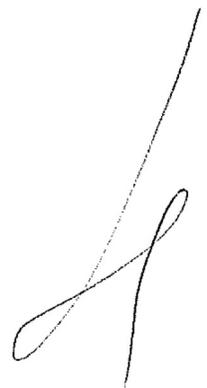


# ПРИЛОЖЕНИЕ №1











**Lemi Trafo**  
Transformers

TRAFO CONTROL | 2304 Pernik, 1 "Vladaisko vastanie" Street

# SOUND LEVEL MEASUREMENT

According to EN/IEC 60076-10/2005, Standard

TEST REPORT No. 000034

## DETAILS OF MEASURED CAST RESIN TRANSFORMER

Rated Power: 400 kVA | Rated Voltage: 10/0.4 kV | Rated Frequency: 50 Hz | Serial No :13577

## DETAILS OF USED MEASURING INSTRUMENTS

- 12-ch Input Module LAN-XI, 25.6 kHz Pulse 18.1.1.9 type 3053-B-120 - Brüel & Kjær - Ser.No. 3053-106824;
- 1/2" free-field Microphones, 8 kHz to 12.5 kHz prepolarised, including preamplifier 2671 with TEDS - Brüel & Kjær Ser.No.No. 2952374; 2952375; 2952376; 2952377; 2952378 and 2952379.

## TEST CONDITIONS

Supplied voltage: 400 V in the Acoustic Semi-Anechoic Chamber - APE 1528 - Ser.No. 2341A  
Selected test method: Sound pressure method of measurement in accordance with EN ISO 3746/2010.

## A-WEIGHTED SOUND PRESSURE LEVEL - L<sub>PA</sub>

Measuring position	dB			Measuring position	dB			Legend
	Source (1)	Backg. (2)	Corr. (3)		Source (1)	Backg. (2)	Corr. (3)	
1	45.78	32.40	45.78	9	47.35	33.06	49.29	(1) = Transformer noise
2	50.63	33.40	50.63	10	49.09	33.51	49.09	(2) = Background noise
3	44.30	32.63	44.30	11	48.56	32.98	48.56	(3) = Transformer corrected noise
4	51.49	35.46	51.49	12	48.44	32.72	48.44	
5	49.02	33.44	49.02	13				Note:
6	49.29	32.51	49.29	14				For calculation of uncorrected sound pressure level a simple arithmetical average is used
7	48.78	32.12	48.78	15				
8	47.16	32.54	47.16	16				

Uncorrected average sound pressure level L<sub>PA0</sub>: **48.32 dB** on 12 measuring points

## TEST ROOM CORRECTION FACTOR

Average acoustic absorption coefficient (α)	0.46
Total area of the test room surface (Sv)	106.000 m <sup>2</sup>
Test area factor A = αS <sub>v</sub>	48.76 m <sup>2</sup>
Principal prescribed contour (S)	22.6801 m <sup>2</sup>
Reference area (S <sub>0</sub> )	1.0000 m <sup>2</sup>

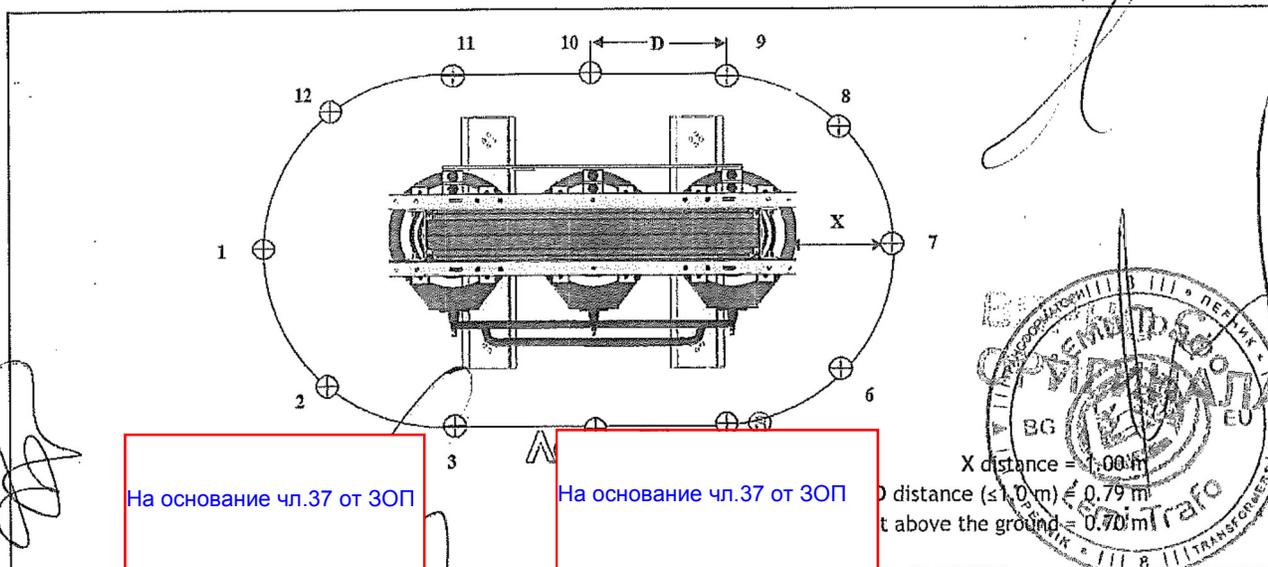
## ENVIRONMENTAL CORRECTION (K)

$$K = 10 \lg \left[ 1 + \frac{4}{A/S} \right] \quad K = \boxed{4.5644972}$$

Corrected average sound pressure level:	L <sub>PA</sub> <b>43.93 dB</b>
Sound Power Level	L <sub>WA</sub> <b>57.49 dB</b>

$$\overline{L_{PA}} = 10 \lg \left( 10^{0.1 \overline{L_{PA0}}} - 10^{0.1 \overline{L_{WA}}} \right) + K$$

$$L_{WA} = \overline{L_{PA}} + 10 \lg \frac{S}{S_0}$$



На основание чл.37 от ЗОП

На основание чл.37 от ЗОП

X distance = 1.00 m  
D distance (≤ 10 m) = 0.79 m  
Height above the ground = 0.70 m

Tested by: Oleg Cvetanov

Approved by: Katerina Raicheva

Date: 30.11.2020



**Лемми Трафо**  
Трансформатори

# ТЕСТОВ ПРОТОКОЛ

сериен № **13272**

Трифазен сух трансформатор

Година **2020**

Характеристики		Надморско ниво <1000 m			
Охлаждане	AN	Първична		Вторична	
		Мощност (kVA)	630		630
	Ток (A)	36.37		909.33	
	AF	Мощност (kVA)			
Ток (A)					
Векторна група <b>Dyn5</b>		Напрежение (V)	10000	400	
Честота <b>50 Hz</b>		Комутация	±2x2,5%		
Свързване		Триъгълник		Звезда+Н	
Темп. клас		F		F	
Макс. Температура (K)		100		100	
Изолационен клас (kV)		12.0		1.1	
		LI	75 AC 28	LI	AC 3

## РУТИННИ ТЕСТОВЕ

Г Р А Н И Ц И И	Съотношение 10000 / 400 V.		Температура еталон 120 °C			Кгд (%) (10000 / 400 V.)			
	Загуби на празен ход	Ток на празен ход	Загуби на късо съед.	Импеданс на напрежение	Общи загуби	Товар	cosφ = 0.9	cosφ = 1	
	Гарантирани	990 W	1.1%	7100 W	6.00%	8090 W	630 kVA	98.66	98.79
	Толеранс (%)	+0%	-30%	+0%	± 10.0%	+0%	473 kVA	98.90	99.01
Измерени	924 W	0.40%	6763 W	6.18%	7687 W	315 kVA	99.09	99.18	
Отклонение (%)	-6.7%	-63.8%	-4.7%	3.0%	-5.0%				
Резултат	⊖	⊖	⊖	⊖	⊖				

## ДИЕЛЕКТРИЧНА ЯКОСТ НА ИЗОЛАЦИЯТА

С индуцирано напрежение					С повишено синусоидално напрежение			
Намотка	Тестово напрежение	Тестова честота	Продължителност	Резултат от теста	Намотка	Тестово напрежение	Продължителност	Резултат от теста
400 V	800 V	150 Hz	40 "	⊕ Позитивен	Първична	28.0 kV	60 "	⊕ Позитивен
					Вторична	3.0 kV		

## ИЗМЕРВАНИЯ НА СЪПРОТИВЛЕНИЕ

Намотка	10000 V	Намотка	Намотка	400 V	Намотка	Температура на околната среда
Фаза	Ω	Фаза	Фаза	Ω	Фаза	°C
1U-1V	1.4746925	1U-1V	2U-2V	0.001255	2U-2V	23 °C
1U-1W	1.4725427	1U-1W	2U-2W	0.0012832	2U-2W	
1V-1W	1.4734663	1V-1W	2V-2W	0.0012562	2V-2W	

## ИЗМЕРВАНИЯ НА ЧАСТИЧЕН РАЗРЯД

Un	Пренатоварване	Измерено	Фаза U	Фаза V	Фаза W	Получено ниво	Резултат от теста
10000 V	18000 V за 30 "	13000 V за 3'	4.0 pC	3.0 pC	4.0 pC	< 10 pC	⊕ Позитивен

## КОЕФИЦИЕНТ НА ТРАНСФОРМАЦИЯ

(Толеранс: ±0,5% на главното стъпало ±1% на другите стъпала)

Съотношение 10000 / 400 V.			Съотношение			Съотношение			Съотношение		
Ком. стъпка 2.50%			Ком. стъпка			Ком. стъпка			Ком. стъпка		
Позиция	Измерено	Резулт.	Позиция	Измерено	Резулт.	Позиция	Измерено	Резулт.	Позиция	Измерено	Резултат
5.00%	45.49	⊖									
2.50%	44.41	⊖									
0	43.32	⊖									
-2.50%	42.23	⊖									
-5.00%	41.14	⊖									

**ЛЕМИ ТРАФО** използвани уреди

ОНМ1	RAP1	TA1	TA2	TA3	TA4	TV1	TV2	TV3	MAG1	WBPA1	DMS1
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ЕКОЛОГИЧЕН, КЛИМАТИЧЕН, ПОЖАРОУСТОИЧИВ КЛАС: E2 - C2 - F1

Подпис за приемане:

Клиент:

ЛЕМИ ТРАФО ЕАД - Производител на високо напрежение трансформатори  
7304 Перник, България  
ул. "Владиславъ въстание" 1  
Тел.: +359 76 670 635; +359 76 670 620; Факс: +359 76 670 621; GSM: +359 897 764 127  
info@lemmi-trafo.com; laboratory@lemmi-trafo.com; BG 2026 43851  
http://www.lemmi-trafo.com





**DETAILS OF MEASURED CAST RESIN TRANSFORMER**

Rated Power: 630 kVA | Rated Voltage: 10/0.4 kV | Rated Frequency: 50 Hz | Serial № :13272 | Manufacturer: TMC Trafo

**DETAILS OF USED MEASURING INSTRUMENTS**

- 12-ch Input Module LAN-XI, 25.6 kHz Pulse 18.1,1.9 type 3053-B-120 - Brüel & Kjær - Ser.No. 3053-106824;
- ¼" free-field Microphones, 8 kHz to 12.5 kHz prepolarised, including preamplifier 2671 with TEDS - Brüel & Kjær Ser.No.No. 2952374; 2952375; 2952376; 2952377; 2952378 and 2952379.

**TEST CONDITIONS**

Supplied voltage: 400 V in the Acoustic Semi-Anechoic Chamber - APE 1528 - Ser.No. 2341A  
Selected test method: Sound pressure method of measurement in accordance with EN ISO 3746/2010

**A-WEIGHTED SOUND PRESSURE LEVEL - L<sub>pA</sub>**

Measured values from 1. to 16 microphones	Measuring position	dB Source (1)	dB Backg. (2)	dB Corr. (3)	Measuring position	dB Source (1)	dB Backg. (2)	dB Corr. (3)	Legend
	1	47.35	31.70	47.35	9	46.24	32.52	46.24	
2	43.71	32.81	43.71	10	46.72	32.37	46.72	Note: For calculation of uncorrected sound pressure level a simple arithmetical average is used	
3	48.45	32.44	48.45	11	47.15	33.31	47.15		
4	45.82	35.67	45.82	12	47.49	33.69	47.49		
5	43.79	33.58	43.79	13					
6	47.51	31.76	47.51	14					
7	45.13	32.11	45.13	15					
8	45.78	32.36	45.78	16					

Uncorrected average sound pressure level L<sub>pA0</sub>: **46.26 dB** on 12 measure points

**TEST ROOM CORRECTION FACTOR**

Average acoustic absorption coefficient (α) 0.46  
Total area of the test room surface (Sv) 106.000 m<sup>2</sup>  
Test area factor  $A = \alpha S_v$  48.76 m<sup>2</sup>  
Principal prescribed contour (S) 23.1374 m<sup>2</sup>  
Reference area (S<sub>0</sub>) 1.0000 m<sup>2</sup>

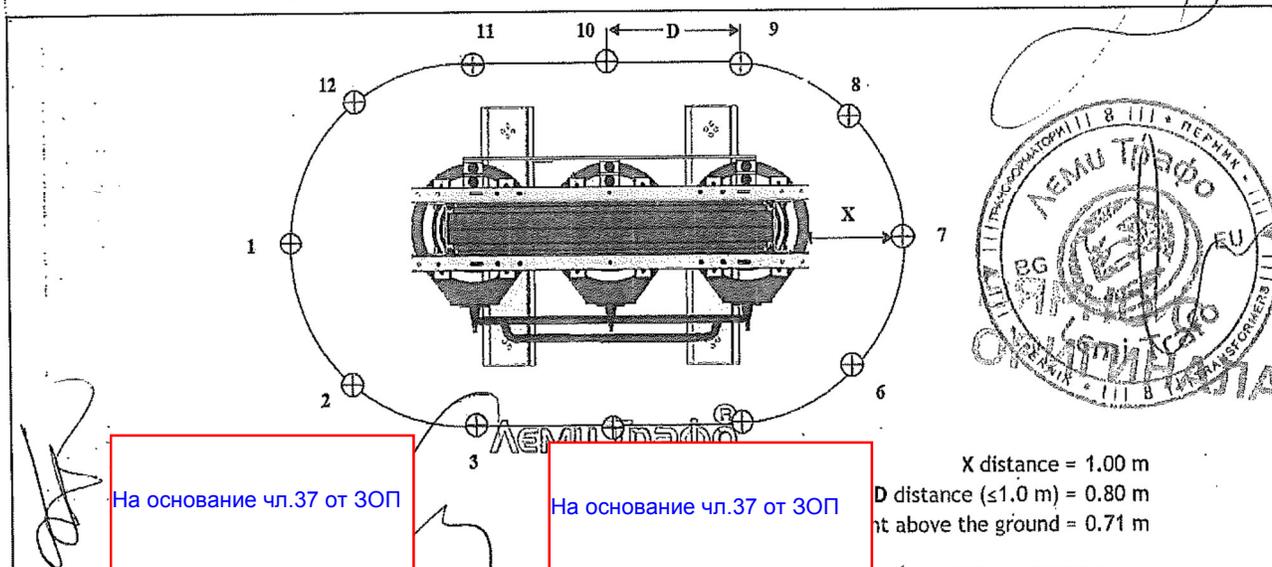
**ENVIRONMENTAL CORRECTION (K)**

$$K = 10 \lg \left[ 1 + \frac{4}{A/S} \right] \quad K = \boxed{4.6210792}$$

$$\overline{L}_{pA} = 10 \lg \left( 10^{0.1 \overline{L}_{pA0}} - 10^{0.1 \overline{L}_{B0}} \right) - K$$

$$L_{WA} = \overline{L}_{pA} + 10 \lg \frac{S}{S_0}$$

Corrected average sound pressure level: L<sub>pA</sub> **40.73 dB**  
Sound Power Level L<sub>WA</sub> **54.37 dB**



На основание чл.37 от ЗОП

На основание чл.37 от ЗОП

X distance = 1.00 m  
D distance (≤1.0 m) = 0.80 m  
h above the ground = 0.71 m

Tested by: *Oleg Cvetajnov*

Approved by: *Katerina Racheva*

Date: 17.6.2020





**DETAILS OF MEASURED CAST RESIN TRANSFORMER**

Rated Power: 400 kVA | Rated Voltage: 20/0,4 kV | Rated Frequency: 50 Hz | Serial No.:12784 | Manufacturer: TMC Trafo

**DETAILS OF USED MEASURING INSTRUMENTS**

- 12-ch Input Module LAN-XI, 25.6 kHz Pulse 18.1.1.9 type 3053-B-120 - Brüel & Kjær - Ser.No. 3053-106824;
- 1/2" free-field Microphones, 8 kHz to 12.5 kHz prepolarised, including preamplifier 2671 with TEDS - Brüel & Kjær Ser.No.No: 2952374; 2952375; 2952376; 2952377; 2952378 and 2952379.

**TEST CONDITIONS**

Supplied voltage: 400 V in the Acoustic Semi-Anechoic Chamber - APE 1528 - Ser.No. 2341A  
Selected test method: Sound preassure method of measurement in accordance with EN ISO 3746/2010

**A-WEIGHTED SOUND PRESSURE LEVEL - L<sub>PA</sub>**

Measuring position	dB			Measuring position	dB			Legend
	Source (1)	Backg. (2)	Corr. (3)		Source (1)	Backg. (2)	Corr. (3)	
1	47.12	33.15	47.12	9	47.48	33.15	47.48	(1) = Transformer noise (2) = Background noise (3) = Transformer corrected noise  Note: For calculation of uncorrected sound pressure level a simple arithmetical average is used
2	46.59	33.23	46.59	10	47.74	33.62	47.74	
3	47.44	33.46	47.44	11	46.88	32.98	46.88	
4	48.22	33.69	48.22	12	47.38	32.83	47.38	
5	47.56	32.47	47.56	13				
6	47.13	32.55	47.13	14				
7	46.89	33.03		15				
8	47.11	33.41		16				

Uncorrected average sound pressure level L<sub>PA0</sub>: 47.30 dB on 12 measure points

**TEST ROOM CORRECTION FACTOR**

Average acoustic absorption coefficient (α) 0.46  
 Total area of the test room surface (Sv) 106.000 m<sup>2</sup>  
 Test area factor A = αS<sub>v</sub> 48.76 m<sup>2</sup>  
 Principal prescribed contour (S) 23.3864 m<sup>2</sup>  
 Reference area (S<sub>0</sub>) 1.0000 m<sup>2</sup>

**ENVIRONMENTAL CORRECTION (K)**

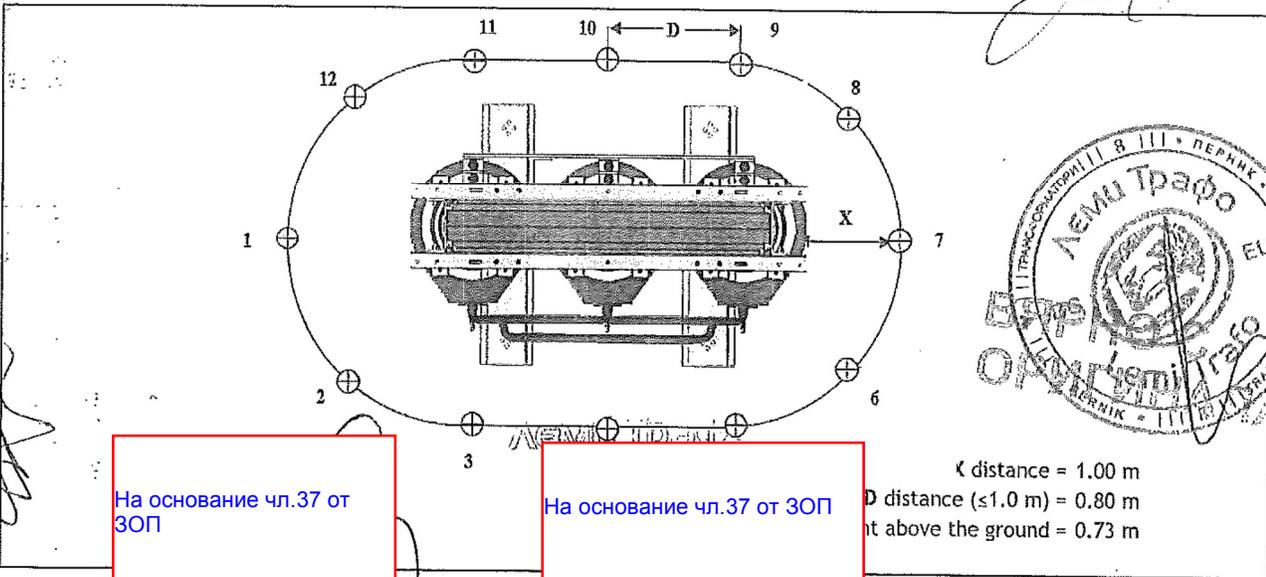
$$K = 10 \lg \left[ 1 + \frac{4}{A/S} \right] \quad K = 4.6515879$$

$$\overline{L}_{PA} = 10 \lg \left( 10^{0.1 \overline{L}_{PA0}} - 10^{0.1 \overline{L}_{BPA}} \right) - K$$

$$L_{WA} = \overline{L}_{PA} + 10 \lg \frac{S}{S_0}$$

Corrected average sound pressure level:  
 and Power Level

L<sub>PA</sub> 41.53 dB  
 L<sub>WA</sub> 55.22 dB



На основание чл.37 от ЗОП

На основание чл.37 от ЗОП

κ distance = 1.00 m  
 D distance (≤1.0 m) = 0.80 m  
 h above the ground = 0.73 m

Tested by: /Oleg Cvetanov/

Approved by: /Katerina Raicheva/

Date: 15.5.2019.



**ЛемИ Трафо**  
Трансформатори

# ТЕСТОВ ПРОТОКОЛ

сериен № **12892**

Трифазен сух трансформатор

Година **2019**

Характеристики		Надморско ниво <1000 m	
ОХЛАЖДАНЕ	AN	Мощност (kVA)	<b>630</b>
		Ток (A)	18.19
	AF	Мощност (kVA)	<b>630</b>
		Ток (A)	909.33
		Напрежение (V)	20000
		Комутация	±2x2.5%
		Свързване	Триъгълник
		Темп. клас	F
		Макс. Температура (K)	100
		Изолационен клас (kV)	24.0
		LI	125 AC 50 LI AC 3

РУТИННИ ТЕСТОВЕ						Надморско ниво <1000 m			Стандарти IEC 60076-11		
Съотношение:		20000 / 400 V		Температурен еталон:		120 °C			КПД (%) (20000 / 400 V)		
	Загуби на празен ход	Ток на празен ход	Загуби на късо съед.	Импеданс на напрежение	Общи загуби	Товар	cosφl = 0.9	cosφl = 1			
Гарантирани	990 W	0.4%	7100 W	6.00%	8090 W	630 kVA	98.66	98.79			
Толеранс (%)	+0%	30%	+0%	± 10.0%	+0%						
Измерени	888 W	0.23%	6838 W	6.13%	7726 W	473 kVA	98.90	99.01			
Отклонение (%)	-10.3%	-43.1%	-3.7%	2.2%	-4.5%						
Резултат	⊕	⊕	⊕	⊕	⊕	315 kVA	99.09	99.18			

ДИЕЛЕКТРИЧНА ЯКОСТ НА ИЗОЛАЦИЯТА					С повишено синусуидално напрежение			
Намотка	Тестово напрежение	Тестова честота	Продължителност	Резултат от теста	Намотка	Тестово напрежение	Продължителност	Резултат от теста
400 V	800 V	150 Hz	40 "	⊕ Позитивен	Първична	50.0 kV	60 "	⊕ Позитивен
					Вторична	3.0 kV		

ИЗМЕРВАНИЯ НА СЪПРОТИВЛЕНИЕ								Температура на околната среда	
Намотка	20000 V	Намотка	400 V	Намотка	400 V	Намотка	400 V	25 °C	
Фаза	Ω	Фаза	Ω	Фаза	Ω	Фаза	Ω		
1U-1V	6.1246306	1U-1V		2u-2v	0.0012486	2u-2v			
1U-1W	6.1408157	1U-1W		2u-2w	0.0012828	2u-2w			
1V-1W	6.1358775	1V-1W		2v-2w	0.0012535	2v-2w			

ИЗМЕРВАНИЯ НА ЧАСТИЧЕН РАЗРЯД							
Un	Пренатоварване	Измерено	Фаза U	Фаза V	Фаза W	Получено ниво	Резултат от теста
20000 V	36000 V за 30 "	26000 V за 3'	3.0 pC	4.0 pC	4.0 pC	< 10 pC	⊕ Позитивен

**КОЕФИЦИЕНТ НА ТРАНСФОРМАЦИЯ**  
(Толеранс: ±0.5% на главното стъпало ±1% на другите стъпала)

Съотношение 20000 / 400 V			Съотношение			Съотношение			Съотношение		
Ком. стъпка	2.50%		Ком. стъпка			Ком. стъпка			Ком. стъпка		
Позиция	Измерено	Резулт.	Позиция	Измерено	Резулт.	Позиция	Измерено	Резулт.	Позиция	Измерено	Резултат
5.00%	90.96	⊕									
2.50%	88.81	⊕									
0	86.67	⊕									
-2.50%	84.53	⊕									
-5.00%	82.39	⊕									

ОИМ1		RAP1		Lemi Trafco		Исползвани уреди		MAG1		WBPA1		DMS1	
						TV1	TV2	TV3					

Подпис за приемане: На основание чл.37 от ЗОП **СТОИЧИВ КЛАС: E2 - C2 - F1** Дата: **16.08.19**

ЛЕМИ ТРАФО ЕАД - Производител  
303 Перник, България  
"Благодийовъе стание" 1  
Тел.: +359 76 671 686; +359 76 671 687  
e-mail: lemi-trafo.com; laborator@lemi-trafo.com  
http://www.lemi-trafo.com

Клиент:   
Исползвани уреди:   
Телефон: +359 887 764 127





Lemi Trafo  
Transformers

# SOUND LEVEL MEASUREMENT

According to EN/IEC 60076-10/2005, Standard

TEST REPORT No. 000032

## DETAILS OF MEASURED CAST RESIN TRANSFORMER

Rated Power: 630 kVA | Rated Voltage: 20/0.4 kV | Rated Frequency: 50 Hz | Serial No.: 12892 | Manufacturer: TMC Trafo

## DETAILS OF USED MEASURING INSTRUMENTS

- 12-ch Input Module LAN-XI, 25.6 kHz Pulse 18:1.1.9 type 3053-B-120 - Brüel & Kjær - Ser.No. 3053-106824;
- 1/2" free-field Microphones, 8 kHz to 12.5 kHz prepolarised, including preamplifier 2671 with TEDS - Brüel & Kjær - Ser.No. 2952374; 2952375; 2952376; 2952377; 2952378 and 2952379.

## TEST CONDITIONS

Supplied voltage: 400 V in the Acoustic Semi-Anechoic Chamber - APE 1528 - Ser.No. 2341A  
Selected test method: Sound pressure method of measurement in accordance with EN ISO 3746/2010

### A-WEIGHTED SOUND PRESSURE LEVEL - L<sub>pA</sub>

Measuring position	dB			Measuring position	dB			Legend
	Source (1)	Backg. (2)	Corr. (3)		Source (1)	Backg. (2)	Corr. (3)	
1	48.46	32.35	48.46	9	47.04	32.84	47.04	(1) = Transformer noise (2) = Background noise (3) = Transformer corrected noise  Note: For calculation of uncorrected sound pressure level a simple arithmetical average is used
2	48.12	32.43	48.12	10	46.81	32.93	46.81	
3	48.78	33.11	48.78	11	47.33	32.66	47.33	
4	49.05	32.78	49.05	12	46.87	32.41	46.87	
5	48.64	32.56	48.64	13				
6	48.32	32.39	48.32	14				
7	47.55	33.24		15				
8	47.19	33.06		16				

Uncorrected average sound pressure level L<sub>pA0</sub>: 47.85 dB on 12 measure points

### TEST ROOM CORRECTION FACTOR

Average acoustic absorption coefficient (α) 0.46  
 Total area of the test room surface (Sv) 106.000 m<sup>2</sup>  
 Test area factor A = αS<sub>v</sub> 48.76 m<sup>2</sup>  
 Principal prescribed contour (S) 24.7779 m<sup>2</sup>  
 Reference area (S<sub>0</sub>) 1.0000 m<sup>2</sup>

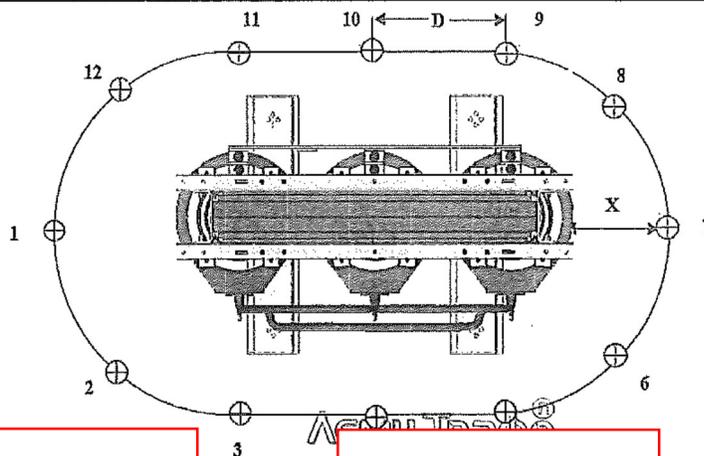
### ENVIRONMENTAL CORRECTION (K)

$$K = 10 \lg \left[ 1 + \frac{4}{A/S} \right] \quad K = 4.8182071$$

$$\overline{L}_{pA} = 10 \lg \left( 10^{0.1 \overline{L}_{pA0}} - 10^{0.1 \overline{L}_{pA0}} \right) - K$$

$$L_{WA} = \overline{L}_{pA} + 10 \lg \frac{S}{S_0}$$

Corrected average sound pressure level:  
 L<sub>pA</sub> 42.02 dB  
 L<sub>WA</sub> 55.96 dB



X distance = 1.00 m  
 distance (≤1.0 m) = 0.80 m  
 above the ground = 0.79 m

На основание чл.37 от ЗОП

На основание чл.37 от ЗОП

Tested by: /Oleg Cvetanov/

Approved by: /Katerina Raicheva/

Date: 15.8.2019



ИЗПЪЛНИТЕЛНА АГЕНЦИЯ  
БЪЛГАРСКА СЛУЖБА ЗА АКРЕДИТАЦИЯ

БСА рег. № 142 ОКС

От: 28.10.2020 г.

Валиден до: 28.10.2024 г.

# СЕРТИФИКАТ ЗА АКРЕДИТАЦИЯ

„ЛЕМИ ТРАФО“ ЕАД, гр. Перник

Орган за контрол от вид С „Трафо контрол“

Адрес на управление и на офис:

2304 гр. Перник, ул. „Владайско въстание“ № 1

ЕИК: 202845851

**Да извършва контрол на:**

Електрически уредби и съоръжения за напрежение до и над 1000V.

Електрически уредби и съоръжения за напрежение до 1000V.

Електрозащитни средства.

Силови кабелни линии с напрежение до 20kV.

Силови трансформатори за напрежение до 35 kV.

Трансформаторно масло.

**АКРЕДИТИРАН СЪГЛАСНО БДС EN ISO/IEC 17020:2012**

Заповед № А 619/28.10.2020 г. е неделима част от сертификата за акредитация, общо 4 страници.

Дата на първоначална акредитация:

30.04.2004 г.

Дата на преакредитация:

28.10.2020 г.

На основание чл.37 от ЗОП

Изпълн.  
Инж. И

1797 София, бул. „Д-р Г.М. Димитров“ № 52А, ет. 7  
тел.: 02 976 6401, факс: 02 976 6415  
e-mail: office@nab-bas.bg  
http://www.nab-bas.bg

BG202003/4  
ВЯРНО С  
ОРИГИНАЛА



# РЕПУБЛИКА БЪЛГАРИЯ

Изпълнителна агенция  
Българска служба за акредитация  
Страна по Многостранното споразумение  
за взаимно признаване на ЕА в тази област



## ЗАПОВЕД

№ А 619

гр. София, 28.10.2020 г.

На основание чл. 10 ал. 1, т. 4, чл. 28 ал. 1 от Закона за националната акредитацията на органи за оценяване на съответствието и съответната т. 6 от Процедура за акредитация BAS QR 2 във връзка с открита процедура с рег. № 44/142 ОКС/ПА/24.04.2020 г., доклад № 44/142 ОКС/ПА/6/В/13.08.2020 г., становище на Комисия по акредитация № 44/142 ОКС/ПА/7/В/19.10.2020 г.

