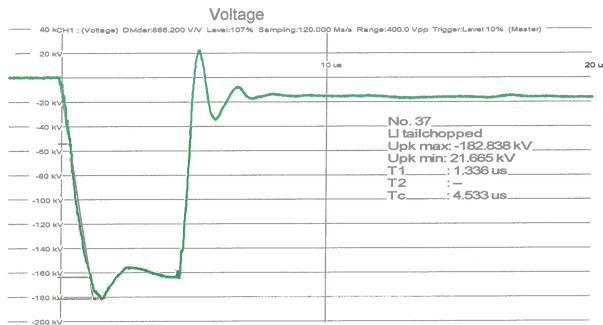
No. 36 LI full Upk: -169.841 kV T1: 1.337 us T2: 45.601 us

2W TAP 1



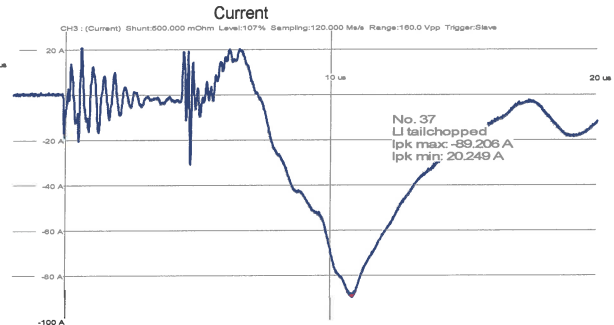
No. 36 LI full Ipk max: -168.581 A Ipk min: 18.764 A

2W TAP 1



No. 37 LI tailchopped Upk max: -182.838 kV Upk min: 21.665 kV T1: 1.336 us

2W TAP 1



No. 37 LI tailchopped Ipk max: -89.206 A Ipk min: 20.249 A

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Reliability

Witnessed

Initial: *[Signature]*

Date: 9.1.20

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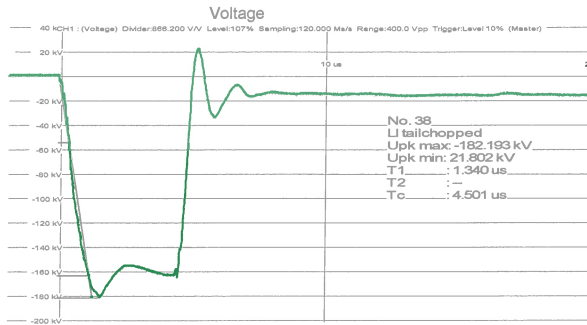
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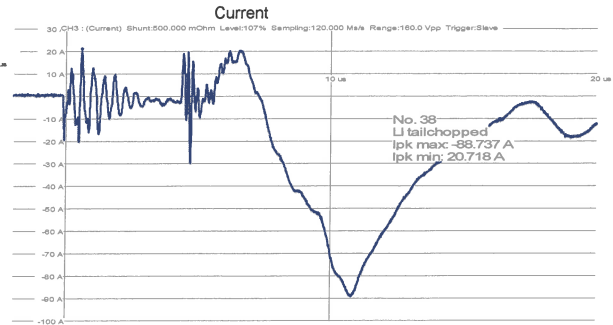
Lightning impulse test

2W TAP 1



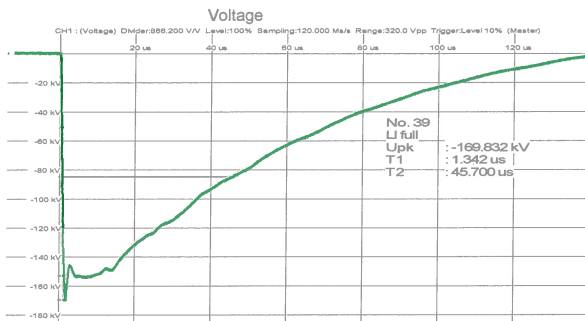
No. 38 LI tailchopped Upk max: -182.193 kV Upk min: 21.802 kV T1: 1.340 us

2W TAP 1



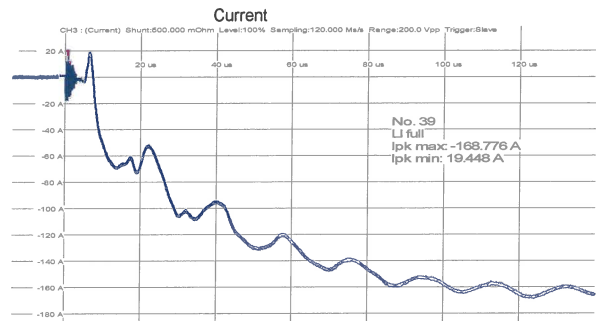
No. 38 LI tailchopped Ipk max: -88.737 A Ipk min: 20.718 A

2W TAP 1



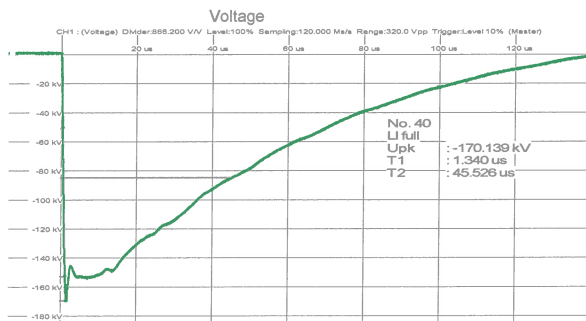
No. 39 LI full Upk: -169.832 kV T1: 1.342 us T2: 45.700 us

2W TAP 1



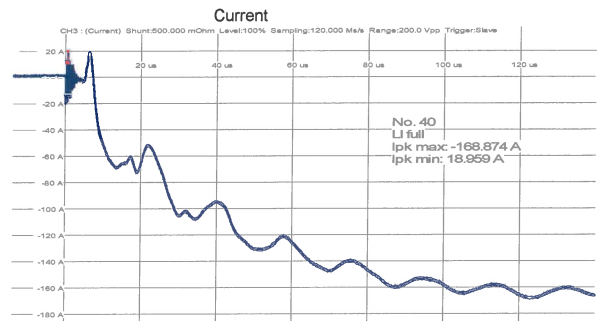
No. 39 LI full Ipk max: -168.776 A Ipk min: 19.448 A

2W TAP 1



No. 40 LI full Upk: -170.139 kV T1: 1.340 us T2: 45.526 us

2W TAP 1



No. 40 LI full Ipk max: -168.874 A Ipk min: 18.959 A

Senior Test Technician

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Date: 8-1-20

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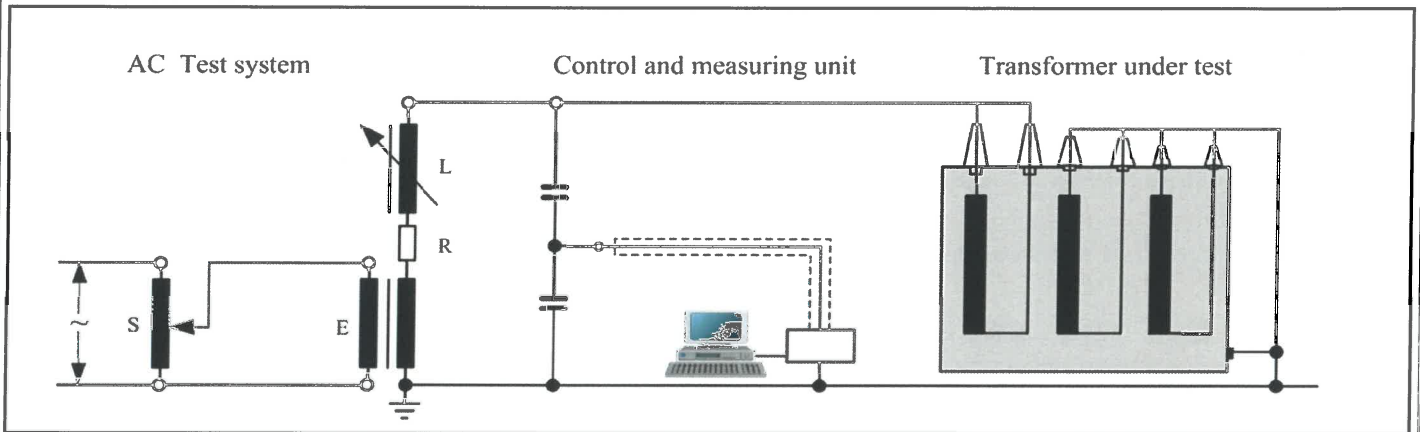
Date : 02.01.2020

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Applied voltage test

Phase under test	*Um [kV]	Test voltage [kV]	Applied voltage [kV]	Test duration [s]	Test frequency [Hz]	Test result
HV-windings to other windings and tank	145.0	95	95	60	50	PASSED
LV-windings to other windings and tank	36.0	70	70	60		
TV-windings to other windings and tank	-	-	-	-		

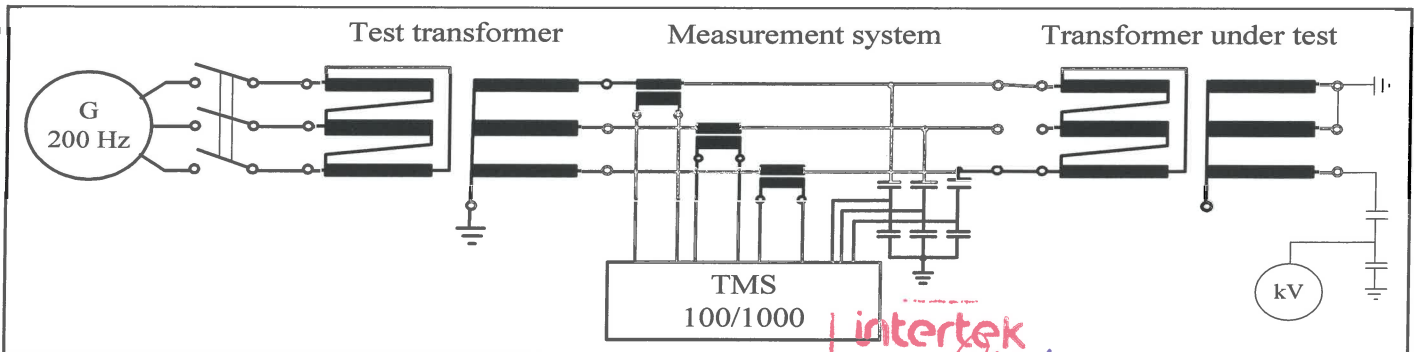
*Um :Highest voltage for equipment.



Measuring instrument : RSZ 400 - 3A ; 50 / 60 Hz ; Serial No. 01100431 ; Haefely / Switzerland

Line terminal AC withstand test (LTAC)

Phase under test	Tap position No	Energized terminals	Earthed terminals	Test voltage [kV]	Measured voltage [kV]	Test duration [s]	Test frequency [Hz]	Test result
1U	1	2U / 2W	1V-1W	275	275	30	200	PASSED
1V	1	2V / 2U	1U-1W	275	275	30	200	PASSED
1W	1	2W / 2V	1U-1V	275	275	30	200	PASSED



Senior Test Technician 	Manager, Testing Laboratory 	<input type="checkbox"/> Reviewed <input checked="" type="checkbox"/> With customer or representative Initial: <i>SA</i> Date: <i>8-1-20</i> TR-0008
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TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

TEST LABORATORY

Date : 02.01.2020

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Induced voltage withstand test (IVW) Induced voltage test with partial discharge measurement (IVPD) [Three phase test]

Calibration : The PD measurement channels were calibrated at 1000 pC .

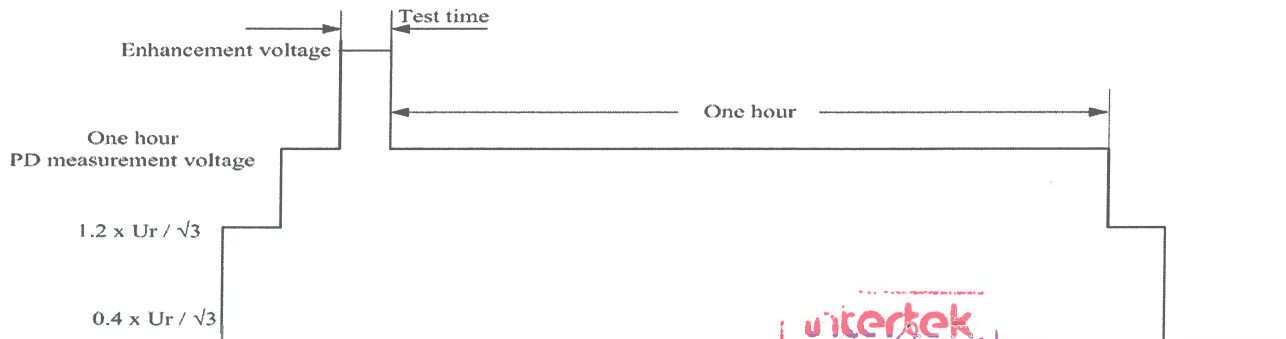
Measurement : [Tap position No : 11] [Ur = 132.0 kV]

