Приложение 2 - Изисквани документи от Технически изисквания и спецификации

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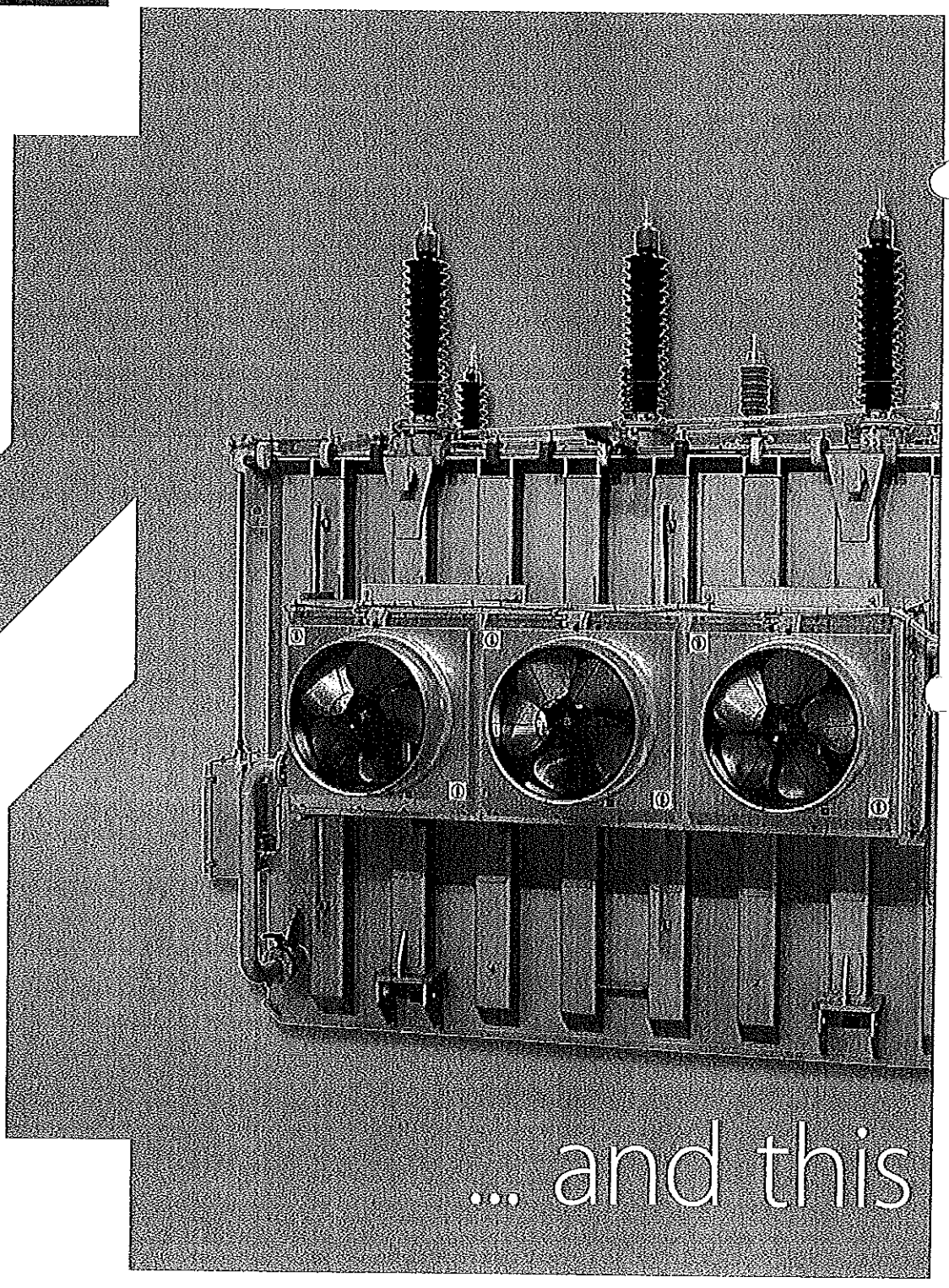
03.2017

Power Transformers

ETRA

It's time...

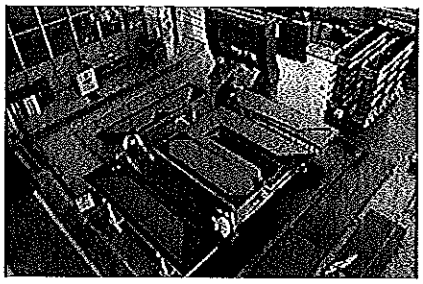


... and this

Company profile

KOLEKTOR ETRA has been acting
as transformer manufacturer
over more than 75 years.
Specializing in the manufacturing
of power transformers rating
up to 500 MVA and 420 kV,
the company is focusing
its activities
mainly in technical areas
like loss and noise level reduction.
Innovation, competence, realiability
and after sales service are the words
which characterize the company
by our valued customers
over the years.

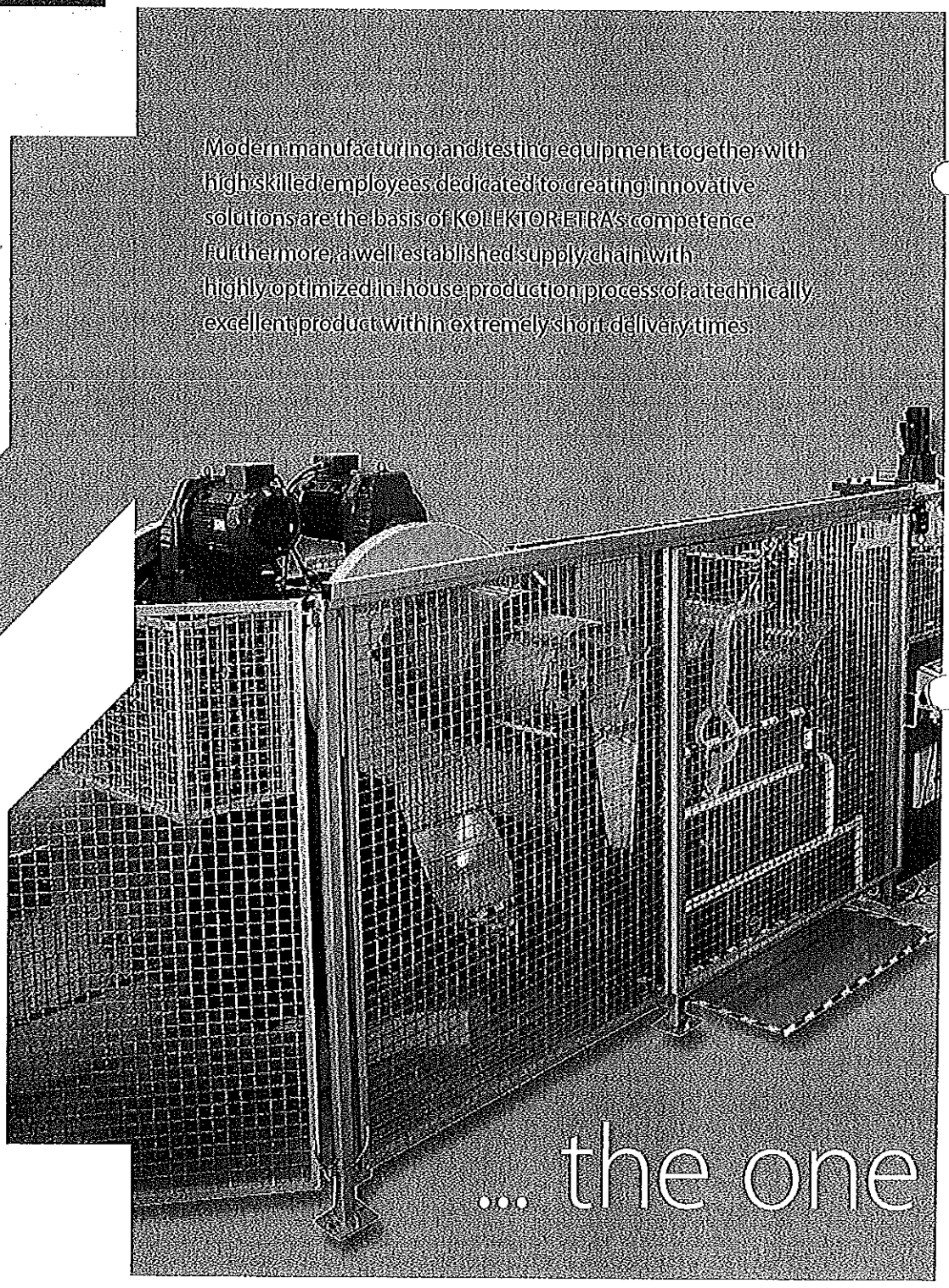
Time belongs to us.



ETRA

It's direction...

Modern manufacturing and testing equipment together with high skilled employees dedicated to creating innovative solutions are the basis of KOLEKTOR ETRA's competence. Furthermore, a well established supply chain with highly optimized in-house production process of a technically excellent product within extremely short delivery times.

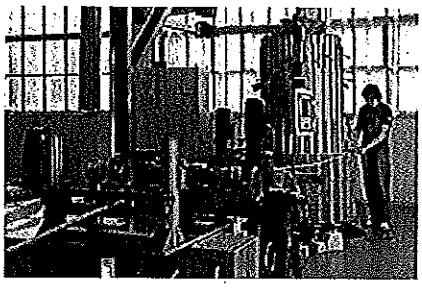


... the one

competence

With highly experienced and professionally trained group of employees we can perform all routine-type and special tests required by international standards.

and only

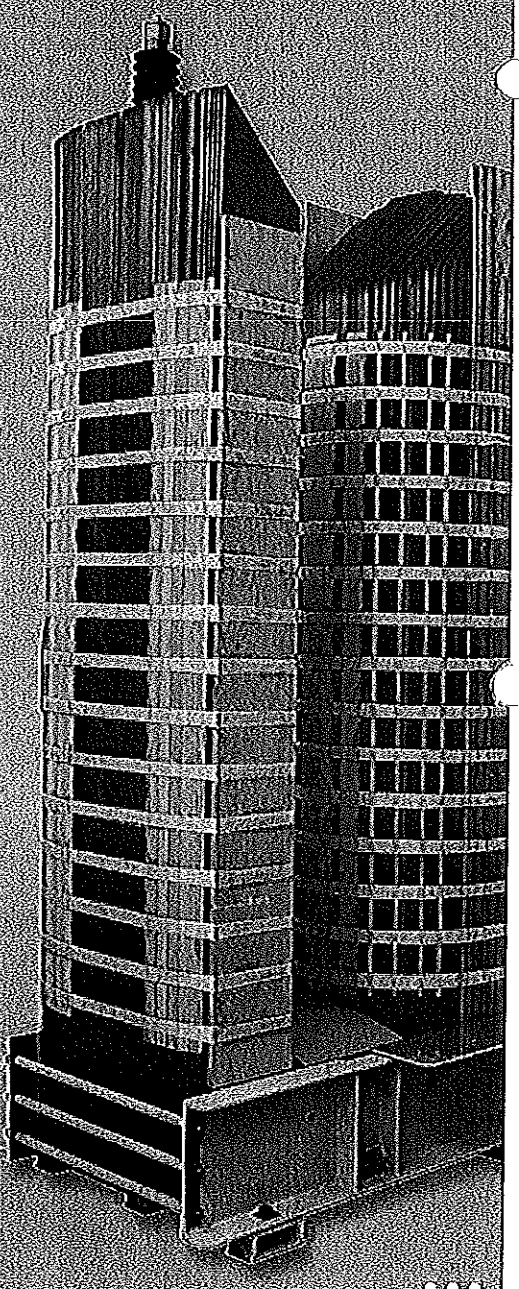


ETRA

It's satisfaction...

KOLEKTOR ETRA's objective is to supply products that convince the client with their technical parameters and high quality as well as an optimum price performance ratio. A long-term commitment to research and development guarantees continuous improvements in performance and efficiency, cost optimization and a prolonged life of the existing products. KOLEKTOR ETRA also continuously develops new, high-tech products to contribute to the evolving market and to satisfy even the most demanding customer requirements.

The entire R&D process is integrated into a collaborative network with universities and research institutes. Both, widespread use of sophisticated design software and high-end test equipment offer the client a guarantee of fully developed products at the cutting edge of technology.



innovation

The company's R & D focuses on:

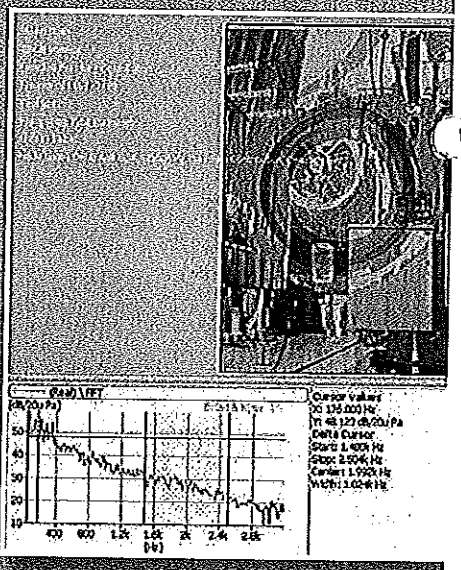
- Electromagnetics
- Structural mechanics
- Thermodynamics
- Acoustics
- Anticorrosion

creating excellence

ETRA

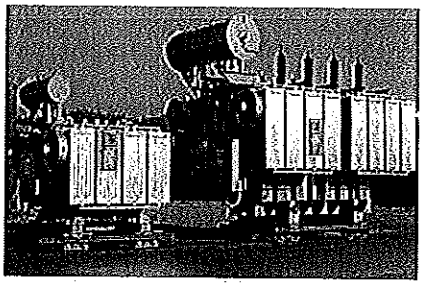
It's something...

KOLEKTOR ETRA offers a complete range of power and special transformers designed to grant the reliability, durability, and efficiency required in industrial, and commercial applications. KOLEKTOR ETRA's liquid filled transformers are manufactured in accordance with the most demanding international industry standards like IEC, EN or ANSI.



...you should

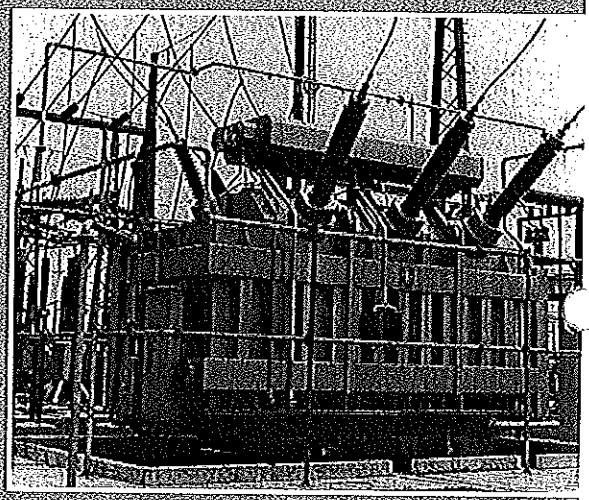
Reliability &
never forget.

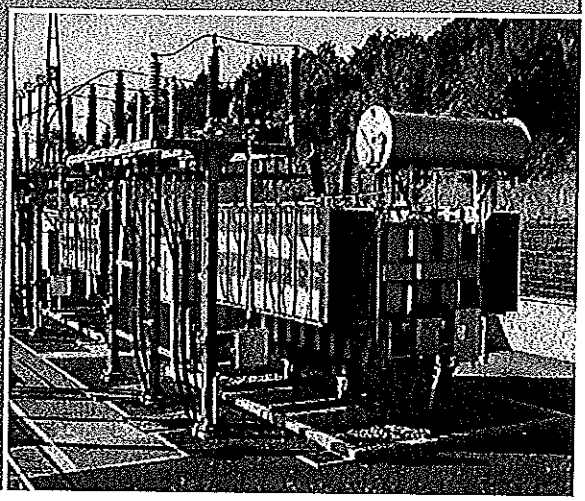


ETRA

It's somebody...

After Sales Service by KOLEKTOR ETRA means being able to draw on a customer oriented transformer services to the full extent. Our customers benefit from over 75 years of experience in the manufacture and service of transformers, concentrated in our individual quotations. As the original equipment manufacturer (OEM) we're familiar with all technical solutions for sophisticated power transformer engineering.



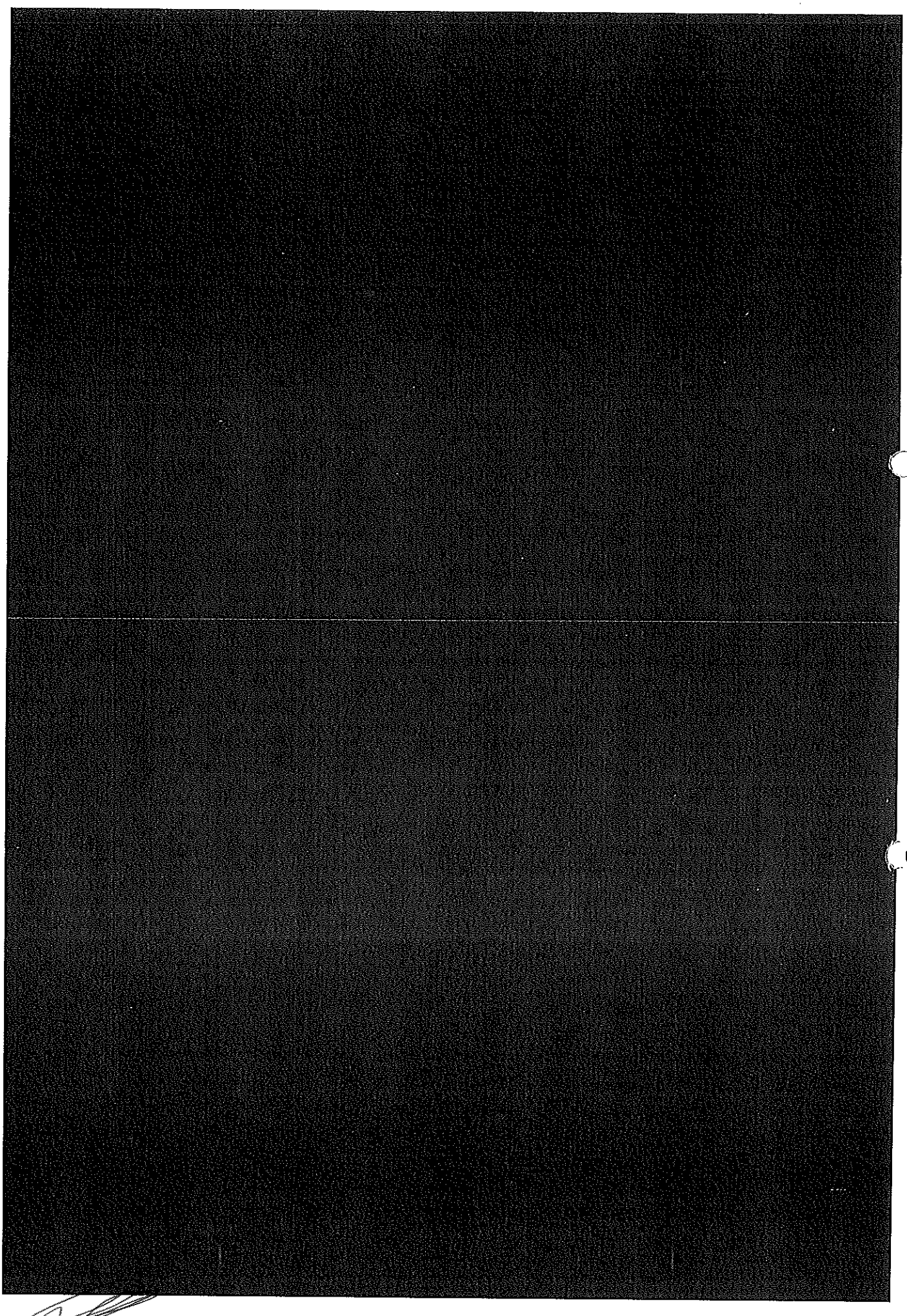


After sales service

... who cares.