## ПРЕАКРЕДИТИРАМ

Орган за контрол от вид С „Трафо контрол“  
при „ЛЕМИ ТРАФО“ ЕАД, гр. Перник

Адрес на управление и на офис: гр. Перник, ул. „Владайско въстание“ № 1

Да извършва контрол на:

Тип обхват: гъвкав*					
№ по ред	Област на контрол	Вид на контрола	Контролиран параметър/характеристика	Методи за изпитване/измерване, използвани при контрол	Нормативни/актове, стандарти, спецификации, схеми
1	2	3	4	5	6
1.	Електрически уредби и съоръжения за напрежение до 1000V	На нови и/или в експлоатация обекти и съоръжения	Импеданс на контура „фаза-защитен проводник“	ПК 02.00	Наредба № 3, ДВ бр. 90 и 91/2004г.; Наредба № 16-116, ДВ бр. 26/2008г.; ТС;
2.	Електрически уредби и съоръжения за напрежение до и над 1000V	На нови и/или в експлоатация обекти и съоръжения	Съпротивление на изолация	НИЕМС, 1995; ПК 01.00	Наредба № 3, ДВ бр. 90 и 91/2004г.; Наредба № 16-116, ДВ бр. 26/2008г.; ТС;
			Съпротивление на защитни заземителни уредби-преходно съпротивление на заземители	ПК 01.00	Наредба № 3, ДВ бр. 90 и 91/2004г.; Наредба № 16-116, ДВ бр. 26/2008г.; ТС;
			Съпротивление на мълниева защитни	ПК 01.00	Наредба № 4, ДВ бр. 6/2011г.; Наредба № 3, ДВ

гр. София 1797, бул. "Г.М.Димитров" №52 А, ет.7  
Тел: +359 9766 401; Факс: (+3592) 9766 415  
e-mail: office@nab-bas.bg

ОРИГИНАЛ

			заземителни уредби – импулсно съпротивление		бр. 90 и 91/2004г.; Наредба № 16-116, ДВ бр. 26/2008г.; ТС;
3.	Електрозащитни средства:				
	Изолиращи щанги Измервателни щанги Изолиращи клещи Диелектрични килимчета и пътеки	Продукти в процес на експлоатация	Електрическа якост на изолацията чрез контрол с променливо напрежение, 50Hz	Наредба № 22, ДВ бр. 45/2006г. ПК 04.00	Наредба № 22, ДВ бр. 45/2006г., ТС;
	Диелектрични ръкавици Диелектрични боти и галоши		Електрическа якост на изолацията чрез контрол с променливо напрежение, 50Hz Ток на утечка	Наредба № 22, ДВ бр. 45/2006г. ПК 04.00	Наредба № 22, ДВ бр. 45/2006г., ТС;
	Указатели за напрежение		Електрическа якост на изолацията чрез контрол с променливо напрежение, 50Hz Праг на напрежение	Наредба № 22, ДВ бр. 45/2006г. ПК 04.00	Наредба № 22, ДВ бр. 45/2006г., ТС;
4.	Силови кабелни линии с напрежение до 20kV	На нови и/или в експлоатация обекти и съоръжения	Електрическа якост на изолацията чрез контрол с повишено постоянно напрежение	БДС 2406 НИЕМС,1995; ПК 05.00	НИЕМС,1995; Наредба № 16-116/ДВ бр. 26/2008г.; ТС;
			Съпротивление на изолация	НИЕМС,1995; БДС 1986 т.3.3 а), б), д) и е) ПК 05.00	Наредба № 3,ДВ бр. 90 и 91/2004г.; ТС;
			Съпротивление на изолация на намотките и отношение	БДС 16654 ПК 06.00	НИЕМС,1995; ТС;
			Коефициент на трансформация	БДС 15320 ПК 06.00	Наредба № 3,ДВ бр. 90 и 91/2004г.; Наредба № 16-116, ДВ бр. 26/2008г.; ТС;
			Напрежение и загуби на късо съединение	БДС 15320 ПК 06.00	БДС EN 50588-1; ТС;
			Електрическа якост на изолацията чрез контрол с	БДС 16249 ПК 06.00	НИЕМС,1995; Наредба № 16-116, ДВ бр. 26/2008г.; ТС;

ОРИГИНАЛ

5.	Силови трансформатори за напрежение до 35 kV	На нови и/или в експлоатация обекти и съоръжения	повишено напрежение с промишлена честота 50Hz		
			Електрическа якост на изолацията чрез контрол с индуктирано напрежение	БДС 16249 ПК 06.00	БДС 16249; ТС;
			Ток и загуби на празен ход	БДС 15320 ПК 06.00	БДС EN 50588-1; ТС;
			Активно съпротивление на намотките	БДС 15320 ПК 06.00	Наредба № 3, ДВ бр. 90 и 91/2004г.; Наредба № 16-116, ДВ бр. 26/2008г.; ТС;
			Група на свързване	БДС 15320 ПК 06.00	Наредба № 3, ДВ бр. 90 и 91/2004г.; Наредба № 16-116, ДВ бр. 26/2008г.; ТС;
6.	Трансформаторно масло	На нови и/или в експлоатация продукти	Пробивно напрежение	БДС EN 60156 ПК 09.00	Наредба № 16-116, ДВ бр. 26/2008г.; ТС;

\* Въвеждането на нова версия на стандарти/документи или стандарти/документи, които ги заменят е разрешено. Актуален списък на стандартите/документите с техните датирани версии се предоставя от ООС.

Наредба № 3 за устройство на електрическите уреди и електропроводните линии (ДВ бр. 90 и бр. 91 /2004 г.)

Наредба № 4 за мълниезащитата на сгради, външни съоръжения и открити пространства (ДВ бр. 45/2006 г.)

Наредба № 16-116 за техническа експлоатация на енергообзавеждането (ДВ бр. 26/2008 г.)

Наредба № 22 за изпитване на електрозащитни средства в експлоатация (ДВ бр. 45/2006г.)

НИЕМС - 1995 - Норми за изпитване на електрически машини и съоръжения

ТС - техническа спецификация

### НАРЕЖДАМ

Да се издаде Сертификат за акредитация с рег. № 280 ОКС от 28.10.2020 г. валиден до 28.10.2024 г. с приложение настоящата заповед, неделима част от него.

Сертификатът за акредитация с приложението да се получат от Управителя на „ЛЕМИ ТРАФО“ ЕАД, гр. Перник, Ръководителя на Орган за контрол от вид С „Трафо контрол“ при „ЛЕМИ ТРАФО“ ЕАД, гр. Перник или друго упълномощено лице в сградата на ИА БСА.

При получаване на издадения сертификат и приложение, акредитираното лице е длъжно да върне в ИА БСА оригиналите на сертификат за акредитация рег. № 142 ОКС/30.01.2019 г. и приложение - заповед на ИА БСА № А 39/30.01.2019г.

Настоящата заповед да се съобщи на юридическото лице/едноличния търговец в 3 (три)- дневен срок от издаването ѝ.

ИРЕ  
Изпълнение:  на основание чл.37 от ЗОП

БСА

ВЪРНО С  
ОРИГИНАЛА



## Декларация

**"ЛЕМИ-ТРАФО" ЕАД**, участник в процедура на договаряне с обявление за сключване на рамково споразумение с предмет **"Трифазни сухи разпределителни капсуловани трансформатори 10 и 20 kV "** реф. № PPD 20-037  
**"Трифазни сухи разпределителни капсуловани трансформатори 10 и 20 kV за склад „София“, склад „Враца“, склад „Левски“ и склад „Дупница“"**

### ДЕКЛАРИРА, че

При доставка трансформаторите, предмет на гореспомената процедура, ще бъдат придружени със съответните протоколи от акредитирана лаборатория, включващи измерване на загуби на празен ход, загуби на късо съединение и ниво на звукова мощност ( $L_{WA}$ ), както и всички необходими рутинни изпитания.

На основание чл.37 от ЗОП

Инж. Евгени Славенин  
Изпълнителен Директор

ЛЕМИ ТРАФО



**Лѐми Трафо**  
Трансформатори



Приложение №3 към Техническото предложение за 10П

**СРОКОВЕ ЗА ДОСТАВКА**

№	Наименование	Мярка	Количество със срок на доставка до 30 кал. дни
1	2	3	4
1	Трансф.сух 10/0,4kV,160kVA,без колела	бр.	1
2	Трансф.сух 10/0,4kV,250kVA,без колела	бр.	1
3	Трансф.сух 10/0,4kV,400kVA,без колела	бр.	1
4	Трансф.сух 10/0,4kV,630kVA,без колела	бр.	1
5	Трансф.сух 10/0,4kV,800kVA,без колела	бр.	1
6	Трансф.сух 20/0,4kV,160kVA,без колела	бр.	1
7	Трансф.сух 20/0,4kV,250kVA,без колела	бр.	1
8	Трансф.сух 20/0,4kV,400kVA,без колела	бр.	2
9	Трансф.сух 20/0,4kV,630kVA,без колела	бр.	1
10	Трансф.сух 20/0,4kV,800kVA,без колела	бр.	2
11	Колела за трансф.сух 10(20)/0,4kV-4бр.	бр.	В зависимост от сроковете на доставка на силовия трансформатор

**Забележки:**

- 1/ Срокът на доставките започва да тече от датата на изпращане на поръчката.
- 2/ В случай, че крайният срок на доставката съвпада с празничен или неработен ден, то доставката се извършва не по-късно от първия работен ден след изтичането на срока.
- 3/ При поръчки на Възложителя на количества в рамките на потвърдените от Изпълнителя и недоставени в посочените срокове, ще бъдат налагани неустойки, съгласно условията на договора.
- 4/ Възложителят може да поръча количества по-малки от посочените в колона 4.
- 5/ Възложителят може да поръчва количества по-високи от посочените в колона 4, като това обстоятелство ще бъде посочено текстово в съответната поръчка изпратена към Изпълнителя. С потвърждението на поръчката, Изпълнителят вписва в същата очаквана дата за доставка на количествата надвишаващи посочените в колона 4.

На основание чл.37 от ЗОП

Дата 07.01.2021 г.

ПОДПИС И ПЕЧАТ:

Гр. Перник

(Евгени Славенин)

(Изпълнителен Директор)

**Лѐми Трафо**

гр. Перник, ул. „Владийско въстание“ 1 | Тел.: 076 670 620, 076 670 696 | Факс: 076 670 871 | GSM централа: 0887 764.127  
E-mail: info@lemi-trafo.com | Website: http://www.lemi-trafo.com



# ПРИЛОЖЕНИЕ №2

A handwritten signature in black ink, consisting of several loops and a long vertical stroke.A small handwritten mark or signature in black ink, resembling a stylized letter 'G' or a similar symbol.



**ЛЕМИ ТРАФО**  
Трансформатори



Материал на намотките - AI

Тип	Мощност	Напрежение	Група на свързване	ик, (%)	Р <sub>0</sub> - max	Рк - max	Ниво на звукова мощност, LWA	Дължина max (mm)	Ширина max (mm)	Височина на max (mm)	Междурелсие (mm)	Общо тегло (kg)
ТСWA 160/10/0.400	160kVA	10/0.4kV	Dyn5	6	360	2600	max 54dB	1170	600	1200	520	750
ТСFA 250/10/0.400	250kVA	10/0.4kV	Dyn5	6	468	3400	max 57dB	1290	685	1315	605	1090
ТСFA 400/10/0.400	400kVA	10/0.4kV	Dyn5	6	675	4500	max 60dB	1335	870	1440	760	1340
ТСFA 630/10/0.400	630kVA	10/0.4kV	Dyn5	6	990	7100	max 62dB	1395	870	1600	760	1700
ТСFA 800/10/0.400	800kVA	10/0.4kV	Dyn5	6	1170	8000	max 64dB	1470	940	1700	760	2090

- 6бр. РТС сензори и 1бр. термо реле T119
- 4бр. халки за повдигане, разположени на горните греди
- Два заземителни болта M12x40
- 4бр. Транспортни колела
- 4бр. Антивибрационни подложки

На основание чл.37 от ЗОП

ПОДПИС И ПЕЧАТ

авенин  
Директор

**ЛЕМИ ТРАФО**

гр. Перник, ул. „Владайско въстание“ 1 | Тел.: 076 670 620, 076 670 696 | Факс: 076 670 871 | GSM централа: 0887 764-127  
E-mail: info@lemi-trafo.com | Website: http://www.lemi-trafo.com



**ЛемИ Трафо**  
Трансформатори



**Материал на намотките - Al**

Тип	Мощност	Напрежение	Група на свързване	u <sub>k</sub> , (%)	Р <sub>0</sub> - max	Р <sub>k</sub> - max	Ниво на звукова мощност, LWA	Дължина max (mm)	Ширина max (mm)	Височина max (mm)	Междурелсие (mm)	Общо тегло (kg)
TCWA 160/20/0.400	160kVA	20/0.4kV	Dyn5	6	360	2600	max 54dB	1295	600	1290	520	980
TCFA 250/20/0.400	250kVA	20/0.4kV	Dyn5	6	468	3400	max 57dB	1295	685	1425	605	1120
TCFA 400/20/0.400	400kVA	20/0.4kV	Dyn5	6	675	4500	max 60dB	1425	870	1535	760	1480
TCFA 630/20/0.400	630kVA	20/0.4kV	Dyn5	6	990	7100	max 62dB	1470	870	1645	760	1890
TCFA 800/20/0.400	800kVA	20/0.4kV	Dyn5	6	1170	8000	max 64dB	1535	940	1745	760	2200

- 6бр. РТС сензори и 1бр. термо реле T119
- 4бр. халки за повдигане, разположени на горните греди
- Два заземителни болта M12x40
- 4бр. Транспортни колела
- 4бр. Антивибрационни подложки

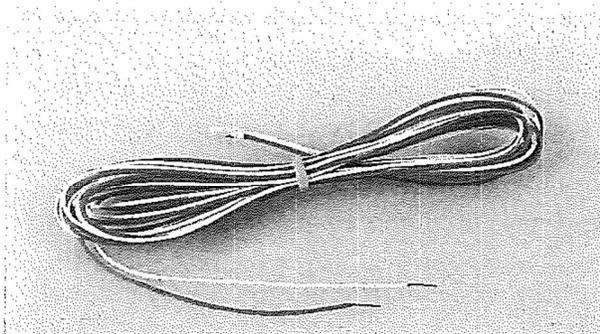
На основание чл.37 от ЗОП

ПОДПИС И ПЕЧАТ

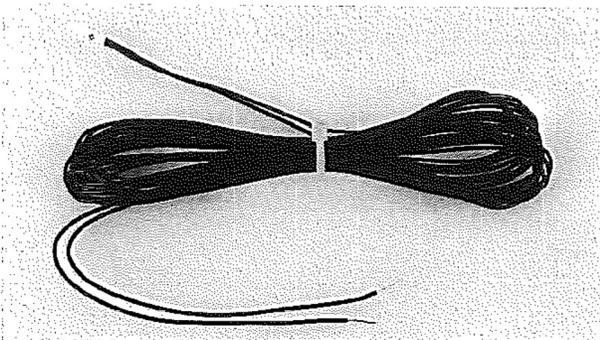
**ЛемИ Трафо**

гр. Перник, ул. „Владийско въстание“ 1 | **Тел.:** 076 670 620, 076 670 696 | **Факс:** 076 670 871 | **GSM център:** 0887 764 127  
**E-mail:** info@lemi-trafo.com | **Website:** http://www.lemi-trafo.com

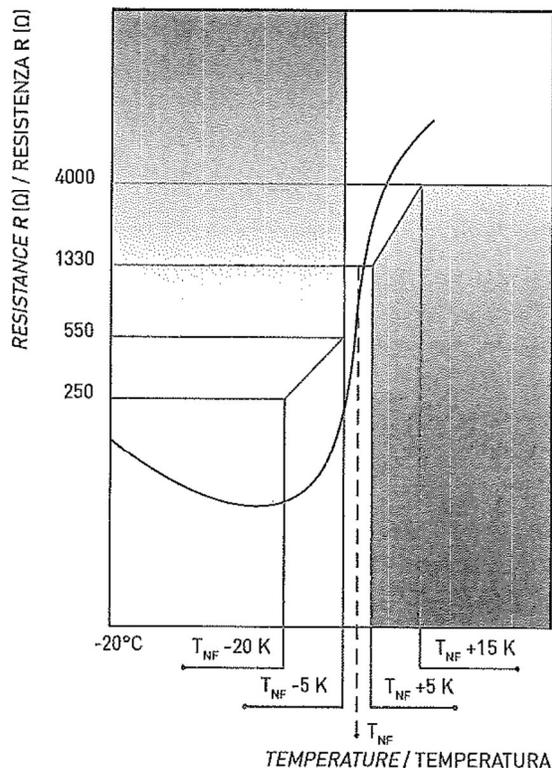
**PTC TEMPERATURE SENSOR**  
**SENSORE TERMOMETRICO PTC**



**PTC 140**



**PTC 150**

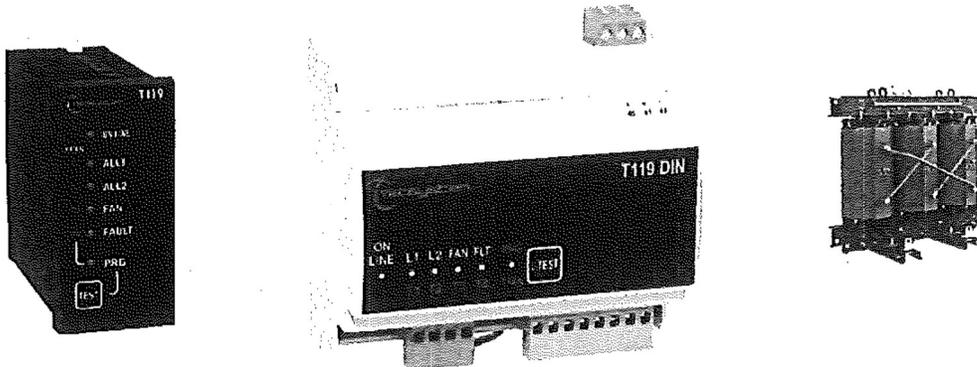


- Designed to control the temperature of the windings of transformers and motors
- In accordance with DIN 44081 and 44082 rules
- Response temperature: from 60°C to 190°C
- Fast response type
- Cable in PTFE (std 3 m) further lengths on request
- Ø of the sensor: 3 mm
- Lead cross-section: 0,14 mm<sup>2</sup>

- Progettate per il controllo della temperatura degli avvolgimenti di trasformatori e motori
- In conformità alle normative DIN 44081 e 44082
- Temperature di intervento: da 60°C a 190°C
- Tipo ad alta sensibilità
- Cavo in PTFE (std 3 m) altre misure a richiesta
- Ø del sensore: 3 mm
- Sezione del cavo: 0,14 mm<sup>2</sup>

**CABLES COLOUR CODING / CODICE COLORI DEI CAVI**

60	70	80	90	100	105	110	115	120	125	130
WHITE BIANCO	WHITE BIANCO	WHITE BIANCO	GREEN VERDE	RED ROSSO	BLUE BLU	BROWN MARRONE	BLUE BLU	GRAY GRIGIO	RED ROSSO	BLUE BLU
GRAY GRIGIO	BROWN MARRONE	WHITE BIANCO	GREEN VERDE	RED ROSSO	GRAY GRIGIO	BROWN MARRONE	GREEN VERDE	GRAY GRIGIO	GREEN VERDE	BLUE BLU
135	140	145	150	155	160	165	170	180	190	
RED ROSSO	WHITE BIANCO	WHITE BIANCO	BLACK NERO	BLUE BLU	BLUE BLU	BLUE BLU	WHITE BIANCO	WHITE BIANCO	BLACK NERO	
BROWN MARRONE	BLUE BLU	BLACK NERO	BLACK NERO	BLACK NERO	RED ROSSO	BROWN MARRONE	GREEN VERDE	RED ROSSO	BROWN MARRONE	



La T119 è una centralina per il controllo della temperatura di trasformatori MT a secco e incapsulati in resina.

L'utilizzo di sensori di temperatura Ptc, conformi alle norme DIN 44081 e 44082, la rendono particolarmente semplice ed economica. La gestione dell'apparecchio affidata ad un microcontrollore permette di mantenere alto il livello di affidabilità.

I 3 ingressi dei sensori Ptc fanno riferimento alle soglie di allarme (ALL1), sgancio (ALL2) e ventilazione forzata (FAN). Su ogni ingresso possono essere collegate da 1 a 9 Ptc in serie. Eventuali anomalie dei sensori o della centralina vengono segnalate come allarme di FAULT.

Tutte le nostre centraline possono inoltre essere fornite tropicalizzate, ovvero resistenti a situazioni climatiche difficili, in particolare caratterizzate da temperatura e tasso di umidità elevati (quali si trovano, appunto, nei climi tropicali).

**ALIMENTAZIONE UNIVERSALE:** da 24 a 240 Vca-cc.

(tabella sensori PTC a pag. 55).

*The T119 is a unit developed to control the temperature of MV cast resin and dry type transformers.*

*The use of Ptc temperature sensors according to DIN 44081 and 44082 makes it particularly simple and economical. Entrusted the management unit to a microcontroller allows to maintain a high level of reliability.*

*The 3 Ptc sensor inputs refer to the alarm thresholds (ALL1), trip (ALL2) and ventilation (FAN). Each input can be connected by 1 up to 9 Ptc's in series.*

*Any sensor or unit anomalies are reported as FAULT alarm.*

*All our units can also be supplied with a special coating on the electronic cards, resistant to difficult weather conditions, particularly characterized by high temperature and humidity (which are in tropical climates).*

**UNIVERSAL POWER SUPPLY:** with input from 24 to 240 Vac-dc.

(PTC sensor table on page 55).

## Altre versioni | Other Versions

T119DIN in contenitore per guida DIN EN 50022

T119DIN with box DIN EN 50022

## Specifiche Tecniche

### Alimentazione

- Valori nominali: 24-240 Vca-cc
- Vcc con polarità invertibili

### Ingressi

- 3 gruppi in serie di ingressi Ptc:
  - 1 serie per ALL1
  - 1 serie per ALL2
  - 1 serie per FAN
- Collegamenti su morsettiere estraibili
- Canali ingresso protetti contro i disturbi elettromagnetici

### Uscite

- 2 relè di allarme (ALL1/FAULT-ALL2)
- 1 relè di gestione ventilazione (FAN) con autoritenuta temporizzata (5-10-20-40 min.) delay OFF
- Relè di uscita con contatti da 5A-250 Vca  $\cos\phi=1$

### Test e prestazioni

- Costruzione in accordo alle normative CE
- Protezione contro disturbi elettromagnetici CEI-EN61000-4-4
- Rigidità dielettrica: 1500 Vca per 1 minuto tra relè di uscita e sonde, relè e alimentazione, alimentazione e sonde
- Temperatura di lavoro: da -20°C a +60°C
- Umidità ammessa: 90% senza condensa
- Contenitore in PPO autoestinguente UL 94V0
- Opzione: tropicalizzazione
- Pellicola frontale policarbonato IP50
- Assorbimento: 2VA
- Memoria dati: 10 anni minimo
- Circuito di autodiagnosi

### Visualizzazione e gestione dati

- Led indicanti allarme, sgancio e fan
- Led indicante il FAULT
- 2 soglie di allarme
- 1 soglia controllo ventilazione ON
- Accesso alla programmazione tramite pulsante frontale

### Dimensioni T119

- 48 x 96 mm DIN IEC 61554 (ex. DIN 43700) prof. 150 mm (compreso morsettieria)
- Foro pannello 44 x 92 mm

### Dimensioni T119 DIN

- 106 x 95 mm DIN 50022 prof. 62 mm
- Contenitore in Blend PC/ABS

## Technical Specifications

### Power Supply

- Rated voltage: 24-240 Vac-dc
- Vdc with reversible polarities

### Inputs

- 3 series of Ptc inputs:
  - 1 serie for ALL1
  - 1 serie for ALL2
  - 1 serie for FAN
- Removable rear terminals
- Input channels protected against electromagnetic noises and spikes

### Outputs

- 2 alarm relays (ALL1/FAULT-ALL2)
- 1 alarm relay for fan control (FAN) with time delay OFF (5-10-20-40 min.)
- Output contacts capacity: 5A-250 Vac  $\cos\phi=1$

### Tests and performances

- Assembling in accordance with CE rules
- Protection against electromagnetic noises CEI-EN61000-4-4
- Dielectric strength: 1500 Vac for 1 minute from relays to sensors, relays to power supply, power supply to sensors
- Ambient operating temperature: -20°C to +60°C
- Humidity: 90% non-condensing
- PPO UL 94V0 self-extinguishing housing
- Option: tropicalization
- Polycarbonate frontal film IP50
- Burden: 2VA
- Data storage: 10 years minimum
- Self-diagnostic circuit

### Displaying and data management

- Led indicating alarm, trip, fan
- Led indicating FAULT
- 2 alarm thresholds
- 1 ON threshold for fan control
- Entering the programming by frontal push button

### Dimensions T119

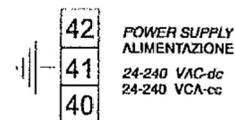
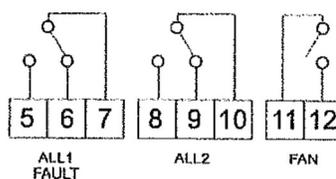
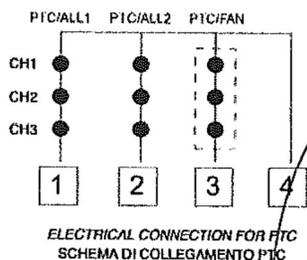
- 48 x 96 mm DIN IEC 61554 (ex. DIN 43700) depth 150 mm (terminals included)
- Panel cut-out 44 x 92 mm

### Dimensions T119 DIN (C-Shaped)

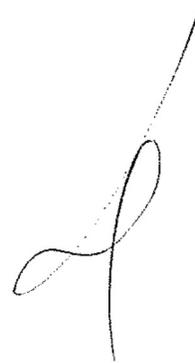
- 106 x 95 mm DIN 50022 depth 62 mm
- Box in Blend PC/ABS

SECTION 2

## Collegamenti elettrici | Electrical connections

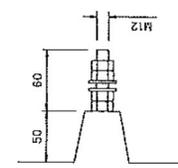
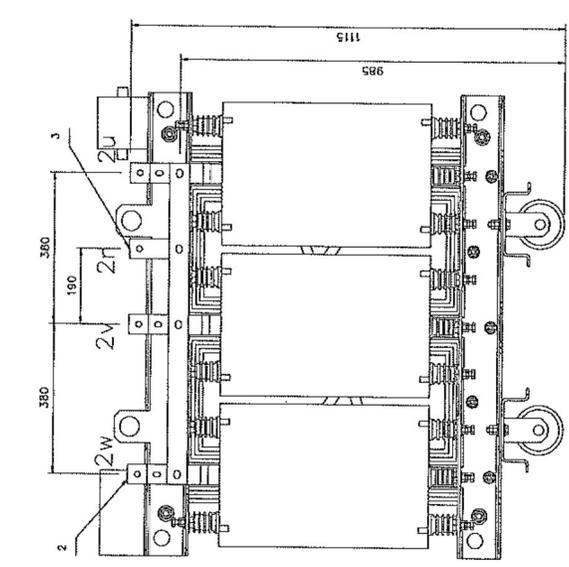
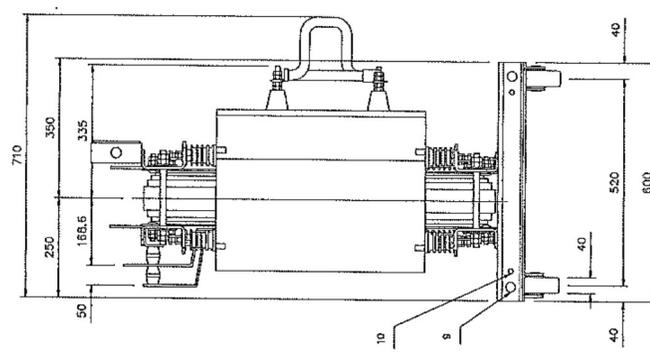
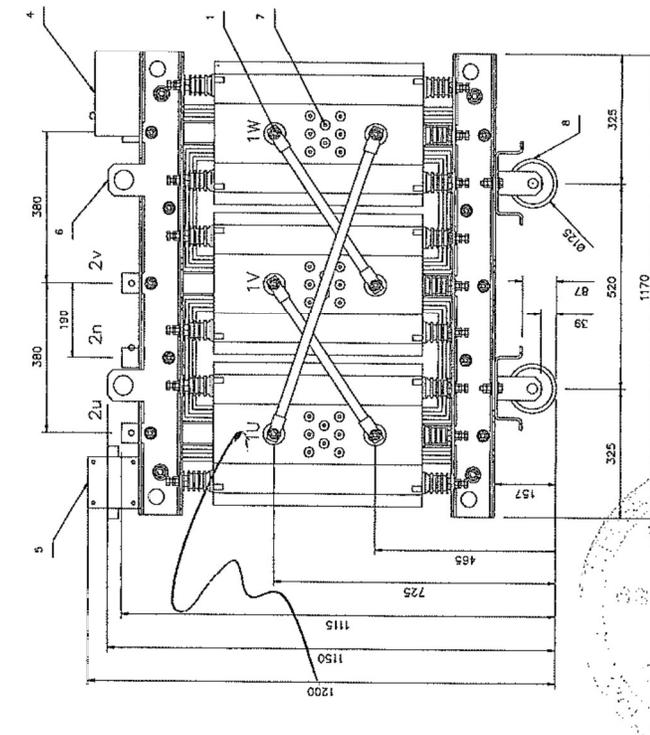


# ПРИЛОЖЕНИЕ №3

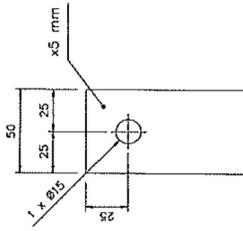
A handwritten signature in black ink, consisting of several loops and a final upward stroke.A small, simple handwritten mark, possibly a checkmark or a short stroke.A handwritten signature in black ink, featuring a large, sweeping initial letter followed by a few more strokes.A handwritten signature in black ink, characterized by a long, thin vertical stroke on the right side and a loop on the left.

1 2 3 4 5 6

*[Handwritten signature]*



Клемма ВН



Клемма НН

Общо тегло 750 kg

10	Завършителна клемма	4	бр.
9	Отбори за теглене	8	бр.
8	Кабел 125 x 40 - NY	4	бр.
7	Регулационни клемми	3	бр.
6	Халба за повдигане ø50	4	бр.
5	Клемна кутия IP55	1	бр.
4	Табела технически данни	1	бр.
3	Клемна НН - нуทรัลа	1	бр.
2	Клемна НН - фаза	3	бр.
1	Извод ВН	3	бр.
Паз	Номер на чертук	Кс	Изм. едичица
	Описание	Материал	

Номер на чертук	CEZ BG	Клиент	CEZ BG	Делук	Керамична	Референция	KVA 160 KV 10/0.4 АЛСАК
Transformer Assembly						Описание	Transformer Assembly
14/12/20	Дата	14/12/20	Дата	А.С.	Преобрено от	Формат	Машаб
14/12/20	Дата	14/12/20	Дата	А.С.	Преобрено от	А3	%
	Изм. едичица		Изм. едичица		Изм. едичица		ммг. kg

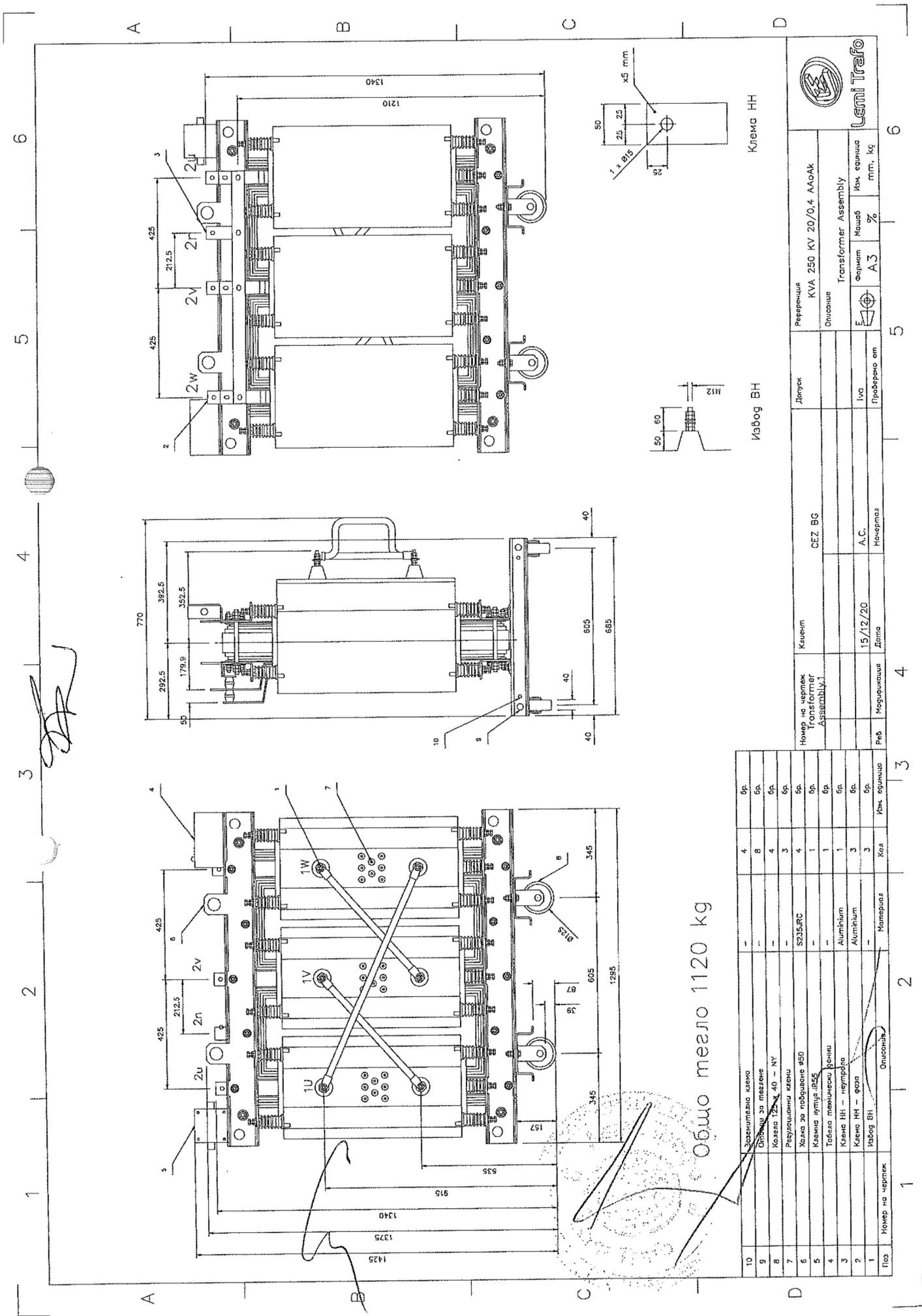


Трансформатори

1 2 3 4 5 6







Общо мезло 1120 kg

№	Номер на чертук	Описание	Материал	Кол	Изв. единица
10		Завършваща клемна		4	бр.
9		Описание за маздане		8	бр.
8		Колела 12x40 - NY		4	бр.
7		Регулационни клемни		3	бр.
6		Халка за повдигане 950	S235JRC	4	бр.
5		Клемна лента IP55		1	бр.
4		Табела полимеризиран полиетилен		1	бр.
3		Клемна HH - цвят	Aluminium	3	бр.
2		Клемна HH - цвят	Aluminium	3	бр.
1		Изв. бр. BH	Material	3	бр.

№	Номер на чертук	Описание	Клемна	CEZ BG	Датум	Репаратура
1		Transformer Assembly				KVA 250 KV 20/D/4 AAOAKK
2		Модификация	15/12/20	А.С.	Иво	Transformer Assembly
3		Материал	Дом	Настенна	Проверено от	Формат
4		Модификация	Дом	Настенна	Проверено от	Мощност
5		Материал	Дом	Настенна	Проверено от	Формат
6		Материал	Дом	Настенна	Проверено от	Мощност



Usmi Trafo













# ПРИЛОЖЕНИЕ №4



A handwritten signature or mark on the left side of the page, consisting of several loops and a vertical stroke.

A handwritten signature or mark on the right side of the page, featuring a large loop and a vertical stroke.

A handwritten signature or mark at the bottom center of the page, consisting of a few simple strokes.