Time [min]	Test voltage		Measured values [pC]		
	Line to earth [kV]	Line to Line [kV]	H1	H2	H3
-	$0.4 \times U_r / \sqrt{3} = 30.5$	$0.4 \times U_r = 52.8$	17.12	13.84	13.64
1	$1.2 \times U_r / \sqrt{3} = 91.5$	$1.2 \times U_r = 158.4$	20.50	16.80	15.22
5	$1.58 \times U_r / \sqrt{3} = 120.4$	$1.58 \times U_r = 208.6$	18.17	14.79	14.00
36 s	$2 \times U_r / \sqrt{3} = 152.4$	$2 \times U_r = 264.0$	-	-	-
5	$1.58 \times U_r / \sqrt{3} = 120.4$	$1.58 \times U_r = 208.6$	17.94	15.03	13.40
10	"	"	18.17	14.79	14.00
15	"	"	17.36	13.25	13.03
20	"	"	19.11	14.20	13.64
25	"	"	18.76	14.20	13.64
30	"	"	17.94	14.79	14.61
35	"	"	18.52	14.43	14.86
40	"	"	17.36	13.84	12.79
45	"	"	18.17	14.20	13.64
50	"	"	19.54	16.21	14.25
55	"	"	18.17	15.03	15.22
60	"	"	17.59	13.25	13.03
1	$1.2 \times U_r / \sqrt{3} = 91.5$	$1.2 \times U_r = 158.4$	17.59	12.66	13.03
-	$0.4 \times U_r / \sqrt{3} = 30.5$	$0.4 \times U_r = 52.8$	17.12	13.01	13.40

Guaranteed values

250 pC at $1.58 \times U_r / \sqrt{3}$

Measuring instrument : Digital partial discharge dedection system/PD calibrator , Serial No: 385 / Power diagnostix / Germany



Senior Test Technician

Manager, Testing Laboratory

Witertek

Customer or representative

Witnessed
Initial: 8-1-20
Date: 02.01.2020



TRANSFORMER TEST REPORT

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Date : 03.01.2020

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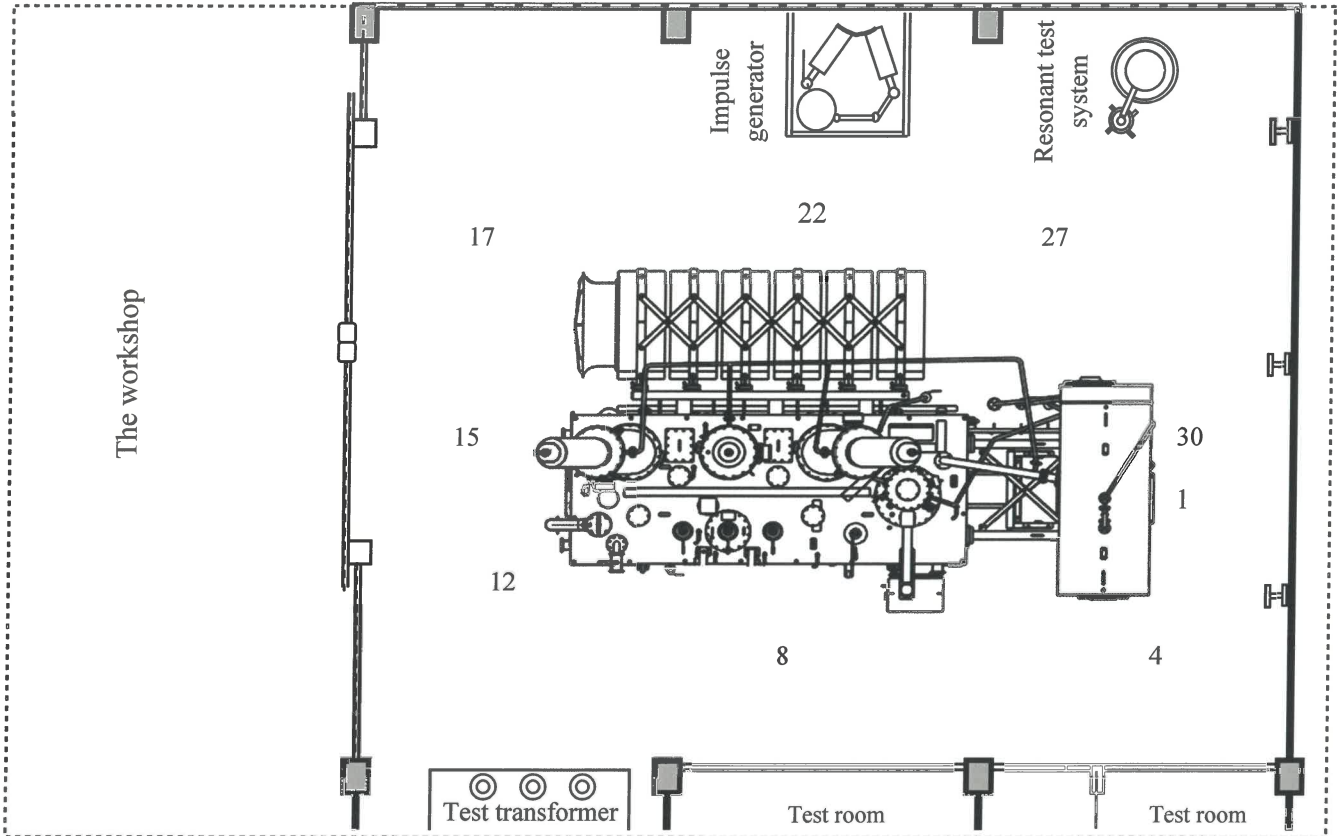
Measurement of sound level

Measurement standard : IEC 60076-10

Measuring instrument : Modular Precision Sound Analyser, Type 2260, Serial number : 2354754

Make : Brüel & Kjaer / Denmark ; Calibrator : Type 4231 , Serial number : 2035481

Plan de mesure :



Test conditions :

Excitation voltage	15	kV
Test frequency	50	Hz
Tap position No	9	
Height of the transformer tank, h	3.08	m
Height of microphone, h	at 1/3 of tank height	1.03 m
	at 2/3 of tank height	2.05 m
Length of prescribed contour, lm	at ONAN cooling	32.0 m
	at ONAN cooling	37.0 m
Area of measurement surface, S	at ONAN cooling	130.6 m ²
	at ONAN cooling	188.0 m ²
10 lg(S/S ₀)	at ONAN cooling	20.9
	at ONAN cooling	22.7

Senior Test Technician

Manager, Testing Laboratory



Reviewed and user or representative

Witnessed

Initial: *g.a.d.*

Date: *03.01.2020*

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Doküman No : 9CJL9-083

Tarih/Rev No.01.06.11/00



TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

TEST LABORATORY

Date : 03.01.2020

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Measurement of sound level

A - weighted sound pressure levels of the background noise

Plan position	At start of tests	At end of tests	Plan position	Avant le test	Avant le test
1	48.3	48.8	6	48.5	47.9
2	49.0	48.9	7		
3	48.0	48.9	8		
4	48.5	49.0	9		
5	49.2	48.2	10		
Arithmetic / energy average, $\overline{L_{bgA}}$				48.6	48.6

Measurement distance, $x = 1.0$ m

[ONAN]

[1 fans in service]

A - weighted sound pressure levels, L_{pAi}

Plan position	Height [h]		Plan position	Height [h]		Plan position	Height [h]		Plan position	Height [h]	
	[1/3]	[2/3]		[1/3]	[2/3]		[1/3]	[2/3]		[1/3]	[2/3]
1	68.4	68.2	13	69.0	68.7	25	71.8	71.3	37		
2	68.5	67.6	14	70.2	70.4	26	71.5	71.7	38		
3	68.6	67.2	15	71.5	71.6	27	70.6	71.2	39		
4	68.2	67.3	16	72.8	72.9	28	70.6	70.2	40		
5	67.2	66.6	17	73.9	74.2	29	69.3	69.0	41		
6	69.2	66.9	18	72.8	73.1	30	68.7	68.2	42		
7	70.1	67.7	19	72.0	72.4	31			43		
8	69.0	67.4	20	70.6	70.7	32			44		
9	68.9	69.8	21	70.4	70.5	33			45		
10	67.7	67.9	22	70.3	70.6	34			46		
11	68.2	66.8	23	70.7	71.0	35			47		
12	68.5	68.0	24	71.2	71.5	36			48		
Moyenne arithmétique, $\overline{L_{pAO}}$											70.3

$\overline{L_{pAO}}$ - maximum $\overline{L_{bgA}}$ (must be ≥ 3 dB(A)		21.1	dB(A)
Environmental correction (must be ≤ 7 dB),	K	4.1	dB
Corrected average A-weighted sound pressure level,	L_{pA}	66.1	dB(A)
Guaranteed A-weighted sound pressure level,	L_{pA}	75.0	dB(A)
Calculated average A-weighted sound power level,	L_{WA}	87.5	dB(A)
Guaranteed A-weighted sound power level,	L_{WA}	-	dB(A)

Senior Test Technician

Manager, Testing Laboratory

Reviewed by user or representative

Witnessed

Initial: *S.1.20*

Date: *8.1.20*

TR-0008



TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

TEST LABORATORY

Date : 03.01.2020

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Temperature rise test

Rated power at ONAN cooling	: 16.000 MVA	Total losses	: 108.431 kW
No-load loss	: 10.106 kW	Rated current	: 82.332 A
Load loss at 75 °C	: 98.325 kW	Tap position No	: 21

Time [hour]	Measured values			Temperatures [°C]										Δty [K]
	kW	kV	A	t-1	t-2	t-3	t-4	t ort.	sg-1	sg-1	sg-2	sg-2	t y	
10:30	165.74	14.869	116.68	23.90	24.03	23.99	24.05	23.99	25.42	22.67	25.45	22.64	25.64	1.65
11:00	165.84	14.585	114.37	23.76	23.86	23.78	23.86	23.82	36.45	24.58	36.99	24.90	30.01	6.20
11:30	165.95	14.004	109.62	23.52	23.66	23.58	23.62	23.60	47.94	34.92	48.21	35.31	41.41	17.82
12:00	165.81	13.904	108.88	23.42	23.55	23.44	23.52	23.48	56.96	43.13	57.16	43.62	50.72	27.24
12:30	165.95	13.769	107.78	23.49	23.69	23.58	23.65	23.60	64.15	49.65	64.45	50.73	58.19	34.59
13:00	165.12	13.585	106.43	23.79	24.03	23.92	24.00	23.94	71.69	56.18	71.89	57.71	65.70	41.77
13:30	165.39	13.573	106.37	24.03	24.27	24.19	24.27	24.19	75.93	60.40	75.99	61.89	70.15	45.96
14:00	165.26	13.462	105.47	24.34	24.68	24.50	24.64	24.54	80.42	64.69	80.68	65.73	74.49	49.95
14:30	165.86	13.435	105.13	24.61	25.02	24.84	24.92	24.85	83.86	67.64	84.20	68.59	78.14	53.29

Down to total losses

14:30	108.62	10.893	85.405	24.61	25.02	24.84	24.92	24.85	83.86	67.64	84.20	68.59	78.14	53.29
15:00	108.44	11.034	86.206	24.92	25.40	25.15	25.23	25.18	83.30	66.88	83.19	68.31	78.80	53.63
15:30	108.95	11.039	86.401	25.13	25.64	25.39	25.44	25.40	81.91	65.87	82.07	67.58	77.31	51.91
16:00	108.44	10.855	84.912	25.37	25.92	25.60	25.64	25.63	82.43	66.74	82.67	67.96	77.52	51.89
16:30	108.52	10.832	84.713	25.57	26.19	25.87	25.88	25.88	82.81	67.23	82.94	68.55	77.97	52.09
17:00	108.74	11.059	86.442	25.82	26.40	26.11	26.05	26.10	83.16	67.30	83.32	68.66	78.21	52.12
17:30	108.93	10.965	85.672	25.99	26.60	26.25	26.22	26.27	83.58	67.99	83.71	68.97	78.73	52.47
18:00	108.62	10.914	85.342	26.16	26.74	26.42	26.40	26.43	84.07	68.44	84.23	69.39	79.12	52.69
18:30	108.51	10.977	85.899	26.33	26.84	26.59	26.50	26.57	84.52	68.86	84.65	69.94	79.40	52.84
19:00	108.55	10.978	85.689	26.47	26.91	26.73	26.60	26.68	84.49	68.69	84.62	69.59	79.64	52.96
19:30	108.60	10.934	85.712	26.54	26.95	26.80	26.67	26.74	84.38	68.35	84.51	69.73	79.50	52.76

Down to rated current

19:30	99.08	10.547	82.504	26.54	26.95	26.80	26.67	26.74	84.38	68.35	84.51	69.73	79.50	52.76
20:00	99.48	10.475	82.994	26.64	26.98	26.90	26.77	26.82	83.37	67.05	83.25	67.96	78.94	52.12
20:30	100.24	10.597	82.803	26.71	27.05	27.00	26.84	26.90	82.01	66.67	82.21	67.82	78.43	51.53

The HV and LV winding resistances were measured.