ETRA

Technical catalogue

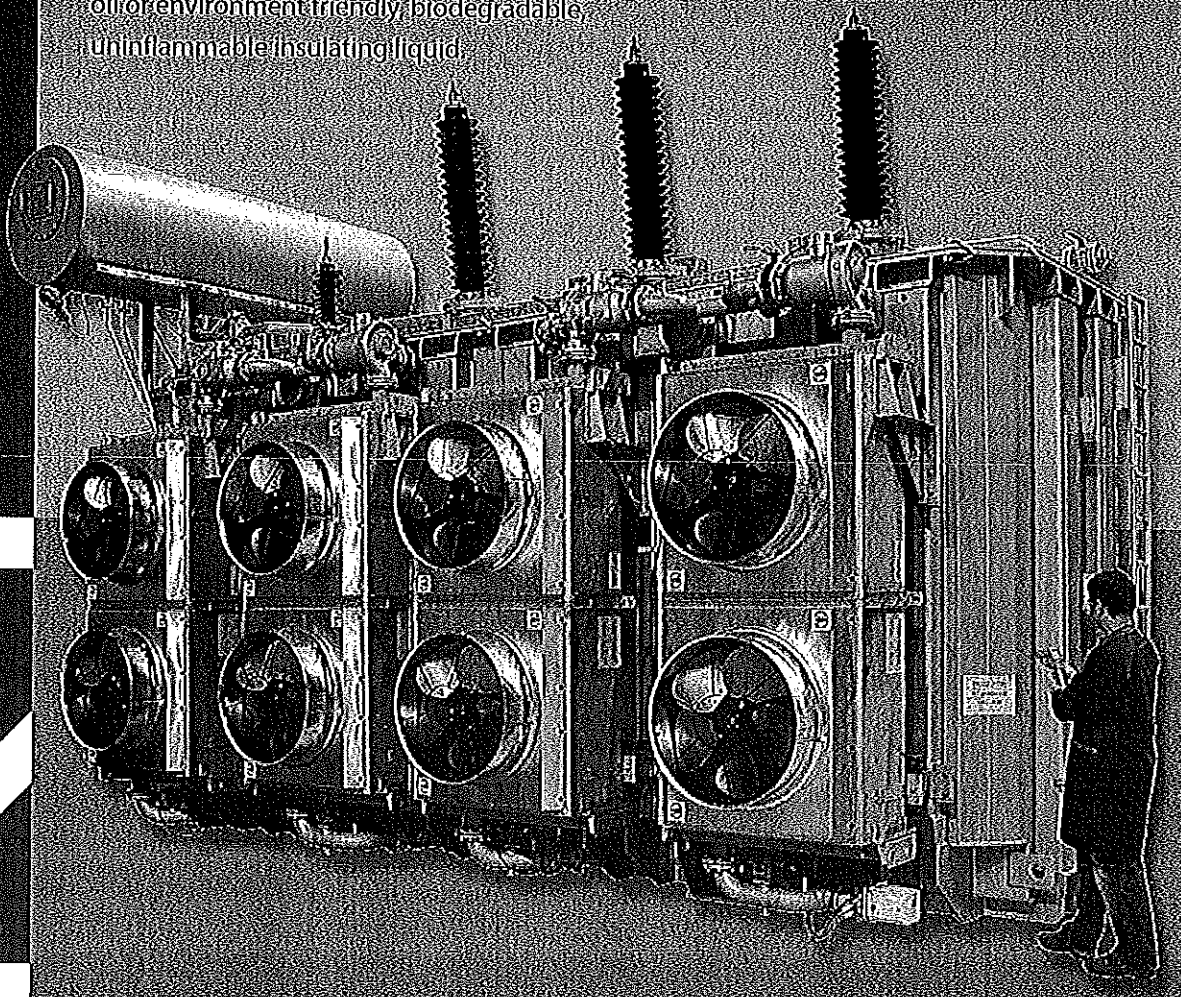


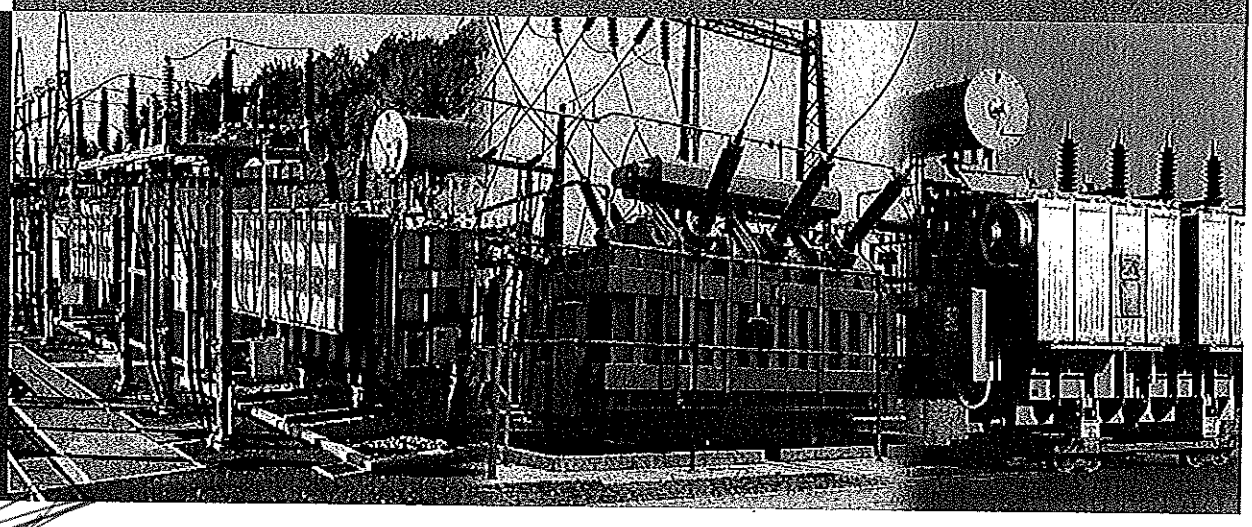
About ETRA

KOLEKTOR ETRA has been acting as transformer manufacturer over more than 75 years. Specializing in the manufacturing of power transformers rating up to 500 MVA and 420 kV, the company is focusing its activities mainly in technical areas like loss and noise level reduction. Innovation, competence, reliability and after sales service are the words which characterize the company by our valued customers over the years.

Power transformers

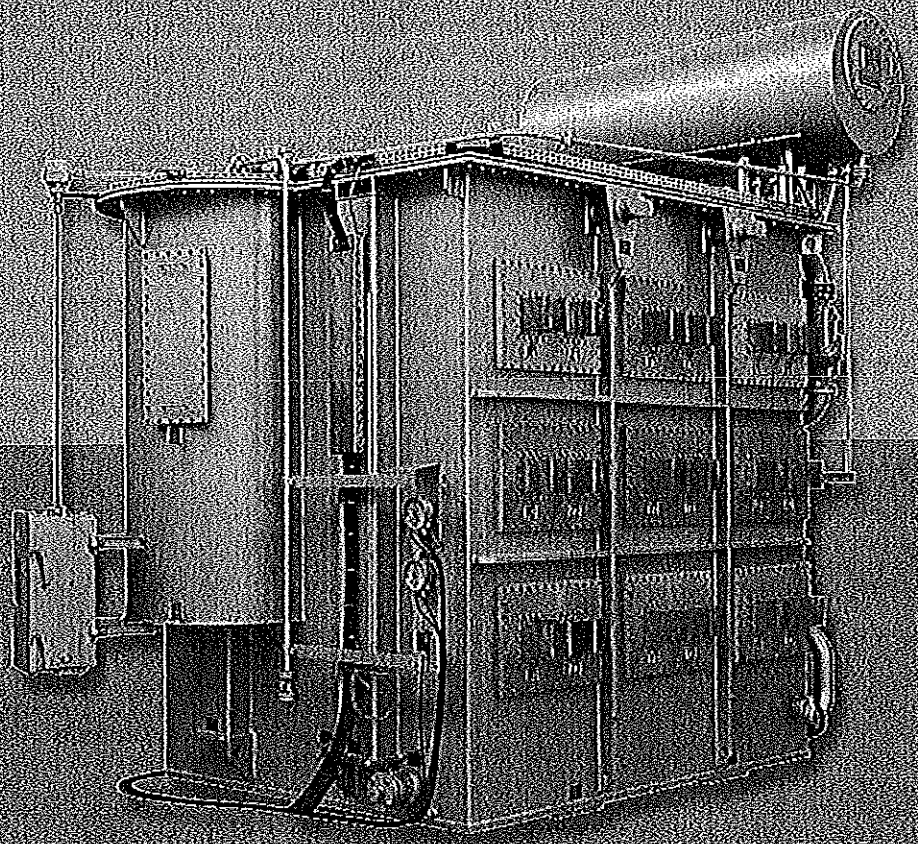
Power transformers and auto-transformers of rated power up to 500 MVA and rated voltage up to 420 kV, filled with mineral oil or environment friendly, biodegradable, uninflammable insulating liquid

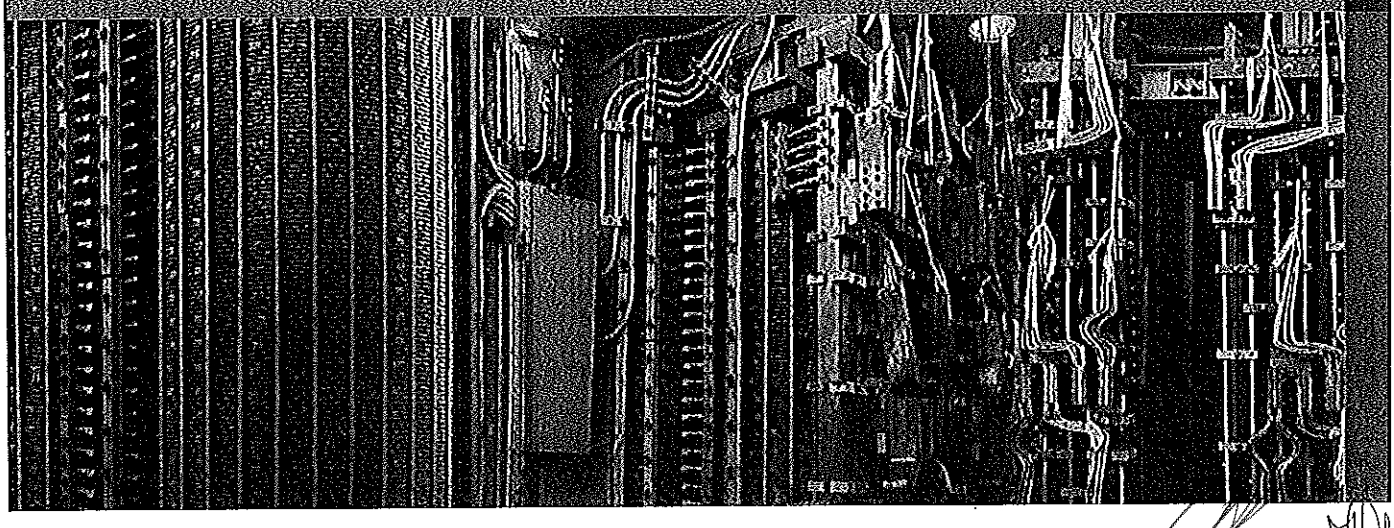




Special transformers

- Furnace transformers with on-load tap-changing used for arc furnaces.
- Furnace transformers with off-load tap-changing used for induction furnaces.
- Rectifier transformers.
- Grounding transformers for the neutral point earthing.

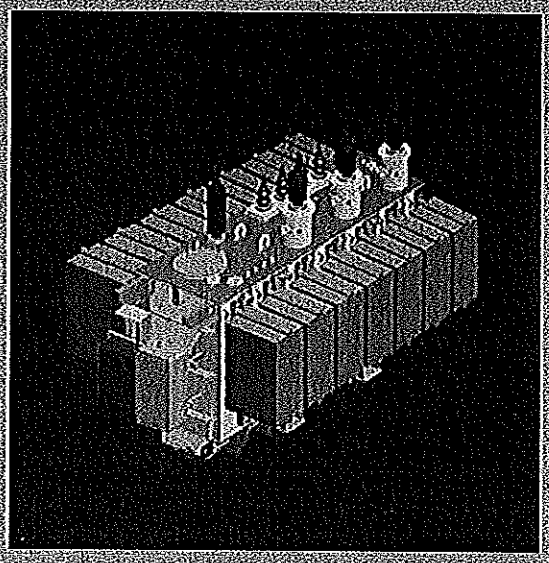


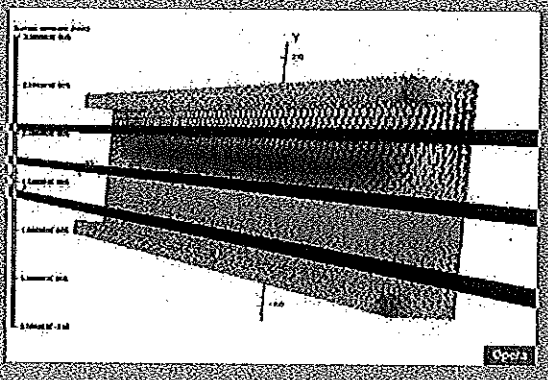


Knowledge

All our products are result of our own design

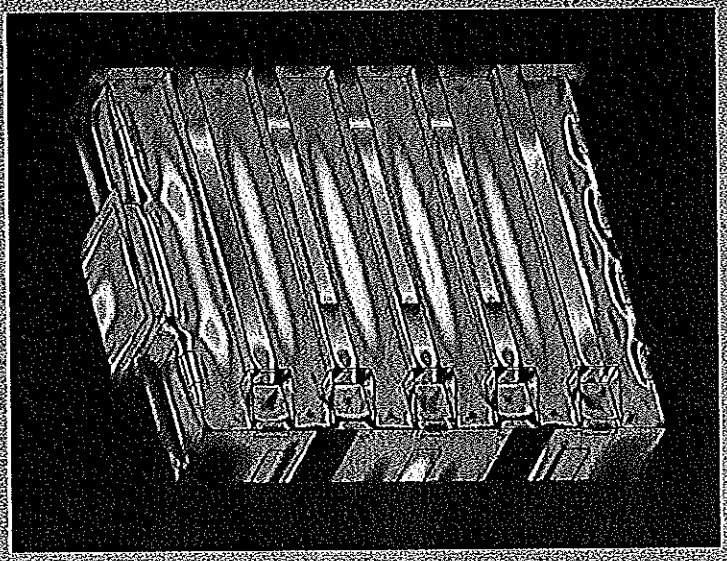
In our archives we preserve more than 4000 different designs. Most of them are currently used for the performance of our servicing activities, but taken as a whole, they are a unique source of tradition, experience and excellence. With modern and approved computer techniques, use of new materials and technologies, we are constantly developing new products.



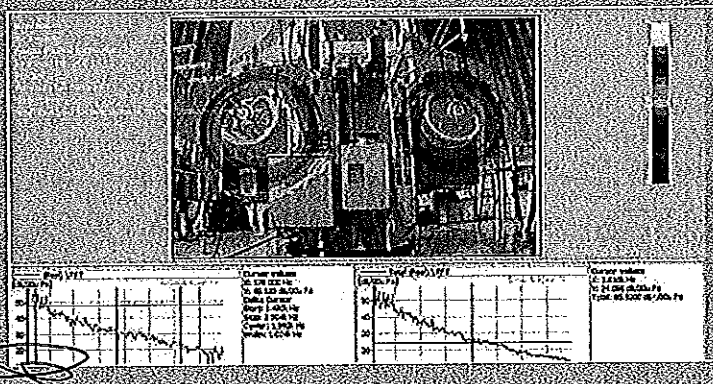


Magnetic field between conductors and ferrous beam

Our aim is to supply our customers with reliable, environment friendly products. Thus, transformers manufactured in KOLEKTOR ETRA have low losses and low noise levels.



Numerical simulation of mechanical stresses in transformer tank

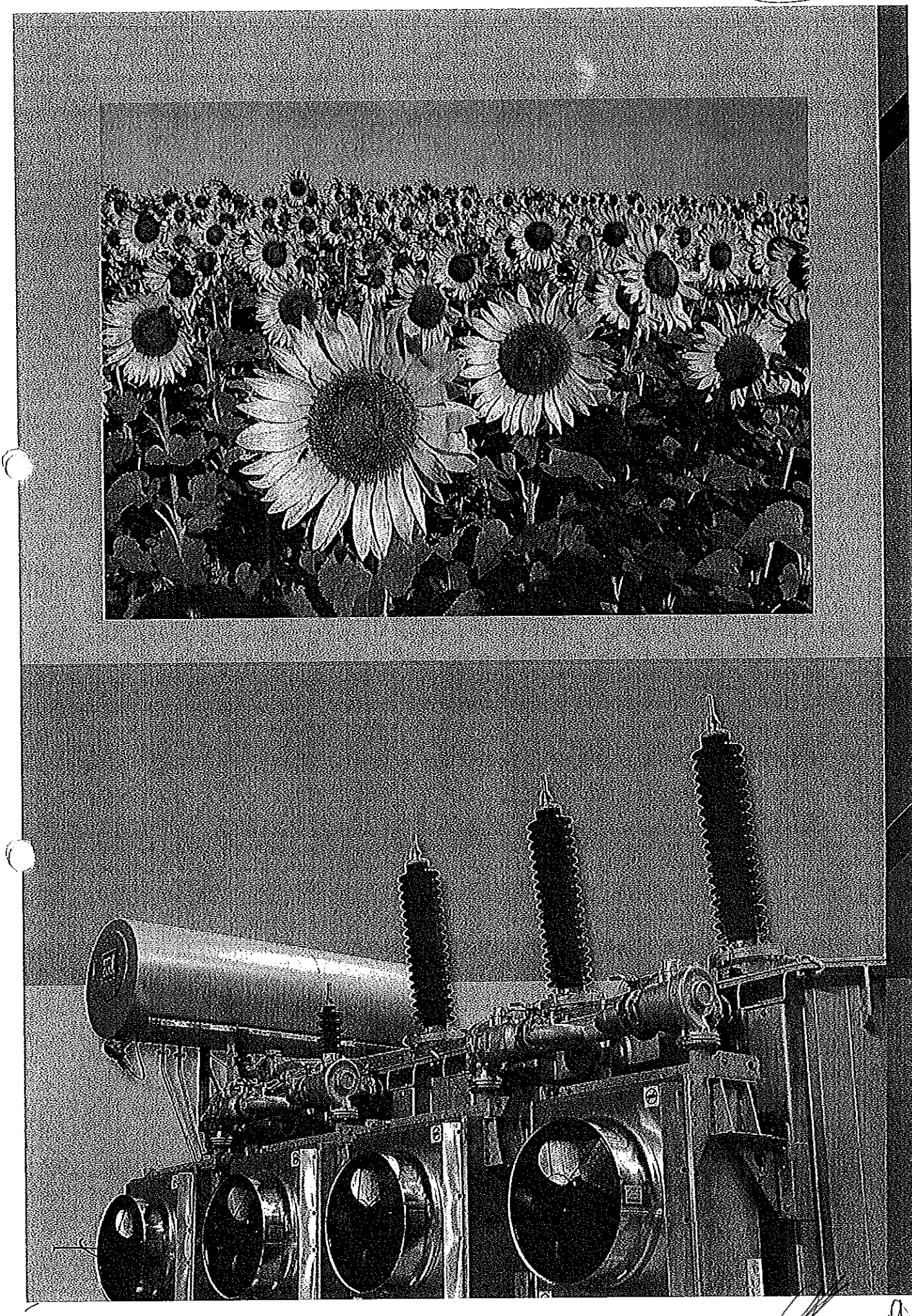


Environment

Our contributions to the protection of environment

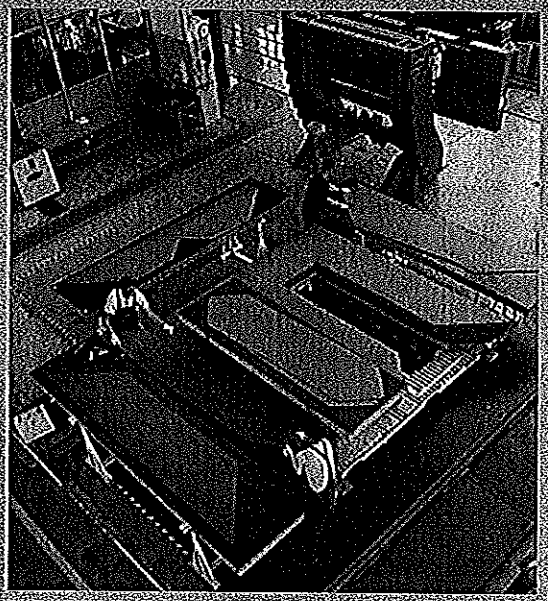
In modern society human beings and machines often share their common life and working space. Operation of each machine or appliance is felt by human beings and the nature as a disturbance. In our factory we do our best that the operation of our transformers is safe, long-lasting, economic and with least possible effects upon environment.

- Mineral oils used for oil immersed transformers do not contain PCBs or other harmful substances.
- In transformers located in fire-resistant and water conservation areas we use synthetic oils, i.e. environment-friendly liquids. Main characteristics of these liquids are: higher flash point and biodegradability.
- We are qualified for repair works, reconstructions, different reworks of transformers, their constituent parts and equipment.
- Our special attention is paid to reduction of noise level of the transformer. Noise levels achieved for transformers are low enough to decrease substantially the costs for the construction of anti-noise barriers in transformer stations.
- Our special contribution to preservation of the environment is safe and environmental friendly decommission of transformers after their life cycle expiration.