Handwritten mark

**СУХ ТРАНСФОРМАТОР** **CE**

БЪЛГАРИЯ, ПЕРНИК, 2304 \* УЛ. ВЛАДАЙСКО ВЪСТАНИЕ №1  
 Тел.: 076 670 696 \* Факс: 076 670 871 \* WEB: www.lemi-trafo.com \* E-Mail: info@lemi-trafo.com

№ [REDACTED] ГОДИНА [REDACTED] МОЩНОСТ [REDACTED] kVA [REDACTED] ФАЗИ [REDACTED] Hz

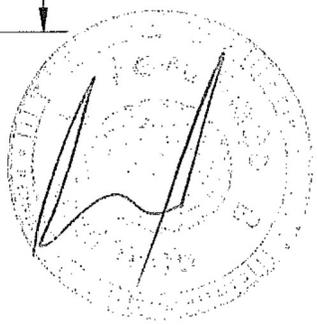
ОХЛАЖДАНЕ [REDACTED] ТЕМПЕРАТУРЕН КЛАС [REDACTED] ТЕМП. ПРЕГРЯВАНЕ [REDACTED] К

ИМПЕДАНС [REDACTED] % ГРУПА [REDACTED] КЛАС НА ИЗОЛАЦИЯ LI [REDACTED] AC [REDACTED] / LI [REDACTED] AC [REDACTED]

ВИСОКО НАПРЕЖЕНИЕ	[REDACTED] V	НИСКО НАПРЕЖЕНИЕ	[REDACTED] V	ТЕГЛО	[REDACTED] kg
[REDACTED]	[REDACTED] V	[REDACTED]	[REDACTED] A	IP 00	[REDACTED] kg
[REDACTED]	[REDACTED] V	[REDACTED]	[REDACTED]	IP	[REDACTED] kg
[REDACTED]	[REDACTED] V	[REDACTED]	[REDACTED]	VH	[REDACTED] kg
[REDACTED]	[REDACTED] V	[REDACTED]	[REDACTED]	HN	[REDACTED] kg
[REDACTED]	[REDACTED] V	[REDACTED]	[REDACTED]	класс поведение при пожар	[REDACTED]
[REDACTED]	[REDACTED] V	[REDACTED]	[REDACTED]	климатичен клас	[REDACTED]
[REDACTED]	[REDACTED] V	[REDACTED]	[REDACTED]	екологичен клас	[REDACTED] Po [REDACTED] Pk
[REDACTED]	[REDACTED] A	[REDACTED]	[REDACTED]		[REDACTED]

Handwritten mark

115mm



215mm

# ПРИЛОЖЕНИЕ №5



A handwritten signature or mark on the left side of the page, consisting of several loops and a vertical stroke.

A handwritten signature or mark on the right side of the page, featuring a long vertical stroke and a loop at the bottom.

A handwritten signature or mark at the bottom center of the page, consisting of a few simple, connected strokes.



## СПИСЪК НА ПРОВЕДЕНИТЕ ИЗПИТВАНИЯ

1. Трифазен сух трансформатор,  
тип ТС 160-10, фабричен №13502, година на производство = 2020.

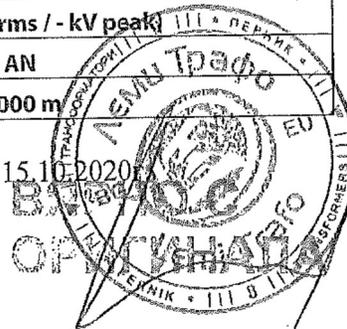
2. Заявител на изпитанието: “Леми Трафо” ЕАД; гр.Перник, ул. Владайско въстание №1,  
заявка № 0047/01.10.2020г.

3. Производител: “Леми Трафо” ЕАД; гр.Перник, ул. Владайско въстание №1.

4. Технически данни:

Обозначение	ТС160-10	
Номинална мощност (kVA)	160	
Честота (Hz)	50	
Номинално напрежение (V)	ВН	10000
	НН	400
Загуби на (W)	Празен ход	360
	Късо съединение към 120°C	2600
Група на свързване	Dyn5	
Регулационни отклонения на страна ВН	± 2 x 2.5%	
Изоляционен клас	ВН	12 kV (28 kV rms / 75 kV peak)
	НН	1.1kV (3kV rms / - kV peak)
Охлаждане	AN	
Надморска височина	<1000 m	

5. Дата на получаване на продукта за изпитване в лабораторията: 15.10.2020г.





6. Извършени изпитвания:

6.1. Рутинен тест:

- 6.1.1. Измерване на коефициента на трансформация и група на свързване (IEC 60076-1:2011-cl.11.3);
- 6.1.2. Измерване на активното съпротивление на намотките в постоянен ток (IEC 60076-1:2011-t.11.2);
- 6.1.3. Измерване на загубите и тока на празен ход (IEC 60076-1:2011-cl.11.5);
- 6.1.4. Измерване на загубите и напрежението на късо съединение (IEC 60076-1:2011-cl.11.4);
- 6.1.5. Диелектрични изпитвания (IEC 60076-3:2013)
  - 6.1.5.1. Изпитване на изолацията с напрежение, приложено от външен източник (IEC 60076-3:2013-t.10);
  - 6.1.5.2. Изпитване на изолацията с индуктирано напрежение (IEC 60076-3:2013-t.11.2);
- 6.1.6. Измерване на частични разряди - (IEC 60076-11: 2018)

6.2. Типов тест:

- 6.2.1. Изпитване на прегряване (IEC 60076-2:2000);
- 6.2.2. Изпитване на изолацията с мълниен импулс (IEC 60076-4:2002);

6.3. Специален тест:

- 6.3.1. Определяне на звуковото ниво (IEC 60076-10:2005);

7. Период на изпитване: 16 - 21.10.2020г.

8. Резултат от изпитванията: **Продуктът Трифазен сух трансформатор тип ТС 160-10, фабричен № 13502, премина успешно изпитанията.**

Резултати от изпитванията са включени в тестови протоколи: № 0055-1/16.10.2020;  
№ 0055-2/19.10.2020; № 0055-3/21.10.2020; № 0055-4/21.10.2020; № 0055-5/21.10.2020;

9. Списък от изпитванията съдържа 2 страници.

РЪКОВОДИТЕЛ НА „ЛТЦ-ТЕСТ”

На основание чл.37 от ЗОП

инж. Катерина Райчева  
(подпис и печат)



	<b>TEST LABORATORY "LTC - TEST"</b> <b>TO "LTC" Ltd.</b>	FC 5.10 – 1/7	
	<b>ROUTINE TEST REPORT</b>	Page 1	All pages 7
		Revision 0	

## TEST REPORT

№ 0055-1/16.10.2020

*Certificate of accreditation  
reg. №81/III valid until 28.12.2022  
issued by Executive Agency "BAS",  
according to the requirements of standard  
EN ISO/IEC 17025:2018*

1. Three phase cast resin transformer,  
TC 160-10; Dyn5, №13502, 2020

2. Customer : LEMI TRAFО JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;  
order 0047/01.10.2020

3. Manufacturer: LEMI TRAFО JSC; 2304 Pernik, BULGARIA ;1 Vladaisko vastanie Street;

4. Test methods used : IEC 60076-11:2018;  
IEC 60076-3:2013;

5. Date on which the product was received in test room: 15.10.2020

6. Tests performed:

6.1. Measurement of voltage ratio and check of phase displacement  
(IEC 60076-1:2011- cl.11.3);

6.2. Measurement of winding resistance (IEC 60076-1:2011-cl.11.2);

6.3. Measurement of no-load losses and current (IEC 60076-1:2011-cl.11.5);

6.4. Measurement of short circuit impedance and load losses  
(IEC 60076-1:2011-cl.11.4);

6.5 Dielectric routine tests (IEC 60076-3:2013):

6.5.1. Separate source AC withstand voltage test (IEC 60076-3:2013-cl.11.2);

6.5.2. Induced AC withstand voltage test (IEC 60076-3:2013-cl.11.2);

7. Test date: 16.10.2020

8. Test result: The product passed the tests

9. The report contains: 7 pages

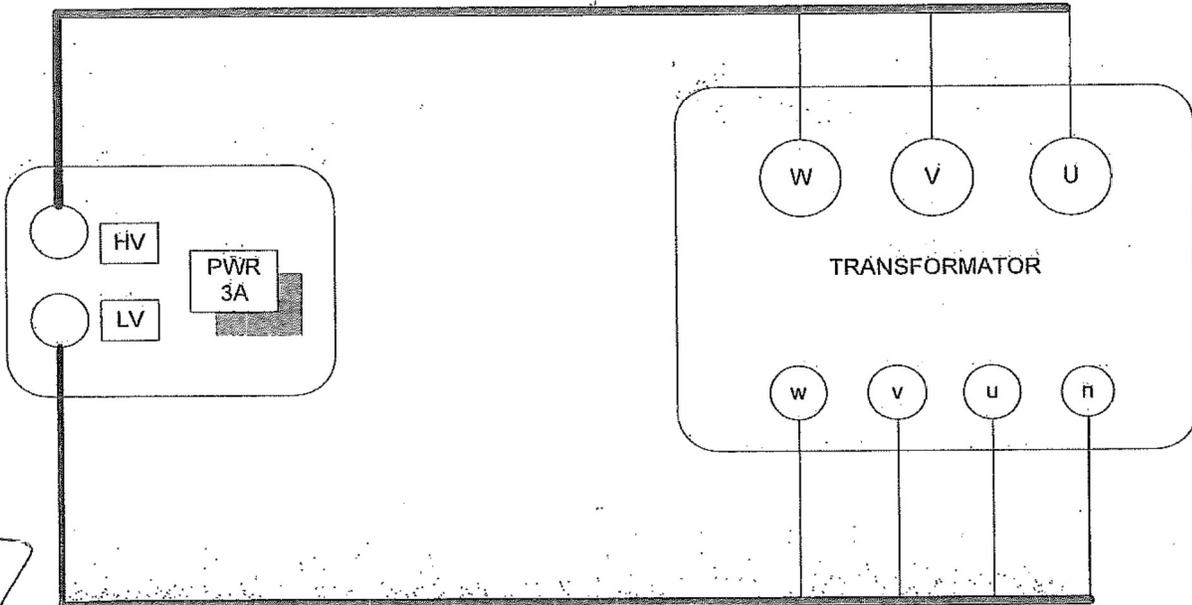


Head of "LTC-TEST":

Eng. Katerina Raicheva  
(signature and stamp)

**10. Test results:**

**10.1. Measurement of voltage ratio (10000/400V) and check of phase displacement:**

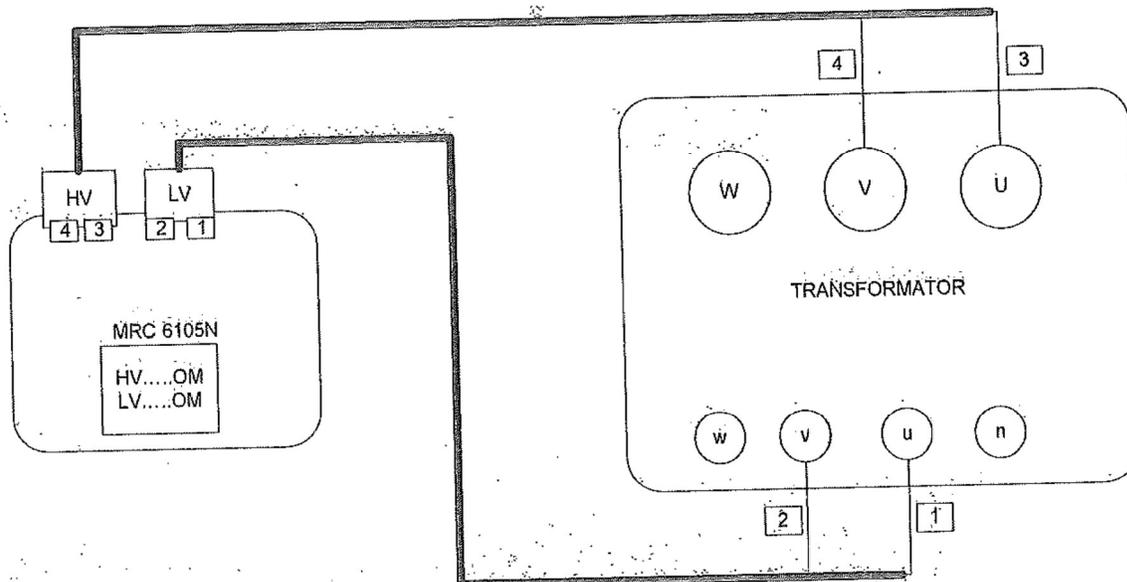


Tap changer position	Phase A	Transformation coefficient's error, %	Phase B	Transformation coefficient's error, %	Phase C	Transformation coefficient's error, %	Vector group
7 - 6	45,484	0,04	45,484	0,04	45,486	0,04	Dyn5
5 - 7	44,401	0,04	44,402	0,04	44,403	0,04	
4 - 7	43,322	0,05	43,323	0,05	43,324	0,05	
8 - 5	42,237	0,04	42,238	0,05	42,239	0,05	
8 - 4	41,151	0,04	41,151	0,04	41,153	0,04	

*Measurements were performed with expanded uncertainty of 3% and the confidence level P = 95%.*



**10.2 Measurement of winding resistance:**



Tap changer position	$R_{U-V}, \Omega$	$R_{U-W}, \Omega$	$R_{V-W}, \Omega$	Temperature during test 20°C	
				$R_{U-V}, \Omega$	
7 - 6	-	-	-	$R_{U-V}, \Omega$	0,0073795
5 - 7	-	-	-	$R_{U-W}, \Omega$	0,0074191
4 - 7	8,4576	8,4523	8,4474	$R_{V-W}, \Omega$	0,0073738
8 - 5	-	-	-		
8 - 4	-	-	-		

Measurements were performed with expanded uncertainty 0,5% and the confidence level  $P = 95\%$ .

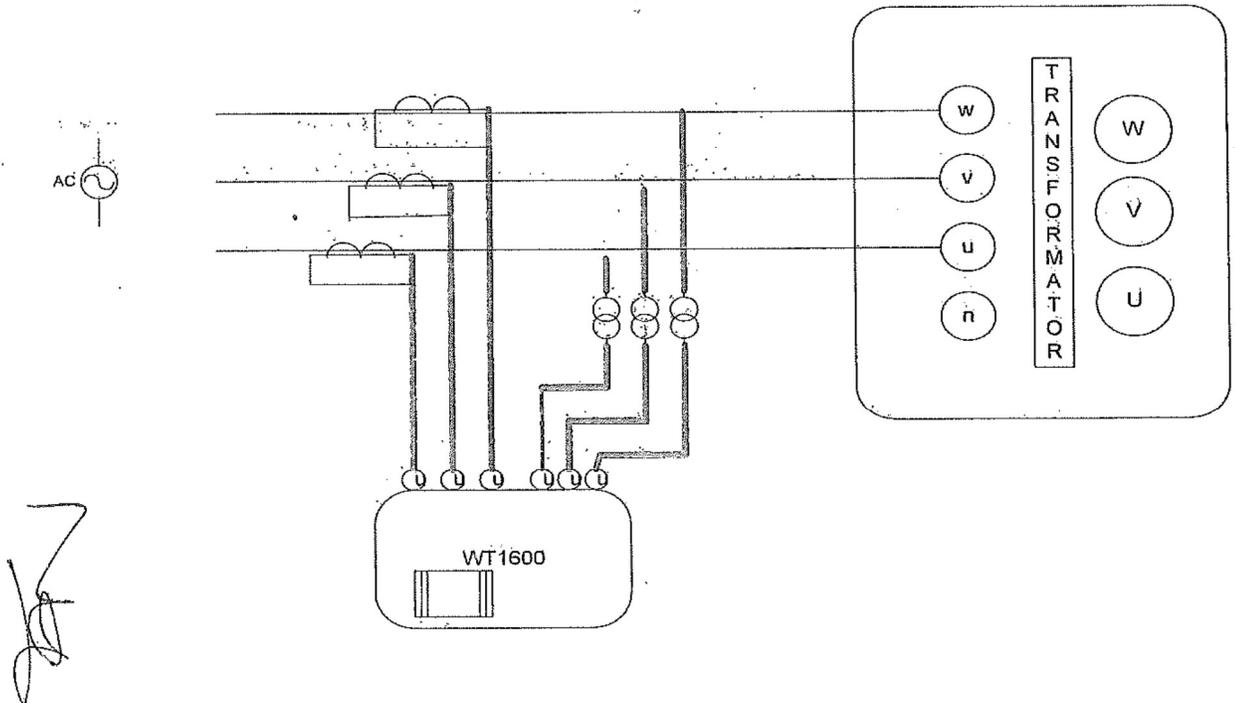
**10.3 Measurement of no-load losses and current:**

Tap changer position	U1 [V]	U2 [V]	U3 [V]	I1 [A]	I2 [A]	I3 [A]	P1 [W]	P2 [W]	P3 [W]
4 - 7	398,7	400,43	400,6	0,884	0,65	0,931	152,5	86,2	105,4

U <sub>av.</sub> [V]	I <sub>av.</sub> [A]	P <sub>tot.</sub> [W]	I <sub>0</sub> [%]
399,91	0,8217	344,1	0,356

Measurements were performed with expanded uncertainty: 2% for voltage, 2,5% for current, 3% for power and the confidence level  $P = 95\%$ .





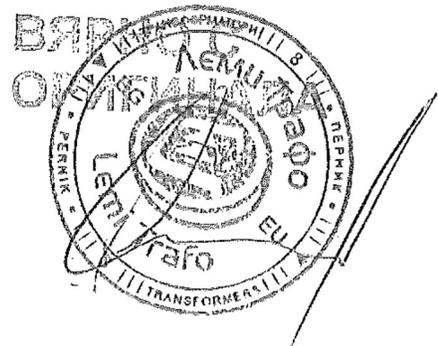
**10.4 Measurement of short circuit impedance and load losses at temperature 20 °C:**

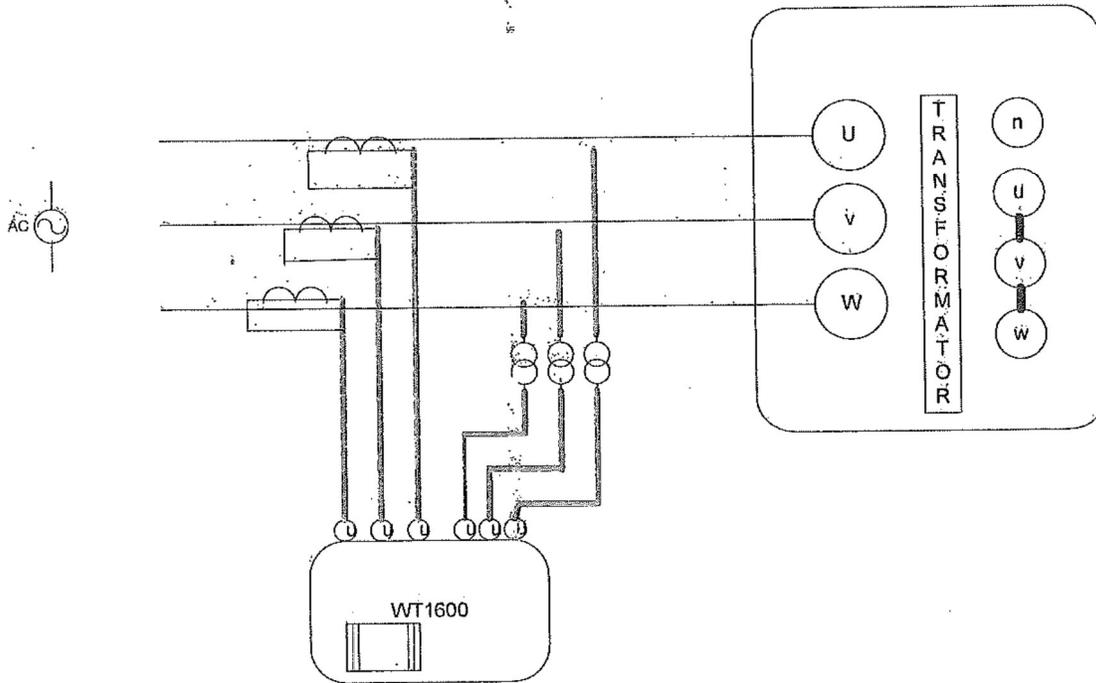
Tap changer position	U1 [V]	U2 [V]	U3 [V]	I1 [A]	I2 [A]	I3 [A]	P1 [W]	P2 [W]	P3 [W]
4 - 7	585,4	587,2	588,2	9,205	9,222	9,246	581,2	576,2	595,3

Uav. [V]	Iav. [A]	ΣP [W]	PK <sup>120°C</sup> [W]	Uk <sup>120°C</sup> [%]
586,92	9,224	1753	2416	5,97

Measurements were performed with expanded uncertainty: 2% for voltage, 2,5% for current, 3% for power and the confidence level P = 95%.

*[Handwritten signature]*





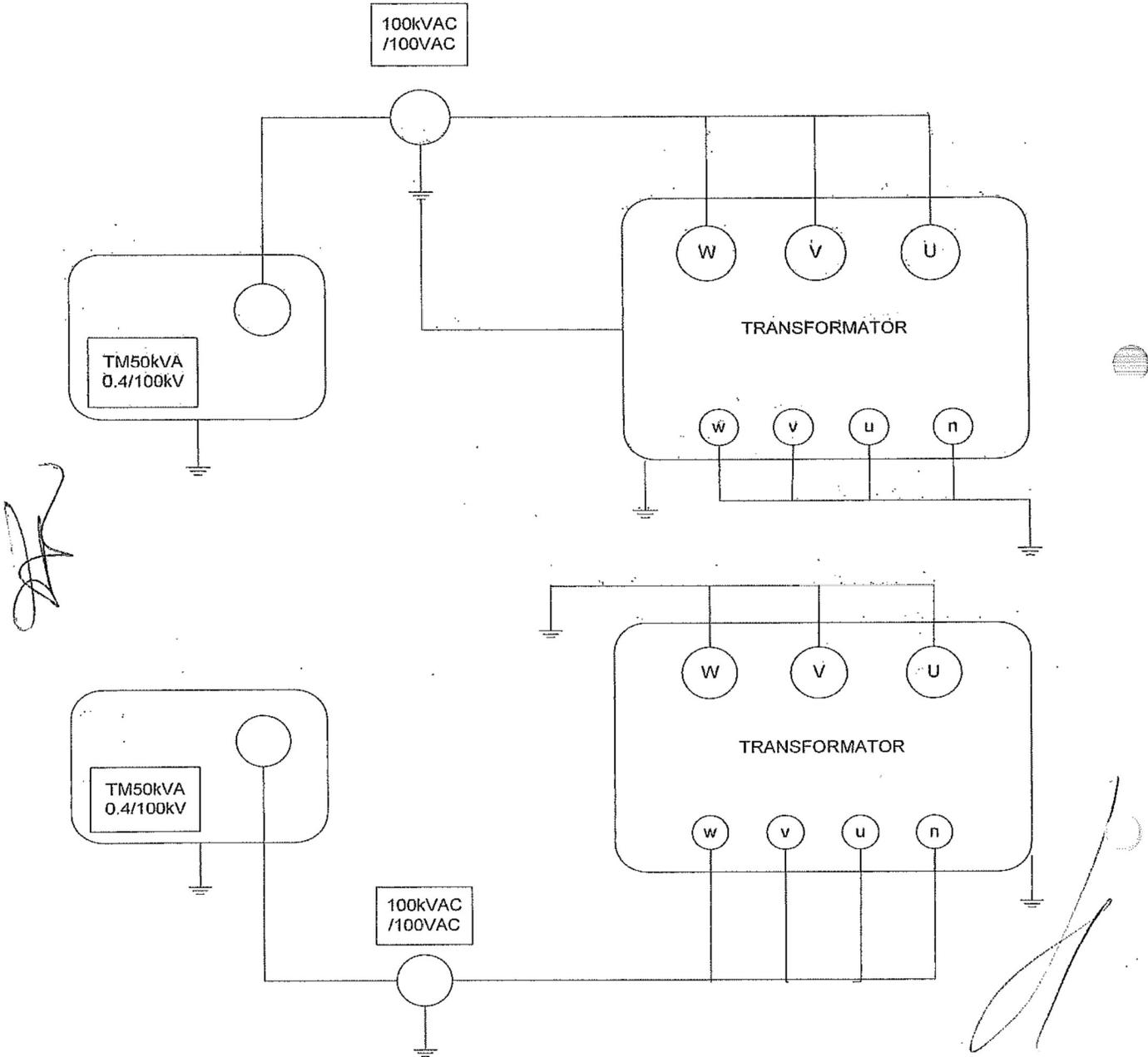
**10.5 Dielectric routine tests :**

**10.5.1 Separate source AC withstand voltage test:**

Winding	Earthing	Test voltage, [kV]	Frequency, [Hz]	Test time, [s]
High voltage	LV+tank	28	50	60
Low voltage	HV+tank	3	50	60

Measurements were performed with expanded uncertainty: 3,6% for voltage and the confidence level P = 95%.

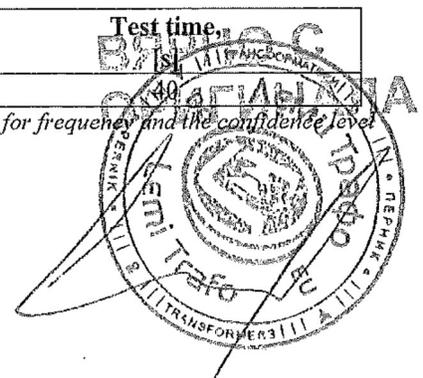


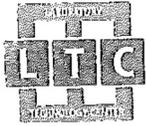


**10.5.2 Induced AC withstand voltage test:**

Test voltage $2xU_n$ , [V]	Frequency, [Hz]	Test time, [min]
800	150	40

Measurements were performed with expanded uncertainty: 2% for voltage, 0,0016% for frequency and the confidence level  $P = 95\%$ .



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**11. Instruments used for the tests:**

- Turn ratio meter PWR 3-A serial nr.0928-5305;
- Microohmmeter-MRC6105N-serial nr.0928-5306;
- Wattmeter "Yokogawa"-WT1600 serial nr.91J702269;
- Cast resin VT CL3.6kV(1500-3000/100V)-VKM24/2/H-serial nr.:  
345080101; 345080102; 345080103;
- Cast resin CT(25-300/5A)-AOS-serial nr.: 09195334; 09195335; 09195336;
- Capacitor divider(100V/100kV)- serial nr.1954
- Digital thermometer type HI 8757 serial nr.1203939
- Mechanical chronometer type Slava serial nr.0521682

**Notes:**

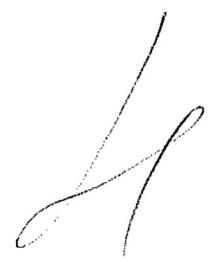
1. The results from the tests are referred for the tested product only.
2. Reproduction or copying of the contents of this report in any other form unless its complete photocopying is not allowed without written consent from LTC-TEST.



**TESTED BY :**

1. Oleg Tsvetanov:.... На основание чл.37 от ЗОП

2. Vasil Vasilev:.....

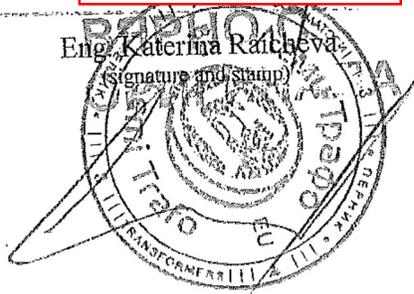


На основание чл.37 от ЗОП

Head of "LTC-TEST" ...

ЛТЦ  
ЕОП  
БЪЛГАРИЯ

Eng. Katerina Raicheva  
(Signature and Stamp)




	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	FC 5.10 – 1/8	
	<b>TEMPERATURE RISE TEST</b>	Page 1	All pages 9
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## TEST REPORT

№0055-2/20.10.2020

*Certificate of accreditation  
reg. №81/III valid until 28.12.2022  
issued by Executive Agency "BAS",  
according to the requirements of standard  
EN ISO/IEC 17025:2018*



1. Three phase cast resin transformer,  
TC 160-10, Dyn5, №13502, 2020
2. Customer : LEMI TRAFО JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street  
order 0047/01.10.2020
3. Manufacturer: LEMI TRAFО JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street
4. Test methods used : IEC 60076-11-cl.23.2.1;
5. Date on which the product was received in test room: 15.10.2020
6. Tests performed:
  - 6.1. Temperature rise test – IEC 60076-2 - cl.7.3.2;
7. Test period: 19-20.10.2020
8. Test result: The product passed the tests
9. The report contains: 9 pages

На основание чл.37 от ЗОП

Head of "LTC-TEST"

Eng. Katerina Raicheva  
(signature and stamp)



	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	FC 5.10 - 1/8	
	<b>TEMPERATURE RISE TEST</b>	Page 2	All pages 9
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**10. Test results:**

Power	160 kVA
Cooling	AN
Insulation class	75/28/12

Frequency	50 Hz
Overtemperature	100 K
Type	TC160-10

Year of production	2020
Vector group	Dyn5
Coeff. Temperat. Material	225

**Primary winding**

Voltage (V)	10000
Tapping's	±2x2.5%
Current (A)	9.24
Connection	Delta
Insulation class (kV)	12

**Secondary winding**

Voltage (V)	400
Tapping's	-
Current (A)	230.94
Connection	Star+n
Insulation class (kV)	1.1

Ratio	10000 / 400 V		Temperature reference (°C) 120		
	No-load losses (Watt)	No-load current (%)	Load losses (Watt)	Impedance voltage (%)	Total losses (Watt)
Guaranteed value	360	1.5	2600	6	2960
Tolerance (%)	+0%	30%	+0%	± 10%	10%
Measured value	344	0,36	2416	5,97	2760
Deviation (%)	-4,44%	-76,00%	-7,08%	-0,50%	-6,76%

**MEASUREMENT OF WINDINGS RESISTANCES BEFORE HEATING**

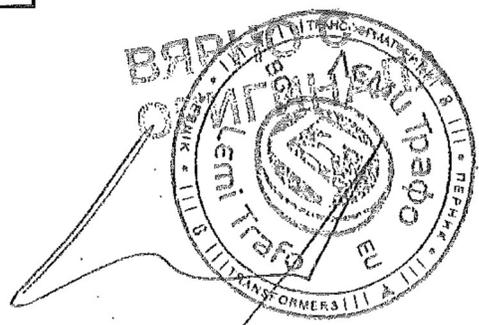
Measure temperature : 20.3°C

<b>Primary winding</b>		10000 V.	
K			[Ω]
Phases			
1V-1W			8,4502

<b>Secondary winding</b>		400 V.	
K			[Ω]
Phases			
2V-2W			0,0073856

**FINAL RESULTS**

Open circuit test conditions : Feeding voltage 400 V  
Short circuit test conditions : Nominal current 9,24 A





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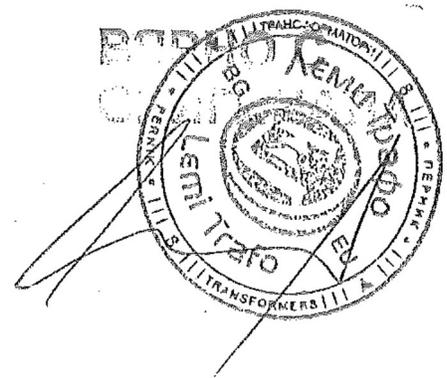
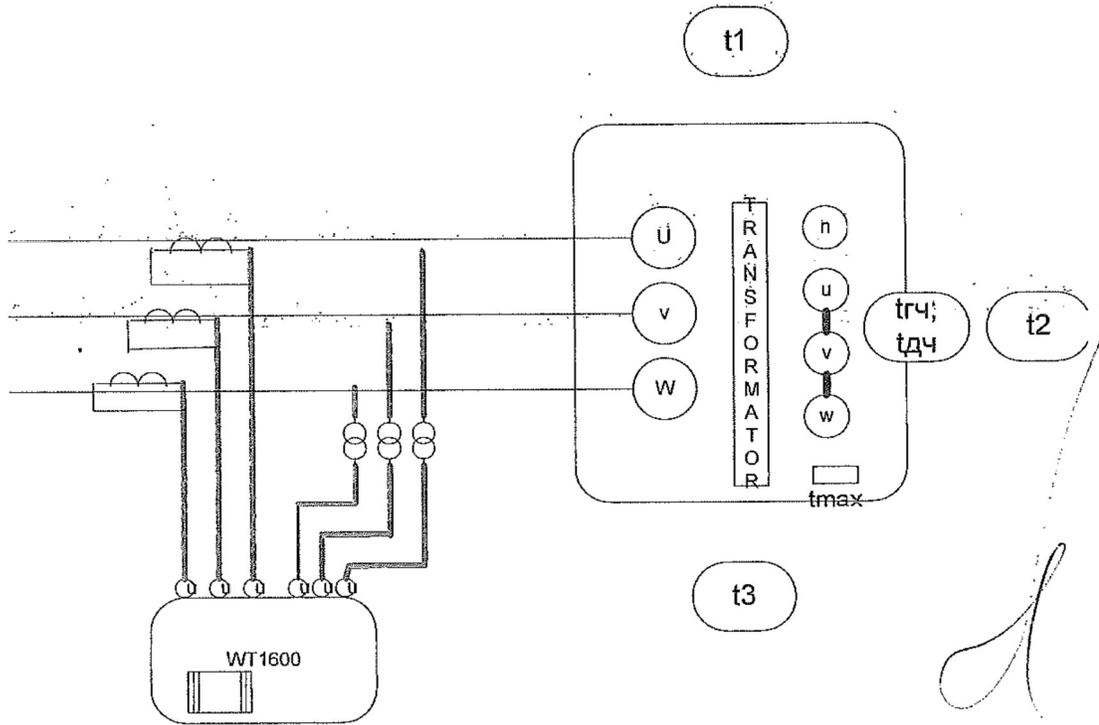
TEMPERATURE RISE TEST

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Revision 0

TEMPERATURE RISE			
Winding	10000 V		400 V
From the open circuit test	4,40 K		11,47 K
From the short circuit test	64,02 K		57,01 K
At rated currents in the winding and normal excitation of the core	65,82 K		63,08 K

Measurements were performed with expanded uncertainty 6% for temperature and the confidence level  $P = 95\%$ .