Measuring instrument : Loss Measurement System LMS 1000/100 , No : 4809 , MI / Canada
TTS ; Type 2285C/0 YB ; Serial Number : 148 681 ; Tette / Switzerland

Senior Test Technician

Manager, Testing Laboratory

Reviewed by Customer or representative

Witnessed

Initial: 81.20

Date: 81.20

IN-0000

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Doküman No : 9CJL9-083

Tarih/Rev No : 01.06.11/00



TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

TEST LABORATORY

Date : 03.01.2020

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Temperature rise test

Rated power at ONAF cooling	: 21.000 MVA	Total losses	: 179.487 kW
No-load loss	: 10.106 kW	Rated current	: 108.060 A
Load loss at 75 °C	: 169.381 kW	Tap position No	: 21

Time [hour]	Measured values			Temperatures [°C]										Δty [K]
	kW	kV	A	t-1	t-2	t-3	t-4	t ort.	sg-1	sg-1	sg-2	sg-2	t y	
21:00	179.90	14.356	112.26	26.81	27.15	27.41	27.01	27.10	78.68	62.61	78.60	63.27	75.53	48.44
21:30	179.73	14.115	110.49	27.19	27.50	27.45	27.50	27.41	79.06	59.29	79.47	50.63	74.98	47.57
22:00	179.87	14.076	110.32	27.81	28.11	27.90	28.15	27.99	79.96	59.64	80.20	50.84	75.85	47.86
22:30	179.60	14.121	110.51	28.29	28.59	28.35	28.63	28.47	79.51	59.12	79.78	50.35	75.53	47.07
23:00	179.41	14.236	111.38	28.60	28.83	28.59	29.94	28.99	79.06	58.77	79.36	50.32	75.19	46.20
23:30	179.91	14.243	111.50	28.70	28.66	28.59	28.70	28.66	78.78	58.26	79.08	49.83	74.78	46.12
00:00	179.57	14.261	111.51	28.53	28.56	28.52	28.66	28.57	78.44	58.01	78.70	49.35	74.39	45.82
00:30	179.26	14.125	110.50	28.32	28.49	28.45	28.59	28.46	77.95	57.50	78.22	49.07	73.94	45.48

Down to rated current

00:30	172.61	13.846	108.43	28.32	28.49	28.45	28.59	28.46	77.95	57.50	78.22	49.07	73.94	45.48
01:00	172.51	13.814	108.19	28.19	28.49	28.38	28.59	28.41	77.53	57.32	77.80	48.73	73.59	45.18
01:30	170.93	13.859	108.45	28.12	28.53	28.35	28.63	28.41	76.87	56.81	77.17	48.48	73.00	44.59

The HV and LV winding resistances were measured.

t1...t4 : Ambient temperature sg-1...sg2 : Cooler inlet temperature ty : Top oil temperature
t ort. : Average ambient temperature sg-1...sg-2 : Cooler outlet temperature Δty : Top oil temperature rise

Measuring instrument : Loss Measurement System LMS 1000/100 , No: 4809 , MI / Canada
TTS ; Type 2285C/0 YB ; Serial Number : 148 681 ; Fettech / Switzerland

Senior Test Technician 	Manager, Testing Laboratory 	Customer or representative <input checked="" type="checkbox"/> Witnessed Initial: Date: 8.1.20 TR- 0008
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Doküman No : 9CJL9-083

Tarih/Rev No : 01.06.11/00



TRANSFORMER TEST REPORT

TEST LABORATORY

Date : 04.01.2020

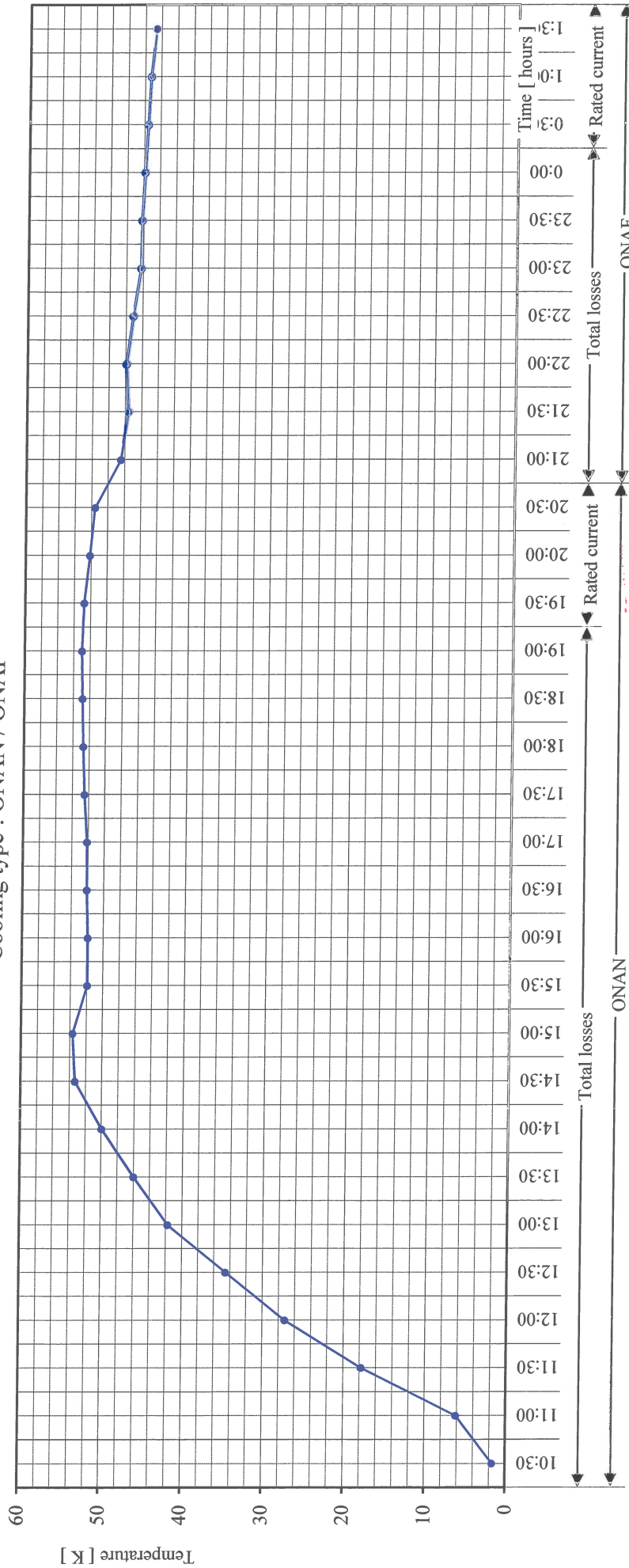
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Serial No : 2XTR 190801

Temperature rise test

Top oil temperature rise

Cooling type : ONAN / ONAF



Senior Test Technician

Manager, Testing Laboratory

End user or representative

atertek
 Reviewed
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 Date: 04.01.2020

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TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

TEST LABORATORY

Date : 04.01.2020

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Temperature rise test

Hot resistances

Cooling type : ONAN				Cooling type : ONAF			
Time [seconds]	$R_{[1U-1V]}$ [mΩ]	Time [seconds]	$R_{[2U-2V]}$ [mΩ]	Time [seconds]	$R_{[1U-1V]}$ [mΩ]	Time [seconds]	$R_{[2U-2V]}$ [mΩ]
72	5924.6167	72	245.3747	90	5725.7102	90	236.5598
102	5917.6543	102	245.1512	120	5717.2349	120	236.2848
132	5910.4405	132	244.9196	150	5708.2364	150	235.9943
162	5903.8812	162	244.7075	180	5700.3992	180	235.7386
192	5898.4963	192	244.5352	210	5694.5263	210	235.5479
222	5892.6858	222	244.3525	240	5688.1094	240	235.3348
252	5886.7928	252	244.1616	270	5681.2667	270	235.1069
282	5880.7096	282	243.9623	300	5674.1998	300	234.8761
312	5874.7979	312	243.7591	330	5667.0994	330	234.6370
342	5867.8261	342	243.5180	360	5658.2821	360	234.3449
372	5861.4302	372	243.2951	390	5650.3632	390	234.0813
402	5855.3477	402	243.0907	420	5643.1392	420	233.8488
432	5849.7341	432	242.9082	450	5636.6143	450	233.6358
462	5844.5147	462	242.7357	480	5630.6236	480	233.4469
492	5839.5156	492	242.5838	510	5625.0652	510	233.2690
522	5834.8397	522	242.4293	540	5620.0144	540	233.1005
552	5830.3830	552	242.2806	570	5615.5608	570	232.9414
582	5826.2497	582	242.1437	600	5611.3430	600	232.7941
612	5822.0031	612	242.0015	630	5607.4780	630	232.6530
642	5818.2887	642	241.8625	660	5604.0125	660	232.5224
672	5814.7465	672	241.7388	690	5600.6964	690	232.4081
702	5811.5053	702	241.6166	720	5597.4534	720	232.3001
732	5808.1246	732	241.4870	750	5594.4906	750	232.1950
762	5805.0383	762	241.3698	780	5591.6064	780	232.0977
792	5801.7918	792	241.2519	810	5588.8988	810	231.9962
822	5798.5578	822	241.1343	840	5586.2906	840	231.8995
852	5795.3874	852	241.0282	870	5583.8848	870	231.8070
882	5792.6177	882	240.9188	900	5581.6847	900	231.7204
912	5789.9341	912	240.8163	930	5579.6801	930	231.6323
942	5787.3973	942	240.7121	960	5577.6834	960	231.5574
972	5784.9954	972	240.6128	990	5575.8091	990	231.4852
1002	5782.6958	1002	240.5032	1020	5574.0227	1020	231.4119
1032	5780.2795	1032	240.4047	1050	5572.2142	1050	231.3371
1062	5777.7089	1062	240.3108	1080	5570.4527	1080	231.2784
1092	5775.3001	1092	240.2200	1110	5568.8572	1110	231.2134
1122	5772.9617	1122	240.1252	1140	5567.3771	1140	231.1488
1152	5770.5367	1152	240.0412	1170	5565.8928	1170	231.0884
1182	5768.5022	1182	239.9515	1200	5564.3734	1200	231.0301
1212	5769.8311	1212	239.9584	1230	5568.7999	1230	231.1423
1242	5768.8031	1242	239.9013	1260	5569.2518	1260	231.1393

Measuring instrument : TTS ; Type 2285C/0 YB ; Serial Number : 148.681 ; Tettex / Switzerland

Senior Test Technician

Manager, Testing Laboratory

Reviewed by Customer or representative

Witnessed

Initial: 81-20

TR-0008



TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

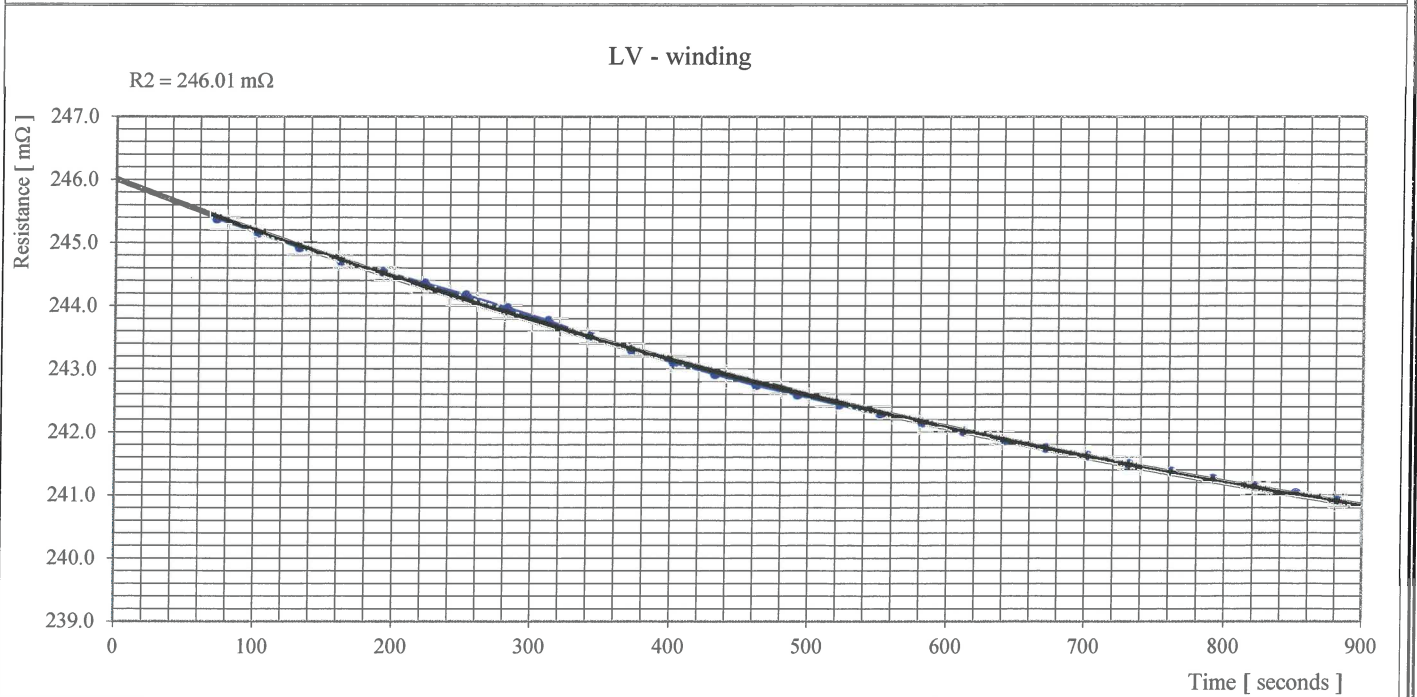
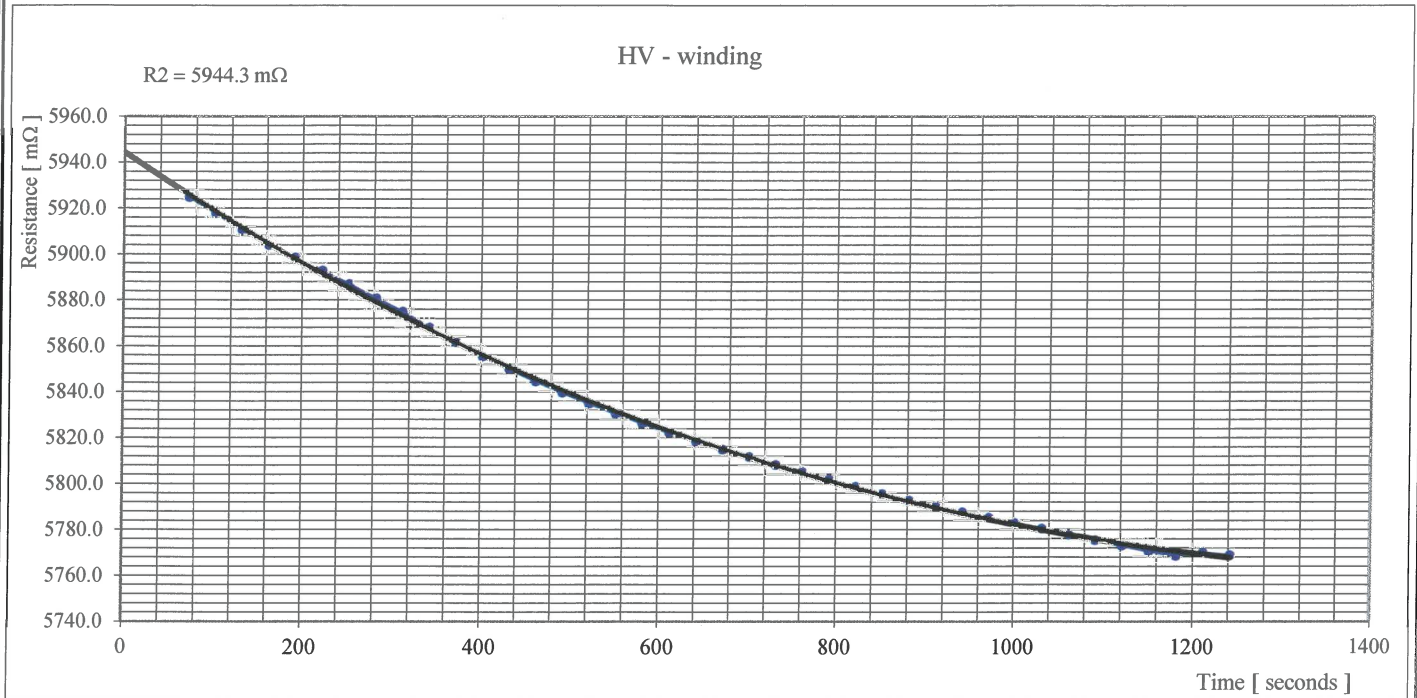
TEST LABORATORY