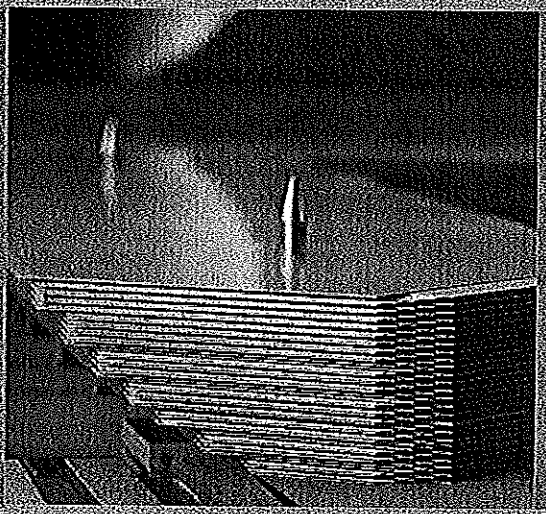


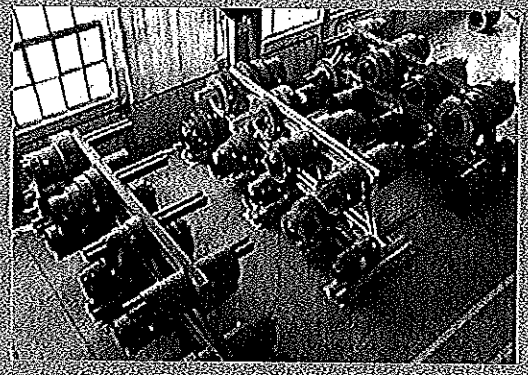
Magnetic core

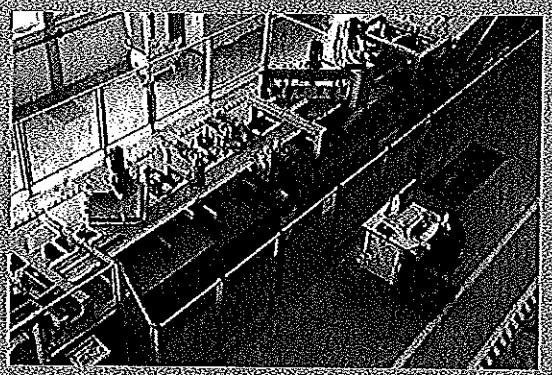
Three quality classes of magnetic steel sheets are in use: oriented conventional magnetic steel sheets of class C G O, steel sheets of high magnetic orientation H-B and laser treated magnetic steel sheets. Magnetic core is stacked by overlapping of individual steel sheets according to the step-lap system. So called core type with two, three or five limbs is used. With accurate cutting and careful stacking of the magnetic steel low no-load loss, low no-load current, low amplitudes of the in-rush current and low noise level is obtained.

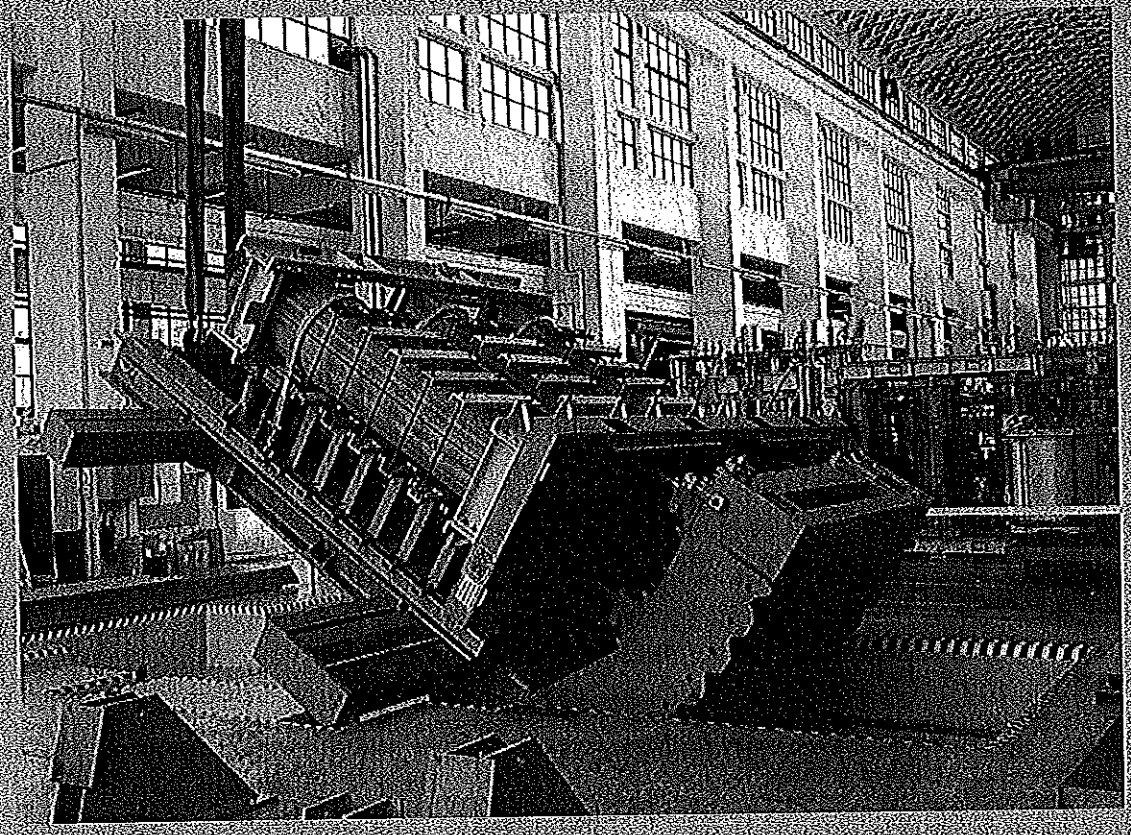


The core laminations are securely held together by means of heat shrinkable polyglass bands and tightening facilities made from anti-magnetic steel in such a way that movement of laminations during transportation and vibrations during operation are prevented.

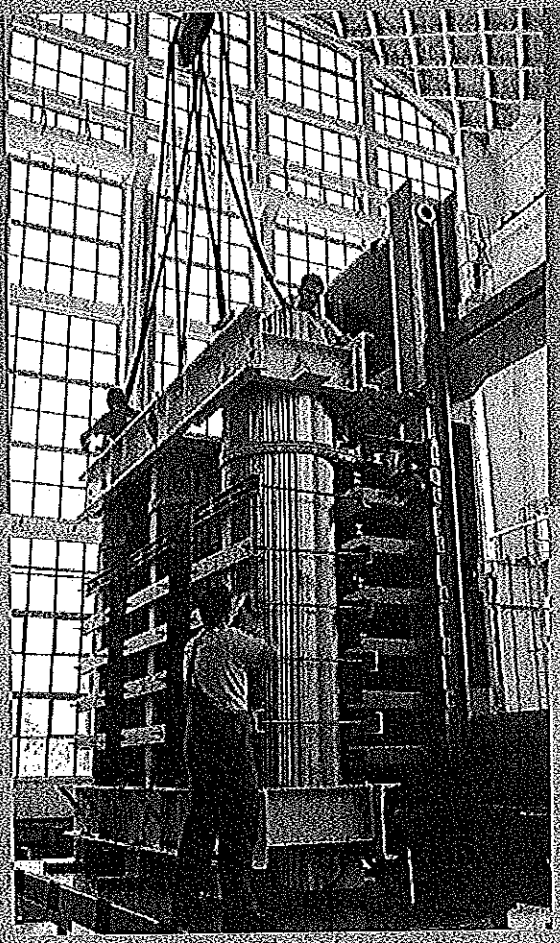








The lower yoke and the limbs are coated with glue varnish. Oscillations and vibrations caused by magnetostriction forces are thus reduced to minimum. The frame formed by yoke and limb clamps around the magnetic core enables safe transporting of the transformer and adequate resistance to electromagnetic short-circuit forces.



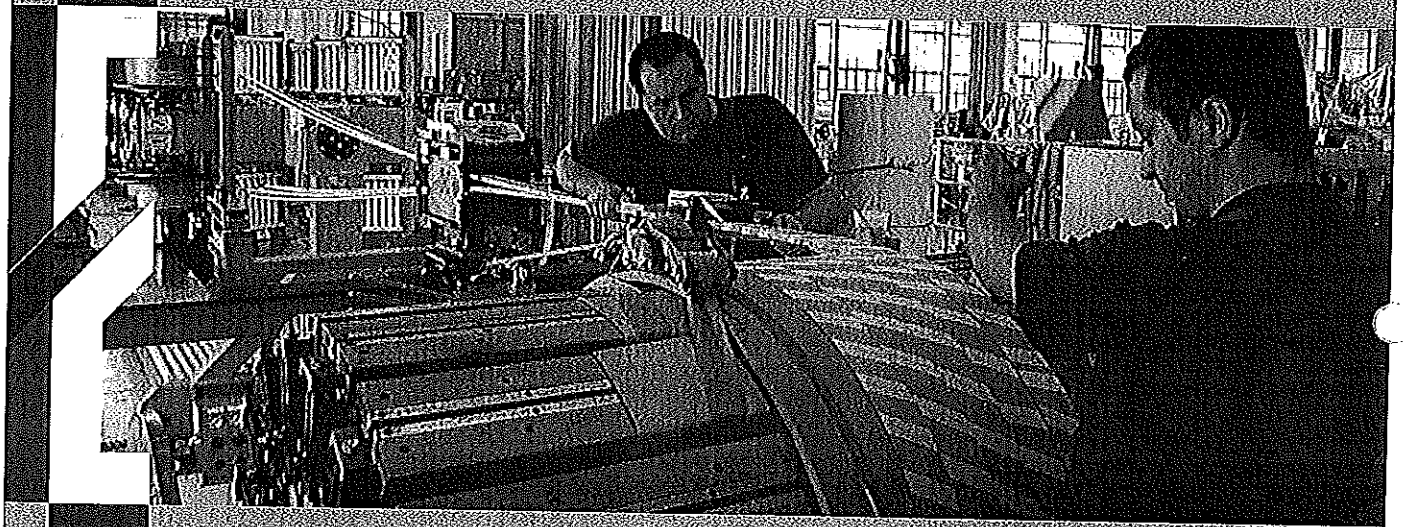
Big units have individual packages of steel separated with insulation barriers and those with higher flux density in core with cooling channels. In such cases all with insulation separated packages are galvanically connected and earthed. Earthing of all iron parts on the magnetic core is performed separately.

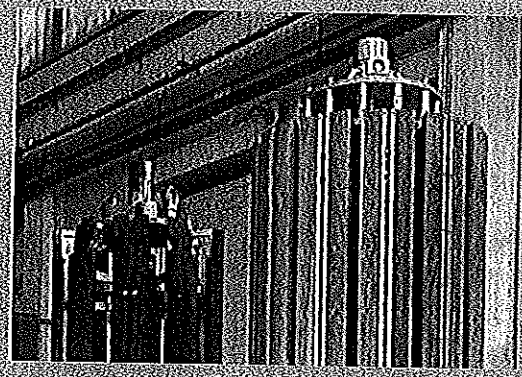
Windings

The windings are made from electrolytic copper of high purity Cu-ETP signed. Specific electric conductivity is 58 Sm/mm². Conductors are in strength by RP0.2 from 90 to 160 N/mm². For higher currents are used foil and rectangular conductors insulated with paper or enamel. For the highest powers and currents is used transposed cable.

Three thermal classes of insulation are in use:

- enamel insulation (PVA), thermal class E (120°C), in compliance with standard IEC 60317-0-2
- Paper insulation 5A2-1M3, thermal class A (105°C), in compliance with standard IEC 554-3-5
- Thermal upgraded paper insulation 5B1-2M3, thermal class E (120°C), in compliance with standard IEC 554-3-5





The windings are manufactured in different variants.

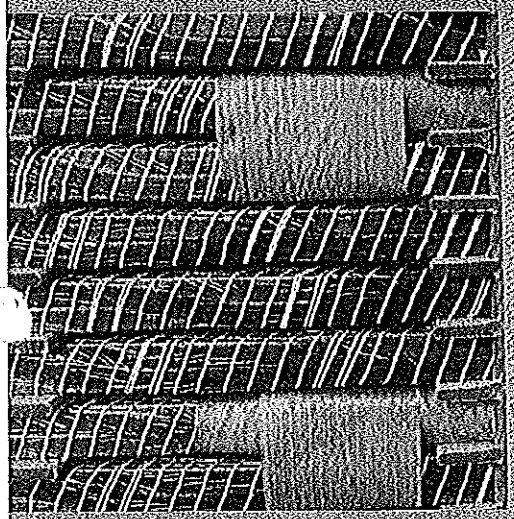
Single-layer or multy-layer windings are used for phase currents up to 1000 A and rated voltages up to 72.5 kV.

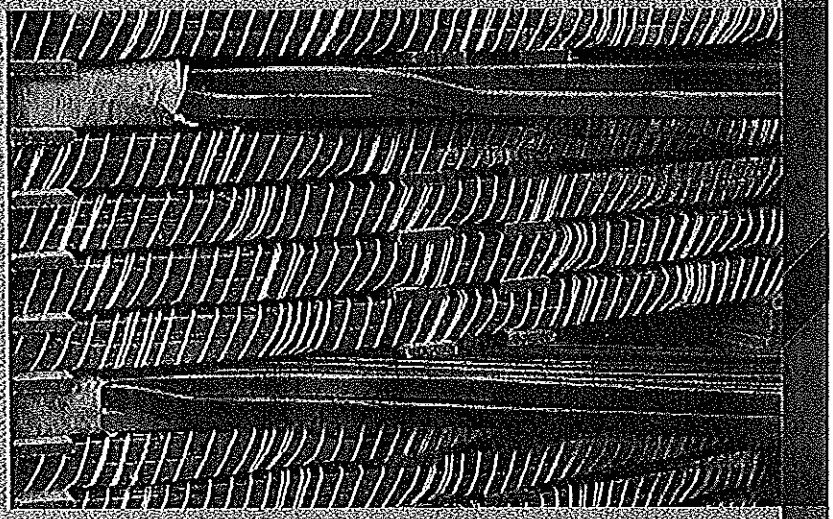
For higher and the highest voltage classes disc windings are used: helical, continuous disc or interleaved.

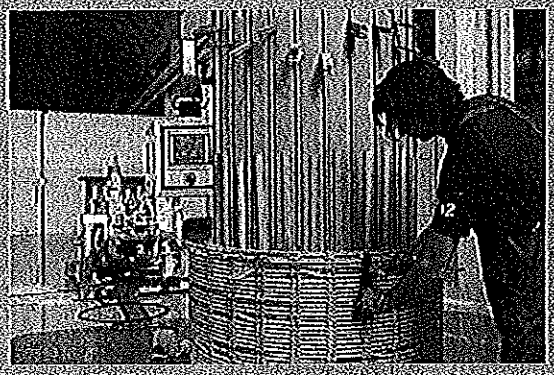
Helical windings are made in form of single or double spirals across the total height of windings. They are suitable for the currents up to 2000 A and voltage up to 36 kV.

Continuous disc windings are made of several numbers of equal coils or sections connected in series. These windings are of advantage when used for transformers rated above 2500 kVA and voltages up to 145 kV.

Interleaved windings are used in case when the transformer has to be tested by lightning impulse voltage above LI 325 kV. Similar as continual disc windings are made of equal coils composed of higher number of equal disks and sections respectively. The connections between the disks are interleaved. After the completion of windings the procedure of thermal stabilization of insulation and the adjustment of specified dimensions follows. Windings are first dried in the drying furnace, after that their height is set by hydraulic pressing device.

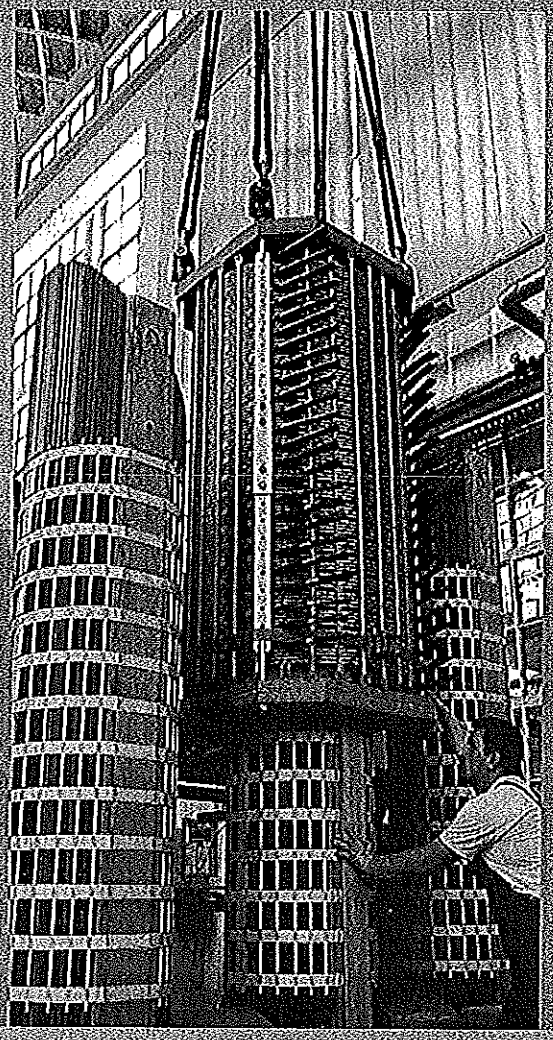




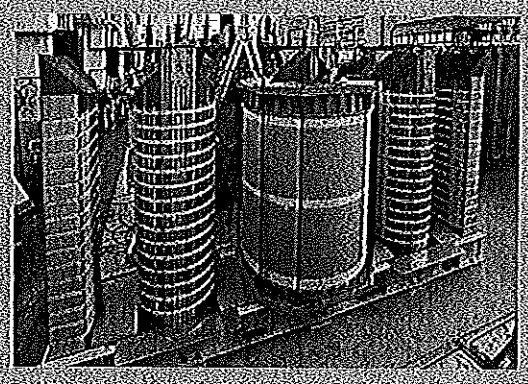


Assembly of active part

After thermal and mechanical stabilization of windings follows the assembly of all windings forming one phase of the transformer. They are clamped between special laminated wooden plates, enabling simple installation of windings on the magnetic core limbs. After closure of the upper magnetic core yoke follows the insertion of both yoke clamps and afterwards of screws and shock absorbers between both yoke clamps and windings for permanent pressure of windings.



Plates and screws for longitudinal pressing of all windings for one phase and the radial tightening cylinder form a compact unit resistant to forces in case of eventual short circuit in the network.



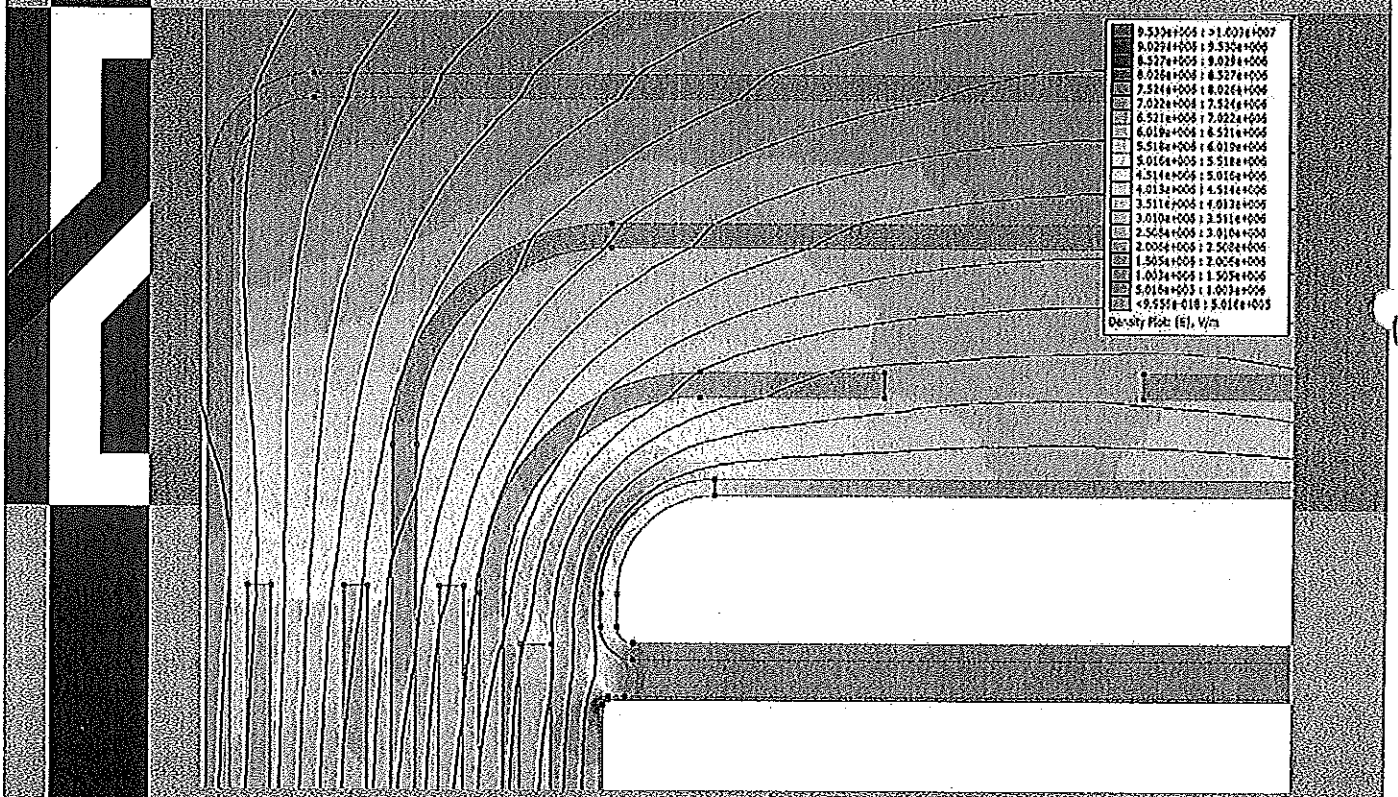
Clamping of windings and of the magnetic core is also important for the transport where compactness of design assures safe transport without damages, internal movements or slipping transformer within the active part.