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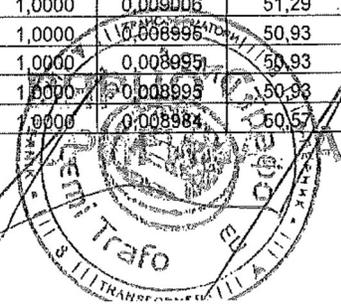
TEMPERATURE RISE TEST

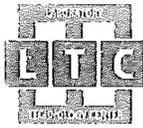
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10.2 Measurement of winding resistance after shutdown:

Seconds	Winding 10000 V				Seconds	Winding 400 V			
	V	A	Ohm	Delta T (°C)		V	A	Ohm	Delta T (°C)
122	10,6977	1,0000	10,6977	62,58	122	0,009146	1,0000	0,009146	55,96
137	10,6919	1,0000	10,6919	62,41	137	0,009146	1,0000	0,009146	55,96
153	10,6854	1,0000	10,6854	62,22	153	0,009135	1,0000	0,009135	55,60
168	10,6800	1,0000	10,6800	62,07	168	0,009135	1,0000	0,009135	55,60
183	10,6731	1,0000	10,6731	61,87	183	0,009124	1,0000	0,009124	55,24
198	10,6672	1,0000	10,6672	61,70	198	0,009124	1,0000	0,009124	55,24
214	10,6611	1,0000	10,6611	61,52	214	0,009124	1,0000	0,009124	55,24
229	10,6611	1,0000	10,6611	61,52	229	0,009114	1,0000	0,009114	54,88
244	10,6494	1,0000	10,6494	61,18	244	0,009114	1,0000	0,009114	54,88
259	10,6437	1,0000	10,6437	61,02	259	0,009114	1,0000	0,009114	54,88
274	10,6381	1,0000	10,6381	60,85	274	0,009103	1,0000	0,009103	54,52
290	10,6327	1,0000	10,6327	60,69	290	0,009103	1,0000	0,009103	54,52
306	10,6268	1,0000	10,6268	60,52	306	0,009092	1,0000	0,009092	54,16
320	10,6207	1,0000	10,6207	60,35	320	0,009092	1,0000	0,009092	54,16
335	10,6154	1,0000	10,6154	60,19	335	0,009092	1,0000	0,009092	54,16
351	10,6100	1,0000	10,6100	60,04	351	0,009092	1,0000	0,009092	54,16
366	10,6040	1,0000	10,6040	59,86	366	0,009081	1,0000	0,009081	53,80
381	10,6040	1,0000	10,6040	59,86	381	0,009081	1,0000	0,009081	53,80
396	10,5934	1,0000	10,5934	59,55	396	0,009070	1,0000	0,009070	53,44
411	10,5880	1,0000	10,5880	59,40	411	0,009070	1,0000	0,009070	53,44
427	10,5828	1,0000	10,5828	59,25	427	0,009070	1,0000	0,009070	53,44
442	10,5772	1,0000	10,5772	59,08	442	0,009070	1,0000	0,009070	53,44
457	10,5718	1,0000	10,5718	58,93	457	0,009060	1,0000	0,009060	53,08
472	10,5666	1,0000	10,5666	58,78	472	0,009060	1,0000	0,009060	53,08
487	10,5615	1,0000	10,5615	58,63	487	0,009060	1,0000	0,009060	53,08
503	10,5557	1,0000	10,5557	58,46	503	0,009049	1,0000	0,009049	52,72
518	10,5509	1,0000	10,5509	58,32	518	0,009049	1,0000	0,009049	52,72
533	10,5456	1,0000	10,5456	58,17	533	0,009049	1,0000	0,009049	52,72
548	10,5404	1,0000	10,5404	58,02	548	0,009038	1,0000	0,009038	52,36
564	10,5355	1,0000	10,5355	57,87	564	0,009038	1,0000	0,009038	52,36
579	10,5306	1,0000	10,5306	57,73	579	0,009038	1,0000	0,009038	52,36
594	10,5250	1,0000	10,5250	57,57	594	0,009027	1,0000	0,009027	52,00
609	10,5200	1,0000	10,5200	57,42	609	0,009027	1,0000	0,009027	52,00
624	10,5149	1,0000	10,5149	57,28	624	0,009016	1,0000	0,009016	51,65
640	10,5100	1,0000	10,5100	57,13	640	0,009016	1,0000	0,009016	51,65
655	10,5047	1,0000	10,5047	56,98	655	0,009016	1,0000	0,009016	51,65
670	10,5000	1,0000	10,5000	56,84	670	0,009016	1,0000	0,009016	51,65
685	10,4947	1,0000	10,4947	56,69	685	0,009006	1,0000	0,009006	51,29
701	10,4897	1,0000	10,4897	56,54	701	0,009006	1,0000	0,009006	51,29
716	10,4845	1,0000	10,4845	56,39	716	0,009006	1,0000	0,009006	51,29
731	10,4801	1,0000	10,4801	56,27	731	0,008995	1,0000	0,008995	50,93
746	10,4748	1,0000	10,4748	56,11	746	0,008995	1,0000	0,008995	50,93
761	10,4701	1,0000	10,4701	55,97	761	0,008995	1,0000	0,008995	50,93
777	10,4652	1,0000	10,4652	55,83	777	0,008984	1,0000	0,008984	50,57





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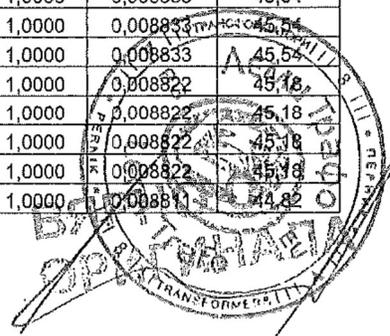
FC 5.10 - 1/8

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TEMPERATURE RISE TEST

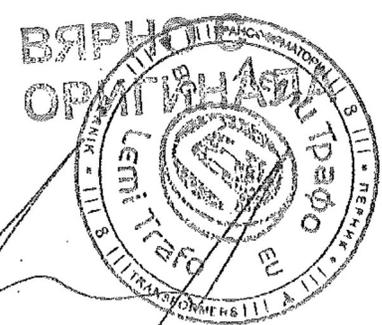
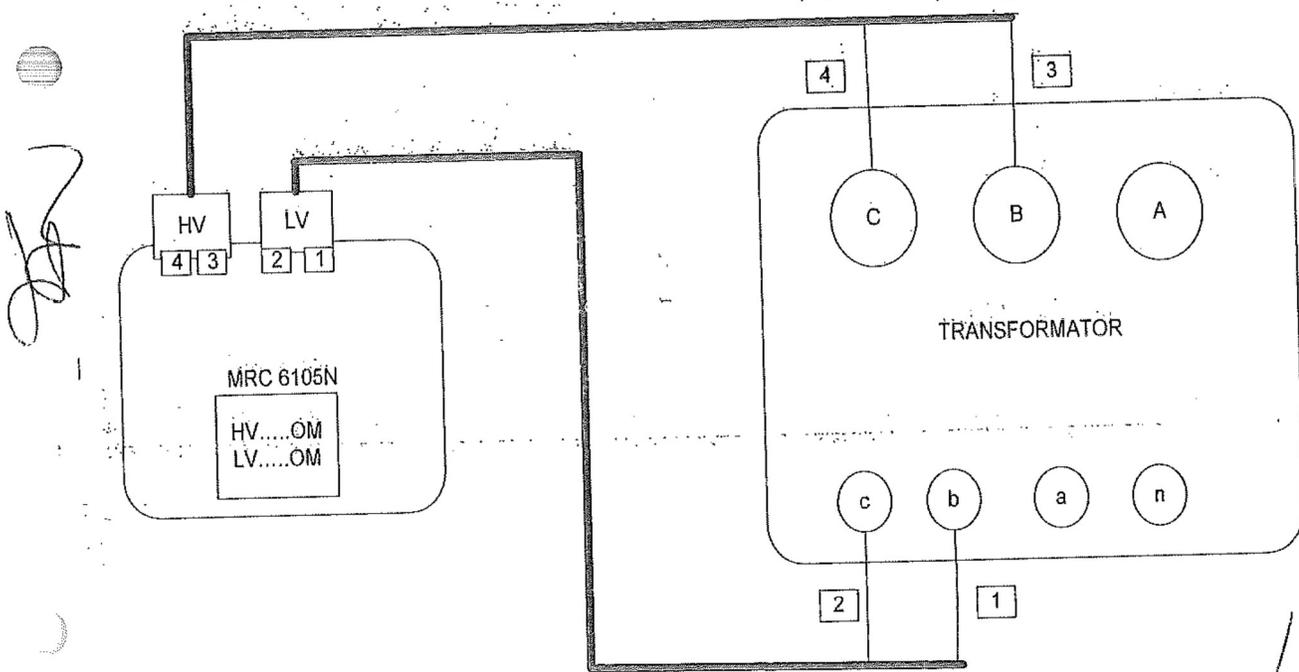
Revision 0

792	10,4609	1,0000	10,4609	55,71	792	0,008984	1,0000	0,008984	50,57
807	10,4555	1,0000	10,4555	55,55	807	0,008984	1,0000	0,008984	50,57
822	10,4509	1,0000	10,4509	55,42	822	0,008973	1,0000	0,008973	50,21
837	10,4459	1,0000	10,4459	55,27	837	0,008973	1,0000	0,008973	50,21
853	10,4415	1,0000	10,4415	55,15	853	0,008973	1,0000	0,008973	50,21
868	10,4361	1,0000	10,4361	54,99	868	0,008973	1,0000	0,008973	50,21
883	10,4315	1,0000	10,4315	54,85	883	0,008952	1,0000	0,008952	49,85
898	10,4268	1,0000	10,4268	54,72	898	0,008952	1,0000	0,008952	49,85
914	10,4220	1,0000	10,4220	54,58	914	0,008952	1,0000	0,008952	49,85
929	10,4169	1,0000	10,4169	54,43	929	0,008952	1,0000	0,008952	49,85
944	10,4131	1,0000	10,4131	54,32	944	0,008952	1,0000	0,008952	49,49
959	10,4078	1,0000	10,4078	54,17	959	0,008952	1,0000	0,008952	49,49
974	10,4031	1,0000	10,4031	54,03	974	0,008952	1,0000	0,008952	49,49
990	10,3982	1,0000	10,3982	53,89	990	0,008941	1,0000	0,008941	49,13
1005	10,3943	1,0000	10,3943	53,77	1005	0,008941	1,0000	0,008941	49,13
1020	10,3890	1,0000	10,3890	53,62	1020	0,008941	1,0000	0,008941	49,13
1035	10,3844	1,0000	10,3844	53,49	1035	0,008930	1,0000	0,008930	48,77
1051	10,3800	1,0000	10,3800	53,36	1051	0,008930	1,0000	0,008930	48,77
1066	10,3751	1,0000	10,3751	53,22	1066	0,008930	1,0000	0,008930	48,77
1081	10,3706	1,0000	10,3706	53,09	1081	0,008919	1,0000	0,008919	48,41
1096	10,3660	1,0000	10,3660	52,95	1096	0,008919	1,0000	0,008919	48,41
1111	10,3614	1,0000	10,3614	52,82	1111	0,008919	1,0000	0,008919	48,41
1127	10,3569	1,0000	10,3569	52,69	1127	0,008919	1,0000	0,008919	48,41
1142	10,3523	1,0000	10,3523	52,55	1142	0,008908	1,0000	0,008908	48,05
1157	10,3478	1,0000	10,3478	52,42	1157	0,008908	1,0000	0,008908	48,05
1172	10,3431	1,0000	10,3431	52,29	1172	0,008908	1,0000	0,008908	48,05
1187	10,3389	1,0000	10,3389	52,17	1187	0,008897	1,0000	0,008897	47,69
1203	10,3343	1,0000	10,3343	52,03	1203	0,008897	1,0000	0,008897	47,69
1218	10,3298	1,0000	10,3298	51,90	1218	0,008897	1,0000	0,008897	47,69
1233	10,3253	1,0000	10,3253	51,77	1233	0,008887	1,0000	0,008887	47,33
1248	10,3210	1,0000	10,3210	51,65	1248	0,008887	1,0000	0,008887	47,33
1264	10,3165	1,0000	10,3165	51,52	1264	0,008887	1,0000	0,008887	47,33
1279	10,3119	1,0000	10,3119	51,38	1279	0,008876	1,0000	0,008876	46,98
1294	10,3078	1,0000	10,3078	51,26	1294	0,008876	1,0000	0,008876	46,98
1309	10,3032	1,0000	10,3032	51,13	1309	0,008876	1,0000	0,008876	46,98
1324	10,2990	1,0000	10,2990	51,01	1324	0,008876	1,0000	0,008876	46,98
1340	10,2946	1,0000	10,2946	50,88	1340	0,008865	1,0000	0,008865	46,62
1355	10,2901	1,0000	10,2901	50,75	1355	0,008865	1,0000	0,008865	46,62
1370	10,2859	1,0000	10,2859	50,63	1370	0,008865	1,0000	0,008865	46,62
1385	10,2816	1,0000	10,2816	50,50	1385	0,008865	1,0000	0,008865	46,62
1401	10,2771	1,0000	10,2771	50,37	1401	0,008854	1,0000	0,008854	46,26
1416	10,2726	1,0000	10,2726	50,24	1416	0,008854	1,0000	0,008854	46,26
1431	10,2684	1,0000	10,2684	50,12	1431	0,008854	1,0000	0,008854	46,26
1446	10,2646	1,0000	10,2646	50,01	1446	0,008843	1,0000	0,008843	45,90
1461	10,2602	1,0000	10,2602	49,88	1461	0,008843	1,0000	0,008843	45,90
1477	10,2557	1,0000	10,2557	49,75	1477	0,008843	1,0000	0,008843	45,90
1492	10,2514	1,0000	10,2514	49,63	1492	0,008843	1,0000	0,008843	45,90
1507	10,2471	1,0000	10,2471	49,50	1507	0,008833	1,0000	0,008833	45,54
1522	10,2428	1,0000	10,2428	49,38	1522	0,008833	1,0000	0,008833	45,54
1537	10,2384	1,0000	10,2384	49,25	1537	0,008833	1,0000	0,008833	45,54
1553	10,2342	1,0000	10,2342	49,13	1553	0,008822	1,0000	0,008822	45,18
1568	10,2305	1,0000	10,2305	49,02	1568	0,008822	1,0000	0,008822	45,18
1583	10,2259	1,0000	10,2259	48,89	1583	0,008822	1,0000	0,008822	45,18
1598	10,2221	1,0000	10,2221	48,77	1598	0,008822	1,0000	0,008822	45,18
1614	10,2175	1,0000	10,2175	48,64	1614	0,008811	1,0000	0,008811	44,82



1629	10,2139	1,0000	10,2139	48,54	1629	0,008811	1,0000	0,008811	44,82
1644	10,2092	1,0000	10,2092	48,40	1644	0,008800	1,0000	0,008800	44,46
1659	10,2058	1,0000	10,2058	48,30	1659	0,008800	1,0000	0,008800	44,46
1674	10,2008	1,0000	10,2008	48,16	1674	0,008800	1,0000	0,008800	44,46
1690	10,1968	1,0000	10,1968	48,04	1690	0,008789	1,0000	0,008789	44,10
1705	10,1925	1,0000	10,1925	47,92	1705	0,008789	1,0000	0,008789343	44,10

Measurements were performed with expanded uncertainty 0,5% for resistance and the confidence level P = 95%.





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TEMPERATURE RISE TEST

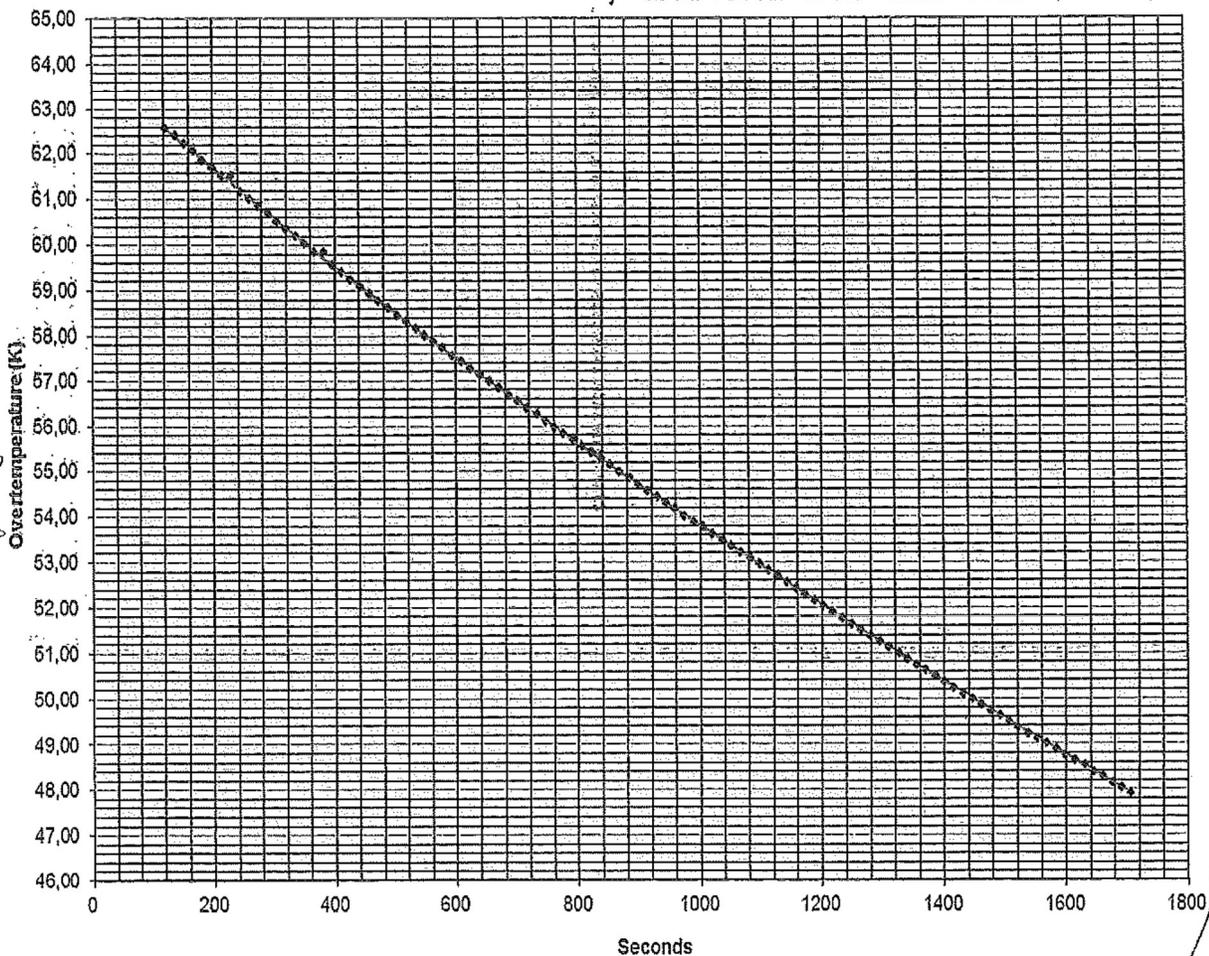
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Revision 0

Overtemperature HV winding

$$y = -5E-19x^6 + 3E-15x^5 - 5E-12x^4 + 4E-09x^3 + 7E-07x^2 - 0,0119x + 64,019$$





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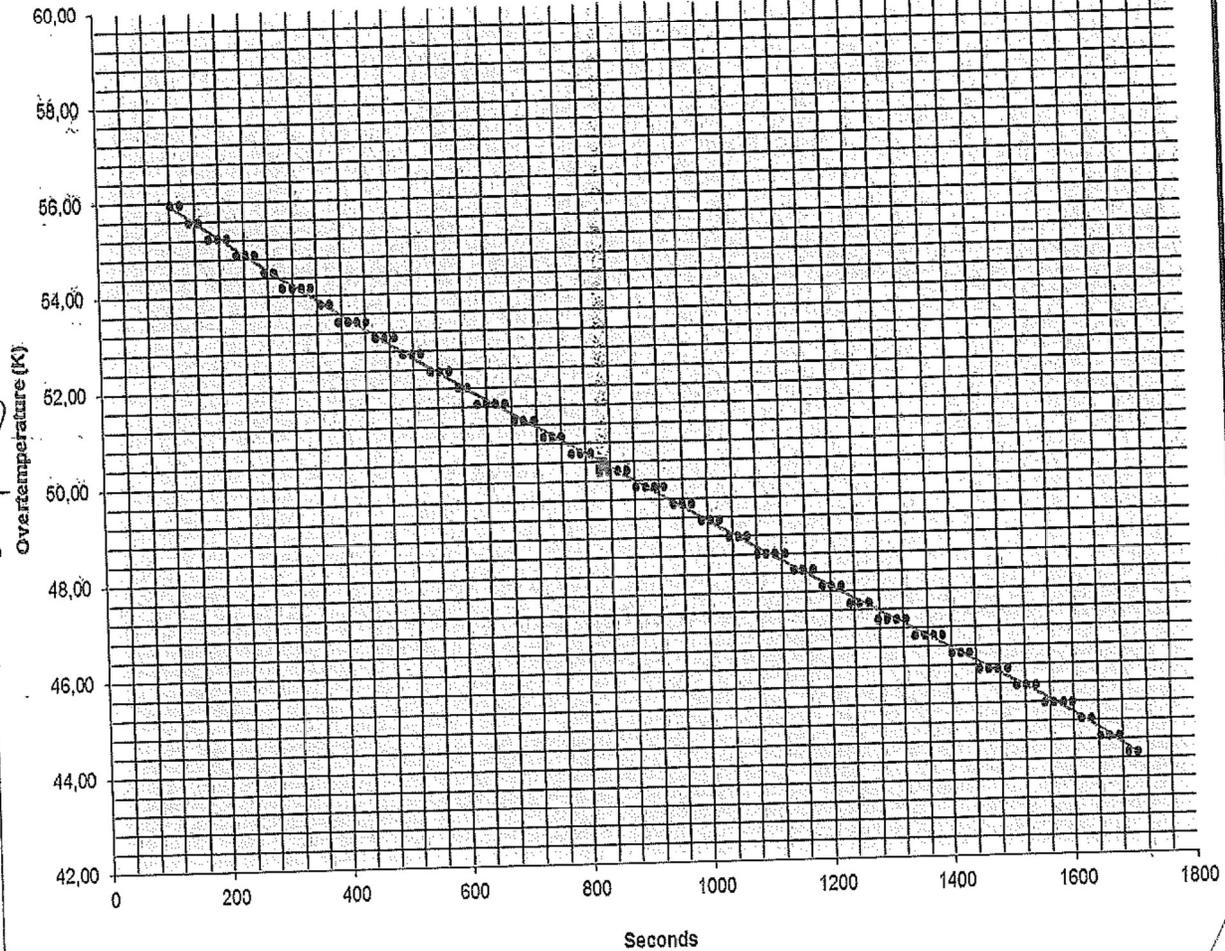
TEMPERATURE RISE TEST

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Revision 0

Overtemperature LV winding

$$y = -2E-18x^6 + 9E+15x^5 - 2E-11x^4 + 1E-08x^3 - 3E-06x^2 - 0,0085x + 57,008$$



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	<b>TEMPERATURE RISE TEST</b>		Page 9	All pages 9
			Revision 0	

**11. Instruments used for the tests:**

- Microohmmeter-MRC6105N-serial nr.0928-5306;
- Wattmeter "Yokogawa"-WT1600 serial nr.91J702269;
- Cast resin VT Cl.3.6kV(1500-3000/100V)-VKM24/2/H-serial nr.: 345080101;345080102;345080103;
- Cast resin CT(25-300/5A)-AOS-serial nr.: 09195334;09195335;09195336;
- Resistance thermometer Pt 100, type 448/2012, - serial nr. 1,2,3,4,5,6,7;
- Mechanical chronometer type Slava serial nr. 0521682

**Notes:**

1. The results from the tests are referred for the tested product only.
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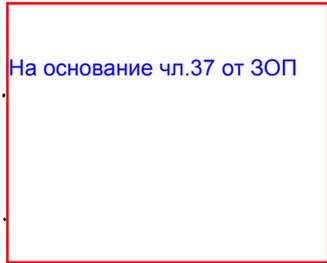


**TESTED BY :**

1. Oleg Tsvetanov:...

На основание чл.37 от ЗОП

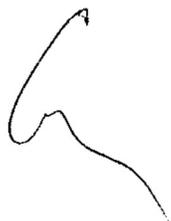
2. Vasil Vasilev:.....



Head of "LTC-TEST"

На основание чл.37 от ЗОП

Eng. Katerina Raicheva  
(signature and stamp)


	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>		FC 5.10 – 1/9	
	<b>LIGHTING IMPULSE TEST</b>		Page 1	All pages 6
			Revision 0	

## TEST REPORT

№ 0055-3/21.10.2020

*Certificate of accreditation  
reg. № 81/II valid until 28.12.2022  
issued by Executive Agency "BAS",  
according to the requirements of standard  
EN ISO/IEC 17025:2018*

CUSTOMER: LEMI TRAFО JSC, 2304 Pernik, BULGARIA, 1 Vladaisko vastanie Street;

SUBJECT: Three phase cast resin transformer  
**160kVA - 10/0.4kV**

REF. CUSTOMER № 47

Dated: 01-Oct-20

REF. CONSTRUCTOR

TEST ROOM : "LTC - TEST" Pernik

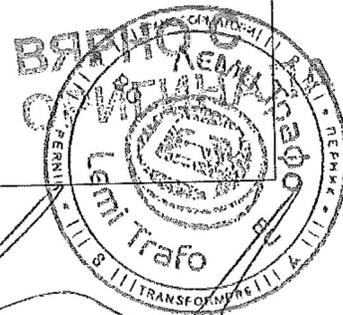
OBJECT OF THE TEST : Test is carried out to determine the conformity of the product to the customer order.

DATE OF ISSUE 21-Oct-20

RECEIVER COPY LEMI TRAFО JSC, 2304 Pernik, BULGARIA, 1 Vladaisko vastanie

THE TESTER		FOR CUSTOMER
------------	---	--------------

На основание чл.37 от ЗОП





TEST LABORATORY "LTC - TEST"  
TO "LTC" Ltd.

FC 5.10 – 1/9

LIGHTING IMPULSE TEST

Page 2 All pages 6

Revision 0

Serial №13502

Power	160 kVA
Cooling	AN
Insulation class	75/28/12

Frequency	50 Hz
Overtemperature	100K
Type	TC160 - 10

Year of production	2020
Vector group	Dyn5
Standard	IEC60076-3

Primary winding

Voltage (V)	10000
Tapping's	±2x2.5%
Current (A)	9.24
Connection	Delta
Insulation class (kV)	12

Secondary winding

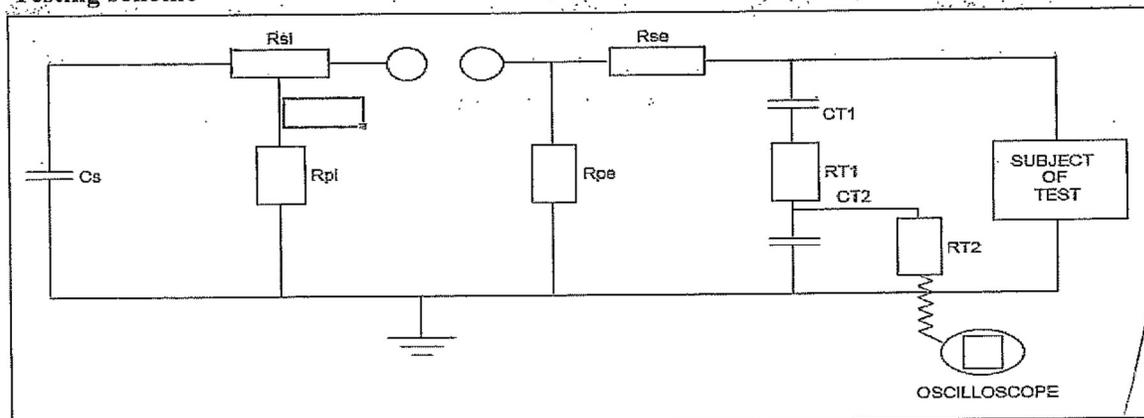
Voltage (V)	400
Tapping's	
Current (A)	230.94
Connection	Star+n
Insulation class (kV)	1:1

IMPULSE TENSION: 75kV

POLARITY: NEGATIVE

Testing scheme

NORMAL WAVE 1,2 ±30% / 50 ±20%



Impulse generator "AME"

Total max load of tension 400kV - Energy at max load of tension- 20 kJ

Number of arms : Two by two arms in paralel

CALIBRATION CONSTANT FOR IMPULSE TEST:

K = 6794.8

Result from the test:

Date: 21.10.2020



На основании чл.37 от 30П

Customer



	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	FC 5.10 – 1/9	
	<b>LIGHTING IMPULSE TEST</b>	Page 3	All pages 6
		Revision 0	

## Three phase cast resin transformer

160kVA - 10/0.4kV

### 1. REQUIREMENTS OF THE TEST:

Perform a Lighting Test over the transformer for each phase of medium voltage side.

The impulse must have the following characteristics:

- |   |                             |
|---|-----------------------------|
| - Nominal Impulse Voltage:                    | 75 kV                       |
| - Nominal time of front duration:             | 1.2 $\mu\text{s}(\pm 30\%)$ |
| - Nominal time duration of the half of tail:  | 50 $\mu\text{s}(\pm 20\%)$  |
| - Max over-shoot on the peak of the waveform: | 10 %                        |

The test will be performed according to IEC standards № IEC-EN-60076-4

### 2. ENVIRONMENTAL CONDITION DURING THE TEST

Air temperature:	21.0°C
Pressure:	944 mb
Relative humidity %	48%





TEST LABORATORY "LTC - TEST"  
TO "LTC" Ltd.

FC 5.10 – 1/9

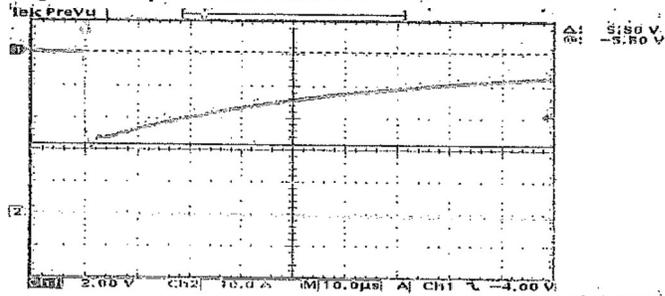
LIGHTING IMPULSE TEST

Page 4 | All pages 6

Revision 0

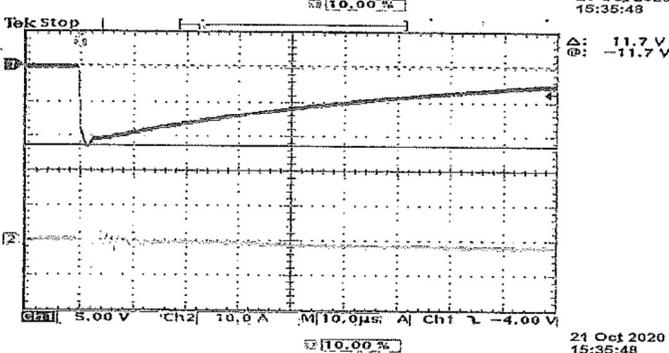
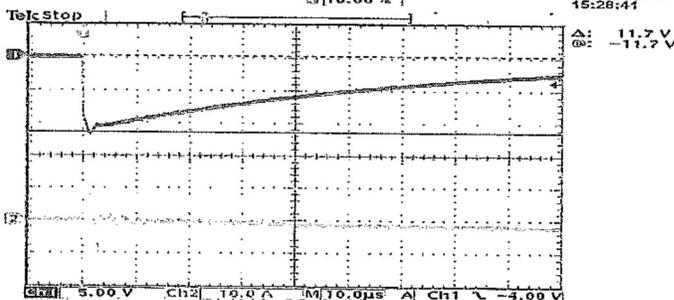
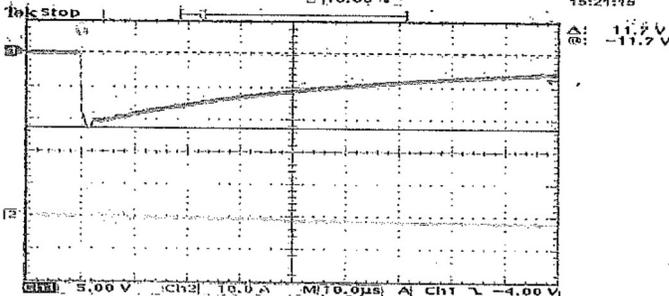
OSCILLOGRAM REGISTRATION

Negative impulse on Phase A



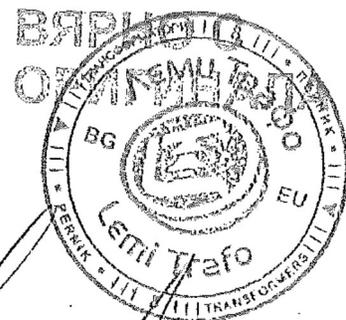
No	kV	T1(μs)	T2(μs)
1	39.4	1.41	52.4
2	77.4	1.41	52.4
3	77.4	1.41	52.4
4	77.4	1.41	52.4

*[Handwritten signature]*



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*[Handwritten signature]*



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TEST LABORATORY "LTC - TEST"  
TO "LTC" Ltd.

LIGHTING IMPULSE TEST

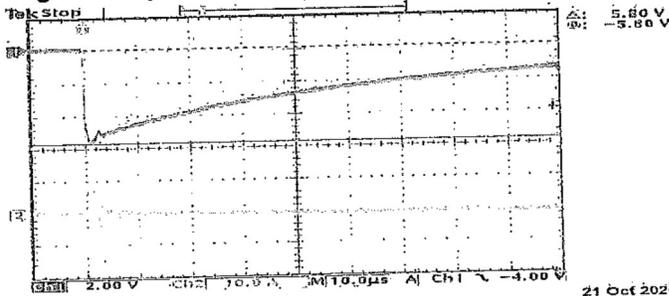
FC 5.10 - 1/9

Page 5 All pages 6

Revision 0

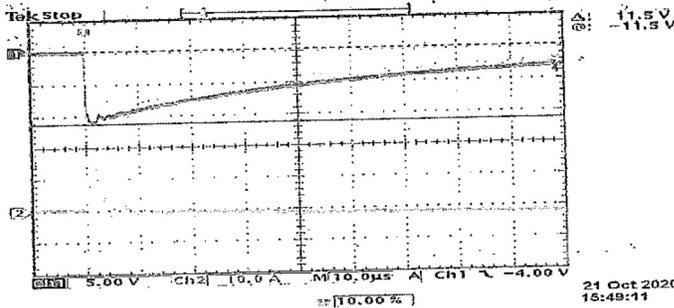
### OSCILLOGRAM REGISTRATION

Negative impulse on Phase B

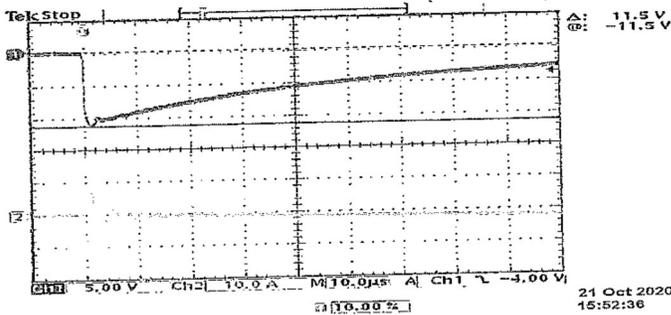


No	kV	T1(μs)	T2(μs)
1	39.4	1.41	52.4
2	76.8	1.41	52.4
3	76.8	1.41	52.4
4	76.8	1.41	52.4

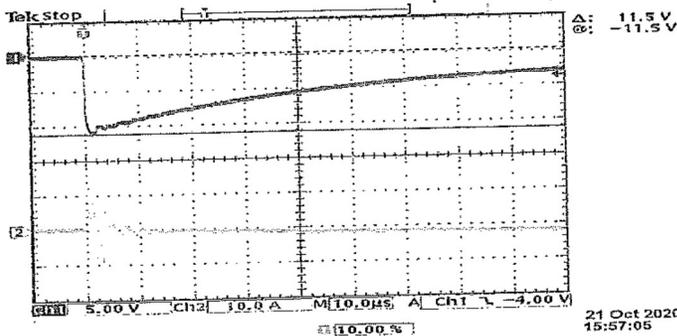
21 Oct 2020  
16:46:26



21 Oct 2020  
16:49:11



21 Oct 2020  
16:52:36



21 Oct 2020  
16:57:05





TEST LABORATORY "LTC - TEST"  
TO "LTC" Ltd.