Date : 04.01.2020

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Temperature rise test Resistances-time curves

Cooling type : ONAN



Senior Test Technician

Manager, Testing Laboratory

intertek

Reviewed by Customer or representative

Witnessed

Initial: *81.20*

Date: *01.20*

11-00018



TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

TEST LABORATORY

Date : 04.01.2020

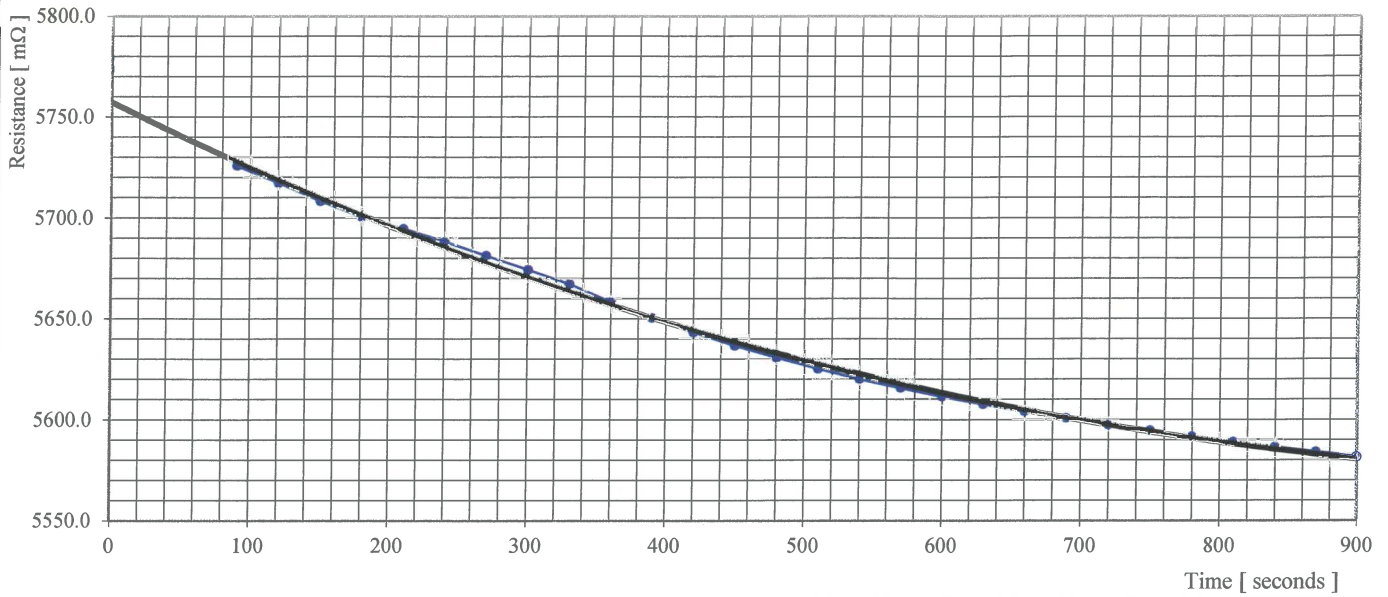
Page No : 41 of 56

Temperature rise test Resistances-time curves

Cooling type : ONAF

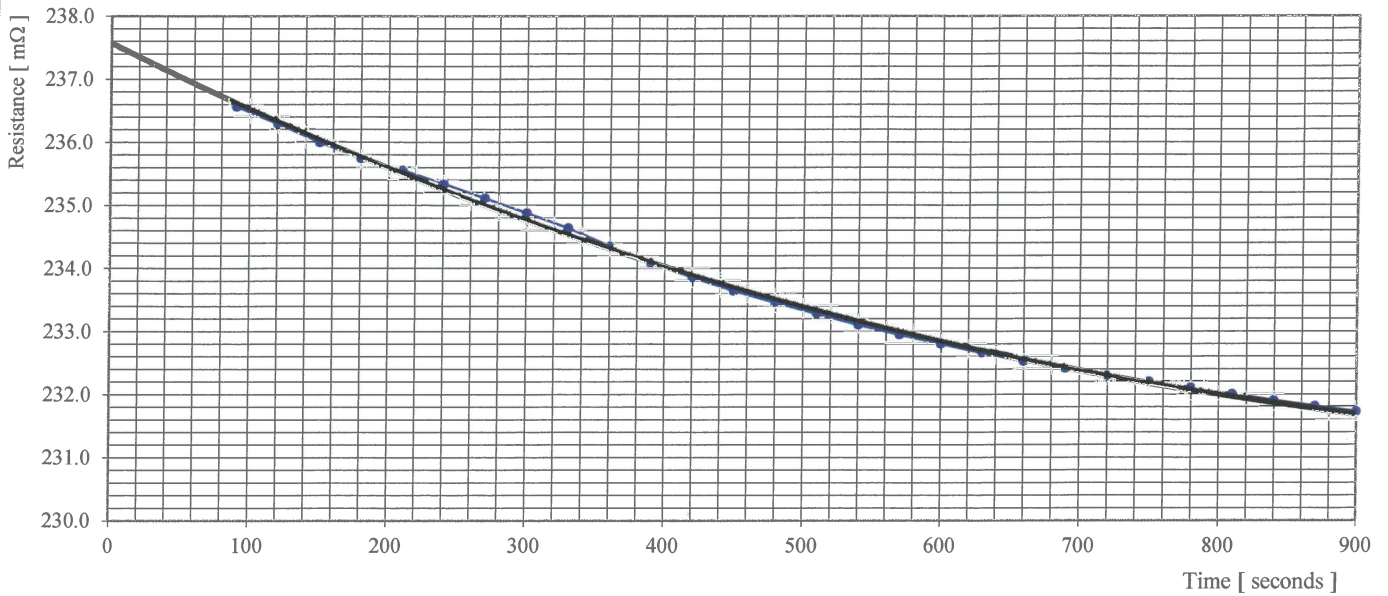
HV - winding

R2 = 5757.2 mΩ



LV - winding

R2 = 237.57 mΩ



Senior Test Technician

Manager, Testing Laboratory

intertek

Reviewed
 Witnessed

Initial: *S-1-20*
Date: *8-1-20*

TR-0008

Customer or representative



TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

TEST LABORATORY

Date : 04.01.2020

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Temperature rise test

Determination of oil temperature rise

Cooling type	ONAN	ONAF	Correction Factor			
Top oil temperature at the total losses	[°C] 79.5	[°C] 73.9	for oil x = 0.9			
Ambient temperature during test	[°C] 26.7	[°C] 28.5	for windings y = 1.6			
Average oil temperature rise at the total losses	[K] 50.0	[K] 37.2	Hot-spot factors			
Corrected average oil temperature rise	[K] 50.0	[K] 37.2	for HV H = 1.18			
Top oil temperature rise	[K] 52.8	[K] 45.5	for LV H = 1.22			
Corrected top oil temperature rise	[K] 52.8	[K] 45.5				

Determination of winding temperature rise

Reference cold resistances at 23.70 °C $R_{l \text{ 1U-1V }} = 4846.652 \text{ [m}\Omega\text{]}$; $R_{l \text{ 2U-2V }} = 201.742 \text{ [m}\Omega\text{]}$

Cooling type	ONAN				ONAF			
	HV	LV	HV	LV	HV	LV	HV	LV
Transformer windings								
Winding resistances at switch off	[mΩ] 5944.300	[mΩ] 246.010	[mΩ] 5944.300	[mΩ] 246.010	[mΩ] 5944.300	[mΩ] 246.010	[mΩ] 5944.300	[mΩ] 246.010
Average oil temperature	[°C] 74.7	[°C] 74.7	[°C] 64.8	[°C] 64.8	[°C] 64.8	[°C] 64.8	[°C] 64.8	[°C] 64.8
Winding temperatures at switch off	[°C] 82.3	[°C] 80.5	[°C] 72.3	[°C] 72.3	[°C] 69.6	[°C] 69.6	[°C] 69.6	[°C] 69.6
Difference between winding and average oil temperature	[K] 7.6	[K] 5.8	[K] 7.5	[K] 7.5	[K] 4.8	[K] 4.8	[K] 4.8	[K] 4.8
Difference between corrected winding and average oil temp.	[K] 7.6	[K] 5.8	[K] 7.5	[K] 7.5	[K] 4.8	[K] 4.8	[K] 4.8	[K] 4.8
The average winding temperature rise	[K] 57.6	[K] 55.8	[K] 44.7	[K] 44.7	[K] 42.0	[K] 42.0	[K] 42.0	[K] 42.0
Hot spot temperature rise	[K] 61.7	[K] 59.8	[K] 54.3	[K] 54.3	[K] 51.3	[K] 51.3	[K] 51.3	[K] 51.3
Guaranteed	Top oil temperature rise	[K] 58.0						
	The average winding temperature rise	[K] 63.0						
	Hot spot temperature rise	[K] 76.0						

Senior Test Technician

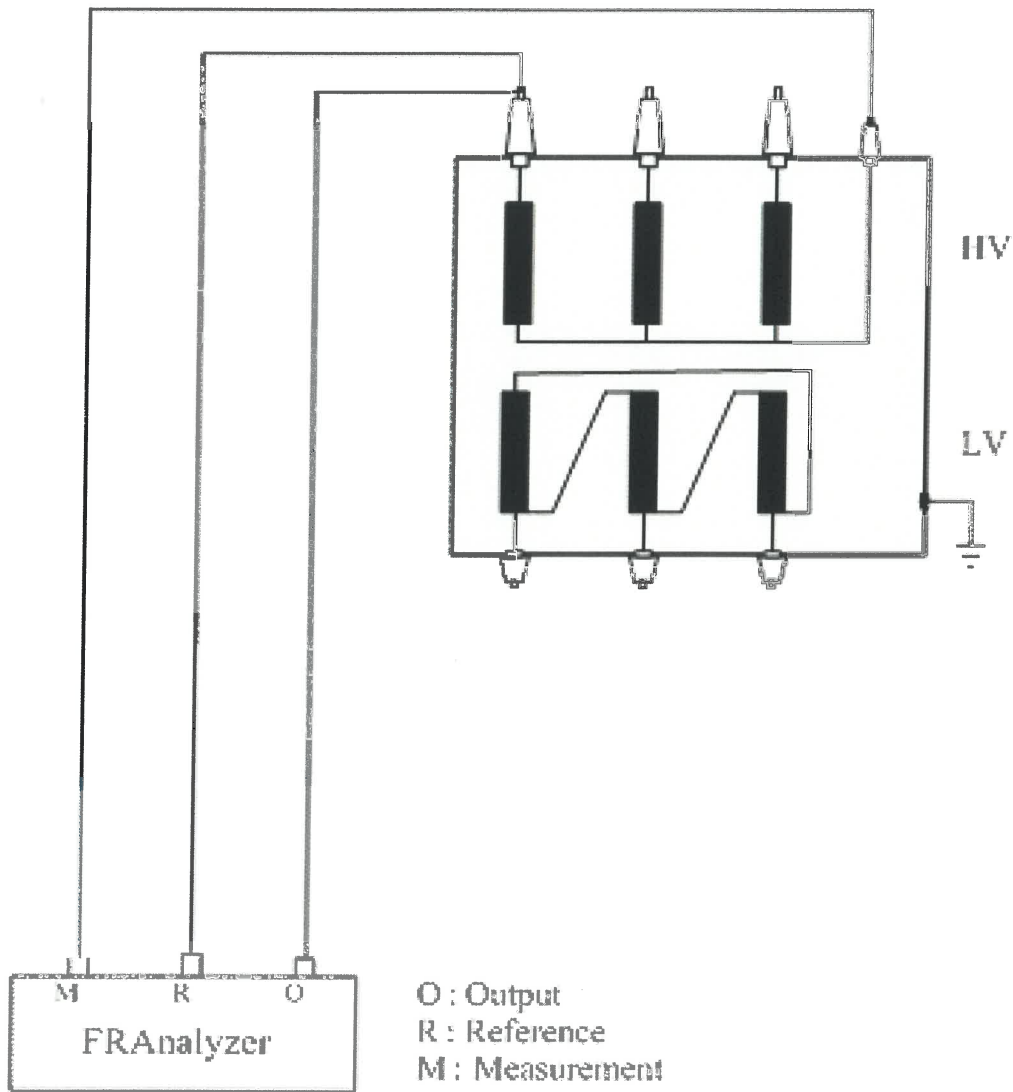
Manager, Testing Laboratory

Customer or representative

Reviewed
 Witnessed
 Initial: S.V.S.P.