Adequate drying of insulation according to vapour phase system and filling of the active part with oil under vacuum are the final phases determining the high dielectric, thermal and dynamic strength of the transformer.

Insulation system

The insulation system in oil-immersed transformers is made of hard insulation and liquid dielectric. The liquid dielectric is usually mineral or synthetic oil. Hard insulation is made of concentric cylinders or barriers from special high-pressure cardboard. We use only high-quality, stabilized insulation produced by renown producers.

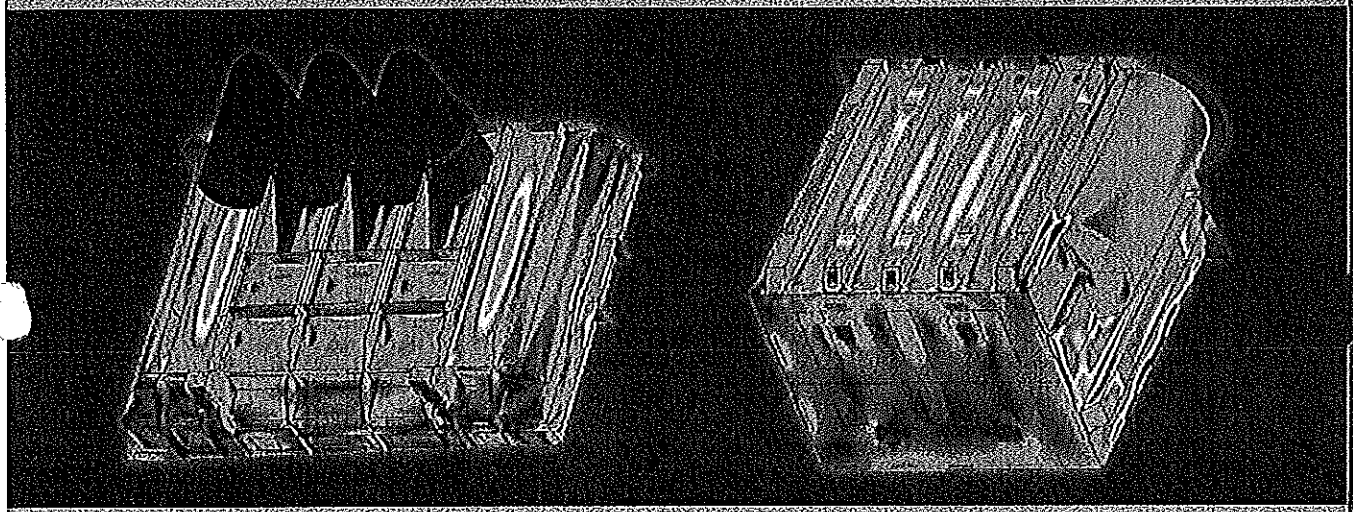
Calculations of dielectric insulation loads are performed according to modern methods based on computer-aided design. This enables a fast and more accurate calculation and optimum design of insulation, especially for high-voltage transformers.



Tank

Tanks are designed with reinforced plane walls to withstand full vacuum and 70 kPa overpressure. We manufacture two types of tanks: the classic tank and the tank in the shape of a bell. The active part in the classic tank is lifted together with the cover while in the bell shaped tank only the bell is lifted without the bottom and active part. Corrosion protection of the tank and equipment is standardized and is defined in dependence on climatic conditions in which the transformer shall be in operation or according to the customer's requirements.

Materials used for the production of tanks are classified into the category of construction steels. The required strength calculations for the tank are performed in accordance with modern methods. With the help of computer aided engineering work and numerical strength tests we assure optimal construction design, perfect safety and safe transport of the transformer to the location of its installation.

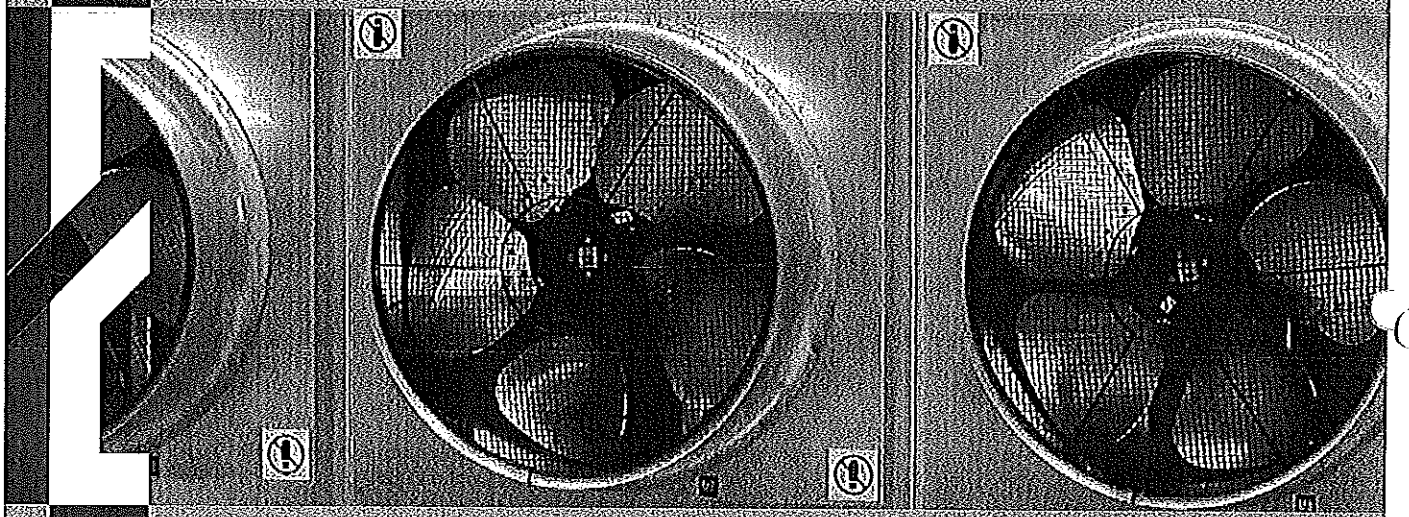


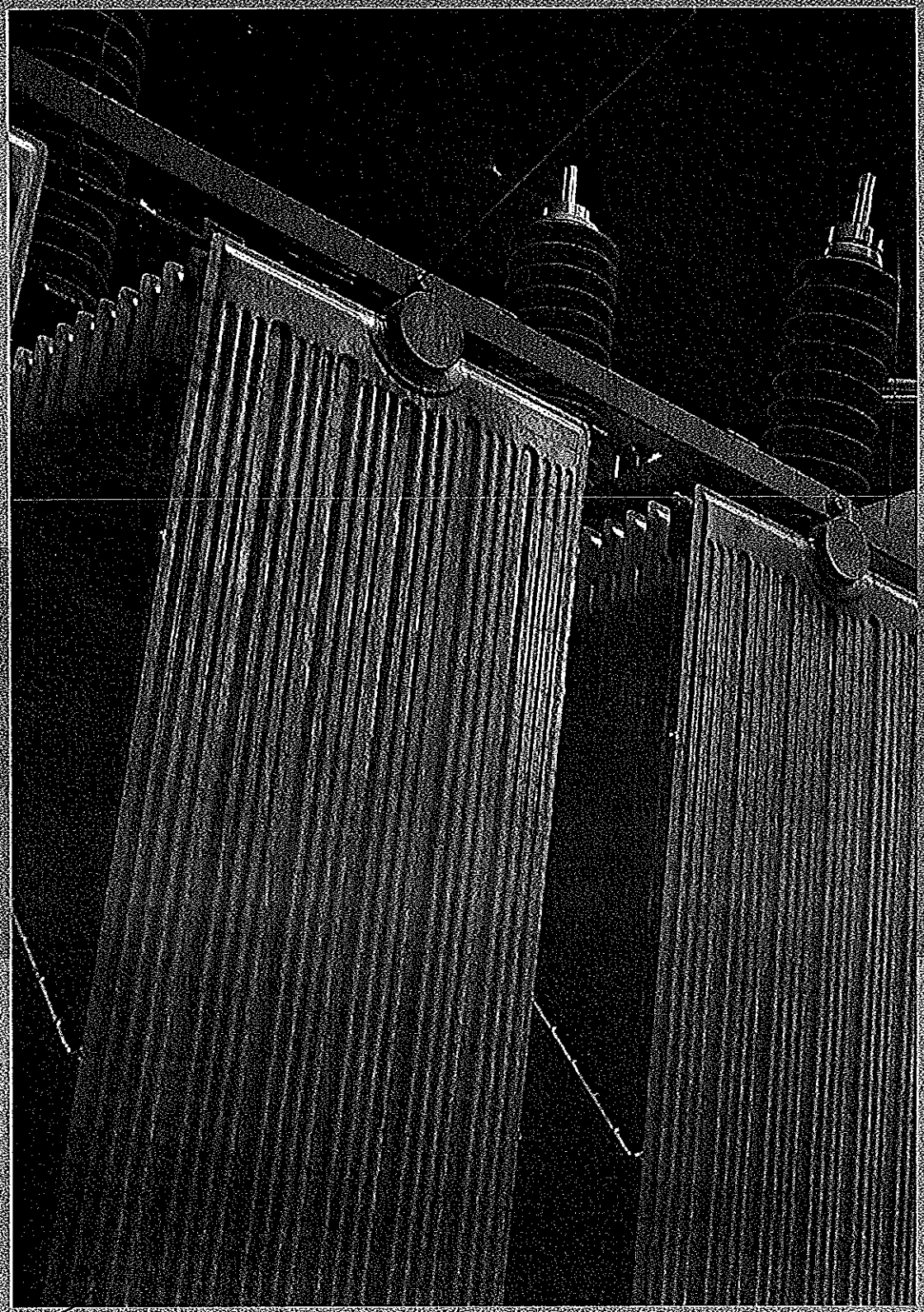
The standard corrosion protection is often adapted to the requirements of our customers, thus they can choose the thickness of individual layers, their combination and the top coat shade. Parts of equipment for large transformers and radiators are often protected with the hot-zincking procedure enabling transformers to operate under hardest climatic conditions.

Cooling system

Transformers are equipped with a cooling system which can efficiently dissipate the heat emerging during operation. The cooling system is designed and tested for permanent operation with declared capacity within the limits of specified temperature rises. If there are no special overloading requirements, the cooling system is designed in correspondence with the IEC 60076-7. It comprises radiators, varied types of oil coolers or heat exchangers.

They can be separated from the tank and divided into several batteries or coolers, what enables fast assembly or dismantling of installations. The cooling system can be separated from the tank and situated in separate facilities with better conditions for the heat dissipation. In such cases the system has installed pumps for faster circulation of oil. Only the OF and OD types of cooling can be applied.

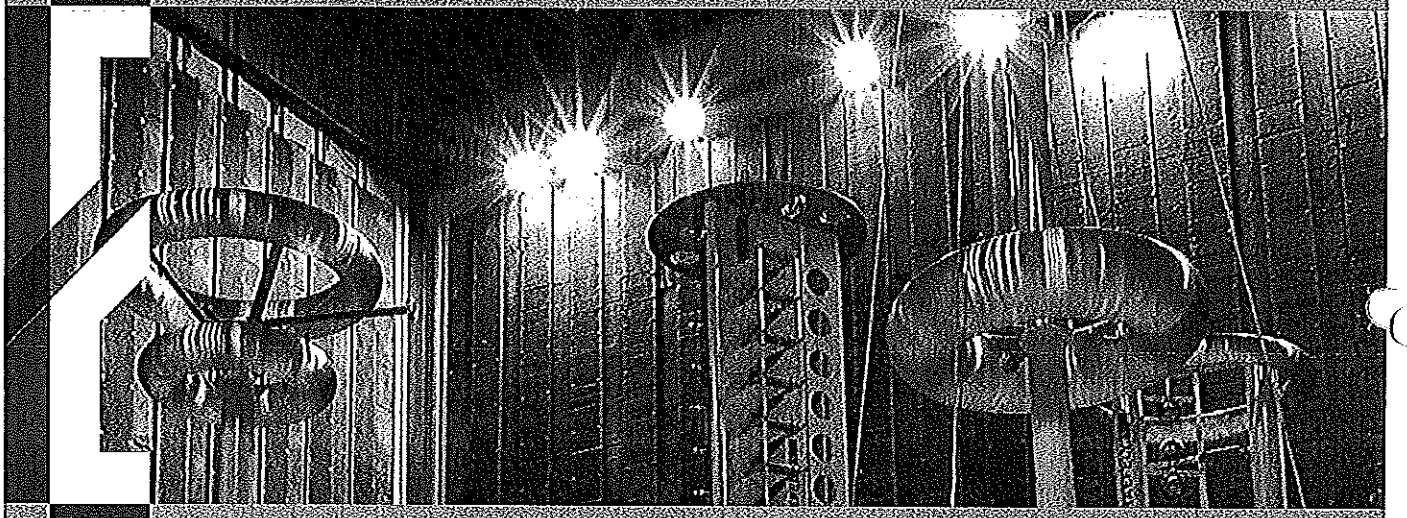




Testing and quality assurance

Each individual core, winding, tank and other parts are subjected to the mechanical and electrical inspection prior to mounting. During the mounting procedure the following is performed: interphase measurement of voltage ratio, measurement of resistance, insulation resistance, measurement of short circuit loss prior to drying process, supervision of drying process and transformer oil dielectric strength testing.

The interphase measurements are carried out in the workshops. The final testing of transformers is carried out in our own, well equipped, up to date designed high voltage laboratory located near the production plant. By using the metal plate cage in the laboratory walls and electrical supply through filters a very low frequency disturbance is achieved which is of great importance when partial discharges are tested, corona measured etc.



Upon the completion the transformer is subjected to routine test and measurement required by the standards, while each new transformer type also demands type testing.

With highly experienced and professionally trained group of employees we can perform routine, type and special tests, required by international standards.

The main equipment of the high voltage laboratory is:

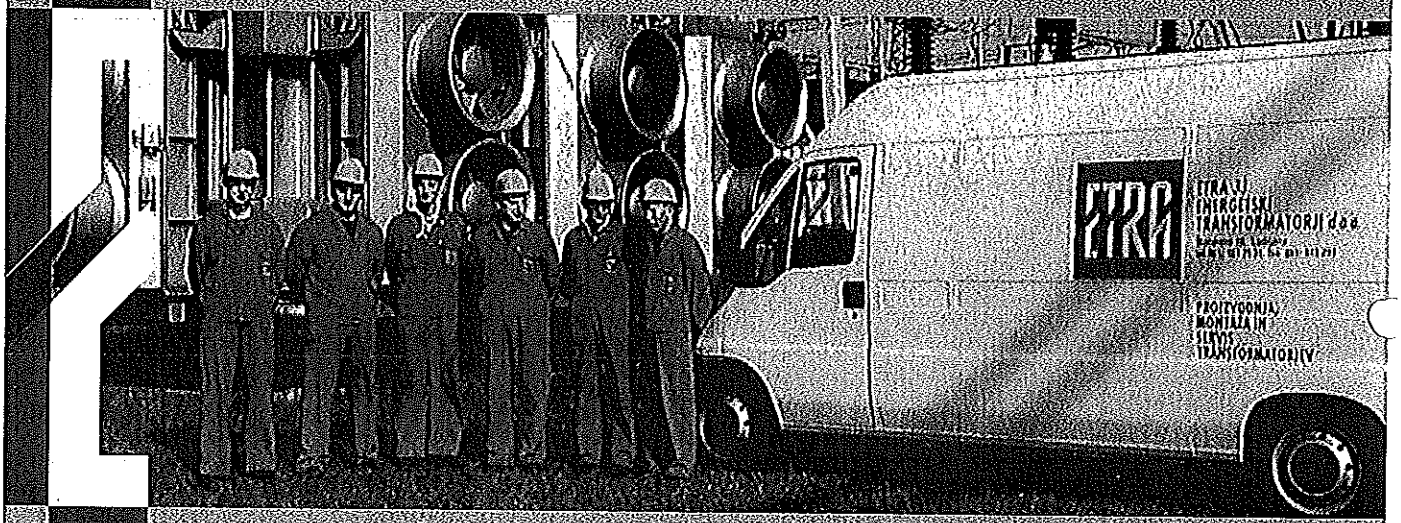
- Motor-generator group 3500/1200/500 kVA, 12/6/6 kV, 50/200/300 Hz
- Test transformer 500 kV with a regulation transformer, compensating reactor, capacity divider and control panel with digital measuring instrument
- Computer controlled impulse voltage generator 2000 kV, 200 kJ provided with a RC divider and chopped wave device
- Mobile equipment for measurement of resistance and temperature rise test with automatic temperature readings
- Digital partial discharge measuring system
- Equipment for measuring tgδ and the transformer capacitance

- Precision wide band power analyser
- Frequency response analyser (FRA)
- Three phase transformer turns ratio meter
- Noise source identifikation system with automated microphone positioning system
- Sound intensity analyser
- Sound level meter
- Automated test unit for testing of transformer oil dielectrical strength
- Testing unit for dissolved gas analyses