FC 5.10 – 1/9

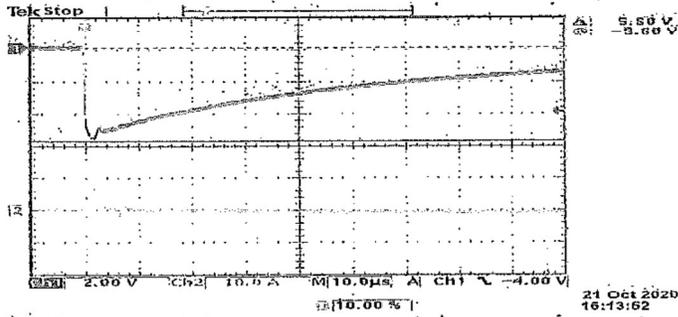
LIGHTING IMPULSE TEST

Page 6 All pages 6

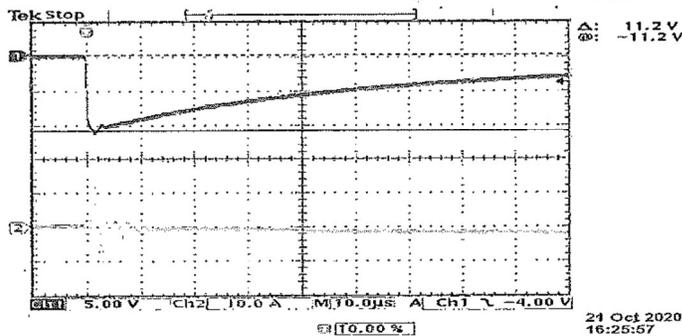
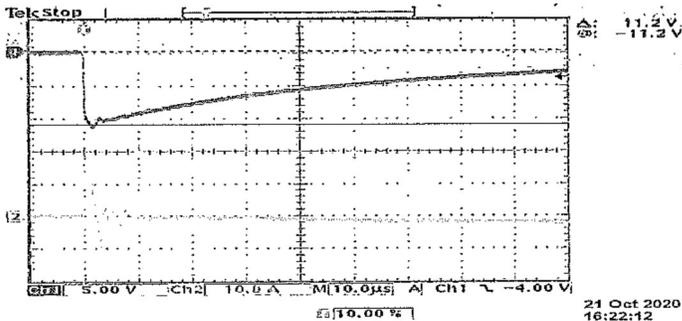
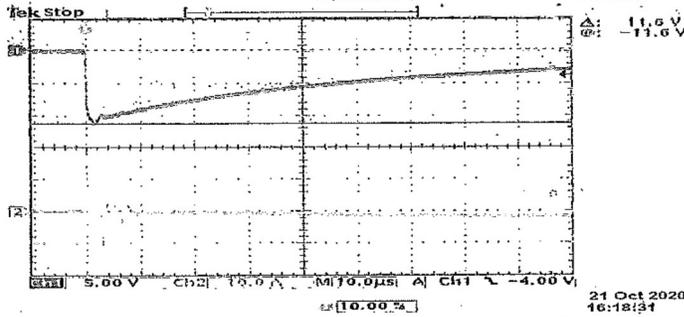
Revision 0

OSCILLOGRAM REGISTRATION

Negative impulse on Phase C



No	kV	T1(μs)	T2(μs)
1	39.4	1.41	52.4
2	77.4	1.41	52.4
3	76.1	1.41	52.4
4	76.1	1.41	52.4



	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	FC 5.10 – 1/10	
	<b>SOUND LEVEL MEASUREMENT</b>	Page 1	All pages 3
		Revision 0	

## TEST REPORT

№ 0055-4/21.10.2020

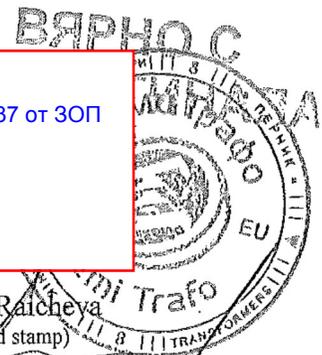
*Certificate of accreditation  
reg. №81.III valid until 28.12.2022  
issued by Executive Agency "BAS"  
according to the requirements of standard  
EN ISO/IEC 17025:2018*

1. Three-phase cast resin transformer,  
TC 160-10, Dyn5, №13502, 2020
2. Customer : LEMI TRAF0 JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;  
order 0047/01.10.2020
3. Manufacturer: LEMI TRAF0 JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;
4. Test methods used : IEC 60076-11:2018;
5. Date on which the product was received in test room: 15.10.2020
6. Tests performed:  
6.1 Determination of sound levels - (IEC60076-10 cl.11.2)
7. Test date : 21.10.2020
8. Test result: The product passed the tests
9. The report contains: 3 pages
10. Site: Test Room "LTC-TEST", Pernik

Head of "LTC-TEST"

На основание чл.37 от ЗОП

Eng. Katerina Raicheva  
(signature and stamp)



**11. Test result:**

**Details of transformer**

Serial No : 13502                      kVA: 160                      Voltage: 10000 ± 2x2,5% / 400

**Details of measuring instrument**

Brand: Brüel & Kjær                      Type: 2238 Mediator                      Serial No : 2684705

Microphone type : 4188                      Microphone serial No : 2690664

**Test conditions**

Feeding voltage: 400V                      Frequency: 50 Hz

Tap Position : 7-4

**A weighted sound pressure level  $L_{pA}$  :**

- Dry type transformer without enclosure
- Dry type transformer with enclosure

Measuring position	dB 1	dB 2	dB 3	Measuring position	dB 1	dB 2	dB 3
1	37,80	33,41	35,80	9	37,30	32,06	35,30
2	38,63	34,37	36,63	10	36,40	32,30	34,40
3	36,60	33,18	33,60	11			
4	36,57	31,85	34,57	12			
5	37,10	31,62	35,10	13			
6	35,70	32,62	32,70	14			
7	36,20	31,63	34,20	15			
8	37,02	31,80	35,02	16			

**Legend**  
1 = Transformer noise  
2 = Background noise  
3 = Transformer correct noise

Arithmetic/energy average : **36,93 dB** on 10 measure points

$L_{pA}$	30,54 dB
LwA	43,71 dB

Environmental correction K

**4,3176735**

Principal prescribed countur

20,7536 m<sup>2</sup>

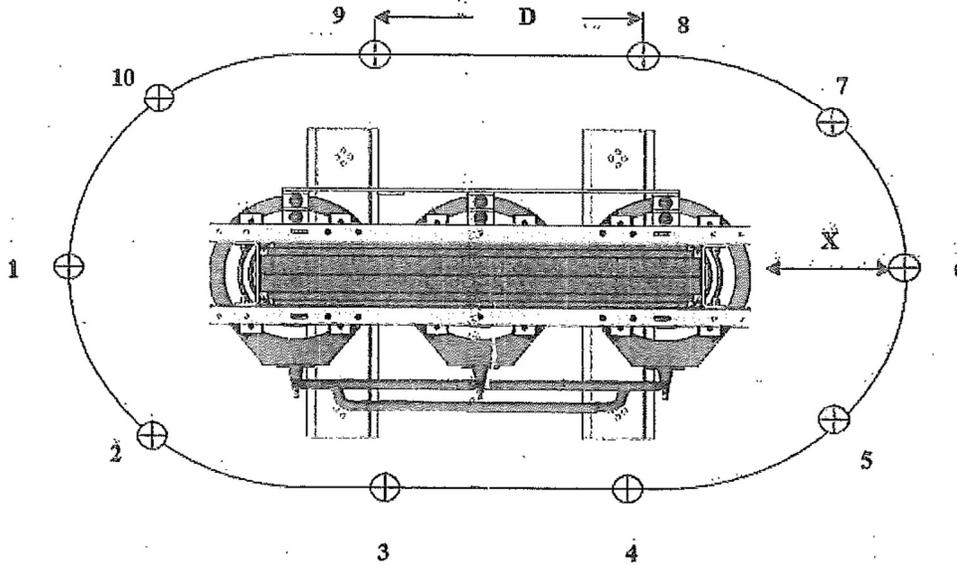
Total area of the surface test room

106 m<sup>2</sup>



	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	FC 5.10 – 1/10	
	<b>SOUND LEVEL MEASUREMENT</b>	Page 3	All pages 3
		Revision 0	

**12. Testing scheme:**



**Distance X = 1.0m. Distance D = 0.95m. Microphone height from floor: 0,59m**

**13. Instruments used for the tests:**

- Calibrator Sound Level Meter, serial nr.2651663
- Sound Level Meter, serial nr. 2684705
- Measuring Roulette, steel, serial nr. 51217

**Notes:**

1. The results from the tests are referred for the tested product only.
2. Reproduction or copying of the contents of this report in any other form unless its complete photocopying is not allowed without written consent from LTC-TEST.

**TESTED BY :**

1. Oleg Tsvetanov:...

На основание чл.37 от ЗОП

2. Vasil Vasilev:.....



На основание чл.37 от ЗОП

Head of "LTC-TEST":

Eng. Katerina Raicheva  
(signature and stamp)

	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	
	<b>PARTIAL DISSCHARGE MEASUREMENT</b>	<b>Page 1</b>   <b>All pages 3</b>
		<b>Revision 0</b>

## TEST REPORT

№ 0055-5/21.10.2020

1. Three-phase cast resin transformer,  
TC 160 - 10, Dyn5, №13502, 2020
2. Customer : LEMI TRAFО JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;  
order 0047/01.10.2020
3. Manufacturer: LEMI TRAFО JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;
4. Test methods used : IEC 60076-11:2018;
5. Date on which the product was received in test room: 15.10.2020
6. Tests performed:  
6.1 Partial discharge measurement - (IEC60076-11 cl.14.2.7.5)
7. Test date : 21.10.2020
8. Test result: The product passed the tests
9. The report contains: 3 pages
10. Site: Test Room "LTC-TEST", Pernik
11. Atmospheric conditions: P=944 mbar; T=22 °C; H<sub>r</sub>=48%

На основание чл.37 от ЗОП

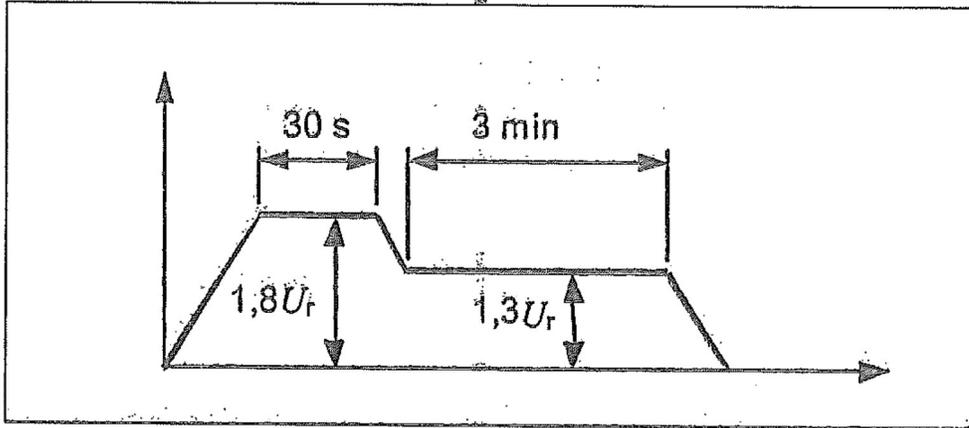
Head of "LTC-TEST"

Eng. Katerina Raicheva  
(signature and stamp)

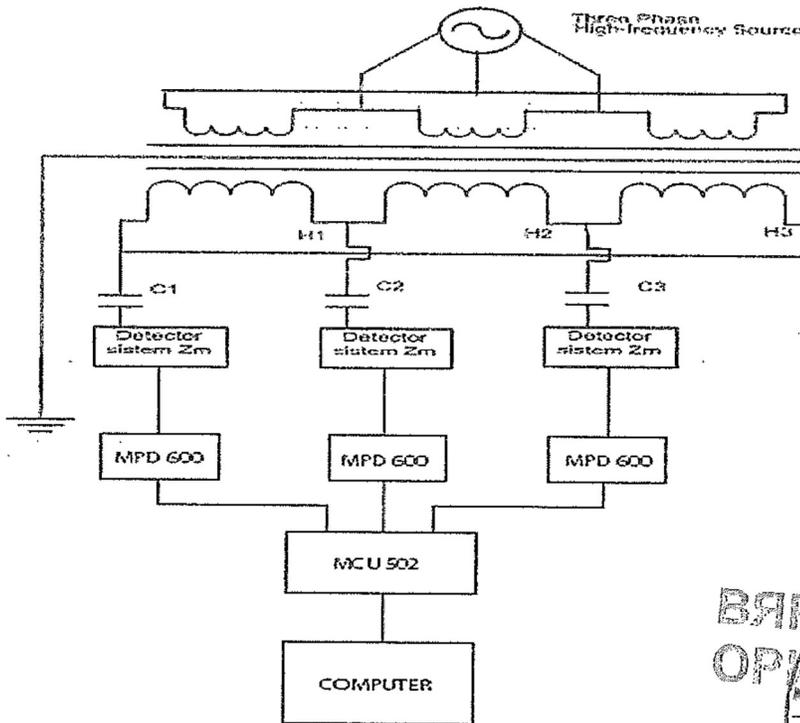




12. Testing scheme:



Measuring circuit of Partial discharge measurement



13. Test results:

Test voltage(kV)	Time	Frequency (Hz)	PD level (pC)		
			1 U	1 V	1 W
$U_3=1,8 \cdot 10 = 18$	30 s	150	-	-	-
$U_2=1,3 \cdot 10 = 13$	3 min		2.25	2.63	3.11
Background 0.3 pC					



	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	
	<b>PARTIAL DISSCHARGE MEASUREMENT</b>	Page 3   All pages 3
		Revision 0

**14. Equipment's used:**

- Group Motor Generator:  $f=150\text{Hz}$
- Coupling capacitors:  $1\text{nF}/100\text{kV}$
- PD Calibrator type CAL 542. Charge for calibration: 0-1000 pC.
- Measuring system OMICRON
- CPL 542
- MPD 600
- MCU 502

**Notes:**

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2. Reproduction or copying of the contents of this report in any other form unless its complete photocopying is not allowed without written consent from LTC-TEST.

**TESTED BY :**

1. Oleg Tsvetanov: На основание чл.37 от ЗОП

2. Vasil Vasilev:.....

Head of "LTC-TEST":

На основание чл.37 от ЗОП

Eng. Katerina Raicheva  
(signature and stamp)





## СПИСЪК НА ПРОВЕДЕНИТЕ ИЗПИТВАНИЯ

1. Трифазен сух трансформатор,  
тип ТС 160-20; фабричен №13065, година на производство - 2020.
2. Заявител на изпитанието: “Леми Трафо” ЕАД; гр.Перник, ул. Владайско въстание №1,  
заявка № 0024/04.05.2020г.
3. Производител: “Леми Трафо” ЕАД; гр.Перник, ул. Владайско въстание №1.
4. Технически данни:

Обозначение	ТС160-20	
Номинална мощност (kVA)	160	
Честота (Hz)	50	
Номинално напрежение (V)	ВН	20000
	НН	400
Загуби на (W)	Празен ход	360
	Късо съединение към 120°C	2600
Група на свързване	Dyn5	
Регулационни отклонения на страна ВН	± 2 x 2.5%	
Изоляционен клас	ВН	24 kV (50 kV rms / 125 kV peak)
	НН	1.1kV (3kV rms / - kV peak)
Охлаждане	AN	
Надморска височина	<1000 m	

5. Дата на получаване на продукта за изпитване в лабораторията: 18.05.2020г.





6. Извършени изпитвания:

6.1. Рутинен тест:

- 6.1.1. Измерване на коефициента на трансформация и група на свързване (IEC 60076-1:2011-cl.11.3);
- 6.1.2. Измерване на активното съпротивление на намотките с постоянен ток (IEC 60076-1:2011-t.11.2);
- 6.1.3. Измерване на загубите и тока на празен ход (IEC 60076-1:2011-cl.11.5);
- 6.1.4. Измерване на загубите и напрежението на късо съединение (IEC 60076-1:2011-cl.11.4);
- 6.1.5. Диелектрични изпитвания (IEC 60076-3:2013)
  - 6.1.5.1. Изпитване на изолацията с напрежение, приложено от външен източник (IEC 60076-3:2013-t.10);
  - 6.1.5.2. Изпитване на изолацията с индуктирано напрежение (IEC 60076-3:2013-t.11.2);
- 6.1.6. Измерване на частични разряди - (IEC 60076-11:2018)

6.2. Типов тест:

- 6.2.1. Изпитване на прегряване (IEC 60076-2:2000);
- 6.2.2. Изпитване на изолацията с мълниен импулс (IEC 60076-4:2002);

6.3. Специален тест:

- 6.3.1. Определяне на звуковото ниво (IEC 60076-10:2005);

7. Период на изпитване: 19 - 22.05.2020г.

8. Резултат от изпитванията: **Продуктът** Трифазен сух трансформатор тип ТС 160-20, фабричен № 13065, **премина успешно изпитанията.**

Резултати от изпитванията са включени в тестови протоколи: № 0026-1/19.05.2020; № 0026-2/21.05.2020; № 0026-3/22.05.2020; № 0026-4/22.05.2020; № 0026-5/22.05.2020;

9. Списъка от изпитванията съдържа 2 страници.

На основание чл.37 от ЗОП

РЪКОВОДИТЕЛ НА "ЛТЦ-ТЕСТ"

ИНЖ. Катерина Райчева  
(подпис и печат)



	<b>TEST LABORATORY "LTC - TEST"</b> <b>TO "LTC" Ltd.</b>	FC 5.10 – 1/7	
	<b>ROUTINE TEST REPORT</b>	Page 1	All pages 7
		Revision 0	

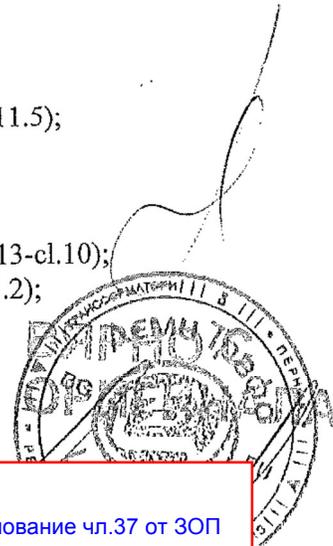
## TEST REPORT

№ 0026-1/19.05.2020



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*according to the requirements of standard*  
*EN ISO/IEC 17025:2018*

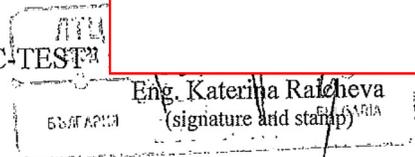
1. Three phase cast resin transformer,  
TC 160-20, Dyn5, №13065, 2020
2. Customer : LEMI TRAFО JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;  
order 0024/04.05.2020
3. Manufacturer: LEMI TRAFО JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;
4. Test methods used : IEC 60076-11:2018;  
IEC 60076-3:2013;
5. Date on which the product was received in test room: 18.05.2020
6. Tests performed:
  - 6.1. Measurement of voltage ratio and check of phase displacement  
(IEC 60076-1:2011- cl.11.3);
  - 6.2. Measurement of winding resistance (IEC 60076-1:2011-cl.11.2);
  - 6.3. Measurement of no-load losses and current (IEC 60076-1:2011-cl.11.5);
  - 6.4. Measurement of short circuit impedance and load losses  
(IEC 60076-1:2011-cl.11.4);
  - 6.5 Dielectric routine tests (IEC 60076-3:2013):
    - 6.5.1. Separate source AC withstand voltage test (IEC 60076-3:2013-cl.10);
    - 6.5.2. Induced AC withstand voltage test (IEC 60076-3:2013-cl.11.2);
7. Test date: 19.05.2020
8. Test result: The product passed the tests
9. The report contains: 7 pages



На основание чл.37 от ЗОП

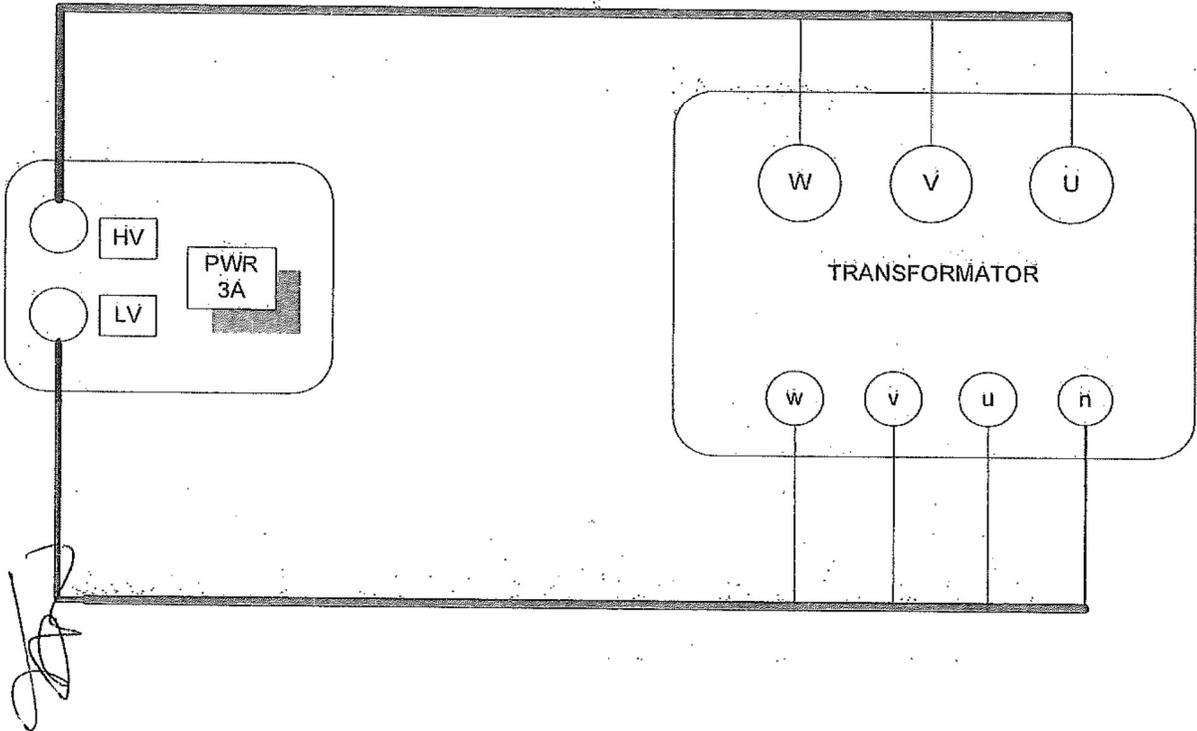


Head of "LTC-TEST"

  
Eng. Katerina Ralcheva  
(signature and stamp)

**10. Test results:**

**10.1. Measurement of voltage ratio (20000/400V) and check of phase displacement:**

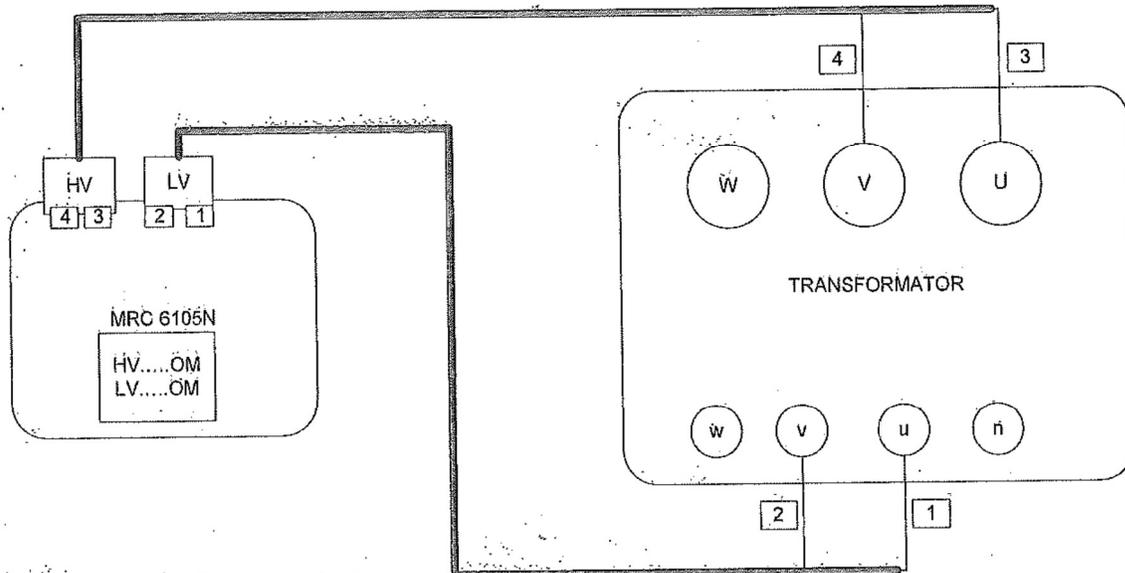


Tap changer position	Phase A	Transformation coefficient's error, %	Phase B	Transformation coefficient's error, %	Phase C	Transformation coefficient's error, %	Vector group
7 - 6	91.011	0.09	91.02	0.10	91.016	0.09	Dyn5
5 - 7	88.847	0.09	88.857	0.10	88.847	0.09	
4 - 7	86.686	0.10	86.691	0.10	86.685	0.10	
8 - 5	84.519	0.10	84.529	0.11	84.518	0.10	
8 - 4	82.362	0.11	82.36	0.11	82.356	0.10	

Measurements were performed with expanded uncertainty of 3% and the confidence level P = 95%.



**10.2 Measurement of winding resistance:**



Tap changer position	$R_{U-v}, \Omega$	$R_{U-w}, \Omega$	$R_{v-w}, \Omega$	Temperature during test 22°C	
				$R_{u-v}, \Omega$	
7 - 6	-	-	-		0.0084066
5 - 7	-	-	-		0.0084424
4 - 7	29.4799	29.4795	29.4976		0.0083790
8 - 5	-	-	-		
8 - 4	-	-	-		

Measurements were performed with expanded uncertainty 0,5% and the confidence level  $P = 95\%$ .

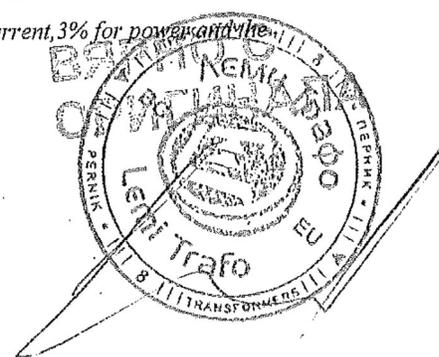
**10.3 Measurement of no-load losses and current:**

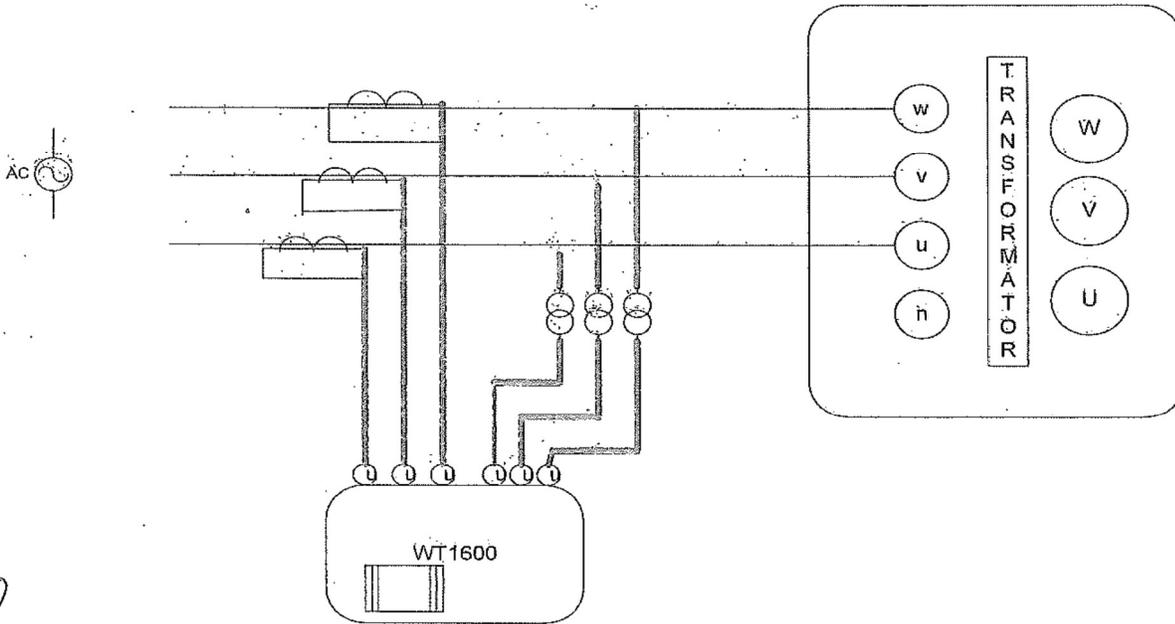
Tap changer position	U1 [V]	U2 [V]	U3 [V]	I1 [A]	I2 [A]	I3 [A]	P1 [W]	P2 [W]	P3 [W]
4 - 7	400.4	399.4	400.3	1.169	0.79	1.175	160.2	92.8	94.8

U <sub>av</sub> [V]	I <sub>av</sub> [A]	P <sub>tot</sub> [W]	I <sub>0</sub> [%]
400.02	1.0447	347.8	0.452

Measurements were performed with expanded uncertainty: 2% for voltage, 2,5% for current, 3% for power and the confidence level  $P = 95\%$ .

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10.4 Measurement of short circuit impedance and load losses at temperature 22 °C:

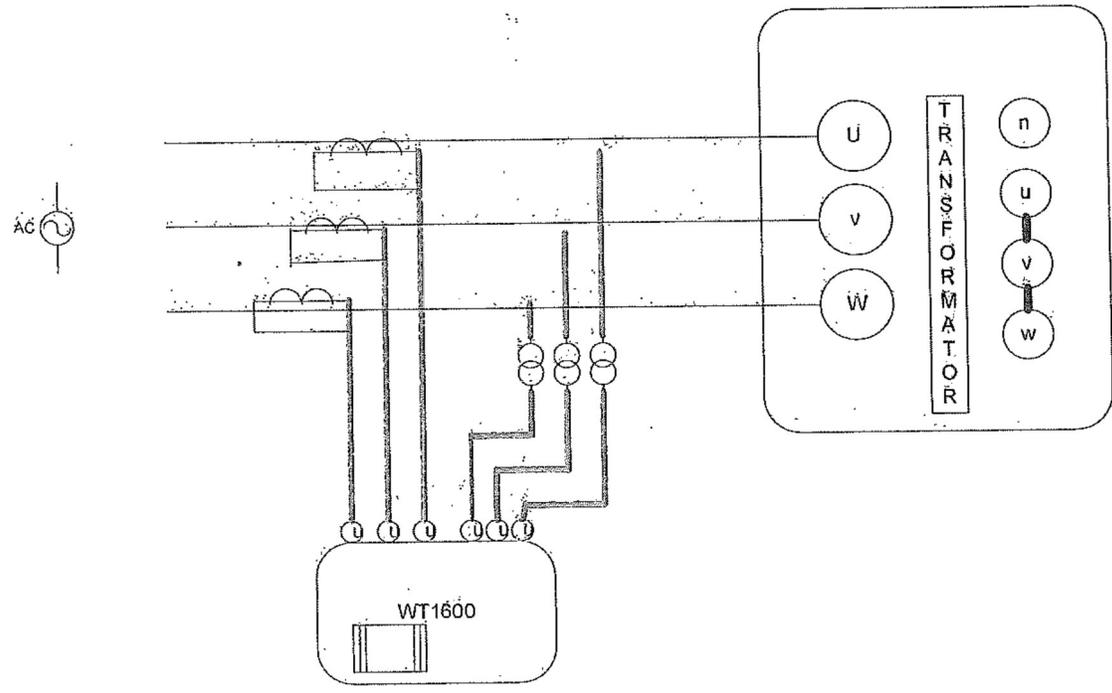
Tap changer position	U1 [V]	U2 [V]	U3 [V]	I1 [A]	I2 [A]	I3 [A]	P1 [W]	P2 [W]	P3 [W]
4 - 7	692.5	696	692.5	2.832	2.826	2.8179	220.7	212.4	223.2

Uav. [V]	Iav. [A]	ΣP [W]	Pk <sup>120°C</sup> [W]	Uk <sup>120°C</sup> [%]
693.67	2.825	656.3	2356	5.75

Measurements were performed with expanded uncertainty: 2% for voltage, 2,5% for current, 3% for power and the confidence level P = 95%.