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Frequency Response Analysis



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TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

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Date : 02.01.2020

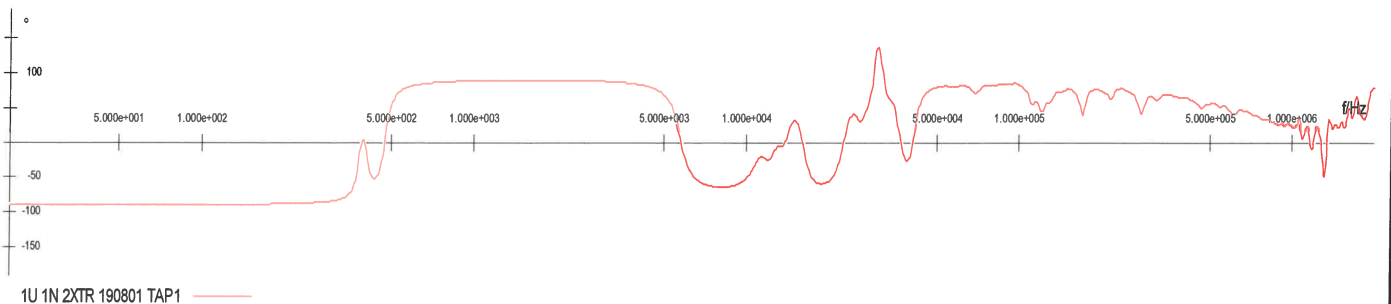
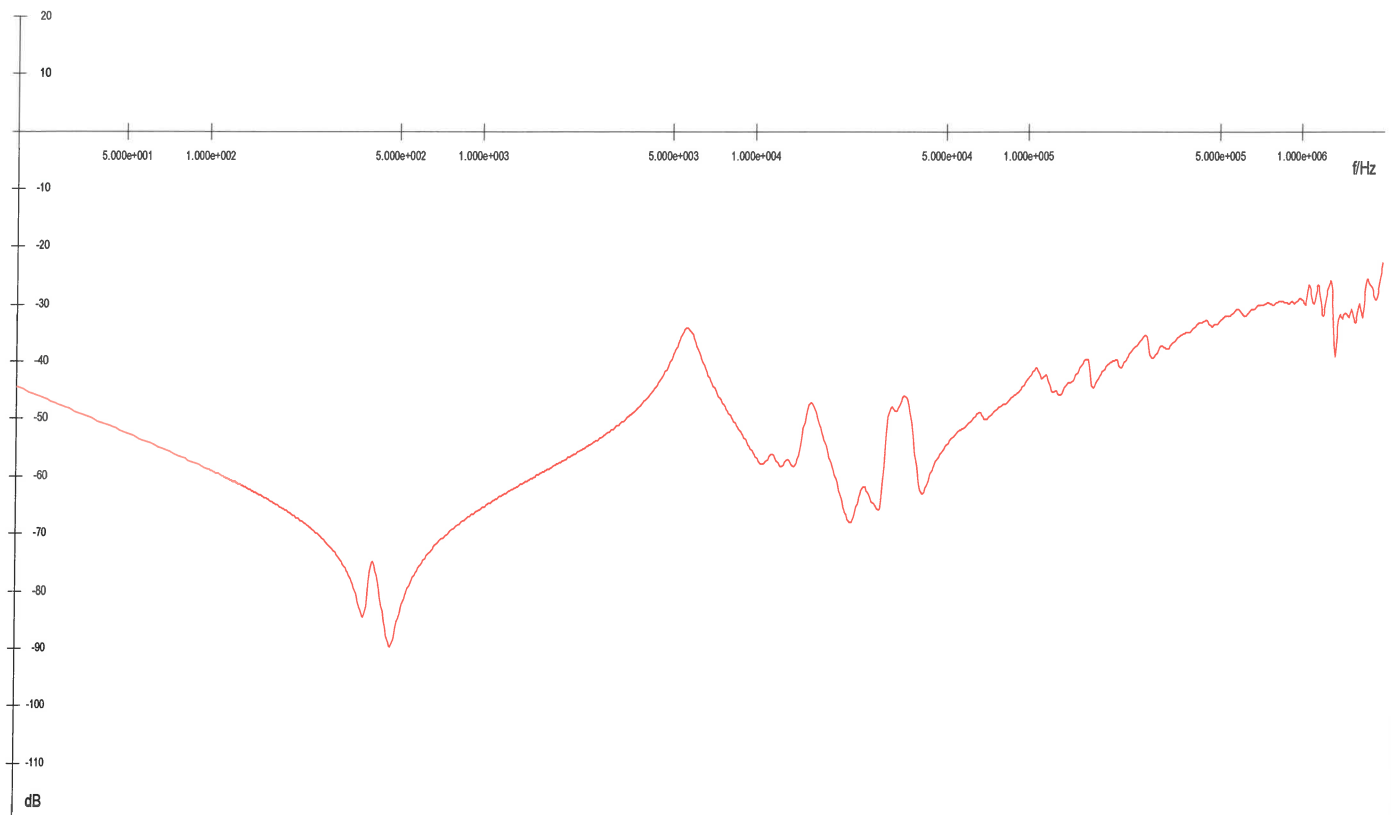
Page No : 44 of 56

Frequency Response Analysis

End-to-end open winding

Phase : 1U -1N

[Tap Position No : 1]



1U 1N 2XTR 190801 TAP1

Measuring instrument : FRAnalyzer ; Serial Number : BK094J ; Omicron / Austria

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Manager, Testing Laboratory

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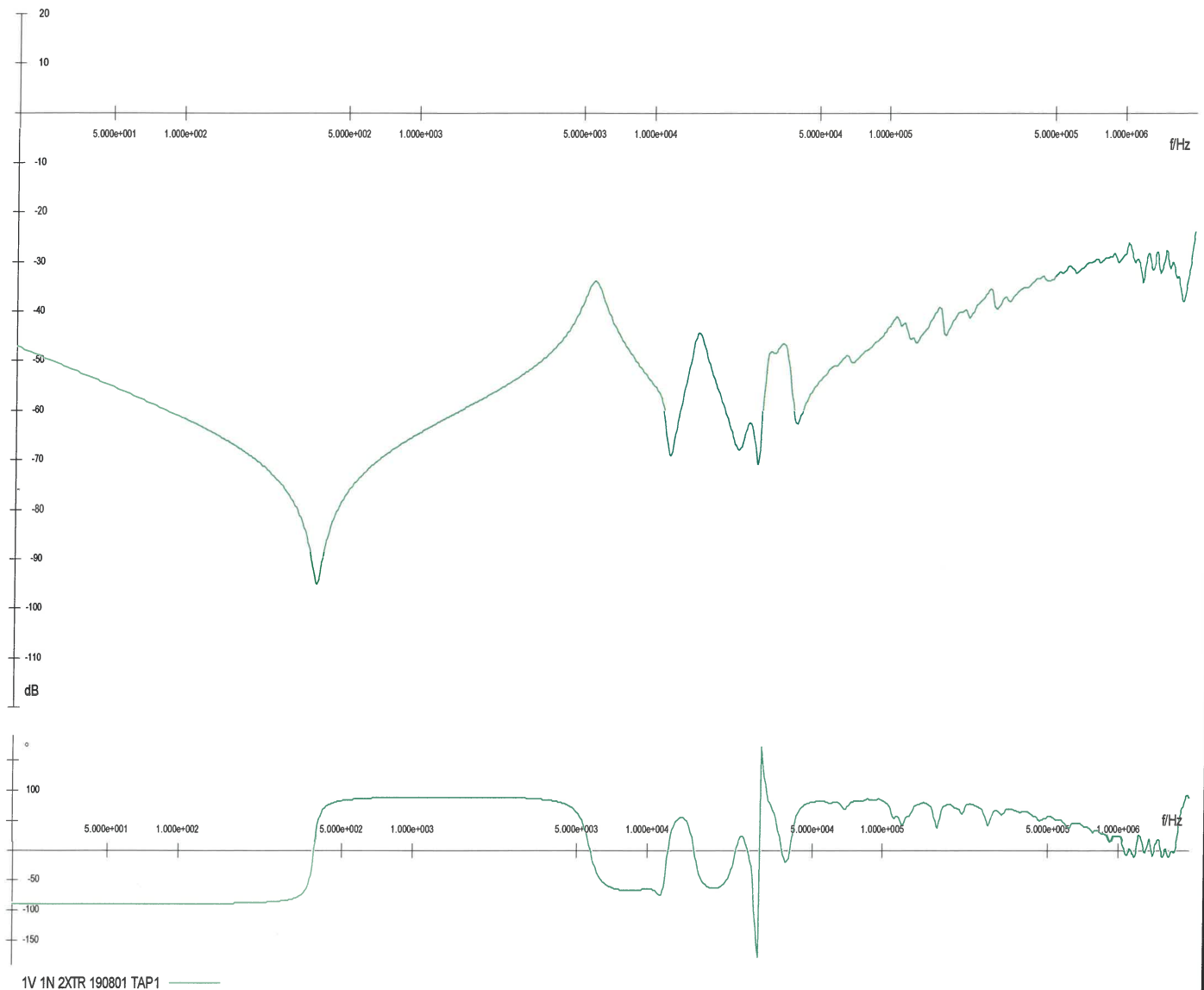
Page No : 45 of 56

Frequency Response Analysis

End-to-end open winding

Phase : 1V - 1N

[Tap Position No : 1]



Measuring instrument : FRAnalyzer ; Serial Number : BK094J ; Omicron / Austria

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Serial No : 2XTR 190801

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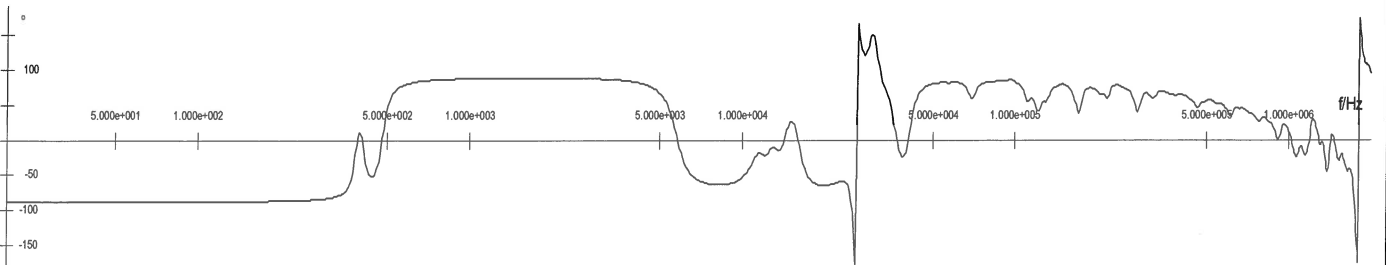
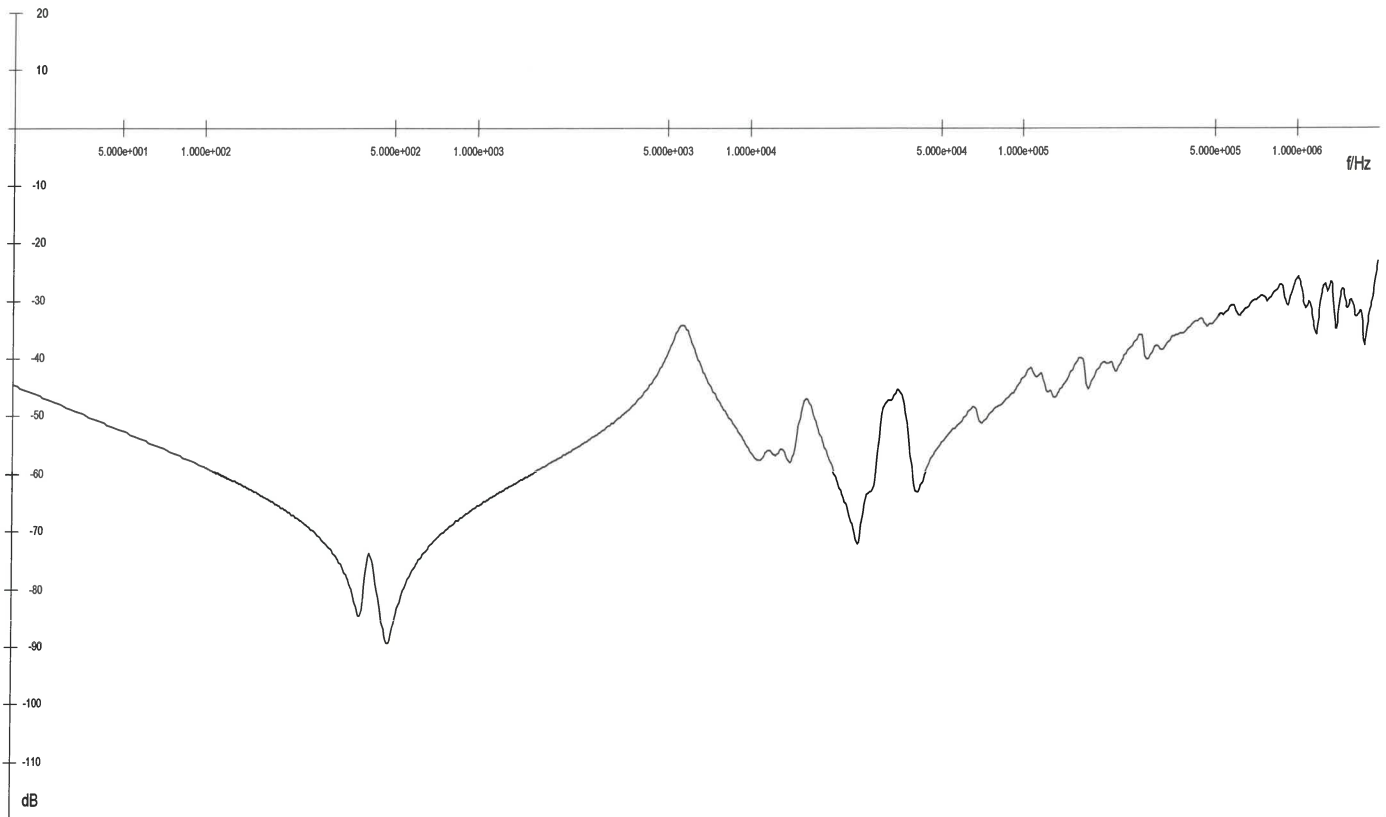
Page No : 46 of 56