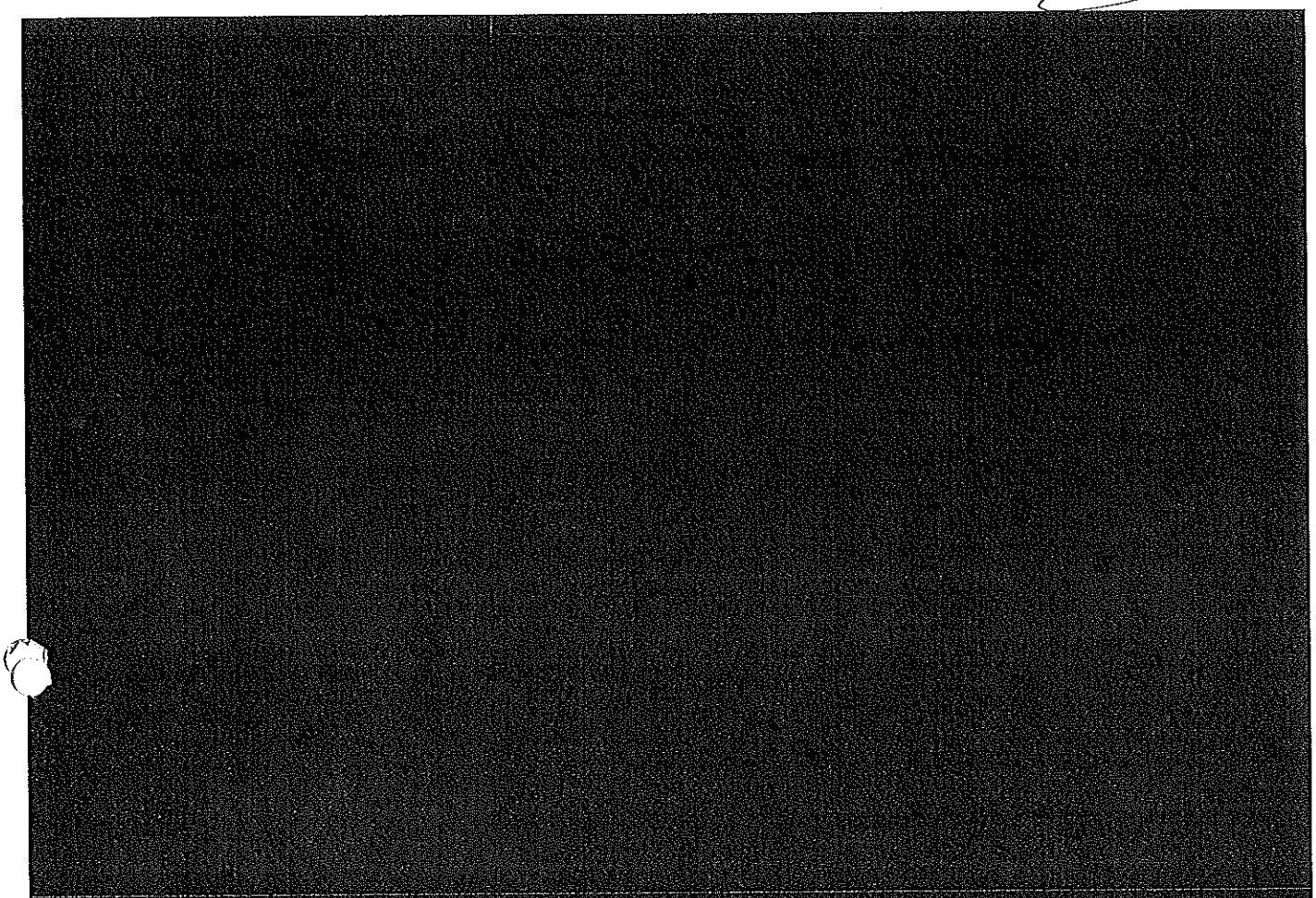
Service activities

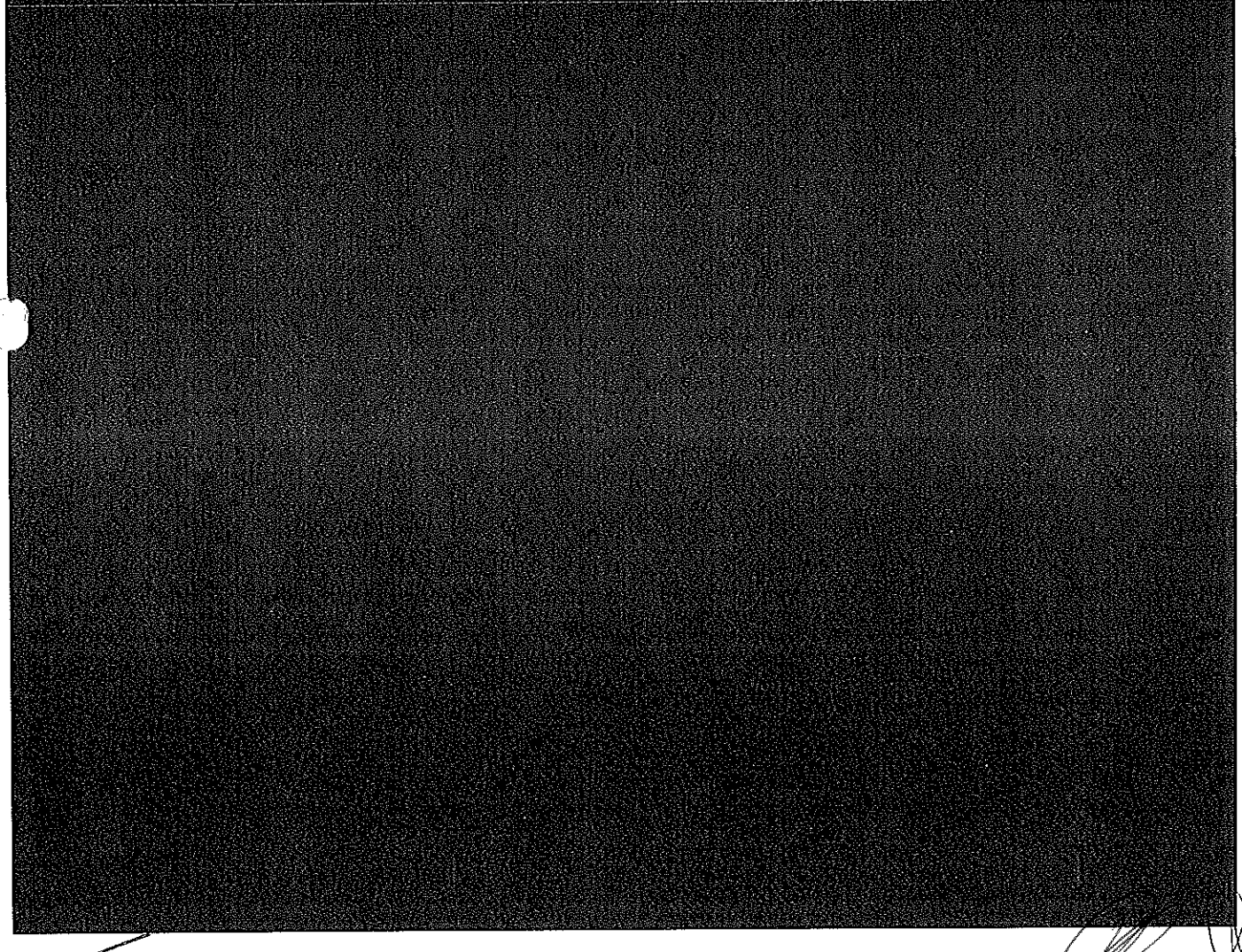
Our factory performs also various service activities such as: repair of transformers of different manufacturers, reconstruction of vital parts of used transformers and reworking of transformers, maintenance of transformers and reactors, supervision of installation and putting into operation of transformers, execution of measurements on transformers and reactors in our own HV laboratory or at site, replacement of transformer oil with new oil or treatment of used oil, and organization of transport, installation and dismantling of transformers and reactors.

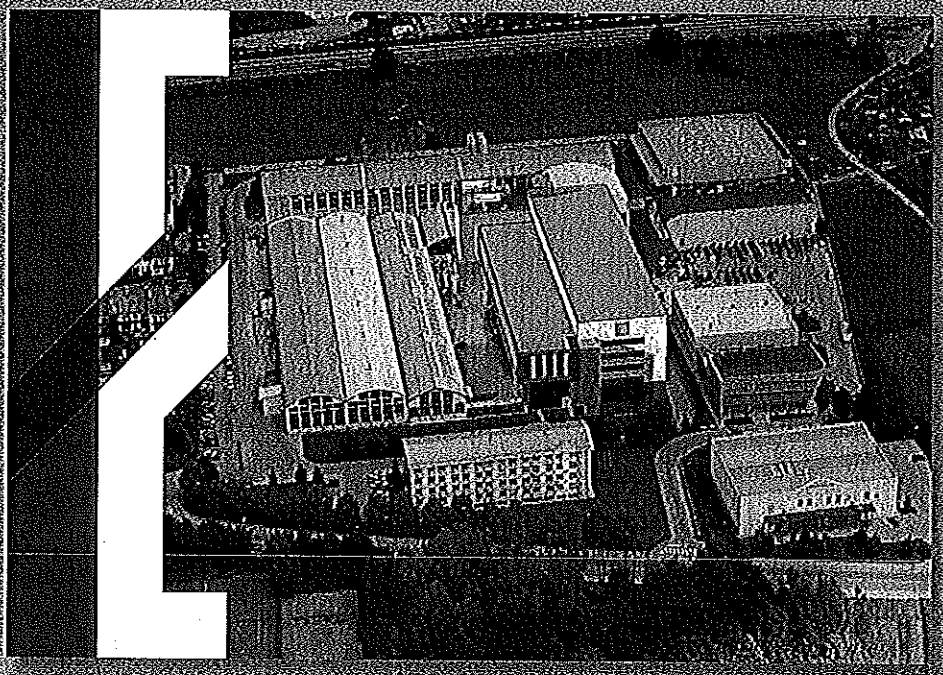
Our service department has several service groups always ready for fast interventions at site. Special service vehicles are equipped with the required equipment, tools and spare parts for fast interventions.



Advantages of our service groups are: fast reaction, professional inspection and diagnosis of failure, performance of repair works within the agreed upon terms and quality technical documentation referring to the performed work.







ETRA

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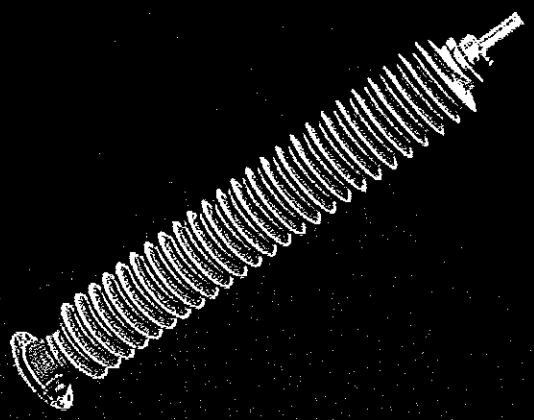

1ZSE 2750-111 en, Rev. 9

Transformer bushings, type GSA-OA
Technical guide

ABB

Original instruction

The information provided in this document is intended to be general and does not cover all possible applications. Any specific application not covered should be referred directly to ABB, or its authorized representative.

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Content

Design

GSA-OA is a Resin Impregnated Paper (RIP) bushing with Silicone Rubber (SiR) insulator. The condenser core is bonded directly to the silicone rubber to give a compact and lightweight bushing, containing no gas, oil or other liquids.

The GSA bushings are produced by winding a crêped paper web onto a mandrel, with aluminium foil inserts for electrical stress control. The core is impregnated and cured under vacuum, giving a partial discharge free bushing with low tan d (dissipation factor). After curing, the core is machined and the flange is fitted.

The inner terminal is fixed to the top piece with a divided ring (patented by ABB) and can be connected to leads by brazing. For maximum current rating, a solid copper rod is used.

Outer terminals are available in a number of standard configurations in aluminium and copper, but can also be modified to suit any connection need.

The standard colour of the mounting flange and of the insulator is ANSI 70, light grey.

Standards
The GSA bushing is designed and tested according to IEC 60137 and IEEE C57.19.00/01 in applicable parts.

Features and benefits
Solid
Reduced risk for fire, any mounting angle possible, oil leakage from the bushing eliminated, no monitoring of pressure and oil level.

Seals the transformer
Reduced risk for fire, risk for oil leakage from the transformer reduced.

Non-shattering materials
Protection of personnell and equipment, easy handling, safe transport - also when mounted on the transformer, high seismic withstand

Light weight, compact
Easy handling, small requirements on space inside transformer, low life cycle environmental impact.

Silicone rubber insulator
Superior electrical performance, cleaning normally not needed.

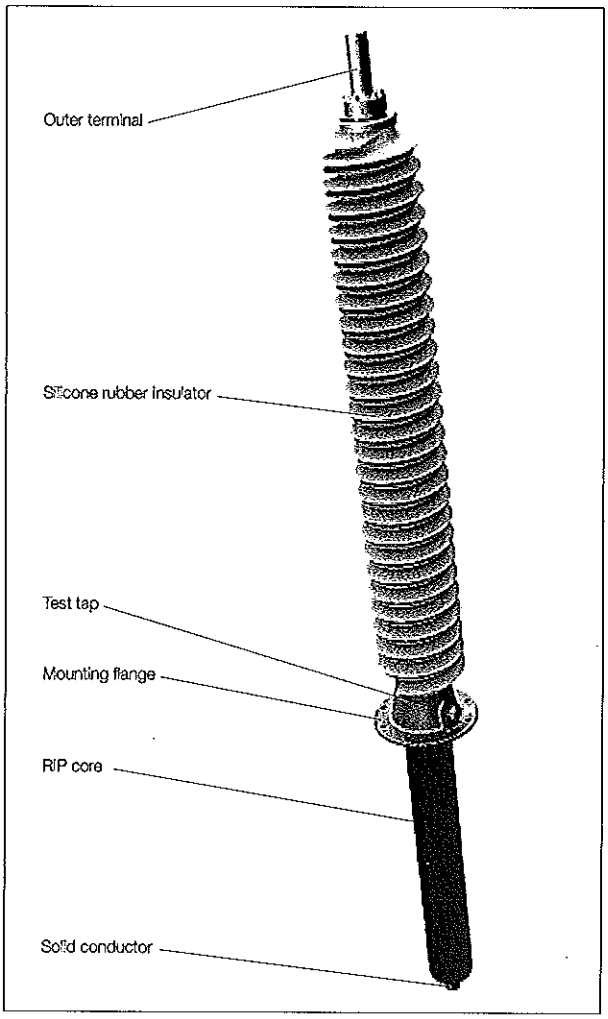

Fig. 1. Transformer bushing type GSA-OA.

Transportation and long term storage

The bushing is surrounded by a sealed moisture-proof wrapping material together with a drying agent upon delivery. The supplied protective wrapping shall not be opened if the bushings are intended to be stored. After transformer test, it is also important to reseal the bushing with the supplied protective wrapping or a similar moisture-proof wrapping, together with a drying agent. The wrapping works as protection for transportation and storage (≤ 6 months). Note that bushings with standard wrapping shall be stored protected from precipitation.

For longer storage times (>6 months) a container have to be ordered separately.

General specifications

For conditions exceeding the standard specification, please consult the supplier.

Application:	Transformers
Classification:	Resin impregnated paper, capacitance graded, outdoor immersed bushing
Ambient temperature:	+40 °C to -40 °C, minimum value acc. to temperature class 3 of IEC 60137
Altitude of site:	< 1000 m
Level of rain and humidity:	1-2 mm rain/min. horizontally and vertically, as per IEC 60060-1, and 5 mm/min. as per IEEE
Pollution level:	According to specific creepage distance and IEC 60815
Immersion medium:	Transformer oil. Maximum daily mean oil temperature +90 °C. Maximum temporary oil temperature +115 °C.
Oil level in transformer:	Not lower than 25 mm from the bushing flange
Max pressure of medium:	100 kPa (over pressure)
Angle of mounting:	Horizontal to vertical
Test tap:	Test tap with 4 mm male contact pin
Capacitance C_2 of test tap:	< 5000 pF
Arcing horns:	Optional
Conductor:	Solid or flexible draw lead conductor
Markings:	Conforming to IEC/IEEE.

Testing

Routine testing
The bushing is routine tested according to applicable standards. The tests include measurement of partial discharge quantity, tan δ, capacitance, dry power frequency voltage withstand test. The flange is separately tightness tested with helium. A visual inspection is performed.

An individual routine test protocol is delivered with each bushing from ABB.

Type tests
Complete type tests have been performed and reports are available on request.

Special tests
A number of tests not specified by international standards have also been performed and reports are available on request.

Test tap
The outer conducting layer of the condenser core is connected to an insulated test tap on the flange. During operation the protective cap must be fitted to earth the outer layer to the flange. The maximum test voltage is 2 kV, 50 Hz for 1 minute. The maximum service voltage is 600 V.

Test tap adapter
For testing, a special test adapter is required for permanent connection of the test tap to the measuring circuits.

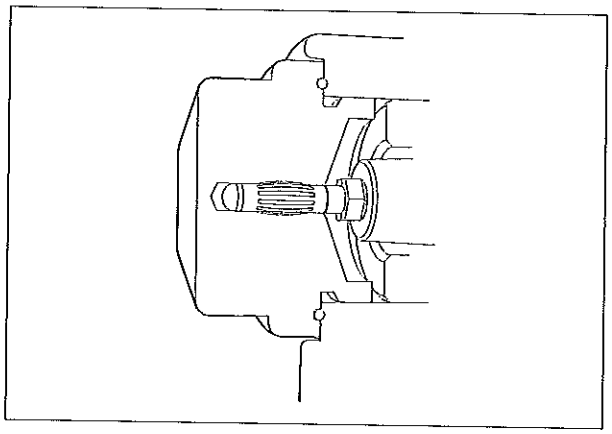

Fig. 2. Test tap.

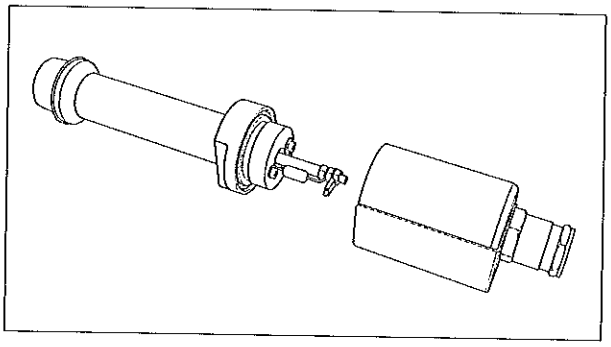

Fig. 3. Test tap adapter, 1ZSC003881-AAC.

Electrical data

Ratings GSA-OA	52	73	123	145	170
Rated voltage IEC (kV)	52	72.5	123-170	145-170	170
Rated phase-to-ground voltage IEC (kV)	30	42	98	98	98
Insulation class IEEE (kV)	46	69	115	138	161
Rated line-to-ground voltage IEEE (kV)	29	44	88	88	102
Basic Insulation Level (kV) (Equal to dry lightning impulse withstand voltage.)	250	350	550	650	750
Rated current (A)	2000	2000	1600	1600	1600
Draw lead current (A)	1250	1250	1250	1250	1250
Rated frequency (Hz)	50/60	50/60	50/60	50/60	50/60
Temporary over voltage (kV)	52	73	170	170	170
Wet power frequency AC (kV)	95	140	230	275	325
Dry power frequency. Routine test 1 minute (kV)	120	160	260	310	365
Nominal capacitance between conductor and test tap C1 ±10 % (pF) Space for current transformer (mm) 0/300/500	215/417/543	325/512/636	216/319/369	233/326/386	311/404/467

Dimensions

Dimensions are subject to modification without notice.

Type GSA	Cat. No.	Dimensions in mm														
		Total L	Oil side L1	Air side L2	Draw lead L4	Top part L5	Arcing distance L7	Flange height L8	Condenser core outer D1	Centre hole D2	Min. gasket surface inner diameter D5	Hole circle D6	Flange D7	Insulator sheds D8	Top piece diameter D9
52	LF 130 052-BA	734	145	589	583	56	467	101	96	51	110	185	225	230	120
	-BB	1034	445												
	-BC	1234	645												
73	LF 130 073-BA	1029	260	769	763	56	647	101	96	51	110	185	225	230	120
	-BB	1329	560												
	-BC	1529	760												
123	LF 130 123-BA	1444	255	1189	1183	56	1067	101	136	51	150	250	290	270	160
	-BB	1744	555												
	-BC	1944	755												
145	LF 130 145-BA	1731	362	1369	1363	56	1247	101	136	51	150	250	290	270	160
	-BB	2031	662												
	-BC	2231	862												
170	LF 130 170-BA	2019	410	1609	1603	56	1487	101	136	51	150	250	290	270	160
	-BB	2319	710												
	-BC	2519	910												

Type GSA	Rated current (A)	Cat. No.	Space for current transformer (mm)	Net mass (kg)	Number of holes n1	Flange thickness T	Creepage distance		Cantilever load Max. permitted loading perpendicular to the terminal	
							total (mm)	protected (mm)	(N)	Test (N)
52	2000	LF 130 052-BA	0	13	6	15	1642	700	2000 [1]	4000
		-BB	300	16						
		-BC	500	17						
73	2000	LF 130 073-BA	0	18	6	15	2323	1000	2000 [1]	4000
		-BB	300	20						
		-BC	500	21						
123	1600	LF 130 123-BA	0	45	8	15	3913	1700	2000 [2]	4000
		-BB	300	50						
		-BC	500	53						
145	1600	LF 130 145-BA	0	52	8	15	4595	2000	2000 [2]	4000
		-BB	300	57						
		-BC	500	60						
170	1600	LF 130 170-BA	0	61	8	15	5504	2400	2000 [2]	4000
		-BB	300	66						
		-BC	500	69						

1) Exceeding IEC 60137 Cantilever load Level II.
2) Conforming to IEC 60137 Cantilever load Level II.

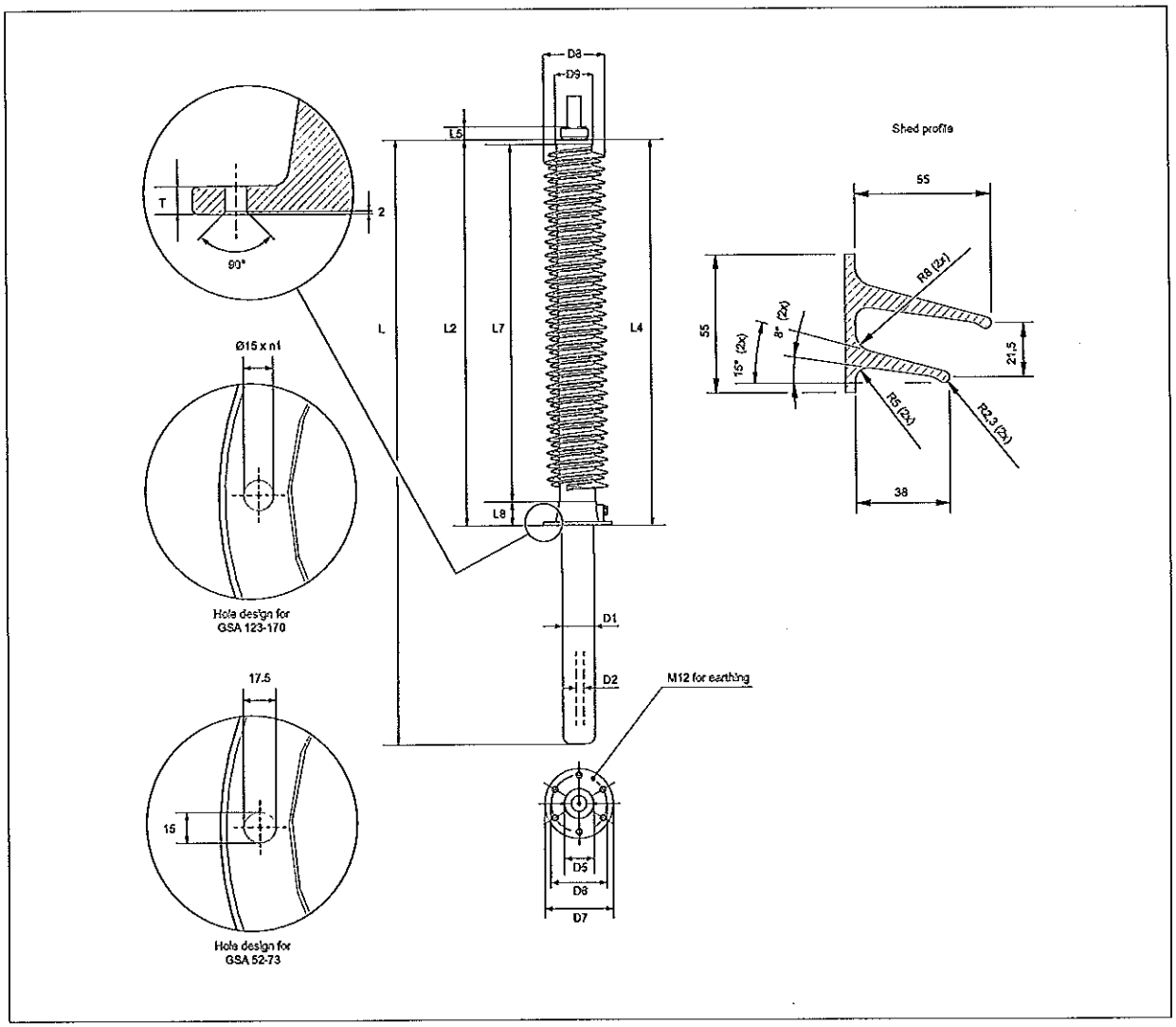

Fig. 5. Dimensions.