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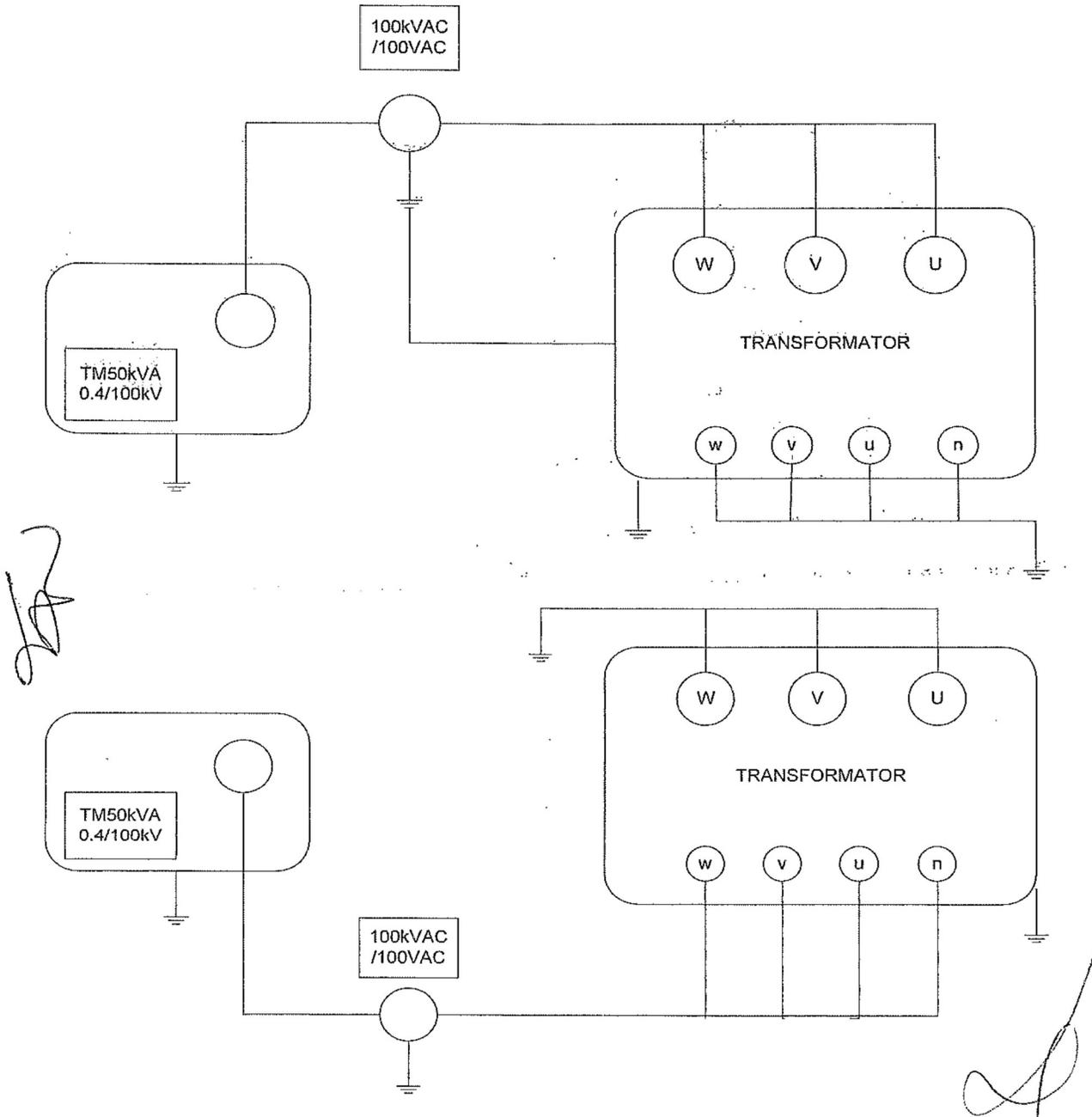


**10.5 Dielectric routine tests :**  
**10.5.1 Separate source AC withstand voltage test:**

Winding	Earthing	Test voltage, [kV]	Frequency, [Hz]	Test time, [s]
High voltage	LV+tank	50	50	60
Low voltage	HV+tank	3	50	60

*Measurements were performed with expanded uncertainty: 3,6% for voltage and the confidence level P = 95%.*

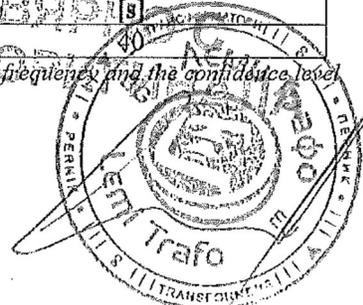




10.5.2 Induced AC withstand voltage test:

Test voltage $2xU_n$ , [V]	Frequency, [Hz]	Test time, [s]
800	150	80

Measurements were performed with expanded uncertainty: 2% for voltage, 0,0016% for frequency and the confidence level  $P = 95\%$ .



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**11. Instruments used for the tests:**

- Turn ratio meter PWR 3-A serial nr.0928-5305;
- Microohmmeter-MRC6105N-serial nr.0928-5306;
- Wattmeter "Yokogawa"-WT1600 serial nr.91J702269;
- Cast resin VT Cl.3.6kV(1500-3000/100V)-VKM24/2/H-serial nr.:  
345080101; 345080102; 345080103;
- Cast resin CT(25-300/5A)-AOS-serial nr.: 09195334; 09195335; 09195336;
- Capacitor divider(100V/100kV)- serial nr.1954
- Digital thermometer type HI 8757 serial nr.1203939
- Mechanical chronometer type Slava serial nr.0521682

**Notes:**

1. The results from the tests are referred for the tested product only.
2. Reproduction or copying of the contents of this report in any other form unless its complete photocopying is not allowed without written consent from LTC-TEST.



**TESTED BY :**

1. Oleg Tsvetanov:....

На основание чл.37 от ЗОП

2. Vasil Vasilev:.....

Head of "LTC-TEST"

На основание чл.37 от ЗОП

Eng. Katerina Raicheva  
(signature and stamp)



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## TEST REPORT

№0026-2/21.05.2020

*Certificate of accreditation  
reg. №81JII valid until 28.12.2022  
issued by Executive Agency "BAS",  
according to the requirements of standard  
EN ISO/IEC 17025:2018*

1. Three phase cast resin transformer;  
TC 160-20, Dyn5, №13065, 2020
2. Customer: LEMI TRAF0 JSC, 2304 Pernik, BULGARIA, 1 Vladaisko vastanie Street  
order 0024/04.05.2020
3. Manufacturer: LEMI TRAF0 JSC, 2304 Pernik, BULGARIA, 1 Vladaisko vastanie Street
4. Test methods used : IEC 60076-11-cl.23.2.1;
5. Date on which the product was received in test room: 18.05.2020
6. Tests performed:
  - 6.1. Temperature rise test – IEC 60076-2 - cl.7.3.2;
7. Test period: 20-21.05.2020
8. Test result: The product passed the tests
9. The report contains: 9 pages

Head of "LTC-TEST" .....

На основание чл.37 от ЗОП

Eng. Katerina Raicheva  
(signature and stamp)



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**10. Test results:**

Power	160 kVA
Cooling	AN
Insulation class	125/50/24

Frequency	50 Hz
Overtemperature	100 K
Type	TC160-20

Year of production	2020
Vector group	Dyn5
Coeff. Temperat. Material	225

**Primary winding**

**Secondary winding**

Voltage (V)	20000
Tapping's	±2x2.5%
Current (A)	4.62
Connection	Delta
Insulation class (kV)	24

Voltage (V)	400
Tapping's	-
Current (A)	230.94
Connection	Star+n
Insulation class (kV)	1.1

Ratio	20000 / 400 V		Temperature reference (°C) 120		
	No-load losses (Watt)	No-load current (%)	Load losses (Watt)	Impedance voltage (%)	Total losses (Watt)
Guaranteed value	360	1.5	2600	6	2960
Tolerance (%)	+0%	30%	+0%	± 10%	+0%
Measured value	348	0.45	2356	5.75	2704
Deviation (%)	-3.33%	-70.00%	-9.38%	-4.17%	-8.65%

**MEASUREMENT OF WINDINGS RESISTANCES BEFORE HEATING**

Measure temperature : 22°C

<b>Primary winding</b>		20000	V.
K			[Ω]
Phases			
1V-1W			29.4977

<b>Secondary winding</b>		400	V.
K			[Ω]
Phases			
2V-2W			0.0083804

**FINAL RESULTS**

Open circuit test conditions : Feeding voltage 400 V  
Short circuit test conditions : Nominal current 4.62 A





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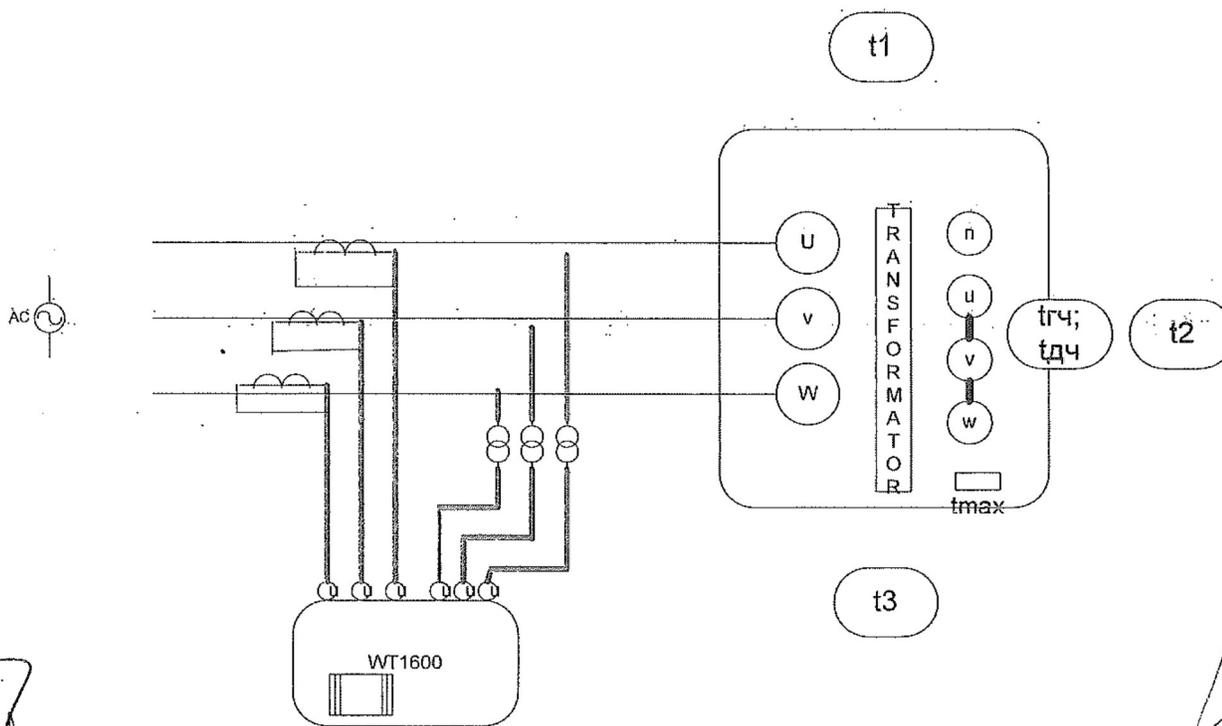
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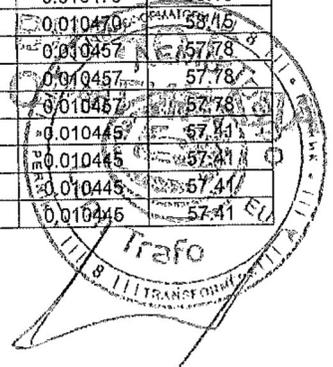
	TEMPERATURE RISE	
Winding	20000 V	400 V
From the open circuit test	5.22 K	11.06 K
From the short circuit test	62.93 K	64.22 K
At rated currents in the winding and normal excitation of the core	<b>65.16 K</b>	<b>69.86 K</b>

Measurements were performed with expanded uncertainty 6% for temperature and the confidence level  $P = 95\%$ .



**10.2 Measurement of winding resistance after shutdown:**

Seconds	Winding 20000 V.				Seconds	Winding 400 V.			
	V	A	Ohm	Delta T (°C)		V	A	Ohm	Delta T (°C)
98	37.2850	1.0000	37.2850	61.78	98	0.010546	1.0000	0.010646	63.35
113	37.2649	1.0000	37.2649	61.61	113	0.010646	1.0000	0.010646	63.35
129	37.2421	1.0000	37.2421	61.42	129	0.010633	1.0000	0.010633	62.97
144	37.2232	1.0000	37.2232	61.26	144	0.010633	1.0000	0.010633	62.97
159	37.1993	1.0000	37.1993	61.06	159	0.010621	1.0000	0.010621	62.60
174	37.1788	1.0000	37.1788	60.89	174	0.010621	1.0000	0.010621	62.60
189	37.1576	1.0000	37.1576	60.71	189	0.010621	1.0000	0.010621	62.60
205	37.1576	1.0000	37.1576	60.71	205	0.010608	1.0000	0.010608	62.23
220	37.1167	1.0000	37.1167	60.37	220	0.010608	1.0000	0.010608	62.23
235	37.0970	1.0000	37.0970	60.20	235	0.010608	1.0000	0.010608	62.23
250	37.0773	1.0000	37.0773	60.04	250	0.010596	1.0000	0.010596	61.86
265	37.0585	1.0000	37.0585	59.88	265	0.010596	1.0000	0.010596	61.86
281	37.0380	1.0000	37.0380	59.71	281	0.010583	1.0000	0.010583	61.49
296	37.0168	1.0000	37.0168	59.53	296	0.010583	1.0000	0.010583	61.49
311	36.9983	1.0000	36.9983	59.38	311	0.010583	1.0000	0.010583	61.49
326	36.9794	1.0000	36.9794	59.22	326	0.010583	1.0000	0.010583	61.49
342	36.9586	1.0000	36.9586	59.04	342	0.010570	1.0000	0.010570	61.12
357	36.9586	1.0000	36.9586	59.04	357	0.010570	1.0000	0.010570	61.12
372	36.9216	1.0000	36.9216	58.73	372	0.010558	1.0000	0.010558	60.75
387	36.9027	1.0000	36.9027	58.58	387	0.010558	1.0000	0.010558	60.75
402	36.8846	1.0000	36.8846	58.42	402	0.010558	1.0000	0.010558	60.75
418	36.8650	1.0000	36.8650	58.26	418	0.010558	1.0000	0.010558	60.75
433	36.8461	1.0000	36.8461	58.10	433	0.010545	1.0000	0.010545	60.38
448	36.8280	1.0000	36.8280	57.95	448	0.010545	1.0000	0.010545	60.38
463	36.8103	1.0000	36.8103	57.80	463	0.010545	1.0000	0.010545	60.38
479	36.7902	1.0000	36.7902	57.63	479	0.010533	1.0000	0.010533	60.01
494	36.7733	1.0000	36.7733	57.49	494	0.010533	1.0000	0.010533	60.01
509	36.7548	1.0000	36.7548	57.34	509	0.010533	1.0000	0.010533	60.01
524	36.7368	1.0000	36.7368	57.19	524	0.010520	1.0000	0.010520	59.64
539	36.7198	1.0000	36.7198	57.04	539	0.010520	1.0000	0.010520	59.64
555	36.7025	1.0000	36.7025	56.90	555	0.010520	1.0000	0.010520	59.64
570	36.6833	1.0000	36.6833	56.74	570	0.010508	1.0000	0.010508	59.27
585	36.6656	1.0000	36.6656	56.59	585	0.010508	1.0000	0.010508	59.27
600	36.6479	1.0000	36.6479	56.44	600	0.010495	1.0000	0.010495	58.89
615	36.6310	1.0000	36.6310	56.30	615	0.010495	1.0000	0.010495	58.89
631	36.6125	1.0000	36.6125	56.15	631	0.010495	1.0000	0.010495	58.89
646	36.5960	1.0000	36.5960	56.01	646	0.010495	1.0000	0.010495	58.89
661	36.5775	1.0000	36.5775	55.85	661	0.010482	1.0000	0.010482	58.52
676	36.5602	1.0000	36.5602	55.71	676	0.010482	1.0000	0.010482	58.52
692	36.5421	1.0000	36.5421	55.56	692	0.010482	1.0000	0.010482	58.52
707	36.5267	1.0000	36.5267	55.43	707	0.010470	1.0000	0.010470	58.15
722	36.5083	1.0000	36.5083	55.27	722	0.010470	1.0000	0.010470	58.15
737	36.4917	1.0000	36.4917	55.13	737	0.010470	1.0000	0.010470	58.15
752	36.4748	1.0000	36.4748	54.99	752	0.010457	1.0000	0.010457	57.78
768	36.4599	1.0000	36.4599	54.87	768	0.010457	1.0000	0.010457	57.78
783	36.4410	1.0000	36.4410	54.71	783	0.010457	1.0000	0.010457	57.78
798	36.4249	1.0000	36.4249	54.57	798	0.010445	1.0000	0.010445	57.41
813	36.4076	1.0000	36.4076	54.43	813	0.010445	1.0000	0.010445	57.41
829	36.3922	1.0000	36.3922	54.30	829	0.010445	1.0000	0.010445	57.41
844	36.3734	1.0000	36.3734	54.14	844	0.010445	1.0000	0.010445	57.41





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TEMPERATURE RISE TEST

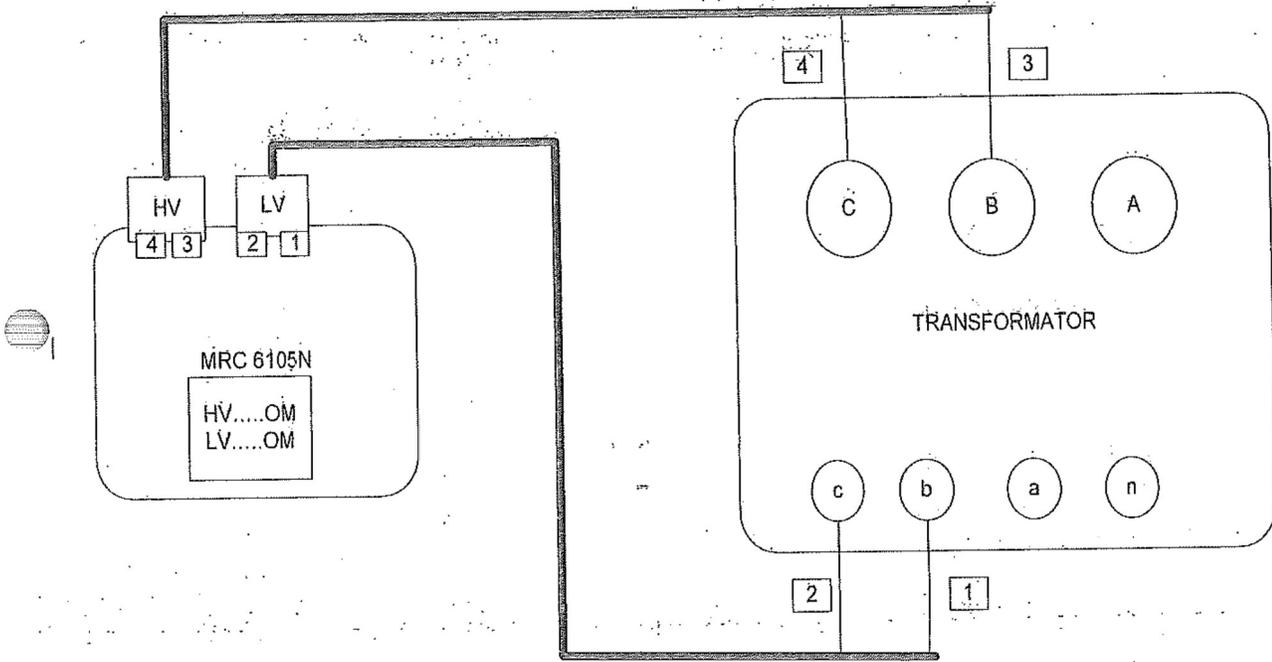
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859	36.3572	1.0000	36.3572	54.01	859	0.010432	1.0000	0.010432	57.04
874	36.3407	1.0000	36.3407	53.87	874	0.010432	1.0000	0.010432	57.04
889	36.3242	1.0000	36.3242	53.73	889	0.010432	1.0000	0.010432	57.04
905	36.3065	1.0000	36.3065	53.58	905	0.010432	1.0000	0.010432	57.04
920	36.2931	1.0000	36.2931	53.47	920	0.010419	1.0000	0.010419	56.67
935	36.2746	1.0000	36.2746	53.32	935	0.010419	1.0000	0.010419	56.67
950	36.2581	1.0000	36.2581	53.18	950	0.010419	1.0000	0.010419	56.67
965	36.2412	1.0000	36.2412	53.04	965	0.010407	1.0000	0.010407	56.30
981	36.2274	1.0000	36.2274	52.92	981	0.010407	1.0000	0.010407	56.30
996	36.2090	1.0000	36.2090	52.77	996	0.010407	1.0000	0.010407	56.30
1011	36.1932	1.0000	36.1932	52.64	1011	0.010394	1.0000	0.010394	55.93
1026	36.1779	1.0000	36.1779	52.51	1026	0.010394	1.0000	0.010394	55.93
1042	36.1606	1.0000	36.1606	52.36	1042	0.010394	1.0000	0.010394	55.93
1057	36.1449	1.0000	36.1449	52.23	1057	0.010382	1.0000	0.010382	55.56
1072	36.1291	1.0000	36.1291	52.10	1072	0.010382	1.0000	0.010382	55.56
1087	36.1130	1.0000	36.1130	51.96	1087	0.010382	1.0000	0.010382	55.56
1102	36.0973	1.0000	36.0973	51.83	1102	0.010382	1.0000	0.010382	55.56
1118	36.0811	1.0000	36.0811	51.70	1118	0.010369	1.0000	0.010369	55.19
1133	36.0654	1.0000	36.0654	51.56	1133	0.010369	1.0000	0.010369	55.19
1148	36.0493	1.0000	36.0493	51.43	1148	0.010369	1.0000	0.010369	55.19
1163	36.0343	1.0000	36.0343	51.30	1163	0.010357	1.0000	0.010357	54.81
1179	36.0186	1.0000	36.0186	51.17	1179	0.010357	1.0000	0.010357	54.81
1194	36.0029	1.0000	36.0029	51.04	1194	0.010357	1.0000	0.010357	54.81
1209	35.9872	1.0000	35.9872	50.91	1209	0.010344	1.0000	0.010344	54.44
1224	35.9722	1.0000	35.9722	50.78	1224	0.010344	1.0000	0.010344	54.44
1239	35.9565	1.0000	35.9565	50.65	1239	0.010344	1.0000	0.010344	54.44
1255	35.9403	1.0000	35.9403	50.52	1255	0.010331	1.0000	0.010331	54.07
1270	35.9262	1.0000	35.9262	50.40	1270	0.010331	1.0000	0.010331	54.07
1285	35.9101	1.0000	35.9101	50.26	1285	0.010331	1.0000	0.010331	54.07
1300	35.8955	1.0000	35.8955	50.14	1300	0.010331	1.0000	0.010331	54.07
1315	35.8802	1.0000	35.8802	50.01	1315	0.010319	1.0000	0.010319	53.70
1331	35.8644	1.0000	35.8644	49.88	1331	0.010319	1.0000	0.010319	53.70
1346	35.8499	1.0000	35.8499	49.76	1346	0.010319	1.0000	0.010319	53.70
1361	35.8349	1.0000	35.8349	49.64	1361	0.010319	1.0000	0.010319	53.70
1376	35.8192	1.0000	35.8192	49.50	1376	0.010306	1.0000	0.010306	53.33
1392	35.8035	1.0000	35.8035	49.37	1392	0.010306	1.0000	0.010306	53.33
1407	35.7889	1.0000	35.7889	49.25	1407	0.010306	1.0000	0.010306	53.33
1422	35.7756	1.0000	35.7756	49.14	1422	0.010294	1.0000	0.010294	52.96
1437	35.7602	1.0000	35.7602	49.01	1437	0.010294	1.0000	0.010294	52.96
1452	35.7445	1.0000	35.7445	48.88	1452	0.010294	1.0000	0.010294	52.96
1468	35.7295	1.0000	35.7295	48.75	1468	0.010294	1.0000	0.010294	52.96
1483	35.7146	1.0000	35.7146	48.63	1483	0.010281	1.0000	0.010281	52.59
1498	35.6997	1.0000	35.6997	48.50	1498	0.010281	1.0000	0.010281	52.59
1513	35.6843	1.0000	35.6843	48.37	1513	0.010281	1.0000	0.010281	52.59
1529	35.6698	1.0000	35.6698	48.25	1529	0.010268	1.0000	0.010268	52.22
1544	35.6568	1.0000	35.6568	48.14	1544	0.010268	1.0000	0.010268	52.22
1559	35.6407	1.0000	35.6407	48.01	1559	0.010268	1.0000	0.010268	52.22
1574	35.6273	1.0000	35.6273	47.90	1574	0.010268	1.0000	0.010268	52.22
1589	35.6116	1.0000	35.6116	47.76	1589	0.010256	1.0000	0.010256	51.85
1605	35.5990	1.0000	35.5990	47.66	1605	0.010256	1.0000	0.010256	51.85
1620	35.5825	1.0000	35.5825	47.52	1620	0.010243	1.0000	0.010243	51.48
1635	35.5707	1.0000	35.5707	47.42	1635	0.010243	1.0000	0.010243	51.48
1650	35.5534	1.0000	35.5534	47.28	1650	0.010243	1.0000	0.010243	51.48
1665	35.5392	1.0000	35.5392	47.16	1665	0.010231	1.0000	0.010231	51.11
1681	35.5243	1.0000	35.5243	47.03	1681	0.010231	1.0000	0.010231	51.11

Measurements were performed with expanded uncertainty 0,5% for resistance and the confidence level P = 95%



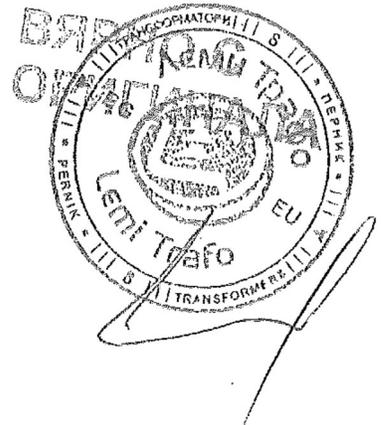
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	<b>TEMPERATURE RISE TEST</b>	Page 6	All pages 9
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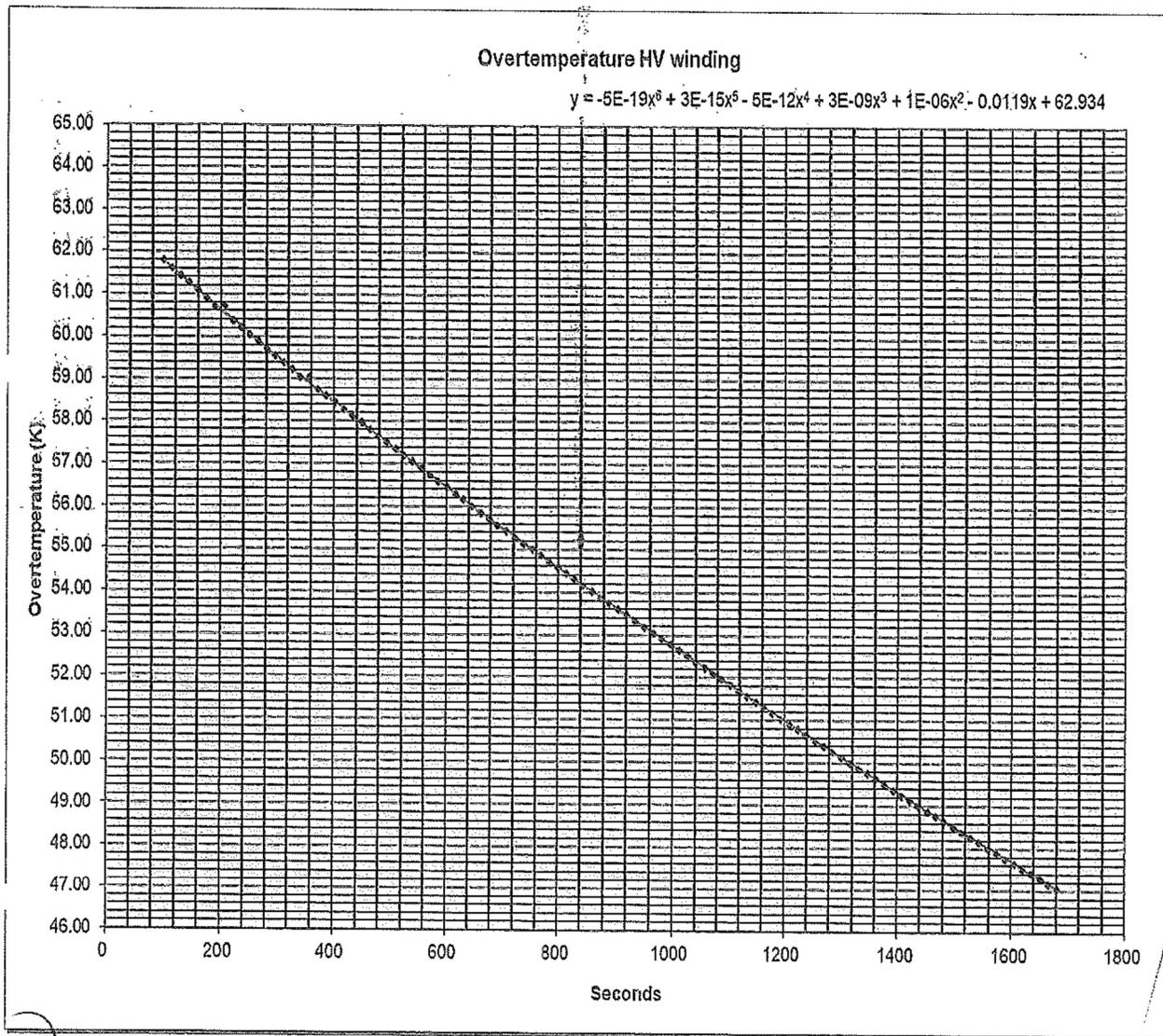
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TEMPERATURE RISE TEST

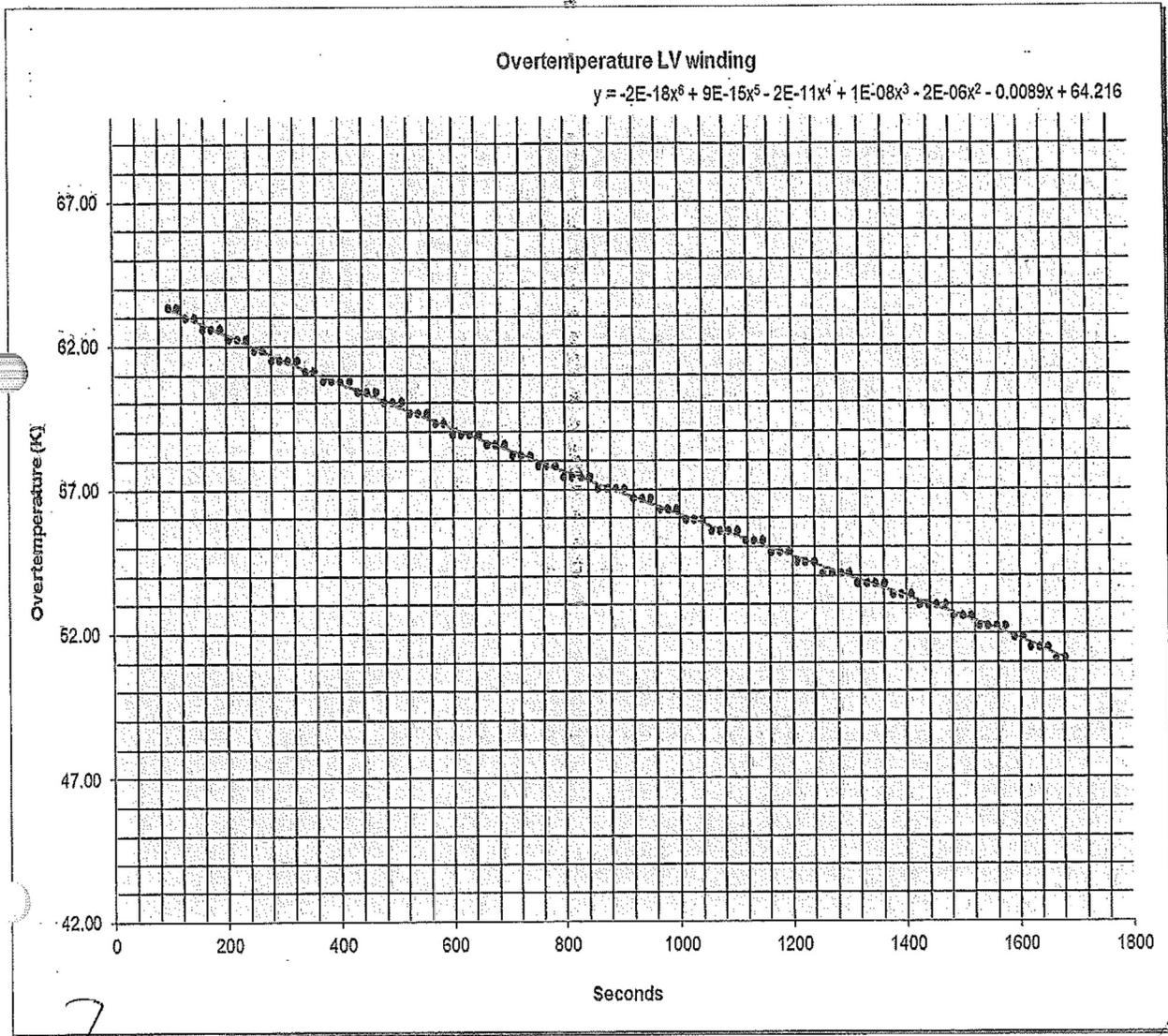
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	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	FC 5.10 – 1/8	
	<b>TEMPERATURE RISE TEST</b>	Page 8	All pages 9
		Revision 0	



11. Instruments used for the tests:



	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	FC 5.10 – 1/8	
	<b>TEMPERATURE RISE TEST</b>	Page 9	All pages 9
		Revision 0	

- Microohmmeter-MRC6105N-serial nr.0928-3306;
- Wattmeter " Yokogawa"-WT1600 serial nr.91J702269;
- Cast resin VT Cl.3.6kV(1500-3000/100V)-VKM24/2/H-serial nr.: 345080101;345080102;345080103;
- Cast resin CT(25-300/5A)-AOS-serial nr.: 09195334;09195335;09195336;
- Resistance thermometer Pt 100, type 448/2012 - serial nr. 1,2,3,4,5,6,7;
- Mechanical chronometer type Slava serial nr. 0521682

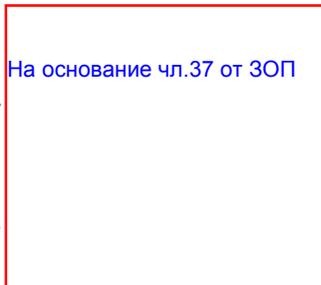
**Notes:**

1. The results from the tests are referred for the tested product only.
2. Reproduction or copying of the contents of this report in any other form unless its complete photocopying is not allowed without written consent from LTC-TEST.

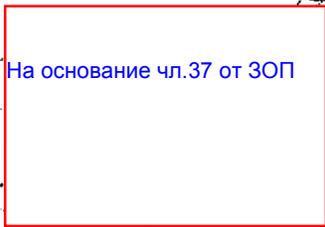


**TESTED BY :**

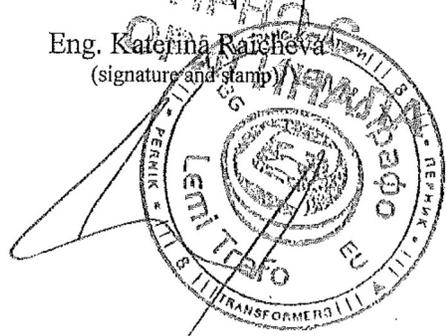
1. Oleg Tsvetanov:....
2. Vasil Vasilev:.....



Head of "LTC-TEST".....



Eng. Katerina Karcheva  
(signature and stamp)



	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	FC 5.10 – 1/9	
	<b>LIGHTING IMPULSE TEST</b>	Page 1	All pages 6
		Revision 0	

## TEST REPORT

№ 0026-3/22.05.2020

*Certificate of accreditation  
reg. №81111 valid until 28.12.2022  
issued by Executive Agency "BAS",  
according to the requirements of standard  
EN ISO/IEC 17025:2018*

CUSTOMER: LEMI TRAFО JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;

SUBJECT: Three phase cast resin transformer  
**160kVA - 20/0.4kV**

REF. CUSTOMER № 24

Dated: 04-May-20

REF. CONSTRUCTOR

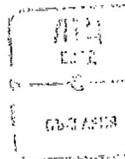
TEST ROOM : "LTC - TEST" Pernik

OBJECT OF THE TEST : Test is carried out to determine the conformity of the product to the customer order.