Frequency Response Analysis

End-to-end open winding

Phase : 1W - 1N

[Tap Position No : 1]



1W 1N 2XTR 190801 TAP1

Measuring instrument : FRAnalyzer ; Serial Number : BK094J ; Omicron / Austria

Senior Test Technician

Manager, Testing Laboratory

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Initial: 8.1.20

Date:

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TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

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Date : 02.01.2020

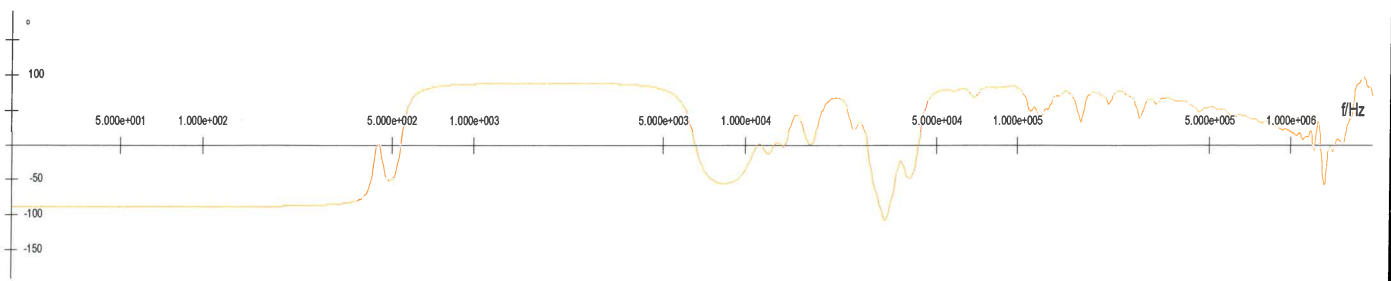
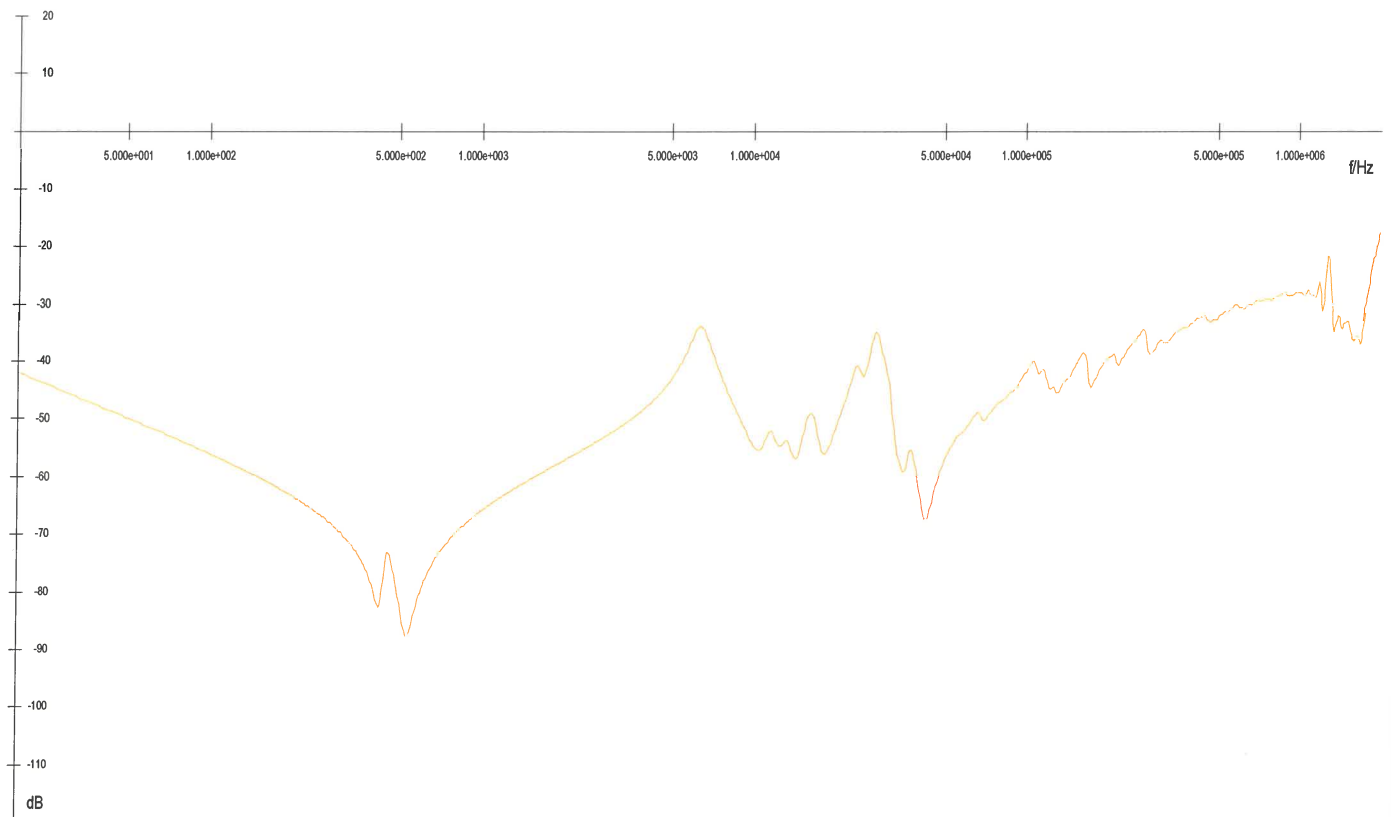
Page No : 47 of 56

Frequency Response Analysis

End-to-end open winding

Phase : 1U - 1N

[Tap Position No : 11]



1U 1N 2XTR 190801 TAP 11 From 1

Measuring instrument : FRAnalyzer ; Serial Number : BK094J ; Omicron / Austria

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 witnessed

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Date: 31.20

TR-0003

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[Signature]

Manager, Testing Laboratory
[Signature]

Customer or representative
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TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

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Date : 02.01.2020

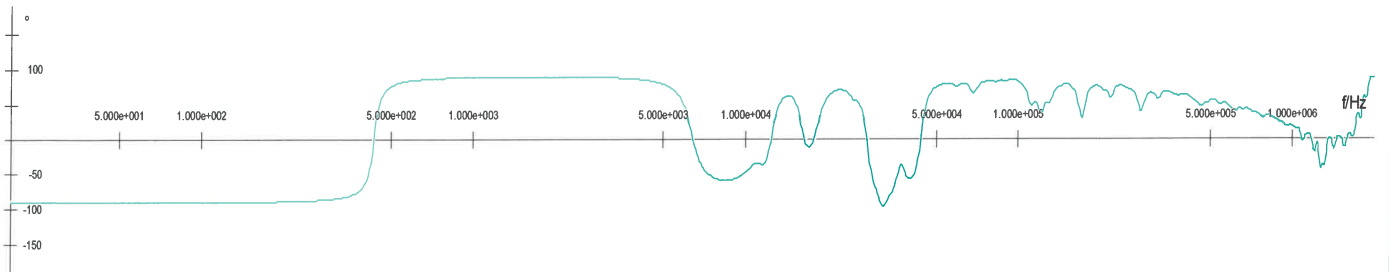
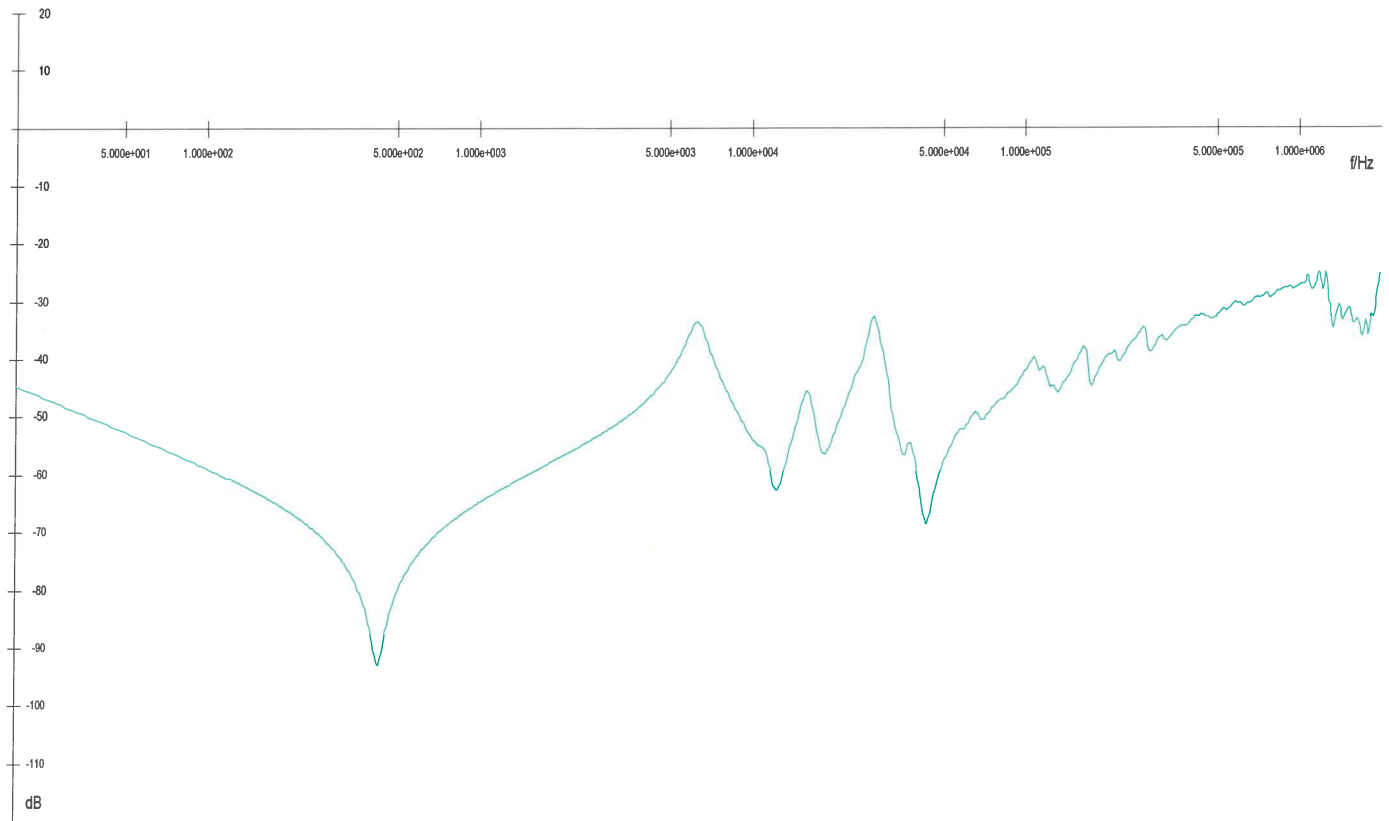
Page No : 48 of 56

Frequency Response Analysis

End-to-end open winding

Phase : 1V - 1N

[Tap Position No : 11]