Connection details

Outer terminal

The outer terminal needs to be specified in each case. The outer terminal is then used together with either a solid rod, for maximum current capacity, or a flexible lead for greater ease of assembly, when the required current capacity is lower.

The outer terminal is available in a number of standard configurations. Other configurations can be supplied on request.

Material	Plating	Stud diameter (mm)	Cat. No. LF 170 079	Mass (kg)
Aluminium	-	60	-A (standard)	2.3
	-	30	-B (standard)	1.6
Copper	-	60	-C (standard)	6.2
	-	30	-D (standard)	3.6
	Tin	60	-E	6.2
	Tin	30	-F	3.6
	Silver	60	-G	6.2
	Silver	30	-H	3.6

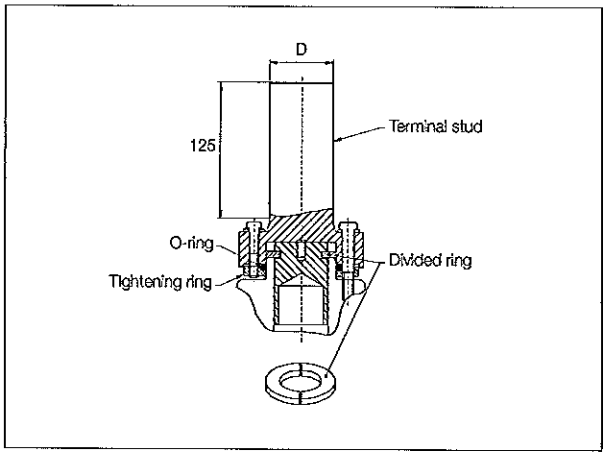

Fig. 8. Outer terminal.

Inner terminal

The inner terminal is made of copper for connection of a draw lead.

Material and design	Conductor diameter (mm)	Cat. No. LF 170 080	Mass (kg)
Copper for brazing	5 (pilot hole)	-A	1
	11	-B	1
	13	-C	1
	15	-D	1
	18	-E	1
	30	-F	1
	42	-G	1
	45	-H	1

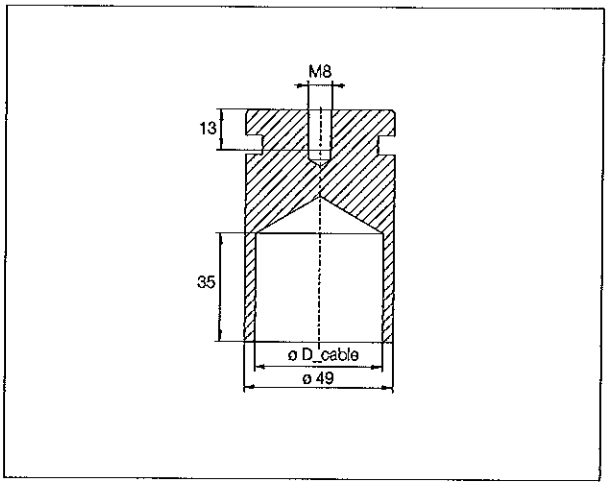

Fig. 9. Inner terminal.

Solid rod conductor

The rod is produced from electrolytical copper and divided into two parts for ease of assembly. The parts are joined with a screw joint with undroppable screws. The lower part of the solid rod is designed to enable connection by brazing. The solid rod is available with two alternative dividing points, 20 mm below the bushing flange or 20 mm below the space for current transformer. The solid rod is delivered without paper insulation.

Conductor insulation

Draw leads and solid rods must be insulated with vacuum oil-impregnated insulating paper or equivalent, to give sufficient insulation integrity. The paper insulation must be min. 2 mm

Draw lead: The paper insulation must be brought min. 50 mm inside the bushing centre hole.

Solid rod: The paper must fill the recess and cover the whole solid rod end downwards.

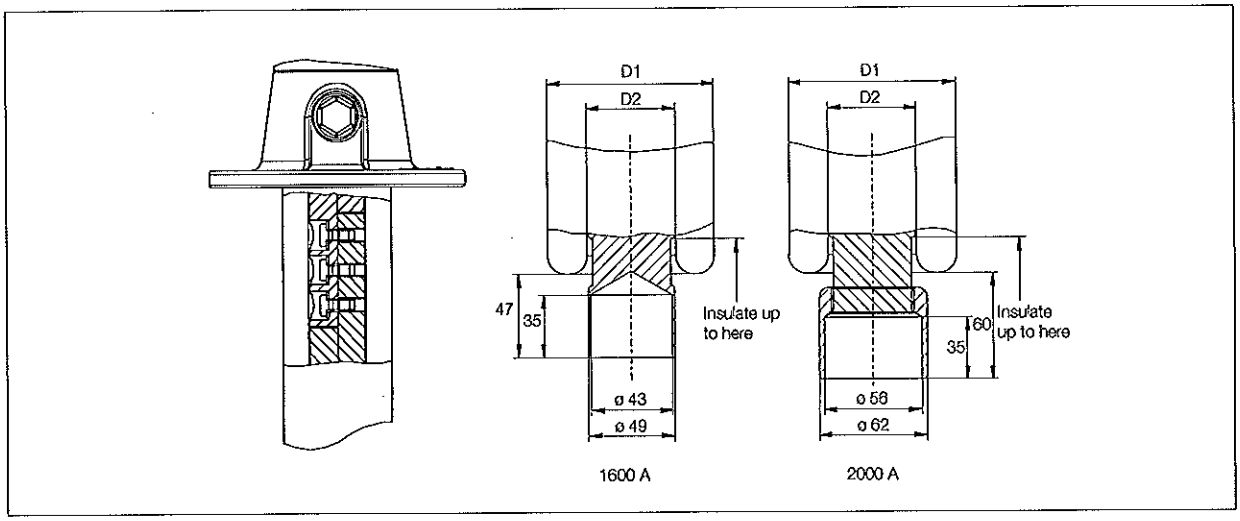

Fig. 10. Solid rod conductor.

Ordering particulars for solid rod conductor

Bushing Cat. No.		Division at flange: Upper part LF 170 081	Division at flange: 1600 A Lower part LF 170 082	Division at flange: 2000 A Lower part LF 170 082	Division at current transformer: Upper part LF 170 081	Division at current transformer: 1600 A Lower part LF 170 082	Division at current transformer: 2000 A Lower part LF 170 082	Mass (kg): 1600 A	Mass (kg): 2000 A
LF 130 052	-BA	-ABA	-DABA	-ABA	-	-	-	13	13.5
	-BB	-BABA	-DABB	-ABB	-ABB	-DBABA	-BABA	18	18.5
	-BC	-CABA	-DABC	-ABC	-ABC	-DCABA	-CABA	21.5	22
LF 130 073	-BA	-BBA	-DBBA	-BBA	-	-	-	18	18.5
	-BB	-BBBA	-DBBB	-BBB	-BBB	-DBBBA	-BBBA	23	23.5
	-BC	-CBBA	-DBBC	-BBC	-BBC	-DCBBA	-CBBA	26	26.5
LF 130 123	-BA	-DBA	-DADBA	-	-	-	-	25	-
	-BB	-BDBA	-DDBB	-	-DBB	-DBDBA	-	30	-
	-BC	-CDBA	-DDBC	-	-DBC	-DDBA	-	33	-
LF 130 145	-BA	-EBA	-DEBA	-	-	-	-	29.5	-
	-BB	-BEBA	-DEBB	-	-EBB	-DBEBA	-	33.7	-
	-BC	-CEBA	-DEBC	-	-EBC	-DCEBA	-	37.1	-
LF 130 170	-BA	-FBA	-DAFBA	-	-	-	-	34.5	-
	-BB	-BFBA	-DFBB	-	-FBB	-DBFBA	-	39.5	-
	-BC	-CFBA	-DFBC	-	-FBC	-DFBA	-	42.5	-

Separate terminal plate with bolts

The separate terminal plate is available for stud with ø 30 mm, and used for connecting the bushing to the line conductor.

Material	Cat. No.
Aluminium	LF 170 014-A
Nickel plated copper	LF 170 021-A

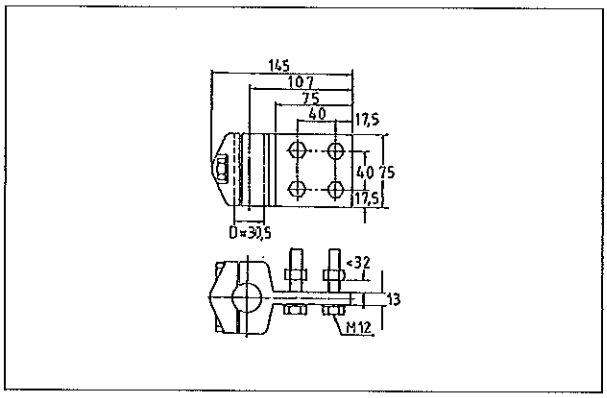

Fig. 11. Separate terminal plate with bolts.

Arcing horns

Arcing horns made of galvanised steel can be mounted on the bushing. The arcing horns are available for stud with ø 30 mm.

The lower rod is fastened onto the flange with one of the fixing screws and the upper rod by means of a bracket on the outer terminal.

The gap distances for standard arcing horns are shown in the table. Other gap distances on request.

Bushing type	K (mm)	C (mm)	H (mm)
GSA 52	230–440	315	112
GSA 73	400–620	315	112
GSA 123	620–960	315	114
GSA 145	700–1080	380	224
GSA 170	820–1290	380	224

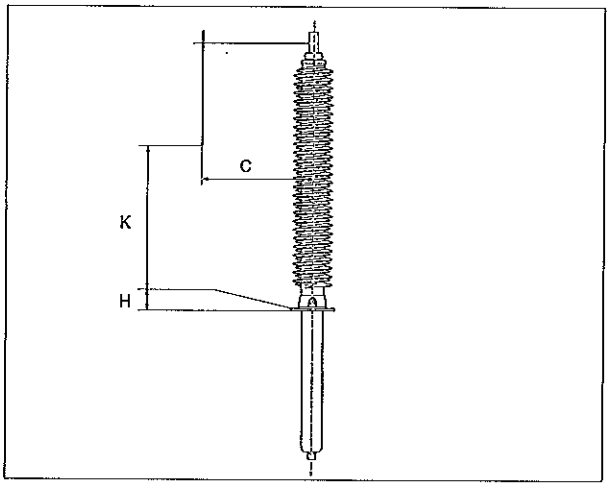

Fig. 12. Arcing horns.

Conductor loading

The GSA bushings fulfil the temperature rise test requirements according to IEC and IEEE for the currents below:

Bushing type GSA-OA	Conductor	Permissible current	
		IEC (A)	IEEE (A)
52-73 kV	Solid rod	2000	2000
123-170 kV	Solid rod	1600	1600
All types	Stranded cable		
	185 mm²	400	400
	740 mm²	1250	1250

Overloading of bushings

If the conductor for the bushing is selected with 120 % of the rated current of the transformer, the bushing is considered to be able to withstand the overload conditions stated in IEC 60354 without further clarifications or tests, according to IEC 60137.

Short-time current

The rated thermal short-time current (I_{th}) is calculated according to IEC 60137.

Conductor	Rated current A	Area mm²	Short-time current (I_{th}) kA, rms		Dynamic current (I_d) kA, peak
			1 s	2 s	
Solid rod Ø 49 mm Cu	2000.. 1600	1886	100	96	240
Stranded draw-lead	1250	740	61	43	107

Ordering particulars

When ordering, please state:

- Type and catalogue number for bushing.
- Catalogue number for inner terminal or conductor, lower and upper part.
- Catalogue number for outer terminal.
- Additional accessories or modifications.
- Test required, in addition to the normal routine tests.

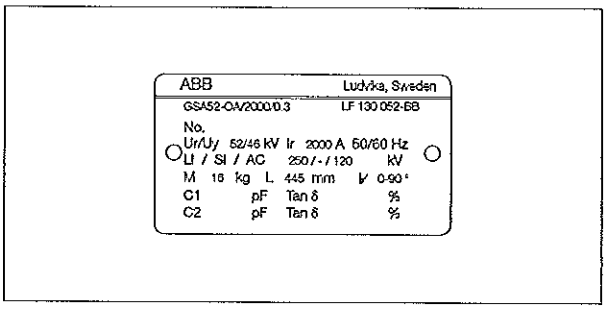

Fig. 13. Nameplate with marking example.

Recommendations for positioning

The maximum stresses in the oil at the surface of the conductor insulation must be limited to those values normal for insulated conductors and similar components in the same transformer.

The adjacent recommendations are intended as guide lines when complete calculations are not carried out.

Type GSA	Internal insulation level of transformer (kV)	Distance to earthed parts R (mm)
52	250-95	75
73	350-140	90
123	550-230	145
145	650-275	165
170	750-325	190

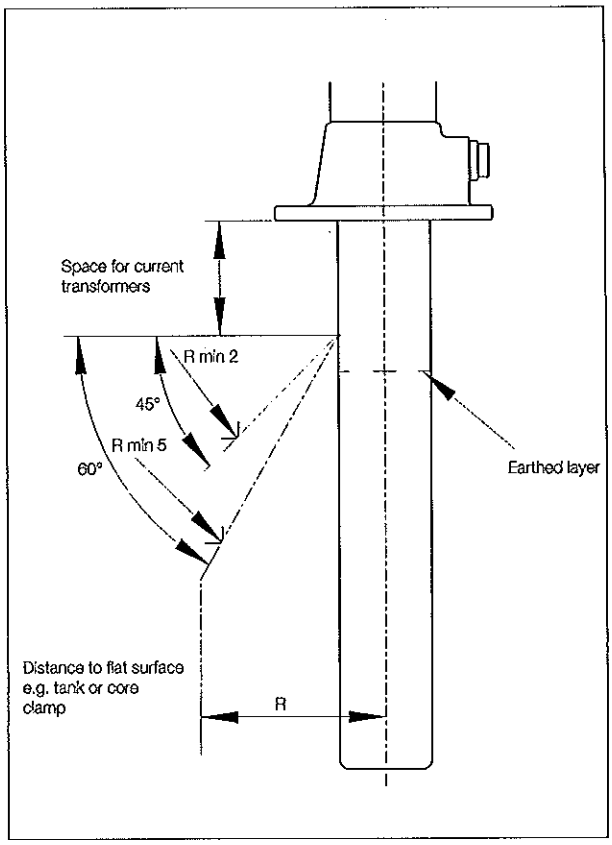

Fig. 14. Recommendations for positioning.

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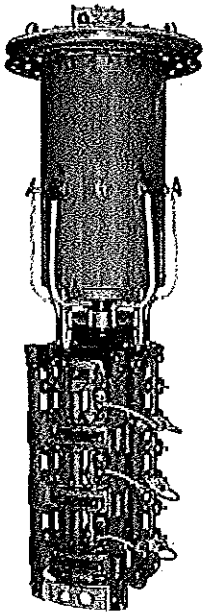
TECHNICAL DATA

TYPE CM2 VACUUM ON-LOAD TAP CHANGER

FOR OIL-IMMERSED TRANSFORMER

HM0.154.5701



SHANGHAI HUAMING POWER EQUIPMENT CO., LTD.

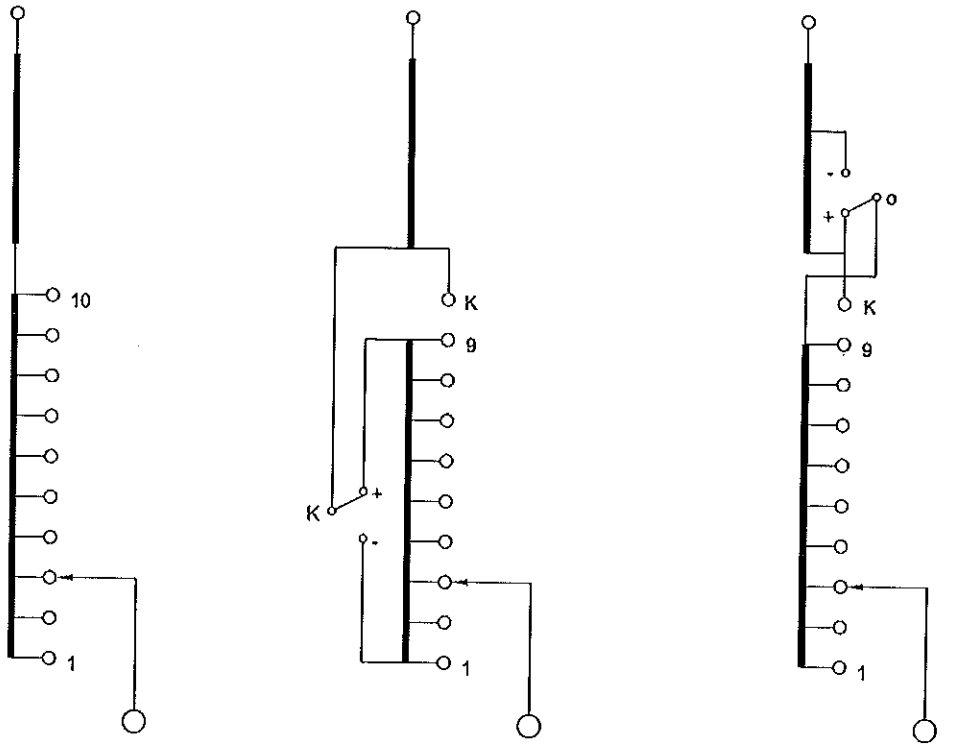
General

1. General

Type CM2 Vacuum On-Load Tap Changer (hereinafter referred as CM2 or CM2 OLTC) is a typical combined-structure tap changer applicable in oil-immersed transformer, comprising of two major parts: diverter switch and tap selector. The CM2 OLTC is put in transformer oil tank and its diverter switch has a separate oil compartment from transformer tank, while tap selector, together with transformer windings, is completely laid inside the tank. OLTC's installation is divided into two types - standard tank flange and bell-type flange.

Three-phase CM2 OLTC could be used at neutral point of star-connection, and a combination of three units of single-phase CM2 OLTC is designed for any selectable winding connection.

Basic connections of tap winding as in fig.1



a) Without change-over selector b) With reversing switch c) With coarse tap selector

Fig.1 Basic Connections of Tap Winding

a) without change-over selector
This linear regulation can be designed by a maximum of 9, 11,13,15 or 17 steps, namely 10, 12,14,16 or 18 operating positions at maximum.

b) with change-over selector
With reversing switch or coarse tap selector, the regulating range will be doubled to maximum ±9, ±11, ±13, ±15 or ±17 steps, namely 19,23,27,31 or 35 operating positions at maximum, when actual positions are less than above mentioned ones, it can be easily realized by passing over continuous operation of motor drive unit or equal potential connection of multiple operating positions.

2. Technical specification

Type CM2 OLTC complies with IEC60214-1: 2003 standard, please refer to below table 1.

Tabe1 CM2 Series OLTC Main Technical Specifications

Item	Specification		CM2III 500Y CM21 500	CM2III 600Y CM21 600	CM21 800	CM21 1200	CM21 1500
1	Max. rated through-current (A)		500	600	800	1200	1500
2	Rated frequency		50 or 60				
3	Connection		Three-phases for neutral point of star connection Single-phase for any selectable winding connection				
4	Max. rated step voltage (V)		3300				
5	Rated step capacity (kVA)		1400	1500	2000	3100	3500
6	Short-circuit current test (kA)	Thermal (3s)	8	8	16	24	24
		Dynamic (Peak)	20	20	40	60	60
7	Max. Operating Positions	Without change-over selector	18				
		With change-over selector	35				
8	Insulation to ground (kV)	Highest voltage for equipment Um	72.5	126	170	252	
		Rated separate source AC withstand voltage(kV/50Hz,1min)	140	230	325	460	
		Rated lightning impulse withstand voltage (kV,1.2/50μs)	350	550	750	1050	
9	Tap selector		4 grades of B, C, D and DE according to insulation level				
10	Mechanical life		Not less than 1,500,000 operations				
11	Contact life		Not less than 600,000 operations				
12	Oil compartment of diverter switch	Service pressure	0.03MPa				
		Leakage test	No leakage under 0.08MPa for 24 hours				
		Over pressure protection	Bursting cap busts at 300 ± 20%kPa				
		Protection relay	Oil flow speed set at 1.0m/s ±10%				
13	Motor drive unit		SHM-III or CMA7				

3. Model designation

3.1 Model designation

Type CM2 OLTC models varies with number of phase, maximum.rated through current, the highest voltage for equipment, insulation grade of tap selector and connection mode, etc.The parameters are represented as in Fig.2 below.