DATE OF ISSUE 22-May-20

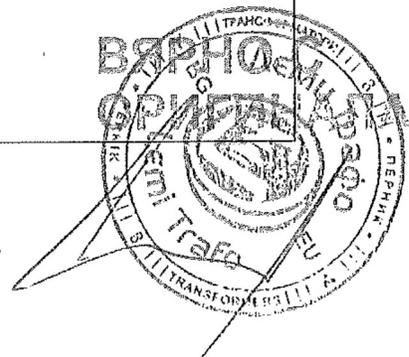
RECEIVER COPY LEMI TRAFО JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie

THE TESTER



На основание чл.37 от ЗОП

CUSTOMER



	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	FC 5.10 – 1/9	
	<b>LIGHTING IMPULSE TEST</b>	Page 2	All pages 6
		Revision 0	

**Serial №13065**

Power	160 kVA
Cooling	AN
Insulation class	125/50/24

Frequency	50 Hz
Overtemperature	100K
Type	TC160-20

Year of production	2020
Vector group	Dyn5
Standard	IEC60076-3

**Primary winding**

Voltage (V)	20000
Tapping's	±2x2.5%
Current (A)	4.62
Connection	Delta
Insulation class (kV)	24

**Secondary winding**

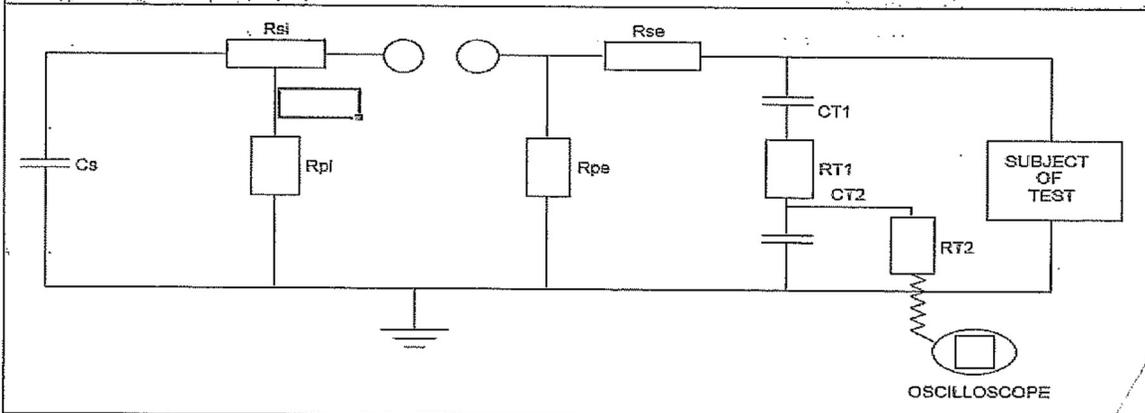
Voltage (V)	400
Tapping's	-
Current (A)	230.94
Connection	Star+n
Insulation class (kV)	1.1

**IMPULSE TENSION: 125kV**

**POLARITY: NEGATIVE**

**Testing scheme**

**NORMAL WAVE 1,2 ±30% / 50 ±20%**



**Impulse generator "AME"**

Total max load of tension 400kV - Energy at max load of tension- 20 kJ

Number of arms : Four arms in serial

**CALIBRATION CONSTANT FOR IMPULSE TEST:**

**K = 6794.8**

**Result from the test:**

Date: 22.05.2020	LTC-TEST	Customer	<b>POSITIVE</b>
	На основании чл.37 от 30П		



TEST LABORATORY "LTC - TEST"  
TO "LTC" Ltd.

FC 5.10 – 1/9

LIGHTING IMPULSE TEST

Page 3 | All pages 6

Revision 0

### Three phase cast resin transformer

160kVA = 20/0.4kV

#### 1. REQUIREMENTS OF THE TEST:

Perform a Lighting Test over the transformer for each phase of medium voltage side.

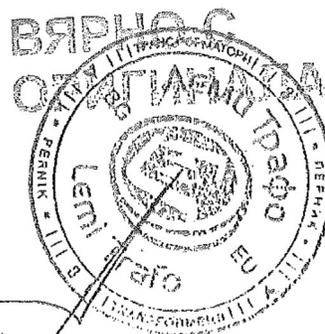
*The impulse must have the following characteristics:*

- Nominal Impulse Voltage: 125 kV
- Nominal time of front duration: 1.2  $\mu$ s( $\pm$ 30%)
- Nominal time duration of the half of tail: 50  $\mu$ s( $\pm$ 20%)
- Max over-shoot on the peak of the waveform: 10 %

*The test will be performed according to IEC standards № IEC-EN-60076-4*

#### 2. ENVIRONMENTAL CONDITION DURING THE TEST

Air temperature: 23°C  
Pressure: 949 mb  
Relative humidity % 43%





TEST LABORATORY "LTC - TEST"  
TO "LTC" Ltd.

FC 5.10 – 1/9

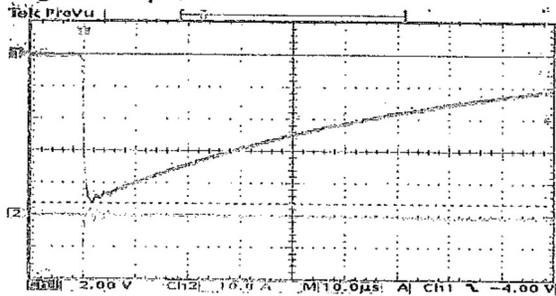
LIGHTING IMPULSE TEST

Page 4 All pages 6

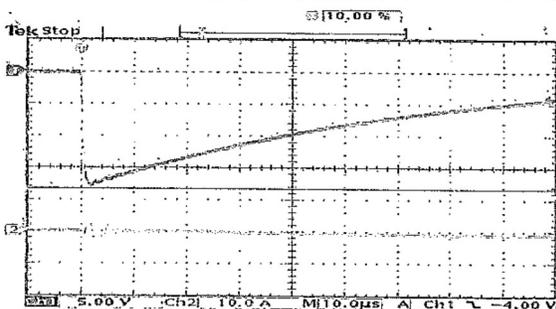
Revision 0

### OSCILLOGRAM REGISTRATION

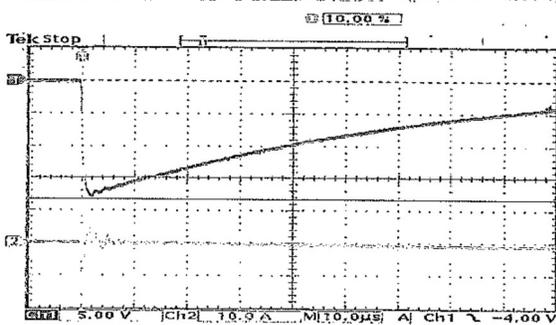
Negative impulse on Phase A



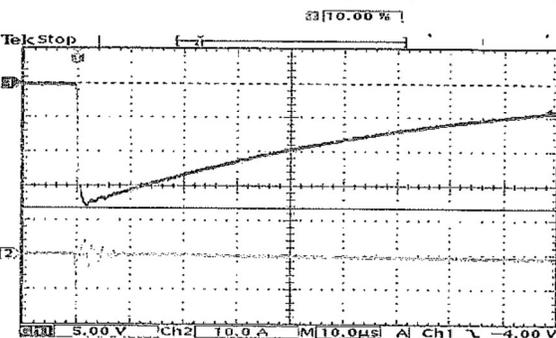
No	kV	T1(μs)	T2(μs)
1	63.0	1.48	49.4
2	124.3	1.48	49.4
3	124.3	1.48	49.4
4	124.3	1.48	49.4



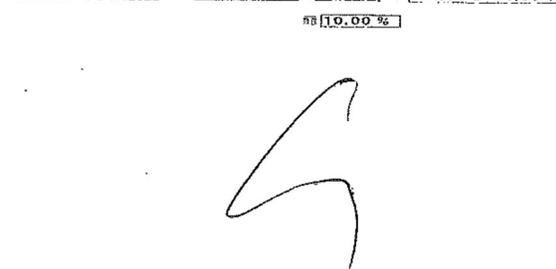
22 May 2020  
13:12:37



22 May 2020  
13:18:36



22 May 2020  
13:22:47



22 May 2020  
13:26:08

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TEST LABORATORY "LTC - TEST"  
TO "LTC" Ltd.

FC 5.10 - 1/9

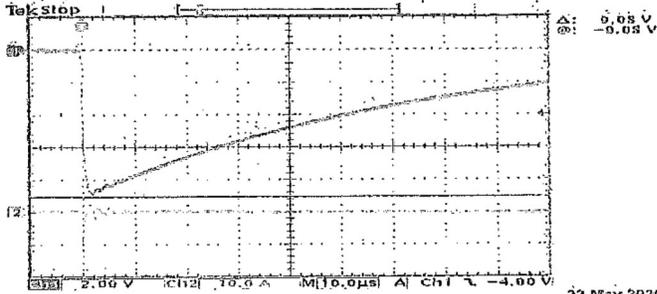
LIGHTING IMPULSE TEST

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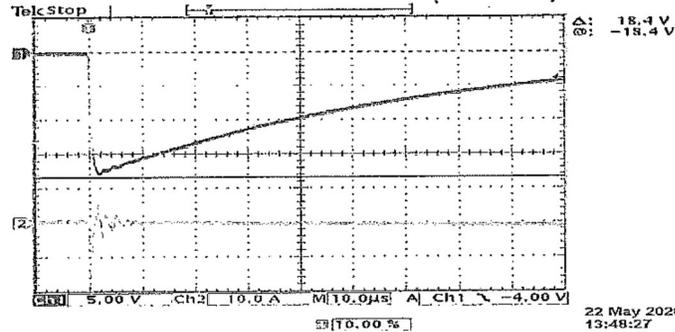
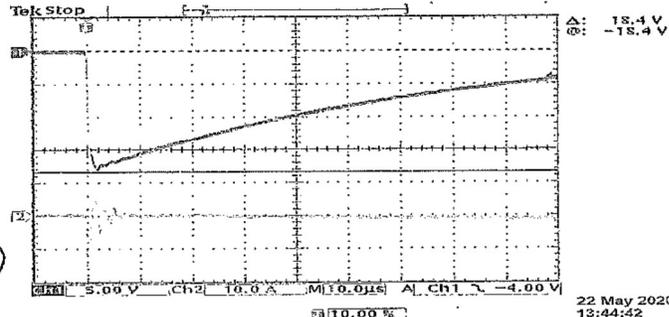
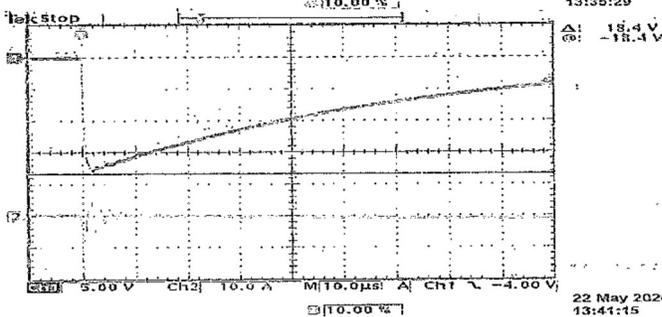
Revision 0

OSCILLOGRAM REGISTRATION

Negative impulse on Phase B



No	kV	T1(μs)	T2(μs)
1	61.7	1.48	49.4
2	125.0	1.48	49.4
3	125.0	1.48	49.4
4	125.0	1.48	49.4



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TEST LABORATORY "LTC - TEST"  
TO "LTC" Ltd.

FC 5.10 - 1/9

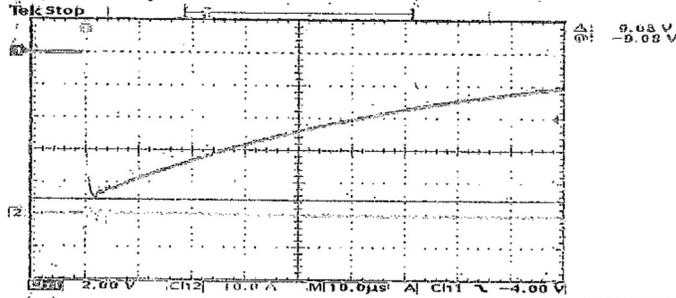
LIGHTING IMPULSE TEST

Page 6 | All pages 6

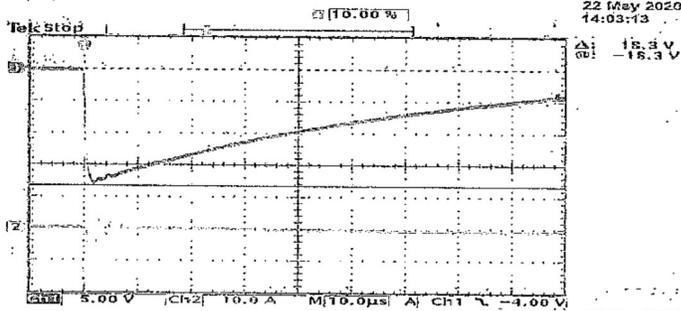
Revision 0

### OSCILLOGRAM REGISTRATION

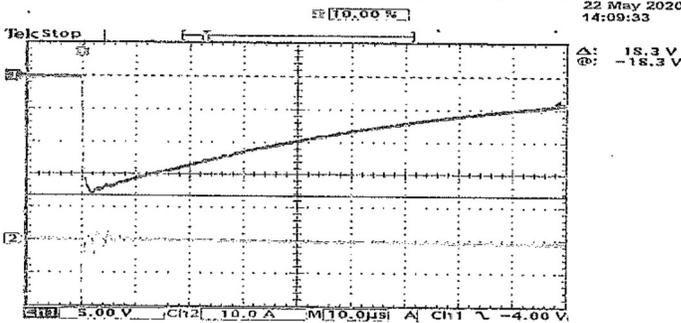
Negative impulse on Phase C



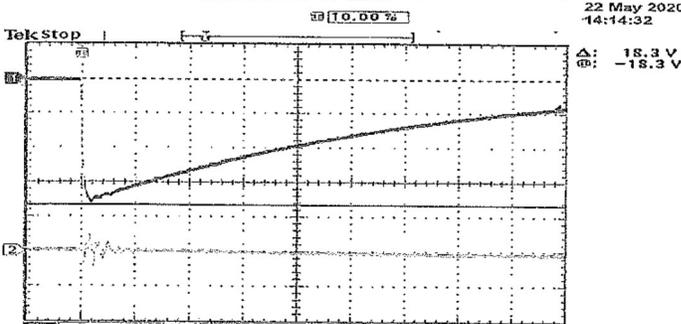
No	kV	T1(μs)	T2(μs)
1	61.7	1.48	49.4
2	124.3	1.48	49.4
3	124.3	1.48	49.4
4	124.3	1.48	49.4



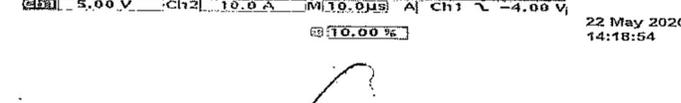
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22 May 2020  
14:09:33



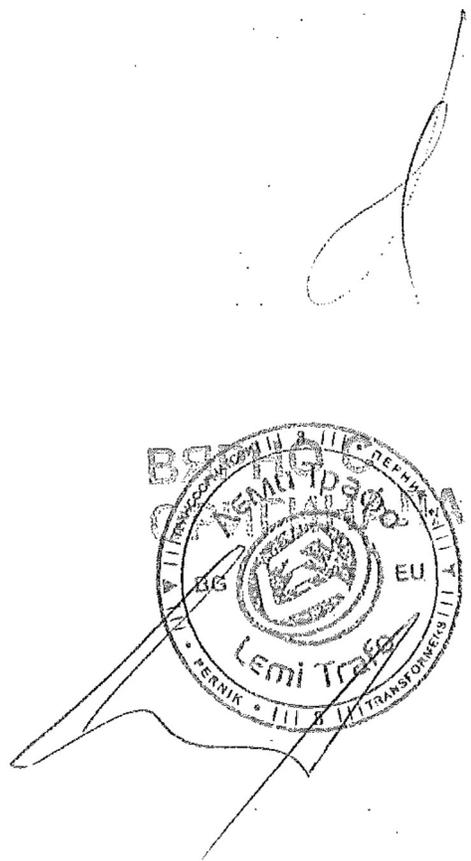
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22 May 2020  
14:18:54

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	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	FC 5.10 – 1/10	
	<b>SOUND LEVEL MEASUREMENT</b>	Page 1	All pages 3
		Revision 0	

## TEST REPORT

№ 0026-4/22.05.2020

*Certificate of accreditation  
reg. №81/III valid until 28.12.2022  
issued by Executive Agency "BAS",  
according to the requirements of standard  
EN ISO/IEC 17025:2018*

1. Three-phase cast resin transformer,  
TC 160-20, Dyn5, №13065, 2020
2. Customer : LEMI TRAF0 JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;  
order 0024/04.05.2020
3. Manufacturer: LEMI TRAF0 JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;
4. Test methods used : IEC 60076-11:2018;
5. Date on which the product was received in test room: 18.05.2020
6. Tests performed:  
6.1 Determination of sound levels - (IEC60076-10 cl.11.2)
7. Test date : 22.05.2020
8. Test result: The product passed the tests
9. The report contains: 3 pages
10. Site: Test Room "LTC-TEST", Pernik



На основание чл.37 от ЗОП

Head of "LTC-TEST" ...

Eng. Katerina Raicheva  
(signature and stamp)

	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>		FC 5.10 – 1/10	
	<b>SOUND LEVEL MEASUREMENT</b>		Page 2	All pages 3
			Revision 0	

**11. Test result:**

**Details of transformer**

Serial No : 13065                      kVA: 160                      Voltage: 20000 ± 2x2,5% / 400

**Details of measuring instrument**

Brand: Brüel & Kjær                      Type: 2238 Mediator                      Serial No : 2684705

Microphone type : 4188                      Microphone serial No : 2690664

**Test conditions**

Feeding voltage: 400V                      Frequency: 50 Hz

Tap Position : 7-4

**A weighted sound pressure level LpA :**

- Dry type transformer without enclosure
- Dry type transformer with enclosure

Measuring position	dB 1	dB 2	dB 3	Measuring position	dB 1	dB 2	dB 3
1	38.02	30.36	37.02	9	38.26	30.52	37.26
2	39.54	30.58	38.54	10	37.74	30.18	36.74
3	37.05	31.02	36.05	11			
4	38.43	31.17	37.43	12			
5	37.86	30.76	36.86	13			
6	39.03	30.89	38.03	14			
7	38.12	30.93	37.12	15			
8	37.96	31.26	36.96	16			

**Legend**

- 1 = Transformer noise
- 2 = Background noise
- 3 = Transformer correct noise

Arithmetic/energy average : **38.20 dB** on 10 measure points

LpA	32.74 dB
LWA	46.22 dB

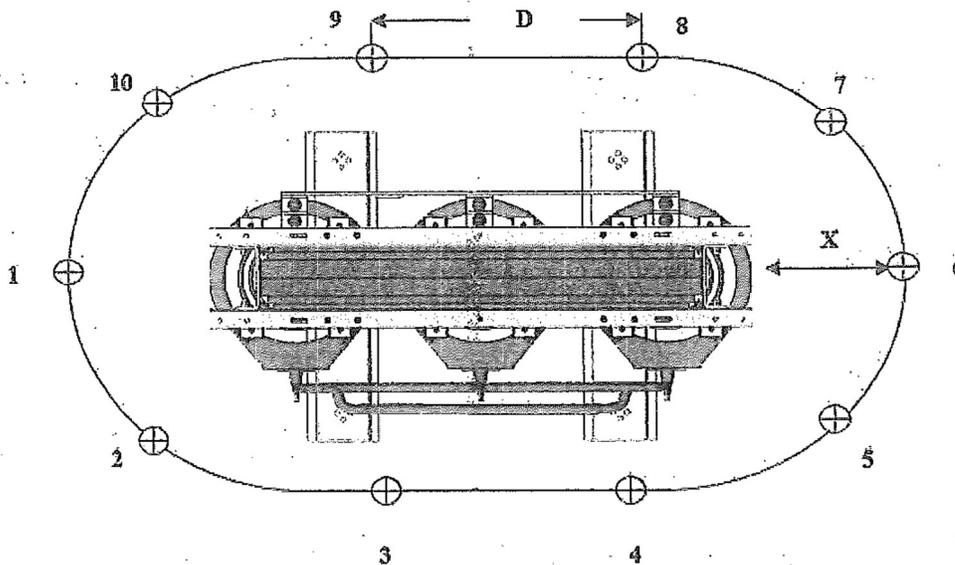
Environmental correction K  
Principal prescribed countur  
Total area of the surface test room

**4.51459**  
22.2817 m<sup>2</sup>  
106 m<sup>2</sup>



	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	FC 5.10 – 1/10	
	<b>SOUND LEVEL MEASUREMENT</b>	Page 3	All pages 3
	Revision 0		

**12. Testing scheme:**



Distance X = 1.0m. Distance D = 0.97m. Microphone height from floor: 0,64m

**13. Instruments used for the tests:**

- Calibrator Sound Level Meter, serial nr.2651663
- Sound Level Meter, serial nr. 2684705
- Measuring Roulette, steel, serial nr. 51217

**Notes:**

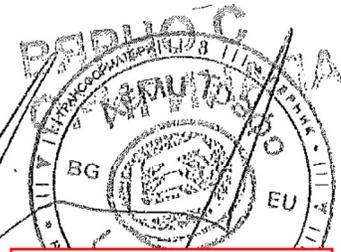
1. The results from the tests are referred for the tested product only.
2. Reproduction or copying of the contents of this report in any other form unless its complete photocopying is not allowed without written consent from LTC-TEST.

**TESTED BY :**

1. Oleg Tsvetanov:..

На основание чл.37 от ЗОП

2. Vasil Vasilev:....



На основание чл.37 от ЗОП

Head of "LTC-TEST" :...

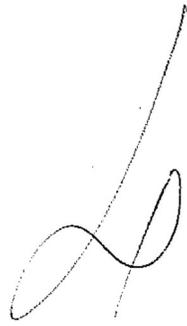
Eng. Katerina Raicheva  
(signature and stamp)

	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	
	<b>PARTIAL DISSCHARGE MEASUREMENT</b>	<b>Page 1</b>   <b>All pages 3</b>
		<b>Revision 0</b>

## TEST REPORT

№ 0026-5/22.05.2020

1. Three-phase cast resin transformer,  
TC 160 - 20, Dyn5, №13065, 2020
2. Customer : LEMI TRAFО JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;  
order 0024/04.05.2020
3. Manufacturer: LEMI TRAFО JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;
4. Test methods used : IEC 60076-11:2018;
5. Date on which the product was received in test room: 18.05.2020
6. Tests performed:  
6.1 Partial discharge measurement - (IEC60076-11 cl.14.2.7.5)
7. Test date : 22.05.2020
8. Test result: The product passed the tests
9. The report contains: 3 pages
10. Site: Test Room "LTC-TEST", Pernik
11. Atmospheric conditions: P=951 mbar; T=23 °C; Hr=44%




На основание чл.37 от ЗОП

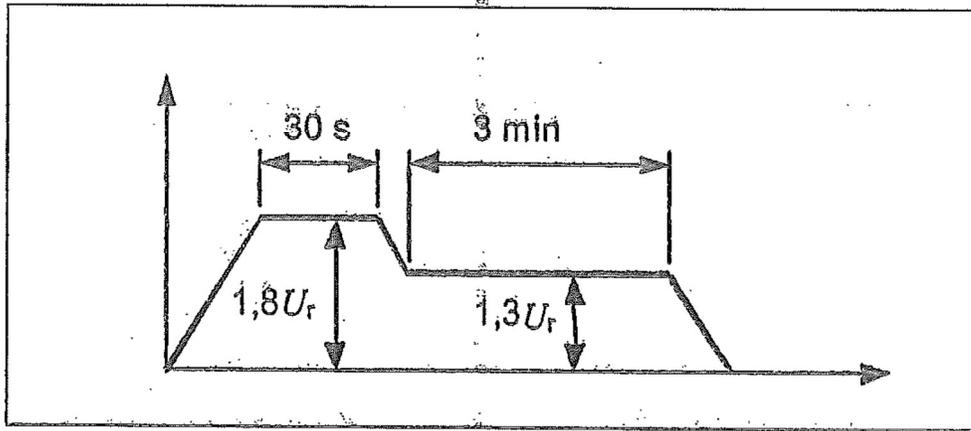
Head of "LTC-TEST"

Eng. Katerina Raicheva  
(signature and stamp)

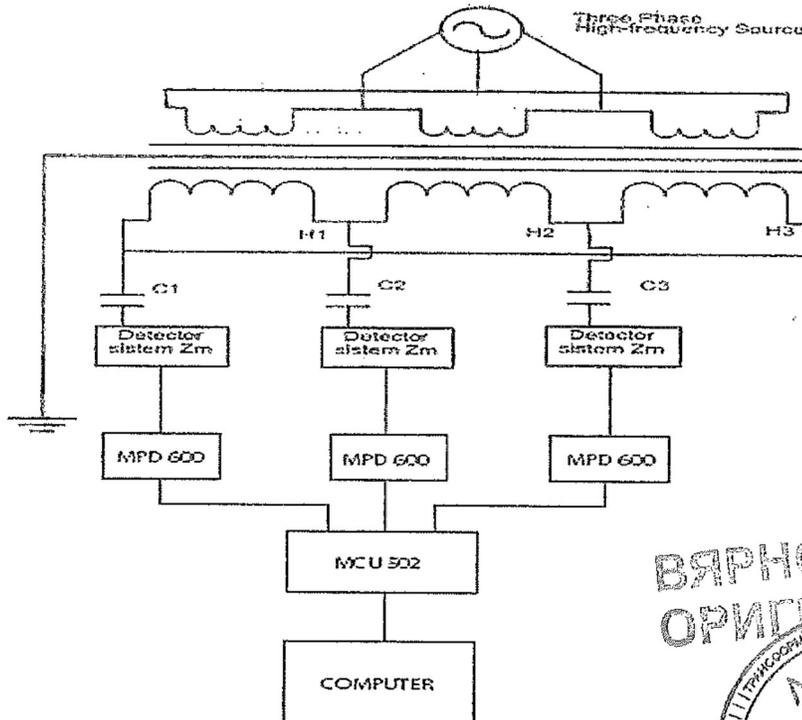




12. Testing scheme:



Measuring circuit of Partial discharge measurement



13. Test results:

Test voltage(kV)	Time	Frequency (Hz)	PD level (pC)		
			1 U	1 V	1 W
$U_3 = 1.8 * 20 = 36$	30 s	150	-	-	-
$U_2 = 1.3 * 20 = 26$	3 min		1.88	1.96	2.44
Background 0.3 pC					



	<b>TEST LABORATORY "LTC - TEST"</b> <b>TO "LTC" Ltd.</b>	
	<b>PARTIAL DISSCHARGE MEASUREMENT</b>	Page 3   All pages 3
		Revision 0

**14. Equipment's used:**

- Group Motor Generator: f=150Hz
- Coupling capacitors: 1nF/100kV
- PD Calibrator type CAL 542. Charge for calibration: 0-1000 pC.
- Measuring system OMICRON
- CPL 542
- MPD 600
- MCU 502

**Notes:**

1. The results from the tests are referred for the tested product only.
2. Reproduction or copying of the contents of this report in any other form unless its complete photocopying is not allowed without written consent from LTC-TEST.

**TESTED BY:**

1. Oleg Tsvetanov:...

На основание чл.37 от ЗОП

2. Vasil Vasilev:.....

Head of "LTC-TEST":

На основание чл.37 от ЗОП

Eng. Katerina Raicheva  
(signature and stamp)





## СПИСЪК НА ПРОВЕДЕНИТЕ ИЗПИТВАНИЯ

1. Трифазен сух трансформатор,  
тип ТС 250-10, фабричен №13384, година на производство - 2020.
2. Заявител на изпитанието: “Леми Трафо” ЕАД; гр.Перник, ул. Владайско въстание №1,  
заявка № 0031/15.07.2020г.
3. Производител: “Леми Трафо” ЕАД; гр.Перник, ул. Владайско въстание №1.
4. Технически данни:

Обозначение	ТС250-10	
Номинална мощност (kVA)	250	
Честота (Hz)	50	
Номинално напрежение (V)	ВН	10000
	НН	400
Загуби на (W)	Празен ход	468
	Късо съединение към 120°C	3400
Група на свързване	Dyn5	
Регулационни отклонения на страна ВН	± 2 x 2.5%	
Изоляционен клас	ВН	12 kV (28 kV rms / 75 kV peak)
	НН	1.1kV (3kV rms / - kV peak)
Охлаждане	AN	
Надморска височина	<1000 m	

5. Дата на получаване на продукта за изпитване в лабораторията: 31.07.2020г.





6. Извършени изпитвания:

6.1. Рутинен тест:

- 6.1.1. Измерване на коефициента на трансформация и група на свързване (IEC 60076-1:2011-cl.11.3);
- 6.1.2. Измерване на активното съпротивлението на намотките с постоянен ток (IEC 60076-1:2011-t.11.2);
- 6.1.3. Измерване на загубите и тока на празен ход (IEC 60076-1:2011-cl.11.5);
- 6.1.4. Измерване на загубите и напрежението на късо съединение (IEC 60076-1:2011-cl.11.4);
- 6.1.5. Диелектрични изпитвания (IEC 60076-3:2013)
  - 6.1.5.1. Изпитване на изолацията с напрежение, приложено от външен източник (IEC 60076-3:2013-t.10);
  - 6.1.5.2. Изпитване на изолацията с индуктирано напрежение (IEC 60076-3:2013-t.11.2);
- 6.1.6. Измерване на частични разряди - (IEC 60076-11: 2018)

6.2. Типов тест:

- 6.2.1. Изпитване на прегряване (IEC 60076-2:2000);
- 6.2.2. Изпитване на изолацията с мълниен импулс (IEC 60076-4:2002);

6.3. Специален тест:

- 6.3.1. Определяне на звуковото ниво (IEC 60076-10:2005);

7. Период на изпитване: 03 - 06.08.2020г.

8. Резултат от изпитванията: **Продуктът Трифазен сух трансформатор тип ТС 250-10, фабричен № 13384, премина успешно изпитанията.**

Резултати от изпитванията са включени в тестови протоколи: № 0034-1/03.08.2020; № 0034-2/05.08.2020; № 0034-3/06.08.2020; № 0034-4/06.08.2020; № 0034-5/06.08.2020;

9. Списък от изпитванията съдържа 2 страници.

На основание чл.37 от ЗОП

РЪКОВОДИТЕЛ НА "ЛТЦ-ТЕСТ" ЕООД

инж. Катерина Райчева  
(подпис и печат)

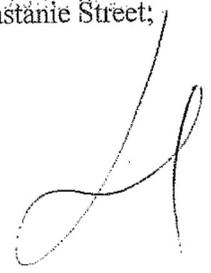


	<b>TEST LABORATORY "LTC - TEST" TO "LTC" Ltd.</b>	FC 5.10 – 1/7	
	<b>ROUTINE TEST REPORT</b>	Page 1	All pages 7
		Revision 0	

**TEST REPORT**  
№ 0034-1/03.08.2020

*Certificate of accreditation  
reg. №81JII valid until 28.12.2022  
issued by Executive Agency "BAS",  
according to the requirements of standard  
EN ISO/IEC 17025:2018*

1. Three phase cast resin transformer;  
 TC 250-10, Dyn5, №13384, 2020
2. Customer : LEMI TRAFO JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;  
order 0031/15.07.2020
3. Manufacturer: LEMI TRAFO JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street;
4. Test methods used : IEC 60076-11:2018;  
IEC 60076-3:2013;
5. Date on which the product was received in test room: 31.07.2020
6. Tests performed:
  - 6.1. Measurement of voltage ratio and check of phase displacement  
(IEC 60076-1:2011- cl.11.3);
  - 6.2. Measurement of winding resistance (IEC 60076-1:2011-cl.11.2);
  - 6.3. Measurement of no-load losses and current (IEC 60076-1:2011-cl.11.5);
  - 6.4. Measurement of short circuit impedance and load losses  
(IEC 60076-1:2011-cl.11.4);
  - 6.5 Dielectric routine tests (IEC 60076-3:2013):
    - 6.5.1. Separate source AC withstand voltage test (IEC 60076-3:2013-cl.10);
    - 6.5.2. Induced AC withstand voltage test (IEC 60076-3:2013-cl.11.2);
7. Test date: 03.08.2020
8. Test result: The product passed the tests
9. The report contains: 7 pages



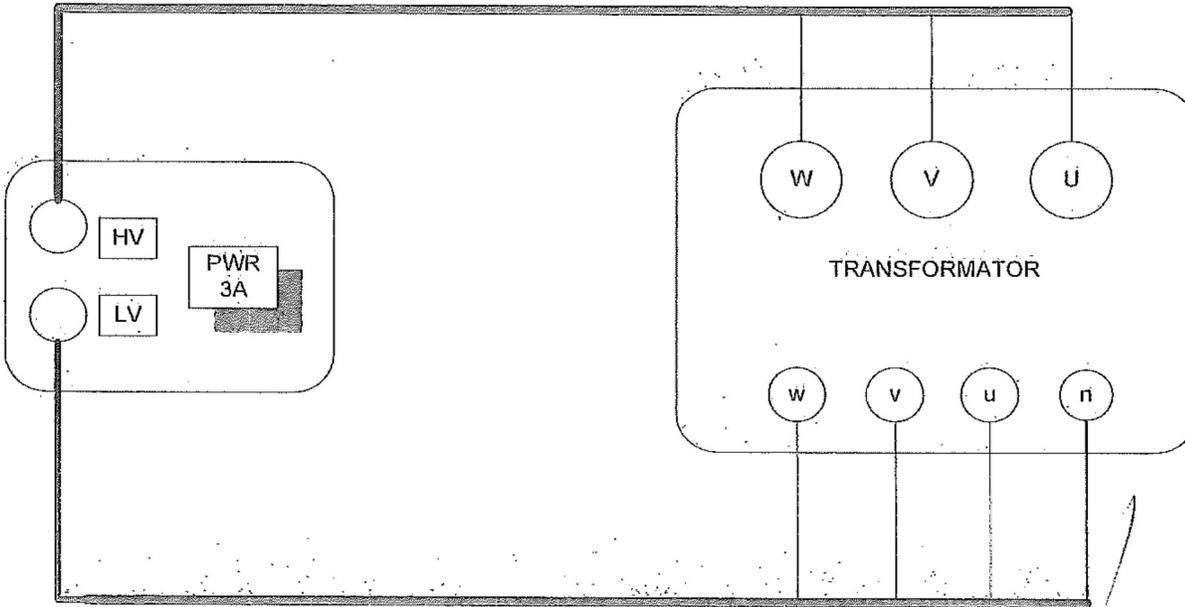

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Head of "LTC-TEST"  
Eng. Katerina Raicheva  
(signature and stamp)

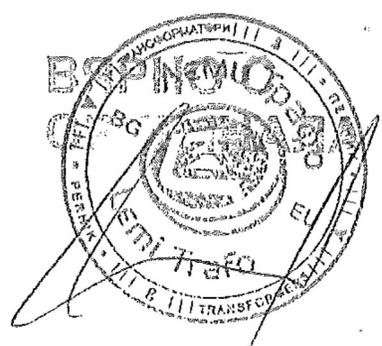
**10. Test results:**

**10.1. Measurement of voltage ratio (10000/400V) and check of phase displacement:**

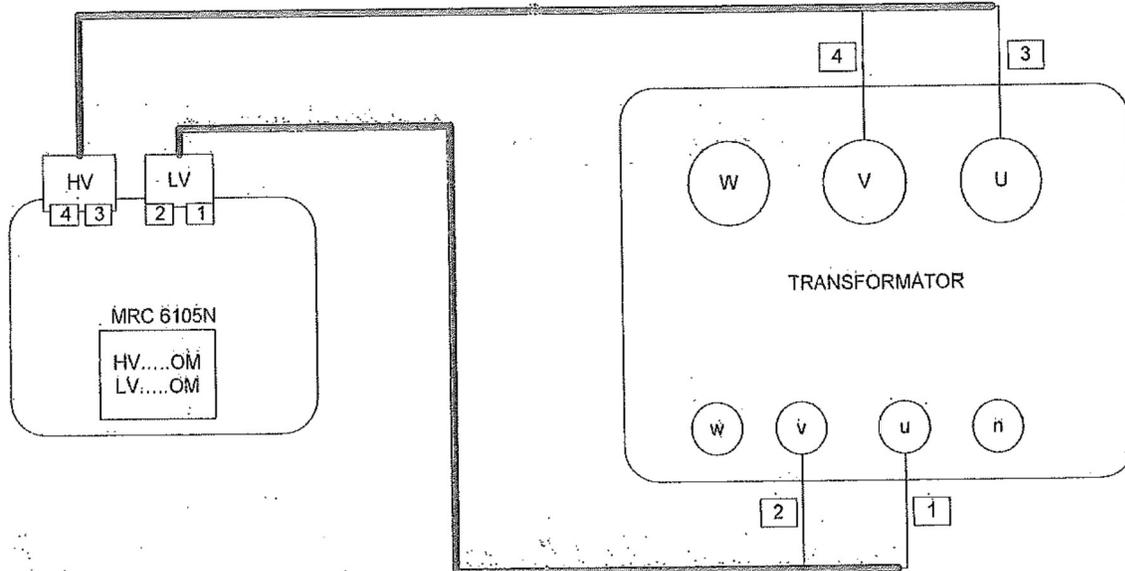


Tap changer position	Phase A	Transformation coefficient's error, %	Phase B	Transformation coefficient's error, %	Phase C	Transformation coefficient's error, %	Vector group
7 - 6	45,512	0,10	45,508	0,09	45,511	0,10	Dyn5
5 - 7	44,426	0,10	44,422	0,09	44,425	0,09	
4 - 7	43,339	0,09	43,336	0,08	43,338	0,08	
8 - 5	42,252	0,08	42,25	0,07	42,251	0,08	
8 - 4	41,166	0,07	41,164	0,07	41,165	0,07	

*Measurements were performed with expanded uncertainty of 3% and the confidence level P = 95%.*



**10.2 Measurement of winding resistance:**



Tap changer position	$R_{U-V}, \Omega$	$R_{U-W}, \Omega$	$R_{V-W}, \Omega$	Temperature during test 26°C	
7 - 6	-	-	-	$R_{U-V}, \Omega$	0,004955
5 - 7	-	-	-	$R_{U-W}, \Omega$	0,004990
4 - 7	3,9831	3,9849	3,9892	$R_{V-W}, \Omega$	0,004949
8 - 5	-	-	-		
8 - 4	-	-	-		

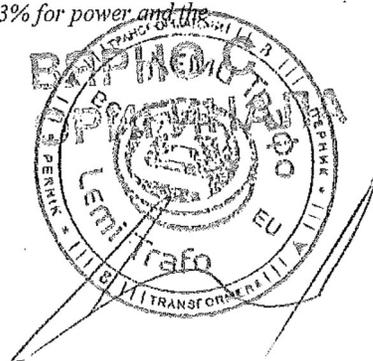
Measurements were performed with expanded uncertainty 0,5% and the confidence level  $P = 95\%$ .