1V 1N 2XTR 190801 TAP 11 From 1

Measuring instrument : FRAnalyzer ; Serial Number : BK094J ; Omicron / Austria

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Manager, Testing Laboratory

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Initial: *[Signature]*

Date: 02-01-20



TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

TEST LABORATORY

Date : 02.01.2020

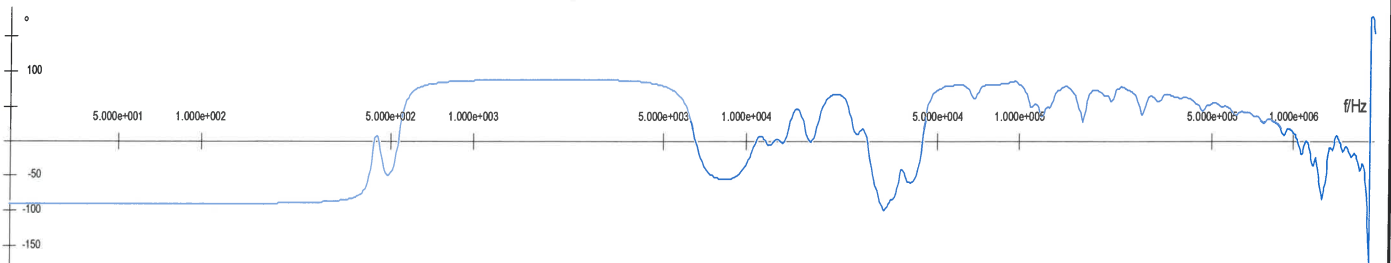
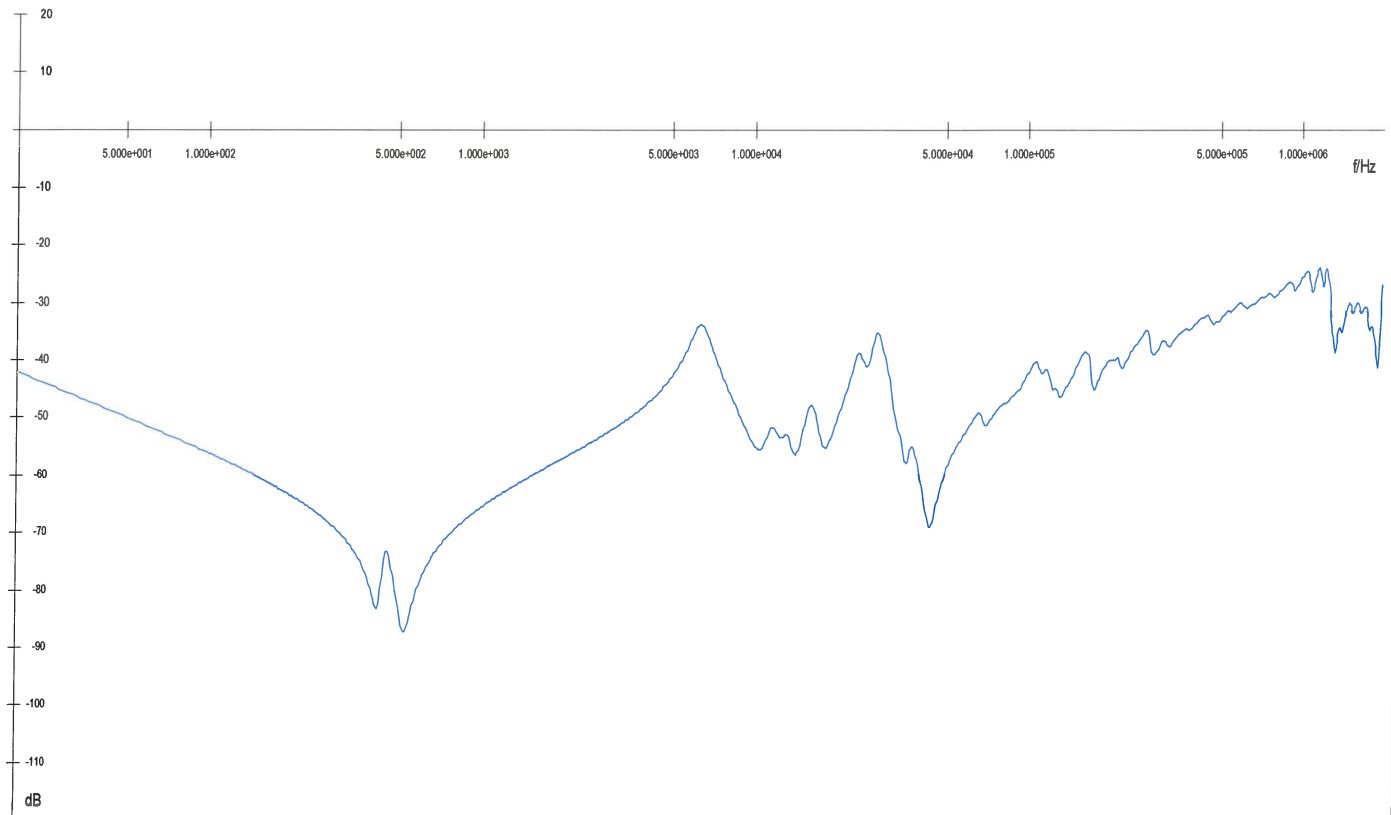
Page No : 49 of 56

Frequency Response Analysis

End-to-end open winding

Phase : 1W - 1N

[Tap Position No : 11]



1W 1N 2XTR 190801 TAP 11 From 1

Measuring instrument : FRAnalyzer ; Serial Number : BK094J ; Omicron / Austria

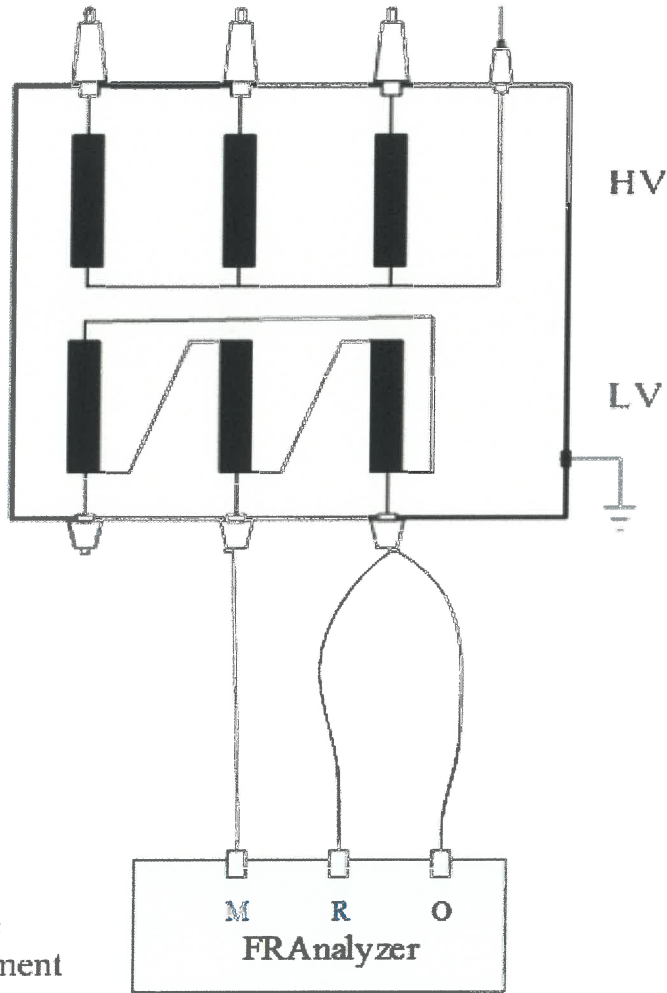
Senior Test Technician

Manager, Testing Laboratory

Intertek
 Approved
 Witnessed
Date: 8.1.20
By: 0002

Customer or representative

Frequency Response Analysis



intertek

Reviewed

Witnessed

Initial: *[Signature]*

Date: 8-1-20

TR-0003

Senior Test Technician

Manager, Testing Laboratory

Customer or representative



TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

TEST LABORATORY

Date : 02.01.2020

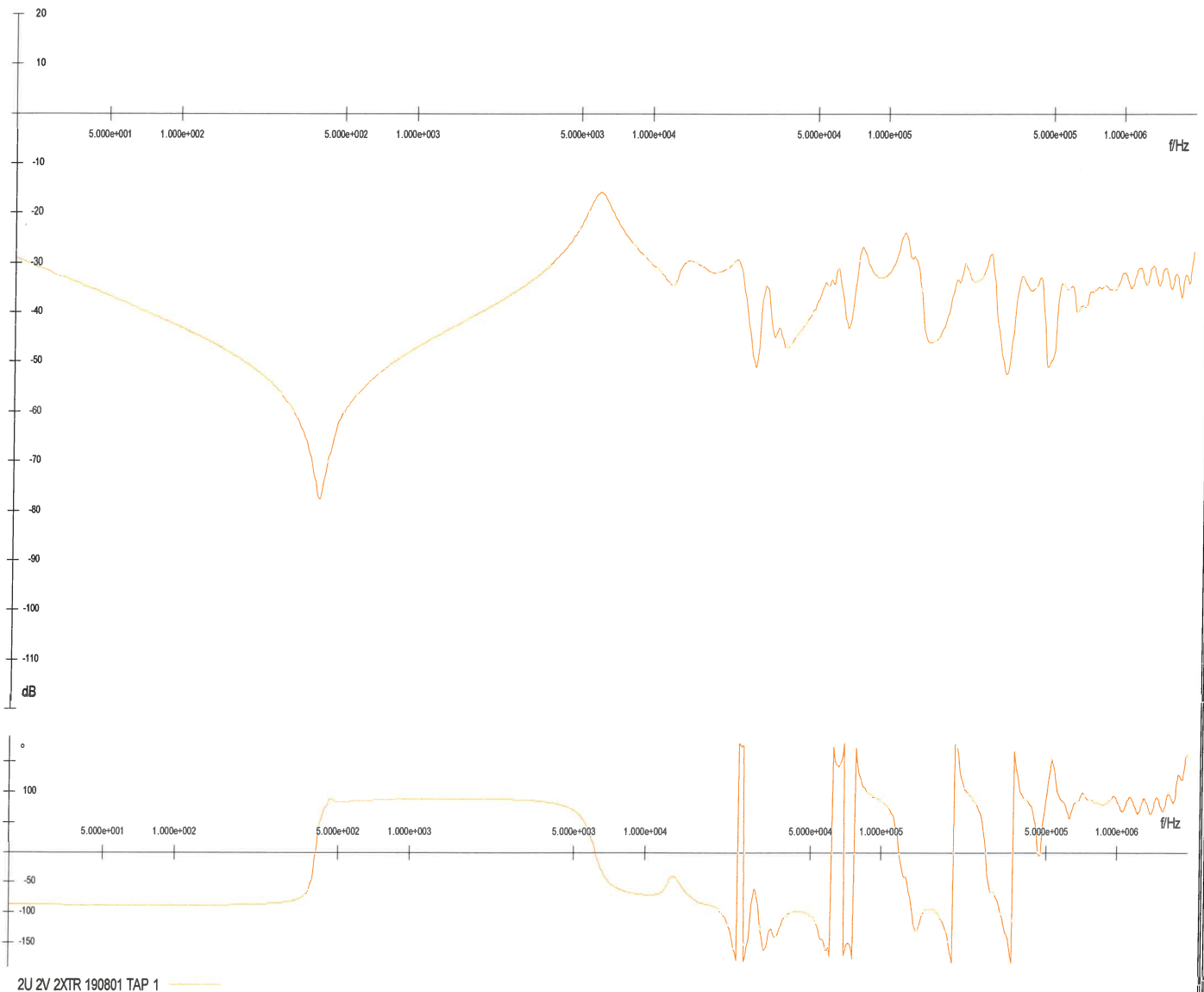
Page No : 51 of 56

Frequency Response Analysis

End-to-end open winding

Phase : 2U - 2V

[Tap Position No : 1]



Measuring instrument : FRAnalyzer ; Serial Number : BK094J ; Omicron / Austria

Senior Test Technician

Manager, Testing Laboratory

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Initial: *S.L.20*

Date: *8.1.20*

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TRANSFORMER TEST REPORT

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Date : 02.01.2020

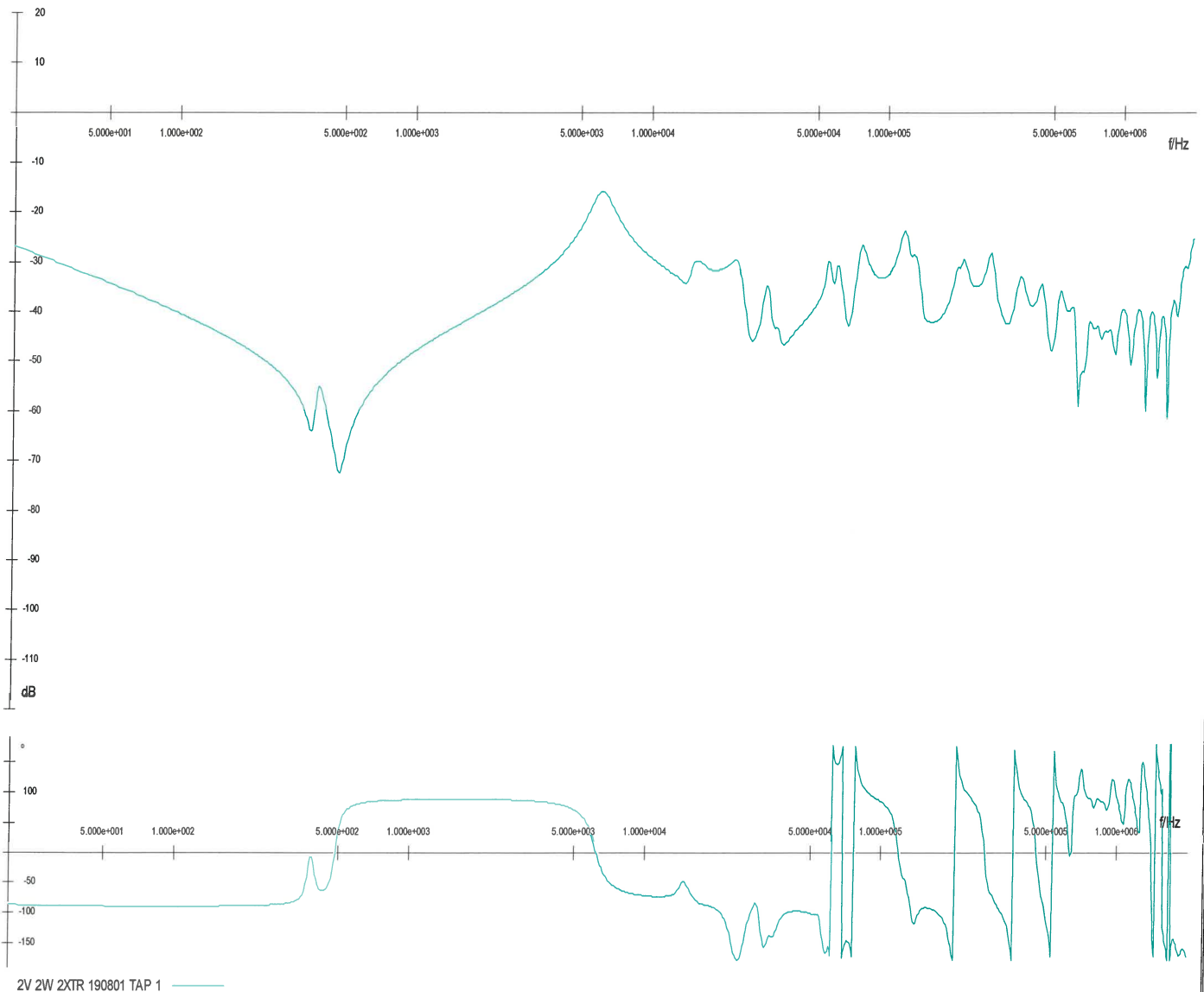
Page No : 52 of 56

Frequency Response Analysis

End-to-end open winding

Phase : 2V - 2W

[Tap Position No : 1]