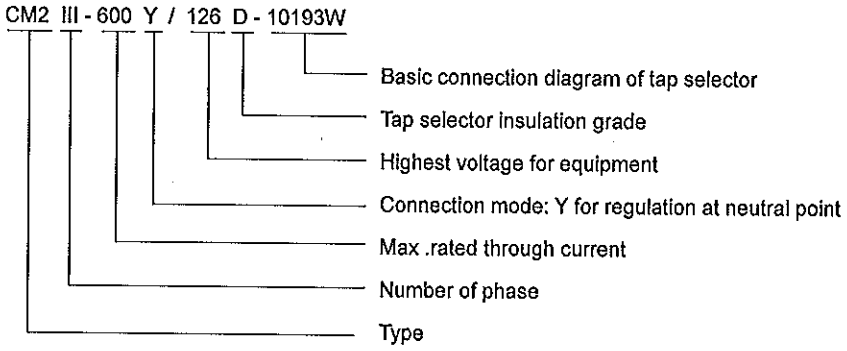


Fig.2 Designation of CM2 OLTC

3.2 Designation of basic connection of tap selector

The tap selector may have different spec with respect to the number of the steps required and connection of the tap winding. The basic connection model reflects the relevant pitch of the contact circuit, the number of operating positions, the number of pitches of tap selector, the number of operating positions, the number of mid-positions and change-over selector type. See below Fig.3 for the indications of tap selector model.

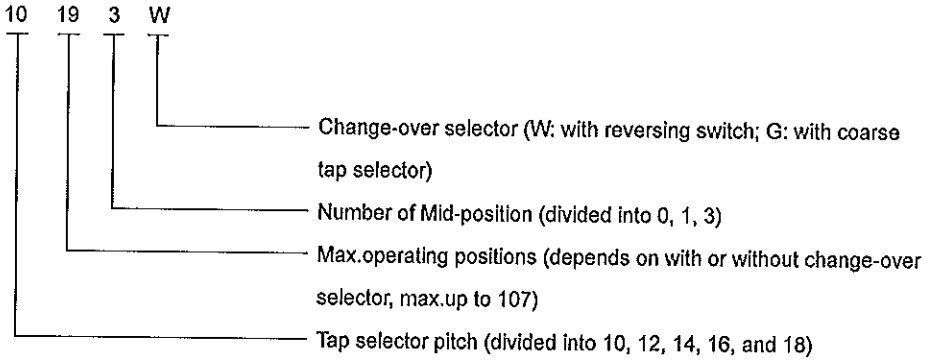


Fig.3 Designation of Basic Connection Diagram of Tap Selector

3.3 Survey of basic connection diagram of tap selector

Different numbers of taps correspond to different connection diagram. Fig.4 shows regular basic connection diagrams of the tap selector, and special design depends on the from customers.

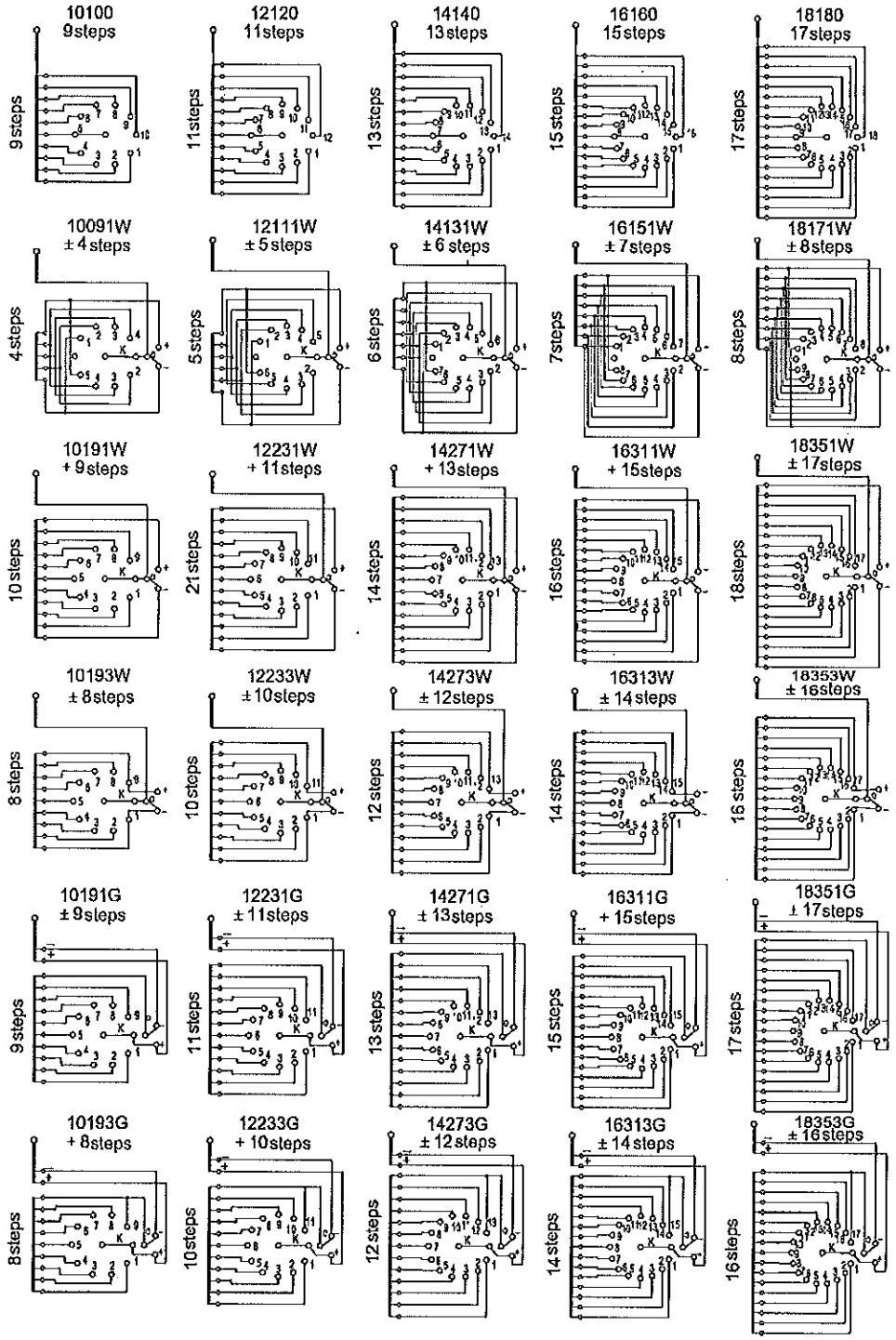


Fig.4 Survey of Basic Connection Diagram of Tap Selector

4. Terms and definitions

4.1 Through current

Rated through current (I_u) : The current flowing through an on-load tap-changer towards the external circuit, which is capable of transferring from one tap to the other at the relevant rated step voltage and which can be carried continuously while meeting the requirements of the standard.

Max. rated though-current (I_{um}): The highest rated through-current for which the tap-changer is designed for and which is the current reference for all related test.

4.2 Step voltage

Rated step voltage (U_i): For each rated through-current, the max. permitted voltage between two terminals which connect to two adjacent taps of the transformer.

Maximum rated step voltage (U_{im}): The highest value of the rated step voltage for which the tap-changer is designed. The maximum rated step voltage of type CM2 is 3300 volt.

4.3 Rated step capacity P_{stn}

The step capacity equals to the product of step voltage multiplied by current. While the rated step capacity of OLTC is a permissible maximum step capacity during continuous operation. That is $P_{stn}=U_i \times I_u$, The rated step capacity refers to Fig.5.

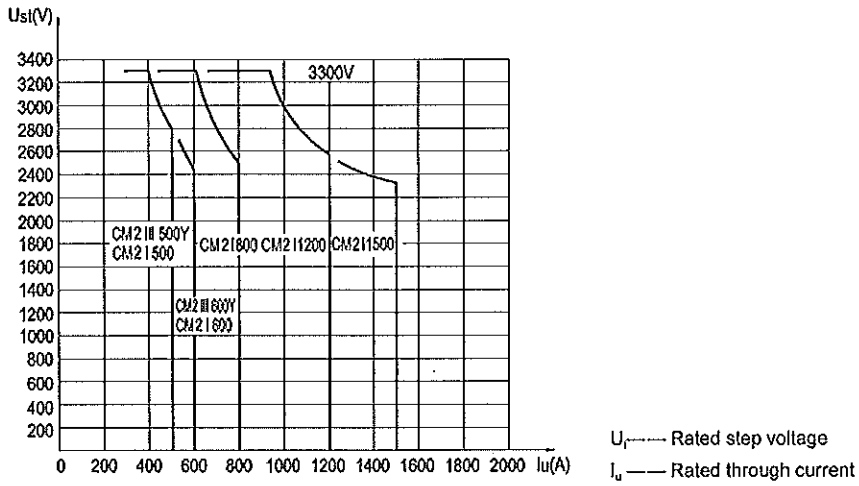


Fig. 5 Curve of The Rated Step Capacity of CM2 OLTC

4.4 Breaking capacity

The breaking capacity refers to the maximum switching capacity under the safe changeover load, according to IEC60214-1(2003) stipulation, 40-time breaking switches shall be performed at a current corresponding to twice the maximum rated through-current (Ium) and at its relevant rated step voltage(U_i).

The breaking capacity of CM2 OLTC: $P_{stmax} = 2P_{stn} \approx 2I_{um} \times U_{stn}$

P_{stn}: Rated step capacity

I_{um}: Max. rated through current

U_{stn}: relevant step voltage

4.5 Electrical life of vacuum interrupter

The electrical life of vacuum interrupter is 600,000 operations.

4.6 Short-circuit current test

According to IEC 60214-1: 2003, all contacts continuously carrying the current shall be able to withstand 2s (±10%) short circuit test current without melting, deformation or mechanical damage. Meanwhile the starting peak current value shall be 2.5 (±5%) times of the root means square value of rated short circuit test current. Refer the short circuit test current values to Table 1. CM2 Series of OLTC Main Technical Specifications.

4.7 Conditions for OLTC's operations

4.7.1 Oil temperature for OLTC's operation ranges from -25°C to 105°C .
4.7.2 Ambient air temperature for OLTC's operation ranges from -25°C to 40°C .
4.7.3 The vertical inclination level of OLTC being installed into transformer towards ground should be less than 2%.
4.7.4 The installation site should be free of heavy dust, explosive or corrosive gas.
Note: Please contact us if special application required.

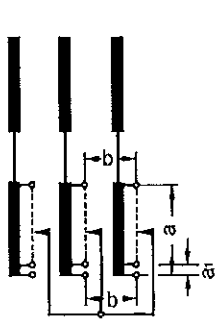
4.8 Internal insulation level

The internal insulation of CM2 OLTC is divided into four levels from low to high: B, C, D and DE.The withstand voltage is different between adjacent taps, max. and min. taps and between phases for tap changers with different insulation grade, Fig.6 shows the potential distribution of various parts after tap changer has been connected to voltage regulation winding. Table 2 shows CM2 OLTC power frequency withstand voltages and BIL values according to different insulation distance.

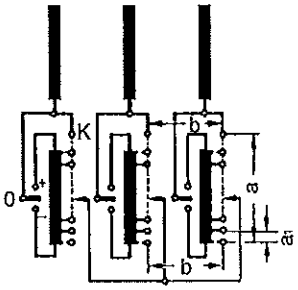
4.9 Insulation level to ground

The insulation level to ground refers to insulation of OLTC live parts against grounding parts, the rated value of which depends on dielectric tests according to IEC-60214-1(2003), please refer to Table 3.

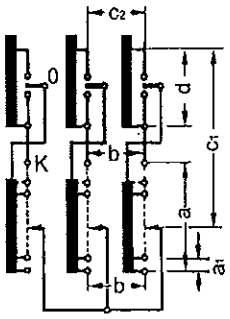
The requirement of insulation to earth for OLTC is relevant to OLTC connection location at transformer tap winding, regulation range and mode, tap winding connection model and structure, as well as the rated voltage of transformer tap winding, anyhow. It is determined by insulation to ground of transformer voltage regulating winding.



10 10 0 ... 18 18 0



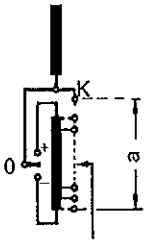
10 09 1W ... 18 17 1W
10 19 1W ... 18 35 1W
10 19 3W ... 18 35 3W



10 19 1G ... 18 35 1G
10 19 3G ... 18 35 3G

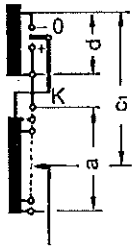
10 10 0 ... 18 18 0

1. Linear regulation



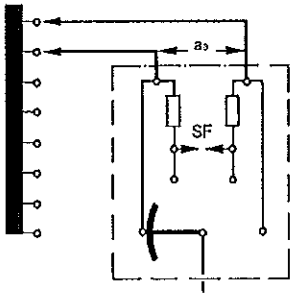
10 09 1W ... 18 17 1W
10 19 1W ... 18 35 1W
10 19 3W ... 18 35 3W

2. With reversing switch



10 19 1G ... 18 35 1G
10 19 3G ... 18 35 3G

3. With coarse change-over selector



4. Diverter switch

Explanation of designation code:
a: across regulation winding for the same phase
a1: between any selected and preselected taps of the tap selector
b: between any two taps of different phases
a0: between any adjacent taps of diverter switch
c1: between the beginning of coarse tap winding and neutral of fine tap winding of the same phase
c2: between beginnings of coarse tap winding of different phases
d: between begining and end of coarse tap winding of the same phase
SF: spark gap

Fig. 6 The Rated Voltage Stress on Tap Winding

Table 2 CM2 OLTC internal insulation

(unit: kV)

Designation code	Tap selector size B		Tap selector size C		Tap selector size D		Tap selector size DE	
	1.2/50μs	50Hz 1min	1.2/50μs	50Hz 1min	1.2/50μs	50Hz 1min	1.2/50μs	50Hz 1min
a	265	50	350	82	460	105	550	120
b	265	50	350	82	460	146	550	160
a_0	90	20	90	20	90	20	90	20
a_1	150	30	150	30	150	30	150	30
c_1	485	143	545	178	590	208	660	230
c_2	495	150	550	182	590	225	660	250
d	265	50	350	82	460	105	550	120

a_0: The inherent insulation level refers to insulation level with spark gap protection when full wave voltage impulse is 130kV, the spark gap will response 100%

Table 3 Insulation Level to Ground of OLTC

(unit: kV)

The highest voltage for equipment Um	Rated separate source AC withstand voltage(kV/50Hz,1min)	Rated lightning impulse withstand voltage (1.2/50μs)
72.5	140	350
126	230	550
170	325	750
252	460	1050

4.10 Installation models

Type CM2 OLTC is mounted onto the transformer cover by tap changer head, a mounting flange (see appendix) must be provided by transformer producer for connection. CM2 OLTC is suitable for either standard tank or bell-type mounting. For bell-type tank transformer, the OLTC support flange is supplied as a temporary support, OLTC will be secured onto transformer mounting flange after complete installation of transformer bell-tank.

5 Special designs

5.1 Potential connection of the tap winding

For high voltage or wide regulation range on-load regulating transformer, during the operation of the change-over selector the tap winding is disconnected momentarily from the main winding, the regulating section will be broken away from the main coil and at status of "suspend", thus voltage regulating winding will gain the new potential that depends upon coupling capacities Ce (to ground) and Cw (between adjacent tap winding), refer to Fig.8. Generally this potential is different from the one of voltage regulating winding before change-over selector acting, the difference of them is designated as recovery voltage. This recovery voltage is produced at the breaking point of the separated contacts during the operation of change-over selector. If these differential voltages exceed a certain limit value, it may cause flashover on change-over selector and bring gas, it will be the serious problem. Therefore measures regarding potential connection of the winding must be taken.

CM2 OLTC could withstand a limit value of recovery voltage of 35 kV, when the potential is expected to overrun the limit value, tap winding should be permanently connected to a fixed potential resistance via a tie-in resistor, see Fig.7. For mounting location and dimensions of CM2 OLTC tie-in resistors, please refer to appendix 9.16

For calculating the change-over selector stress and dimensioning the tie-in resistors, the following details of the transformer specifications required when ordering:

a) Complete transformer parameter: rated capacity, rated voltage, voltage regulating range, winding connection mode, insulation level and so on.

b) Arrangement of the windings, i.e. the relative position of the tap winding to the adjacent coil or winding parts

c) Operating A.C.voltage across windings or layers of windings adjacent to the tap windings

d) Capacitance of the tap winding to adjacent windings(Cw)

e) Capacitance of the tap winding to ground or grounded adjacent windings (if exist) (Ce)

f) Voltage stress across half the tap winding at lightning impulse voltage test

g) A.C.voltage across half the tap winding under operation and test conditions.(Normally derived from order specification sheet for tap changer)

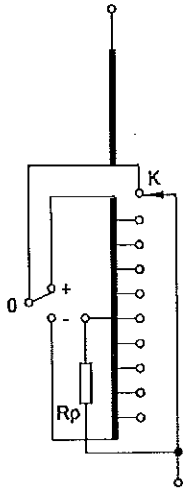


Fig.7 Potential Connection by Tie-In Resistor Rp

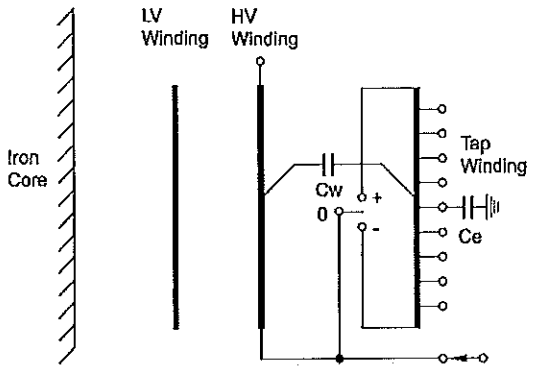
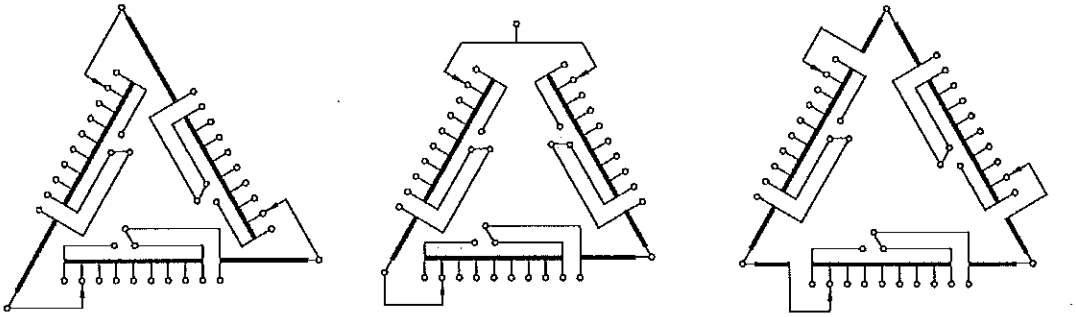


Fig.8 Arrangement of Winding and Coupling Capacitance

5.2 Special CM2 OLTC combinations (3×CM2I or CM2I+CM2II), driven by one or separated motor drive units and used for delta connection of windings or others except neutral point.



Regulating at Coil End of 3-Phase Delta Connection

OLTC Combination (CMI+CMII) for the Specific Delta Connection

Regulating at Middle of 3-Phase Delta Connection

Fig.9 Connection Diagram for Multiple CM OLTC Applications

6. Motor drive unit

CM2 OLTC may operated by SHM-III or CMA7 motor drive unit according to the requirement, please refer to Table 4 for technical data.

Table 4 Technical Data of Motor Drive Unit

Motor drive unit		SHM-III		CMA7	
Motor	Rated power (W)	750	1100	750	1100
	Rated voltage (V)	380,3AC/N		380/3AC	
	Rated current (A)	2.1	2.8	2.0	2.8
	Rate frequency(Hz)	50 or 60		50 or 60	
	Rotate speed (r.p.m.)	1400		1400	
Rated torque on drive shaft (Nm)		45	66	18	26
Revolution of the drive shaft per switching operation		33		33	
Revolution of the hand crank per switching operation		33		33	
Running time per switching operation (S)		5.6		About 5	
Max. operation positions		35		107	
Voltage for control circuit and heater circuit (V)		220/AC		220/AC	
Heater power (W)		50		50	
A.C. voltage test to ground (kV/50Hz, 1min)		2		2	
Approx. weight (kg)		73		90	
Protective degree		IP66		IP56	
Mechanical endurance (operations)		Not less than 2,000,000		Not less than 800,000	

Note: Please specify if special voltage required for motor, and control & heater circuit.