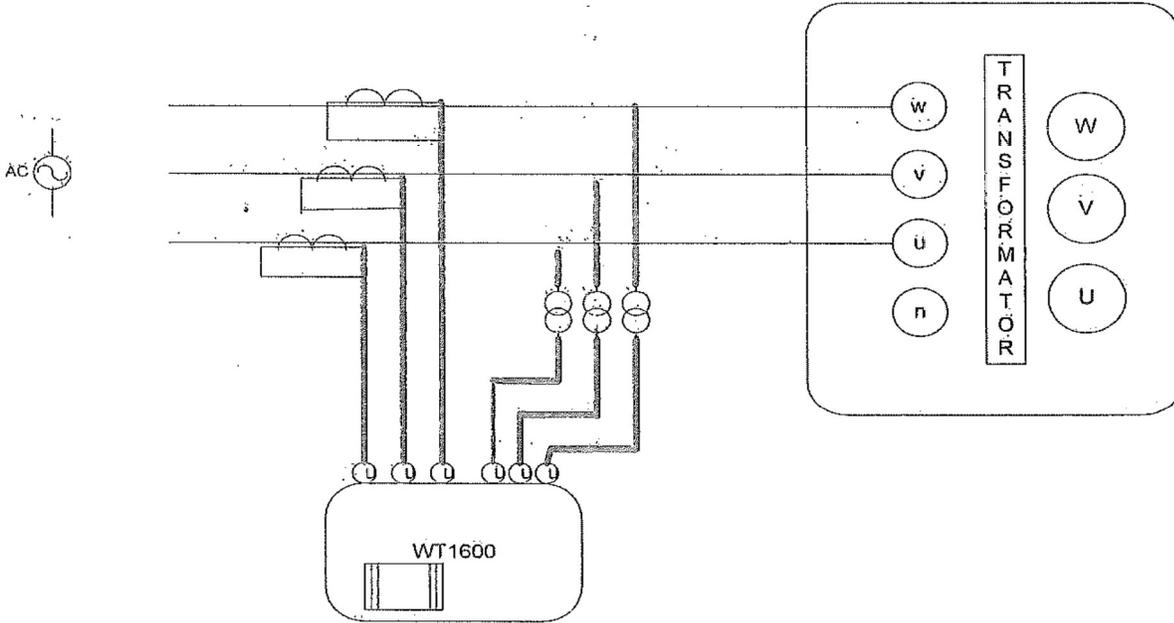
**10.3 Measurement of no-load losses and current:**

Tap changer position	U1 [V]	U2 [V]	U3 [V]	I1 [A]	I2 [A]	I3 [A]	P1 [W]	P2 [W]	P3 [W]
4 - 7	401,1	399,38	399,5	1,25	0,957	1,338	190,8	117,2	151,1

U <sub>av.</sub> [V]	I <sub>av.</sub> [A]	P <sub>tot.</sub> [W]	I <sub>0</sub> [%]
399,99	1,1815	459	0,33

Measurements were performed with expanded uncertainty: 2% for voltage, 2,5% for current, 3% for power and the confidence level  $P = 95\%$ .





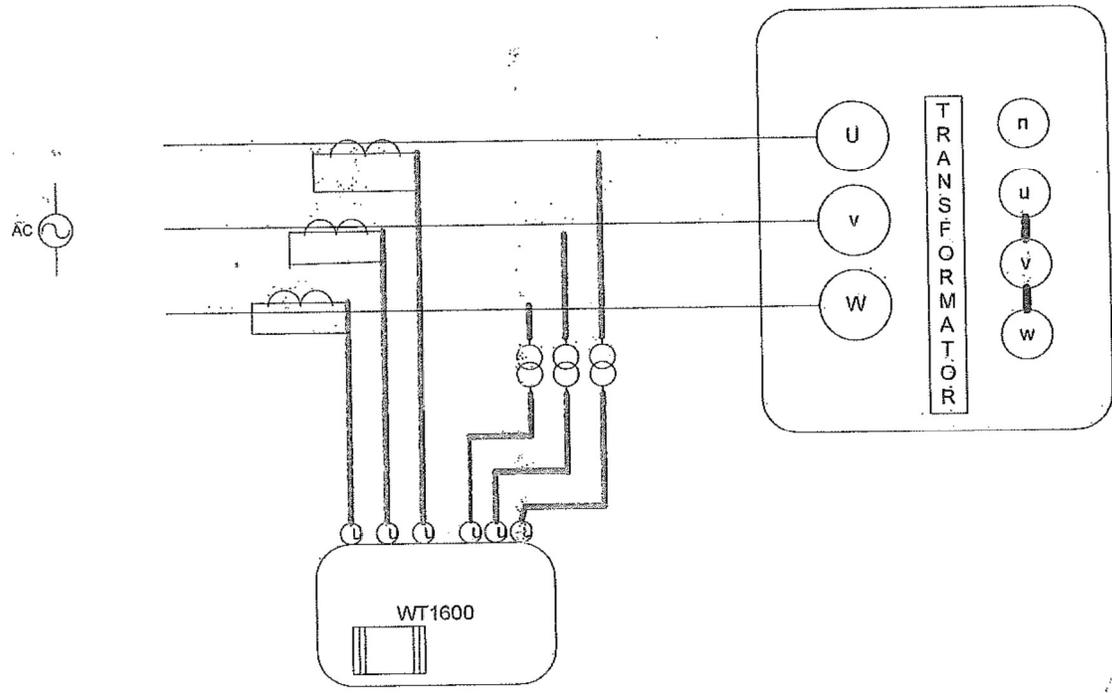
10.4 Measurement of short circuit impedance and load losses at temperature 26 °C:

Tap changer position	U1 [V]	U2 [V]	U3 [V]	I1 [A]	I2 [A]	I3 [A]	P1 [W]	P2 [W]	P3 [W]
4 - 7	356,5	356,2	356,6	8,779	8,723	8,701	306,8	310,5	301,5

U <sub>av</sub> [V]	I <sub>av</sub> [A]	ΣP [W]	P <sub>k</sub> <sup>120°C</sup> [W]	U <sub>k</sub> <sup>120°C</sup> [%]
356,42	8,734	918,8	3259	5,95

Measurements were performed with expanded uncertainty: 2% for voltage, 2,5% for current, 3% for power and the confidence level P = 95%.





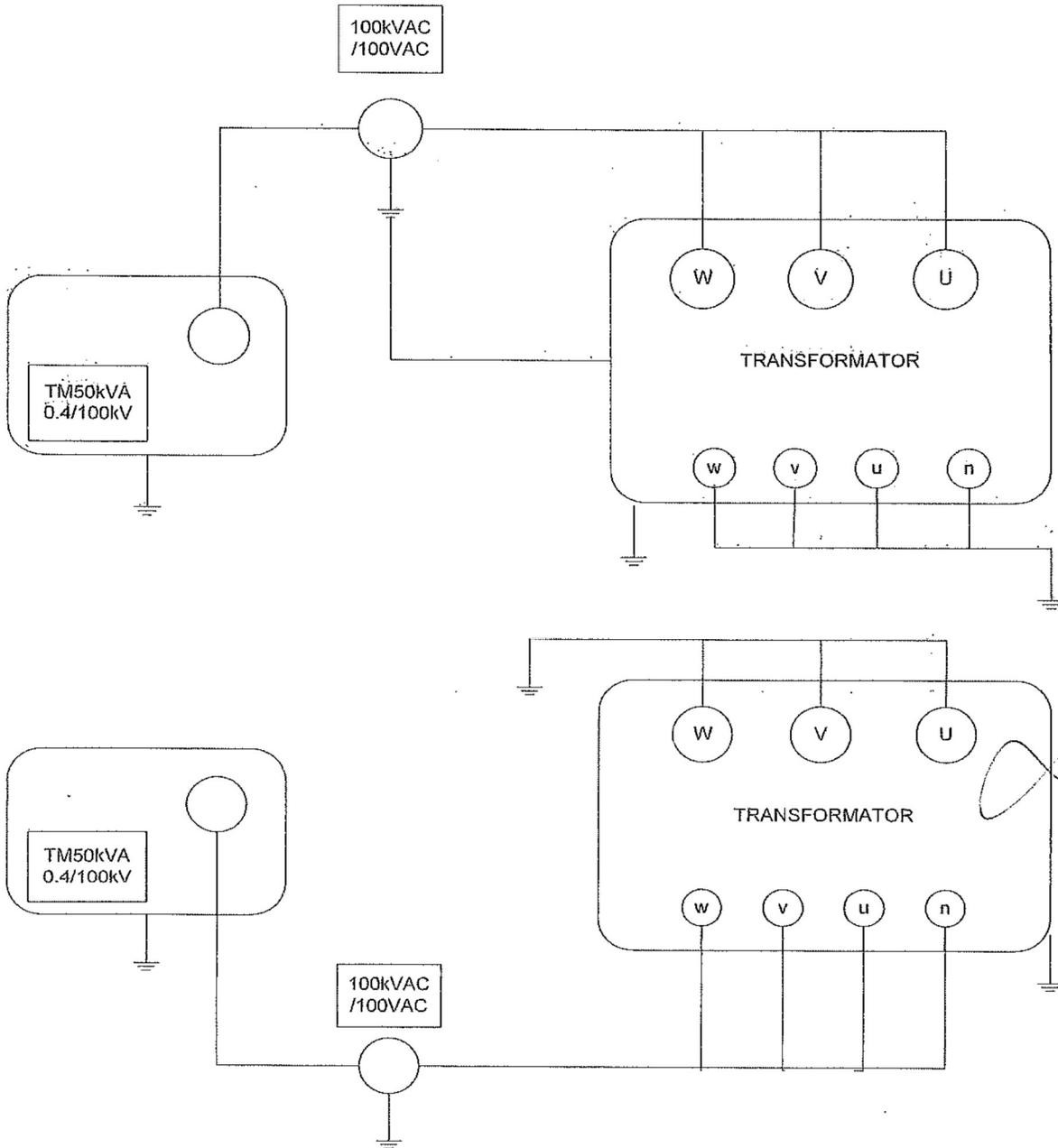
**10.5 Dielectric routine tests :**

**10.5.1 Separate source AC withstand voltage test:**

Winding	Earthing	Test voltage, [kV]	Frequency, [Hz]	Test time, [s]
High voltage	LV+tank	28	50	60
Low voltage	HV+tank	3	50	60

*Measurements were performed with expanded uncertainty: 3,6% for voltage and the confidence level P = 95%.*

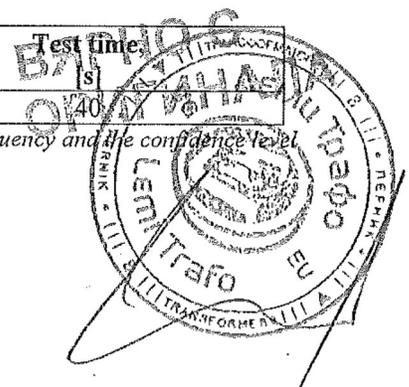




10.5.2 Induced AC withstand voltage test:

Test voltage $2xU_n$ , [V]	Frequency, [Hz]	Test time, [s]
800	150	40

Measurements were performed with expanded uncertainty: 2% for voltage, 0,0016% for frequency and the confidence level  $P = 95\%$ .



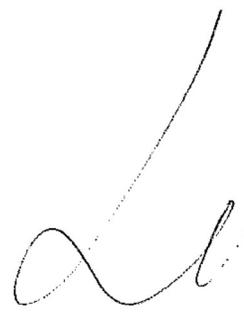
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**11. Instruments used for the tests:**

- Turn ratio meter PWR 3-A serial nr.0928-5305;
- Microohmmeter-MRC6105N-serial nr.0928-5306;
- Wattmeter "Yokogawa"-WT1600 serial nr.91J702269;
- Cast resin VT Cl.3.6kV(1500-3000/100V)-VKM24/2/H-serial nr.:  
345080101; 345080102; 345080103;
- Cast resin CT(25-300/5A)-AOS-serial nr.: 09195334; 09195335; 09195336;
- Capacitor divider(100V/100kV)- serial nr.1954
- Digital thermometer type HI 8757 serial nr.1203939
- Mechanical chronometer type Slava serial nr.0521682

**Notes:**

1. The results from the tests are referred for the tested product only.
2. Reproduction or copying of the contents of this report in any other form unless its complete photocopying is not allowed without written consent from LTC-TEST.



**TESTED BY :**

1. Oleg Tsvetanov: На основание чл.37 от ЗОП

2. Vasil Vasilev:...



На основание чл.37 от ЗОП

Head of "LTC-TEST" ...

ИТЛ  
ЕООД  
БЪЛГАРИЯ

Eng. Katerina Raicheva  
(signature and stamp)



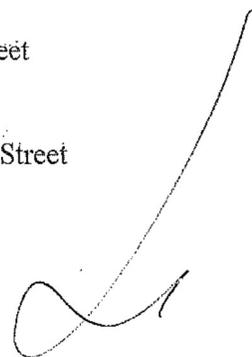

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## TEST REPORT

№0034-2/05.08.2020

*Certificate of accreditation  
reg. №81JII valid until 28.12.2022  
issued by Executive Agency "BAS",  
according to the requirements of standard  
EN ISO/IEC 17025:2018*

1. Three phase cast resin transformer,  
TC 250-10, Dyn5, №13384, 2020
2. Customer : LEMI TRAFO JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street  
order 0031/15.07.2020
3. Manufacturer: LEMI TRAFO JSC, 2304 Pernik, BULGARIA ,1 Vladaisko vastanie Street
4. Test methods used : IEC 60076-11-cl.23.2.1;
5. Date on which the product was received in test room: 31.07.2020
6. Tests performed:
  - 6.1. Temperature rise test – IEC 60076-2 - cl.7.3.2;
7. Test period: 04-05.08.2020
8. Test result: The product passed the tests
9. The report contains: 9 pages

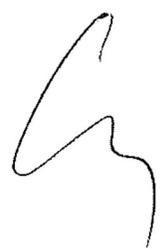


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Head of "LTC-TEST"

Eng. Katerina Racheva  
(signature and stamp)





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**10. Test results:**

Power	250 kVA
Cooling	AN
Insulation class	75/28/12

Frequency	50 Hz
Overtemperature	100 K
Type	TC250-10

Year of production	2020
Vector group	Dyn5
Coeff. Temperat. Material	225

**Primary winding**

Voltage (V)	10000
Tapping's	±2x2.5%
Current (A)	14.43
Connection	Delta
Insulation class (kV)	12

**Secondary winding**

Voltage (V)	400
Tapping's	
Current (A)	360.84
Connection	Star+n
Insulation class (kV)	1.1

Ratio	10000 / 400 V		Temperature reference (°C) 120		
	No-load losses (Watt)	No-load current (%)	Load losses (Watt)	Impedance voltage (%)	Total losses (Watt)
<b>Guaranteed value</b>	468	1,4	3400	6	3868
<b>Tolerance (%)</b>	+0%	30%	+0%	± 10%	+0%
<b>Measured value</b>	459	0,33	3259	5,95	3718
<b>Deviation (%)</b>	-1,92%	-76,43%	-4,15%	-0,83%	-3,88%

**MEASUREMENT OF WINDINGS RESISTANCES BEFORE HEATING**

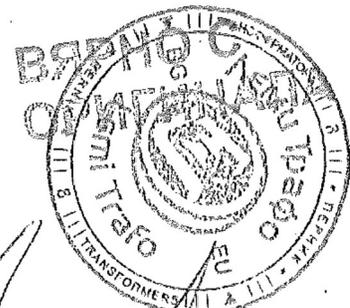
Measure temperature : 26.1°C

<b>Primary winding</b>		10000 V.	
K			[Ω]
Phases			
1V-1W			3,98962

<b>Secondary winding</b>		400 V.	
K			[Ω]
Phases			
2V-2W			0,0049503

**FINAL RESULTS**

Open circuit test conditions : Feeding voltage 400 V  
Short circuit test conditions : Nominal current 14,43 A





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TEMPERATURE RISE TEST

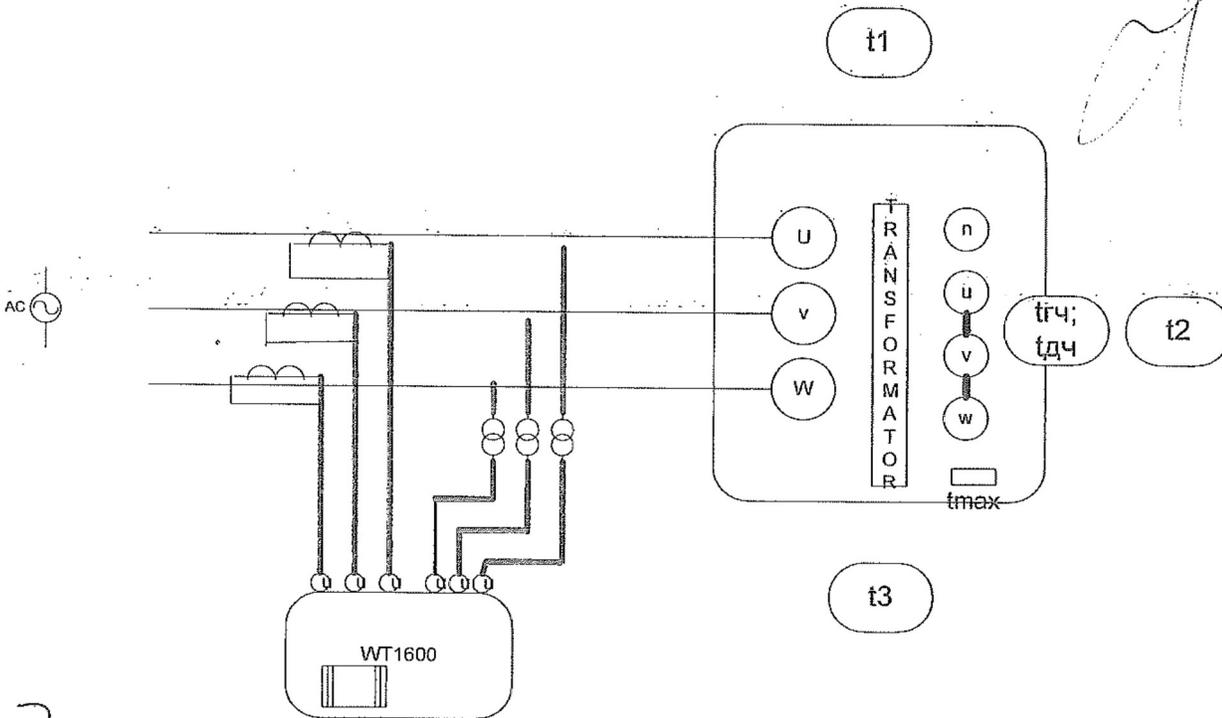
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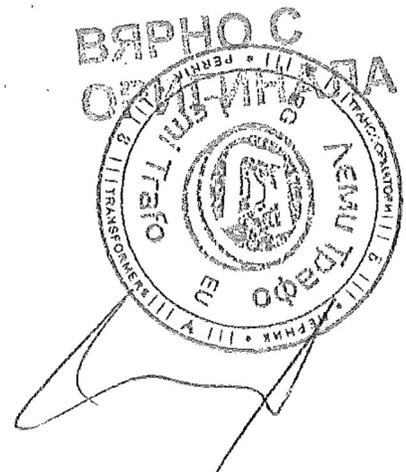
TEMPERATURE RISE		
Winding	10000 V	400 V
From the open circuit test	3,66 K	14,38 K
From the short circuit test	71,08 K	82,73 K
At rated currents in the winding and normal excitation of the core	72,47 K	90,08 K

Measurements were performed with expanded uncertainty 6% for temperature and the confidence level  $P = 95\%$ .



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TEMPERATURE RISE TEST

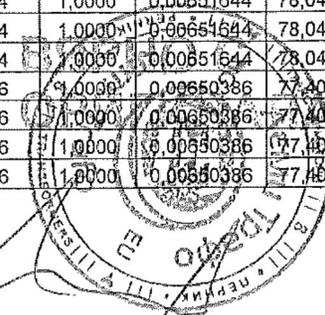
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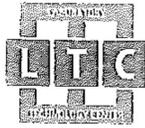
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10.2 Measurement of winding resistance after shutdown:

Seconds	Winding 10000 V.				Seconds	Winding 400 V.			
	V	A	Ohm	Delta T (°C)		V	A	Ohm	Delta T (°C)
133	5,0979	1,0000	5,09787	68,36	133	0,00659192	1,0000	0,0065919	81,87
148	5,0916	1,0000	5,09164	67,96	148	0,00659192	1,0000	0,00659192	81,87
163	5,0895	1,0000	5,08847	67,82	163	0,00659192	1,0000	0,00659192	81,87
178	5,0844	1,0000	5,08438	67,50	178	0,00659192	1,0000	0,00659192	81,87
193	5,0794	1,0000	5,07942	67,19	193	0,00657934	1,0000	0,00657934	81,23
209	5,0750	1,0000	5,07501	66,91	209	0,00657934	1,0000	0,00657934	81,23
224	5,0705	1,0000	5,07054	66,63	224	0,00657934	1,0000	0,00657934	81,23
239	5,0661	1,0000	5,06614	66,35	239	0,00657934	1,0000	0,00657934	81,23
254	5,0617	1,0000	5,06166	66,07	254	0,00657934	1,0000	0,00657934	81,23
270	5,0571	1,0000	5,05706	65,78	270	0,00657934	1,0000	0,00657934	81,23
285	5,0528	1,0000	5,05278	65,51	285	0,00657934	1,0000	0,00657934	81,23
300	5,0491	1,0000	5,04909	65,28	300	0,00656676	1,0000	0,00656676	80,59
315	5,0443	1,0000	5,04425	64,98	315	0,00656676	1,0000	0,00656676	80,59
330	5,0401	1,0000	5,04006	64,71	330	0,00656676	1,0000	0,00656676	80,59
346	5,0358	1,0000	5,03582	64,45	346	0,00656676	1,0000	0,00656676	80,59
361	5,0316	1,0000	5,03159	64,18	361	0,00656676	1,0000	0,00656676	80,59
376	5,0277	1,0000	5,02771	63,94	376	0,00655418	1,0000	0,00655418	79,96
391	5,0233	1,0000	5,02334	63,66	391	0,00656676	1,0000	0,00656676	80,59
406	5,0194	1,0000	5,0194	63,41	406	0,00655418	1,0000	0,00655418	79,96
422	5,0152	1,0000	5,0152	63,15	422	0,00655418	1,0000	0,00655418	79,96
437	5,0114	1,0000	5,01135	62,91	437	0,00655418	1,0000	0,00655418	79,96
452	5,0073	1,0000	5,0073	62,65	452	0,00654160	1,0000	0,0065416	79,32
467	5,0031	1,0000	5,0031	62,39	467	0,00655418	1,0000	0,00655418	79,96
483	4,9992	1,0000	4,99916	62,14	483	0,00654160	1,0000	0,0065416	79,32
498	4,9950	1,0000	4,99495	61,87	498	0,00654160	1,0000	0,0065416	79,32
513	4,9915	1,0000	4,99153	61,66	513	0,00654160	1,0000	0,0065416	79,32
528	4,9875	1,0000	4,98748	61,40	528	0,00654160	1,0000	0,0065416	79,32
543	4,9836	1,0000	4,9836	61,16	543	0,00654160	1,0000	0,0065416	79,32
559	4,9798	1,0000	4,97975	60,92	559	0,00654160	1,0000	0,0065416	79,32
574	4,9761	1,0000	4,97605	60,68	574	0,00654160	1,0000	0,0065416	79,32
589	4,9717	1,0000	4,97174	60,41	589	0,00652902	1,0000	0,00652902	78,68
604	4,9717	1,0000	4,97174	60,41	604	0,00652902	1,0000	0,00652902	78,68
620	4,9644	1,0000	4,96438	59,95	620	0,00652902	1,0000	0,00652902	78,68
635	4,9609	1,0000	4,96086	59,73	635	0,00651644	1,0000	0,00651644	78,04
650	4,9573	1,0000	4,9573	59,50	650	0,00651644	1,0000	0,00651644	78,04
665	4,9535	1,0000	4,95345	59,26	665	0,00652902	1,0000	0,00652902	78,68
680	4,9493	1,0000	4,94933	59,00	680	0,00652902	1,0000	0,00652902	78,68
696	4,9458	1,0000	4,94578	58,78	696	0,00651644	1,0000	0,00651644	78,04
711	4,9422	1,0000	4,94218	58,55	711	0,00651644	1,0000	0,00651644	78,04
726	4,9389	1,0000	4,93886	58,34	726	0,00651644	1,0000	0,00651644	78,04
741	4,9349	1,0000	4,93493	58,10	741	0,00651644	1,0000	0,00651644	78,04
756	4,9312	1,0000	4,93121	57,86	756	0,00650386	1,0000	0,00650386	77,40
772	4,9277	1,0000	4,92771	57,64	772	0,00650386	1,0000	0,00650386	77,40
787	4,9246	1,0000	4,92456	57,44	787	0,00650386	1,0000	0,00650386	77,40
802	4,9208	1,0000	4,92082	57,21	802	0,00650386	1,0000	0,00650386	77,40





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817	4,9175	1,0000	4,91753	57,00	817	0,00650386	1,0000	0,00650386	77,40
833	4,9140	1,0000	4,91396	56,78	833	0,00650386	1,0000	0,00650386	77,40
848	4,9103	1,0000	4,91027	56,54	848	0,00650386	1,0000	0,00650386	77,40
863	4,9069	1,0000	4,90688	56,33	863	0,00650386	1,0000	0,00650386	77,40
878	4,9032	1,0000	4,90323	56,10	878	0,00650386	1,0000	0,00650386	77,40
893	4,8998	1,0000	4,89981	55,89	893	0,00650386	1,0000	0,00650386	77,40
909	4,8966	1,0000	4,89661	55,68	909	0,00649128	1,0000	0,00649128	76,76
924	4,8931	1,0000	4,89311	55,46	924	0,00649128	1,0000	0,00649128	76,76
939	4,8904	1,0000	4,89044	55,30	939	0,00649128	1,0000	0,00649128	76,76
954	4,8865	1,0000	4,88648	55,05	954	0,00649128	1,0000	0,00649128	76,76
970	4,8831	1,0000	4,88307	54,83	970	0,00649128	1,0000	0,00649128	76,76
985	4,8803	1,0000	4,88026	54,66	985	0,00647870	1,0000	0,0064787	76,13
1000	4,8767	1,0000	4,87674	54,43	1000	0,00647870	1,0000	0,0064787	76,13
1015	4,8733	1,0000	4,87326	54,21	1015	0,00647870	1,0000	0,0064787	76,13
1030	4,8700	1,0000	4,86996	54,01	1030	0,00647870	1,0000	0,0064787	76,13
1046	4,8670	1,0000	4,86695	53,82	1046	0,00647870	1,0000	0,0064787	76,13
1061	4,8636	1,0000	4,86362	53,61	1061	0,00647870	1,0000	0,0064787	76,13
1076	4,8606	1,0000	4,86056	53,42	1076	0,00647870	1,0000	0,0064787	76,13
1091	4,8573	1,0000	4,8573	53,21	1091	0,00647870	1,0000	0,0064787	76,13
1106	4,8539	1,0000	4,85389	53,00	1106	0,00647870	1,0000	0,0064787	76,13
1122	4,8512	1,0000	4,85122	52,83	1122	0,00646612	1,0000	0,00646612	75,49
1137	4,8478	1,0000	4,84775	52,61	1137	0,00646612	1,0000	0,00646612	75,49
1152	4,8443	1,0000	4,84429	52,39	1152	0,00646612	1,0000	0,00646612	75,49
1167	4,8414	1,0000	4,84143	52,21	1167	0,00646612	1,0000	0,00646612	75,49
1183	4,8386	1,0000	4,83864	52,04	1183	0,00646612	1,0000	0,00646612	75,49
1198	4,8355	1,0000	4,83551	51,84	1198	0,00646612	1,0000	0,00646612	75,49
1213	4,8325	1,0000	4,83247	51,65	1213	0,00646612	1,0000	0,00646612	75,49
1228	4,8297	1,0000	4,82969	51,47	1228	0,00646612	1,0000	0,00646612	75,49
1243	4,8264	1,0000	4,8264	51,27	1243	0,00646612	1,0000	0,00646612	75,49
1259	4,8235	1,0000	4,82353	51,08	1259	0,00646612	1,0000	0,00646612	75,49
1274	4,8200	1,0000	4,82004	50,87	1274	0,00645354	1,0000	0,00645354	74,85
1289	4,8176	1,0000	4,81756	50,71	1289	0,00645354	1,0000	0,00645354	74,85
1304	4,8143	1,0000	4,81425	50,50	1304	0,00645354	1,0000	0,00645354	74,85
1320	4,8114	1,0000	4,81141	50,32	1320	0,00645354	1,0000	0,00645354	74,85
1335	4,8084	1,0000	4,80839	50,13	1335	0,00645354	1,0000	0,00645354	74,85
1350	4,8056	1,0000	4,80559	49,96	1350	0,00645354	1,0000	0,00645354	74,85
1365	4,8023	1,0000	4,80234	49,75	1365	0,00645354	1,0000	0,00645354	74,85
1380	4,7998	1,0000	4,79984	49,59	1380	0,00645354	1,0000	0,00645354	74,85
1396	4,7968	1,0000	4,79677	49,40	1396	0,00645354	1,0000	0,00645354	74,85
1411	4,7939	1,0000	4,79392	49,22	1411	0,00644096	1,0000	0,00644096	74,21
1426	4,7910	1,0000	4,79104	49,04	1426	0,00644096	1,0000	0,00644096	74,21
1441	4,7884	1,0000	4,78839	48,87	1441	0,00644096	1,0000	0,00644096	74,21
1457	4,7852	1,0000	4,78518	48,67	1457	0,00644096	1,0000	0,00644096	74,21
1472	4,7827	1,0000	4,78274	48,52	1472	0,00644096	1,0000	0,00644096	74,21
1487	4,7796	1,0000	4,77962	48,32	1487	0,00644096	1,0000	0,00644096	74,21
1502	4,7769	1,0000	4,77692	48,15	1502	0,00644096	1,0000	0,00644096	74,21
1517	4,7737	1,0000	4,7737	47,95	1517	0,00644096	1,0000	0,00644096	74,21
1533	4,7711	1,0000	4,77112	47,79	1533	0,0064410	1,0000	0,00644096	74,21
1548	4,7685	1,0000	4,76849	47,62	1548	0,0064410	1,0000	0,00644096	74,21
1563	4,7654	1,0000	4,76543	47,43	1563	0,0064410	1,0000	0,00644096	74,21
1578	4,7627	1,0000	4,76266	47,25	1578	0,0064410	1,0000	0,00644096	74,21
1593	4,7600	1,0000	4,76001	47,09	1593	0,0064284	1,0000	0,00642838	73,57
1609	4,7575	1,0000	4,75749	46,93	1609	0,0064284	1,0000	0,00642838	73,57
1624	4,7548	1,0000	4,75477	46,76	1624	0,0064284	1,0000	0,00642838	73,57
1639	4,7517	1,0000	4,7517	46,56	1639	0,0064284	1,0000	0,00642838	73,57

*[Handwritten signatures]*