Measuring instrument : FRAnalyzer ; Serial Number : BK094J ; Omicron / Austria

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Date: 8.1.20

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Serial No : 2XTR 190801

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Date : 02.01.2020

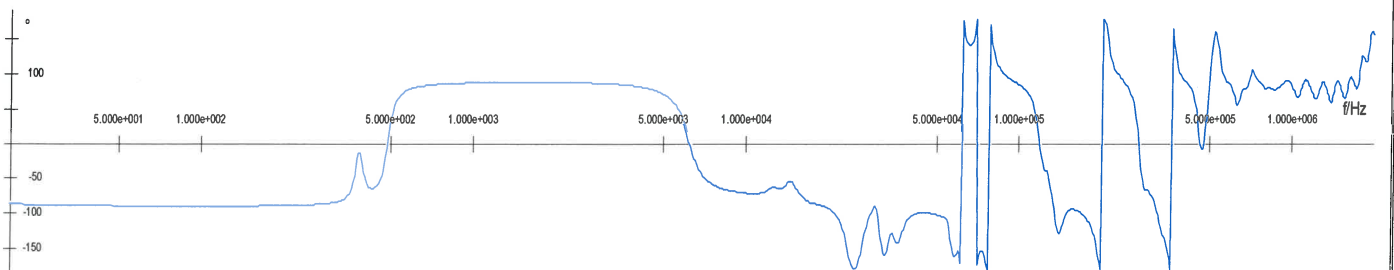
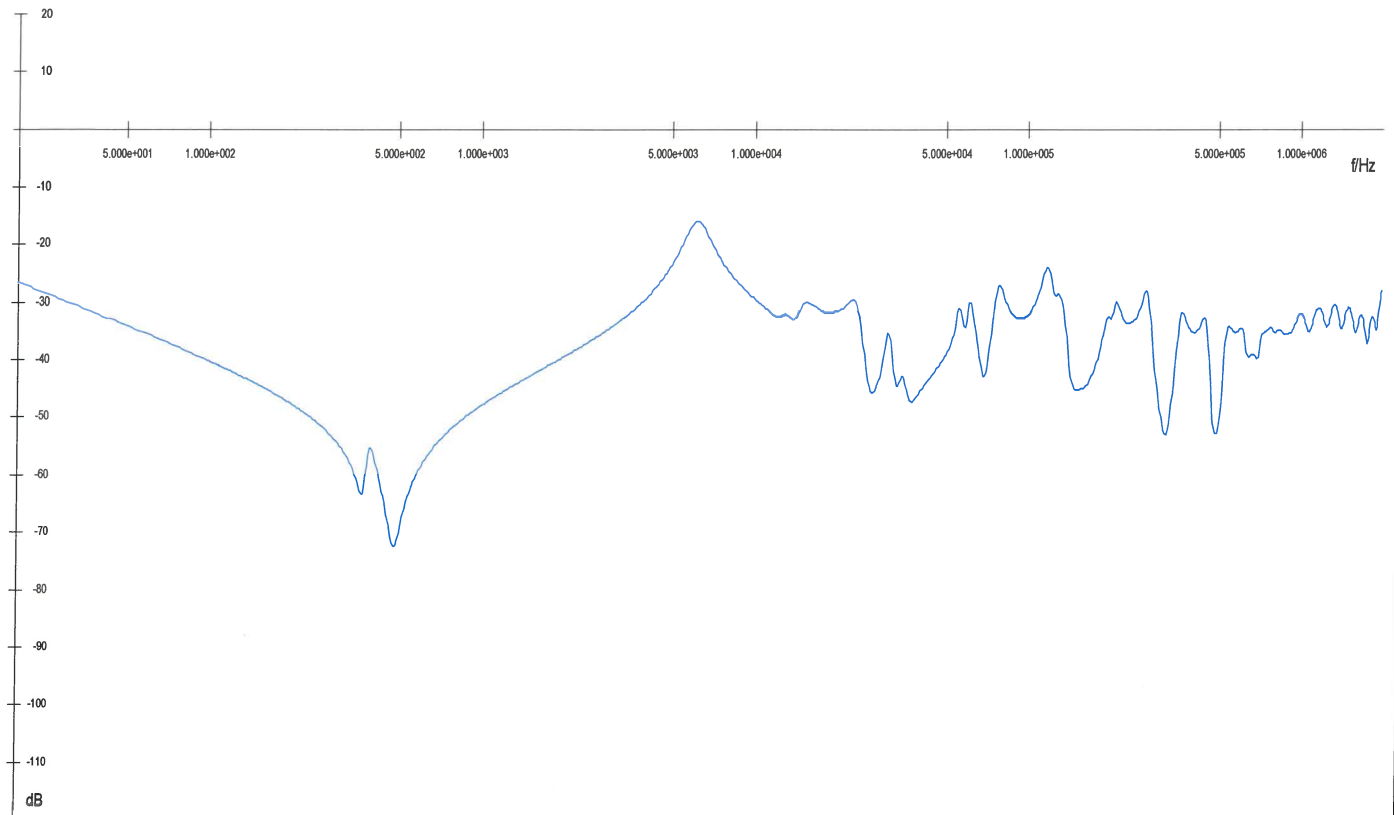
Page No : 53 of 56

Frequency Response Analysis

End-to-end open winding

Phase : 2W - 2U

[Tap Position No : 1]



2W 2U 2XTR 190801 TAP 1

Measuring instrument : FRAnalyzer ; Serial Number : BK094J ; Omicron / Austria

Senior Test Technician

Manager, Testing Laboratory

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TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

TEST LABORATORY

Date : 06.12.2019

Page No : 54 of 56

Test of on-load tap changer

Make : ABB
Type : UCGRN 380/300/C
Serial number : 1ZSC 8730295
Year of manufacture : 2019
Test standard : IEC 60076

Operation tests :

- 1 . With the transformer un-energized, 8 complete cycles of operation (a cycle of operation goes from one end of the tapping range to the other, and back again).
- 2 . With the transformer un-energized, and with the auxiliary voltage reduced to 85 % of its rated value, one complete cycle of operation.
- 3 . With transformer energized at rated voltage and frequency at no-load, one complete cycle of operation.
- 4 . With one winding short- circuited, and as far as practicable, rated current in the tapped winding, 10 tap change operations across the range of 2 steps on each side from where a coarse or reversing change over selector operates, or otherwise from the middle tapping.

These tests were performed without failure.

Senior Test Technician

Manager, Testing Laboratory

intertek

Revised

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TRANSFORMER TEST REPORT

Serial No : 2XTR 190801

TEST LABORATORY

Date : 06.01.2020

Page No : 55 of 56

Analysis of dissolved gases in transformer oil

Gases		Unit	1	2	3
Methane	CH4	ppm	0	0	0
Hydrogen	H2	ppm	0	0	0
Carbon dioxide	CO2	ppm	185	164	245
Ethylene	C2H4	ppm	0	0	0
Ethane	C2H6	ppm	0	0	0
Acetylene	C2H2	ppm	0	0	0
Oxygen	O2	ppm	1739	1327	2100
Nitrogen	N2	ppm	3288	2659	3971
Carbon monoxide	CO	ppm	14.0	10.0	28.0
Total dissolved gas		ppm	5226	4160	6344
		%	0.52	0.42	0.63
Total combustible gas		ppm	14.00	10.00	28.00
		%	0.27	0.24	0.44

Test equipment : MYRKOS TRANSFORMER FAULT GAS ANALYZER , 10752003 , MORGAN SCHAFFER

Note : The oil samples were taken from the transformer as below.

1. Before tests
2. After tests
3. After temperature rise tests

 Chemical Engineer	 Senior Test Technician	 Manager, Testing Laboratory	 Customer or representative Date: 8.1.20 TR- 0008
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Dokuman No : 9CJL9-083

Tarih/Rev No : 01.06.11/00



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Serial No : 2XTR 190801

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Date : 06.01.2020

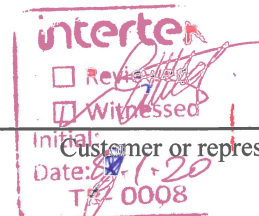
Page No : 56 of 56

Oil tests :

No	The oil sample was taken from the transformer as below.
1	The oil sample was taken from the transformer before tests.
2	The oil sample was taken from the transformer after tests.
3	The oil sample was taken from the transformer after temperature rise tests.
4	-

Tests	Unit	Standard	Limits [IEC 60296]	Sample		Test result	
				1	2	1	2
Dissipation factor at 100 °C	%	D 924	0.5	0.11	0.09	OK	OK
Interfacial tension at 25 °C	Dyn / cm	D 971	40	47.2	47.2	"	"
Water content	ppm	D 1533	10	7.0	7.0	"	"
Dielectric strength at 2.5 mm	kV	D 1816	70	81.0	81.0	"	"

Tests	Unit	Standard	Limits [IEC 60296]	Sample		Test result	
				3	4	3	4
Dissipation factor at 100 °C	%	D 924	0.5	0.10	-	OK	-
Interfacial tension at 25 °C	Dyn / cm	D 971	40	46.0	-	"	-
Water content	ppm	D 1533	10	4.0	-	"	-
Dielectric strength at 2.5 mm	kV	D 1816	70	85.0	-	"	-



Chemical Engineer 	Senior Test Technician 	Manager, Testing Laboratory 	Customer or representative Initial: Date: 06-1-20 TF-0008
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TRANSFORMER TEST REPORT

Serial No : 1ZTR 190801

Quality Assurance & Control

Date : 10,01,2020

Page : 1 / 1

OIL LEAK TEST (PRESSURE TEST)

Completely assembled transformer unit with its compartments has been subjected to a pressure of twice of the normal liquid pressure for 24 hours. No oil leakage observed.

Hydrostatic Pressure : 0,37 kPa

Test Pressure : 0,75 kPa

Duration : 24 hrs

DIELECTRIC TEST on AUXILIARY WIRING

The wiring for auxiliary power, and control circuitry were subjected to a 1 min AC separate source test of 2 kV to earth. The test was passed that no voltage collapsed or other sign of breakdown occurred.

OPERATION TEST of AUXILIARY DEVICES

Operation tests of all devices have been performed and accepted.

CHECK of DIMENSIONS

The dimensions of the Main Body, Cooling System, Cable Boxes and Oil Conservator have been checked according to the approved drawings and found acceptable.

VERIFICATION of CURRENT TRANSFORMERS

The ratios, polarities and the resistances of the current transformers have been checked according to the approved drawings and found acceptable.

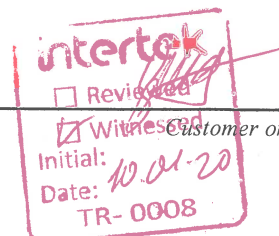
PAINT THICKNESS MEASUREMENTS

The paint thickness values below are randomly taken from tank, radiators, conservator and attachments & found acceptable.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
350	298	321	310	292	293	306	302	329	350	292	289	335	319	283	334	340	342	284	291

Manufacturing Tester

Quality Assurance Specialist



Customer or representative



Transformer S/N 2XTR190801 – PEI CALCULATION BASED ON COMMISSION REGULATION (EU)
No 548/2014 MODIFIED ON 1ST OCTOBER 2019

Taking into account that the rating of the transformer is 21 MVA, and the measured No load Losses and Load Losses of the transformer have been:

No load losses (kW)	10,106 kW
Load losses (kW)	127,978 kW

The calculated PEI of this transformer according to the formula in ANNEX II of such normative is:

$$\text{PEI} = 99,6575 \%$$

Which is bigger than the minimum PEI corresponding to the power of the transformer (21 MVA) in TIER1 stage, which is 99,6426 %.