7. Controllers for On-Load tap changer

7.1 HMK8 controller

HMK8 controller is the device for remote control of SHM-III motor drive unit; it realizes OLTC switching operation through SHM-III. HMK8 can display the OLTC switching operation status and tap positions.

HMK8 has BCD code position signal output (contact capacity:AC250V/5A or DC30V/5A) and remote control signal input (non potential contact), it can also communicate with host computer via RS485 interface to realize remote supervising of OLTC position.

HMK8 main technical data is as below, refer to HMK8 manual for more details.
Working voltage: 380V, 3AC/N
Power frequency: 50Hz/60Hz
Maximum operation positions: 35
Environment temperature: -10°C to 40°C Indoor

7.2 HMC-3C position indicator

HMC-3C OLTC position indicator is a support fitting for CMA7 and CMA9 motor drive unit, it can be used to indicate the OLTC step, and has the function of "1-N", "STOP", "N-1" control as well as remote control indicator lamp, its input is decimal code and output is BCD code. Please refer to HMC-3C manual for details.

HMC-3C technical data is as below, refer to manual for more details.
Working voltage: 220V AC
Power frequency: 50/60Hz
Maximum operation positions: 107
Environment temperature: -10°C to 40°C Indoor

7.3 Automatic voltage regulator ET-SZ6 and HMK-2A

Automatic voltage regulator ET-SZ6 and HMK-2A is adopted for OLTC automatic voltage regulation, ET-SZ6 can be used for parallel operation in model of master and slave, please refer to relevant manual for details.

If you have any special technical requirements of above controller, please specify when ordering.

8. OLTC accessories

8.1 Bevel gear unit

Bevel gear unit is used for connection horizontal shaft and vertical shaft between OLTC body and motor drive unit, thus driving torque of motor drive unit can be transmitted to on-load tap changer, the overall dimensions of bevel gear unit is shown on appendix 9.25

8.2 Protective relay

Protective relay is the one of protective devices for oil-immersed on-load tap changer, when OLTC interior failure produces gas and oil surge, the protective relay contact acts, and switches on to the tripping circuit of the transformer circuit breaker, the transformer will be cut off at once.

Protective relay is mounted onto the connection pipe between OLTC head and conservator; make sure that protective relay marked with arrowhead side shall be connected to conservator. Huaming provides two types of protective relay which are QJ4-25 and QJ4-25 A, both of them have gas signal contact and trip contact, especially QJ4-25A can be equipped gas release device to man position. Please refer to Appendix.

8.3 Pressure relief devices

Pressure relief valve and pressure release cover is the security protective device for oil-immersed OLTC, when any failure happens inside the OLTC, oil in oil chamber is gasified to produce plenty of gas, thus oil pressure of oil chamber is increased rapidly, OLTC oil compartment will be deform or even explode if the pressure inside is not released in time, therefore, pressure relief device is necessary be installed to avoid failures extending.

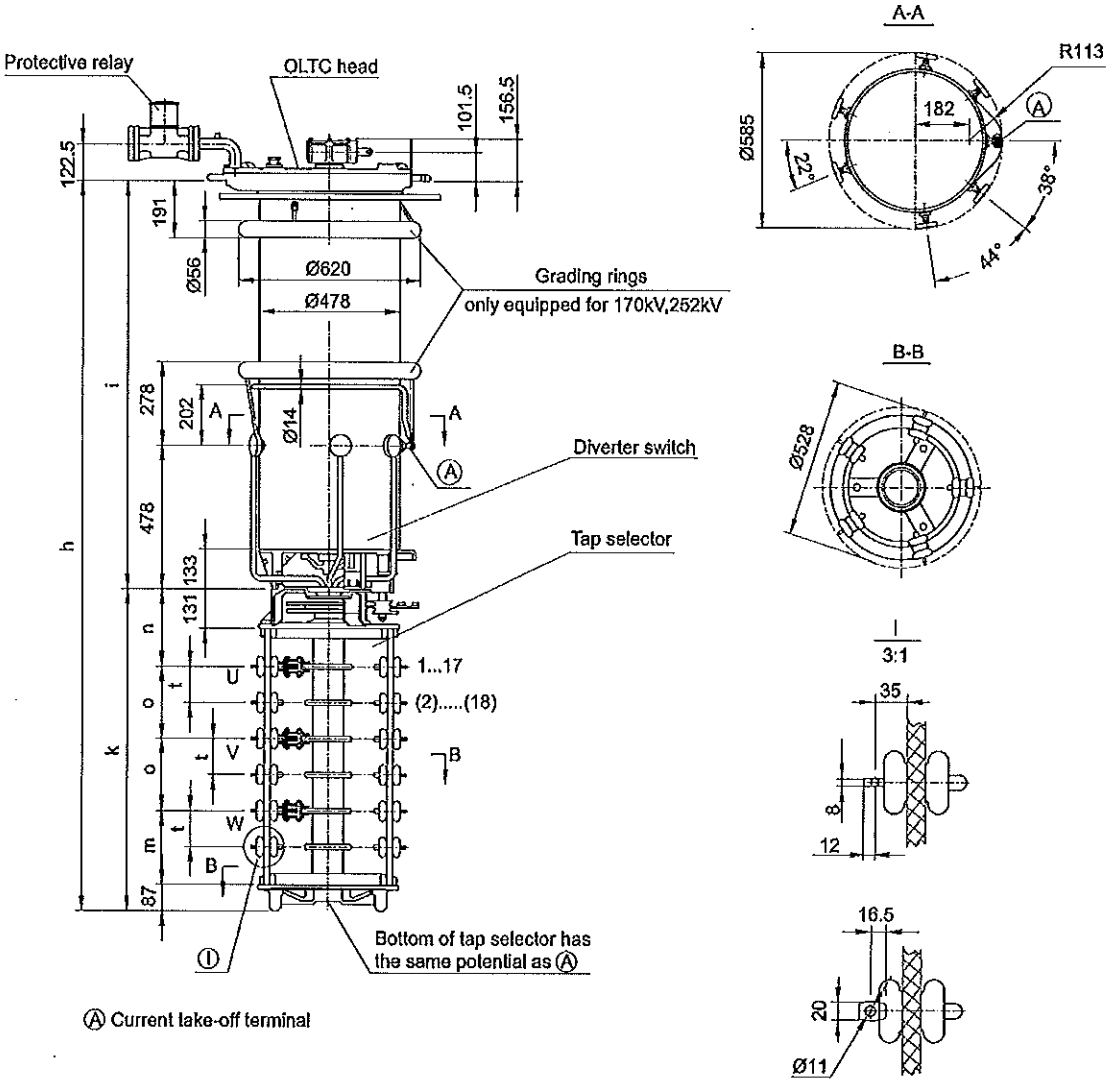
Pressure relief valve is an auto-sealed valve, when over pressure, the cover is open and pressure will be released, and then it will close again. It can be used repeatedly, and the liquid loss could be controlled to be minimum volume when it is acting.

Pressure release cover is the weak portion on the OLTC head cover, once oil chamber pressure exceeds adjusted value, the pressure release cover will be broken, thus over-pressure is released, and OLTC oil compartment is protected.

Pressure relief valve is a device for low energy failure, and pressure release cover is the device for high energy failure, whereas most of failure of OLTC body is of high energy failure, so our standard offer is OLTC equipped with pressure release cover, and pressure relief valve is only provided when customer specifies.

9. Appendixes

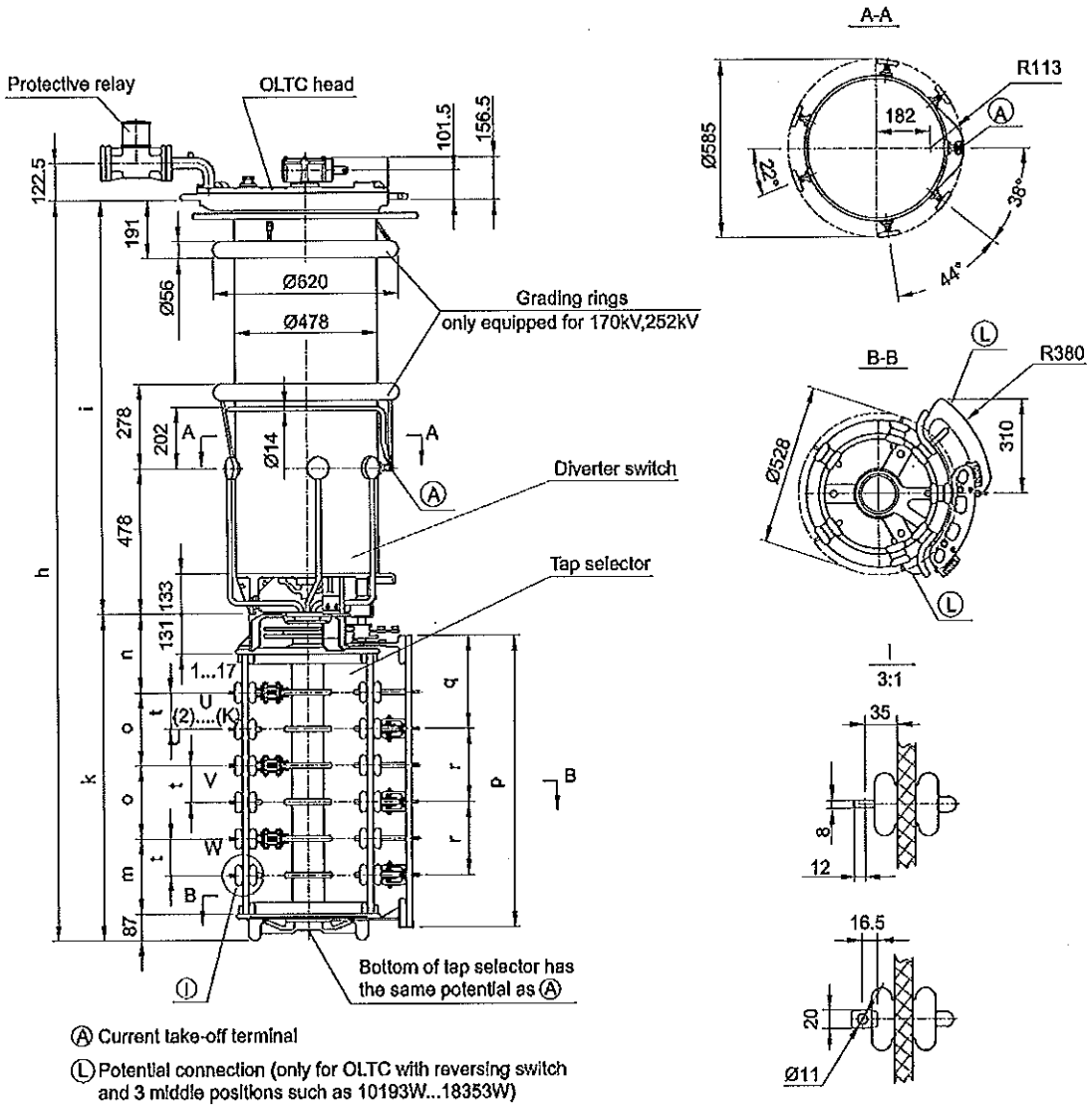
9.1. CM2 III 500Y/600Y without change-over selector, overall dimensions



Model		CM2III500Y/600Y-72.5-252/B				CM2III500Y/600Y-72.5-252/C				CM2III500Y/600Y-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1897	2027	2157	2257	2072	2202	2332	2432	2527	2657	2787	2887
	i	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	897				1072				1527			
	n	233				258				323			
	o	190				240				370			
	t	95				120				185			
	m	197				247				377			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		194	219	239	259	195	220	240	260	198	223	243	263
Weight (kg)		260				265				275			

Unit: mm

9.2. CM2 III 500Y / 600Y with reversing switch, overall dimensions



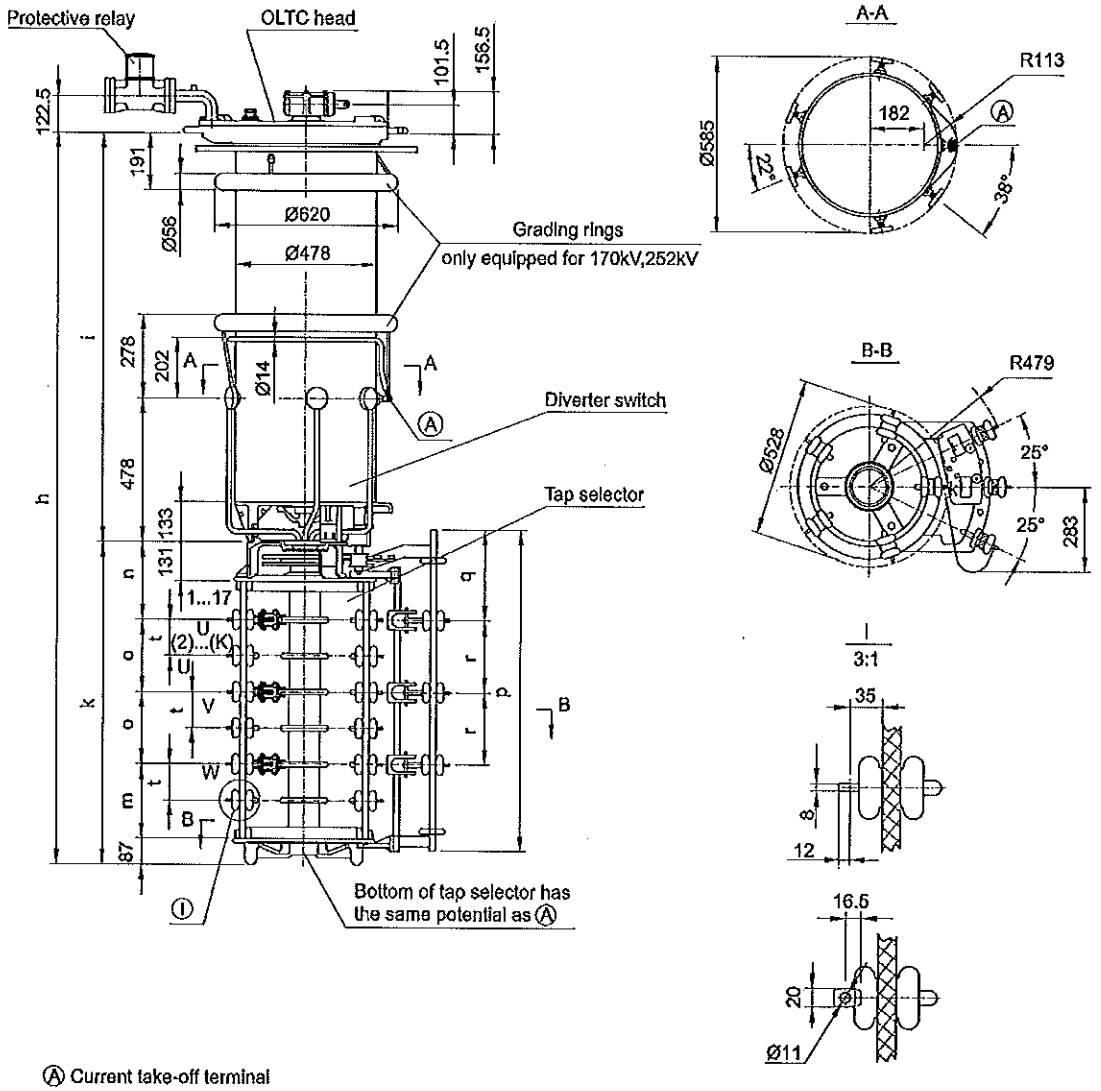
Ⓐ Current take-off terminal

Ⓛ Potential connection (only for OLTC with reversing switch and 3 middle positions such as 10193W...18353W)

Model		CM2 III 500Y/600Y-72.5-252/B				CM2 III 500Y/600Y-72.5-252/C				CM2 III 500Y/600Y-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1897	2027	2157	2257	2072	2202	2332	2432	2527	2657	2787	2887
	l	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	897				1072				1527			
	n	233				258				323			
	o	190				240				370			
	t	95				120				185			
	m	197				247				377			
	r	190				240				370			
	q	255				305				435			
	p	783				958				1413			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		199	224	244	264	200	225	245	265	207	232	252	272
Weight (kg)		275				285				310			

Unit: mm

9.3. CM2 III 500Y / 600Y with coarse change-over selector, overall dimensions

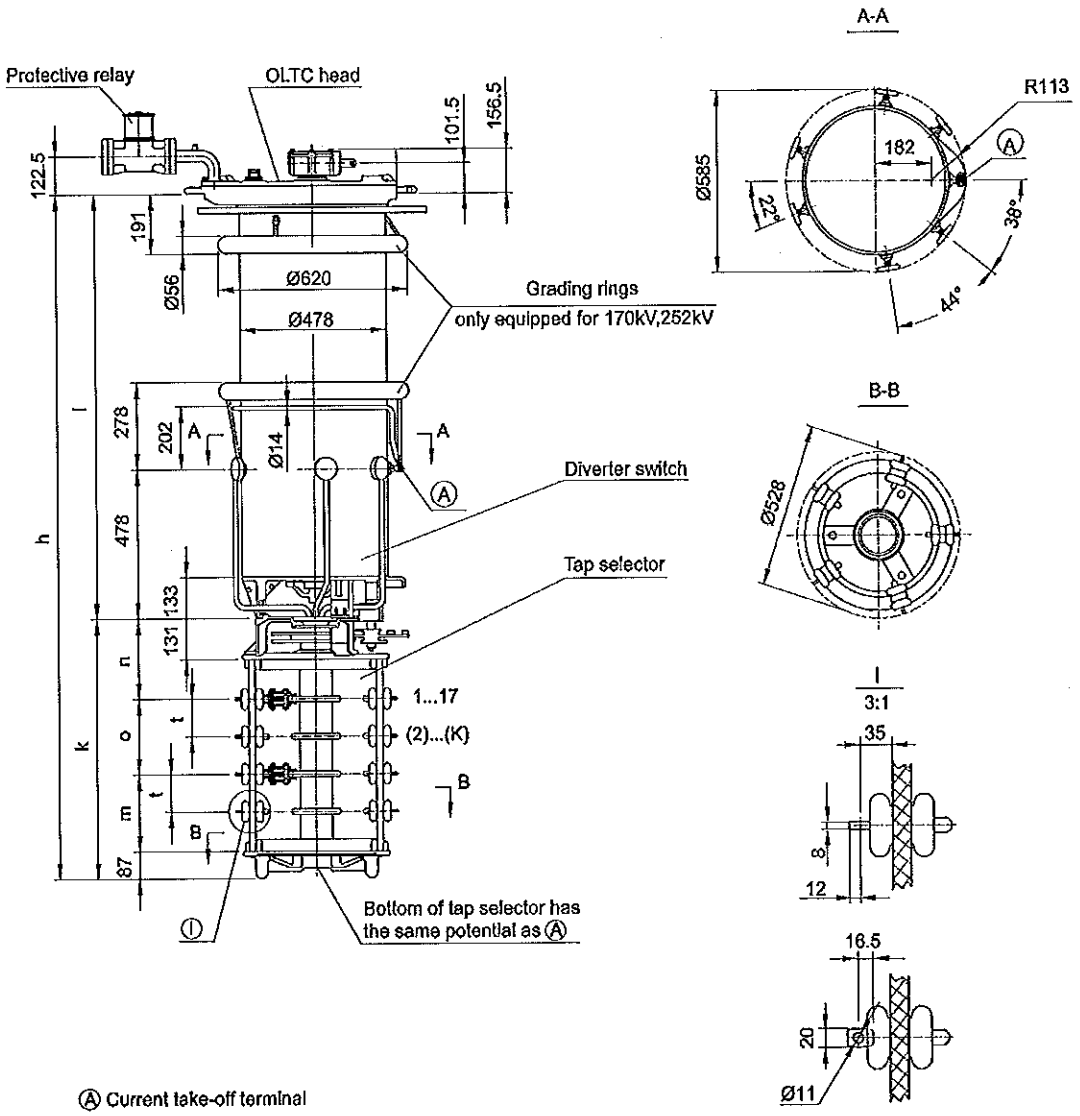


Ⓐ Current take-off terminal

Model		CM2 III500Y/600Y-72.5-252/B				CM2 III500Y/600Y-72.5-252/C				CM2III500Y/600Y-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1897	2027	2157	2257	2072	2202	2332	2432	2527	2657	2787	2887
	i	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	897				1072				1527			
	n	233				258				323			
	o	190				240				370			
	t	95				120				185			
	m	197				247				377			
	r	190				240				370			
	q	276.5				301.5				366.5			
	p	892				1067				1522			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		199	224	244	264	199	224	244	264	207	232	252	272
Weight (kg)		275				280				305			

Unit: mm

9.4. CM2 II 500 / 600 without change-over selector, overall dimensions

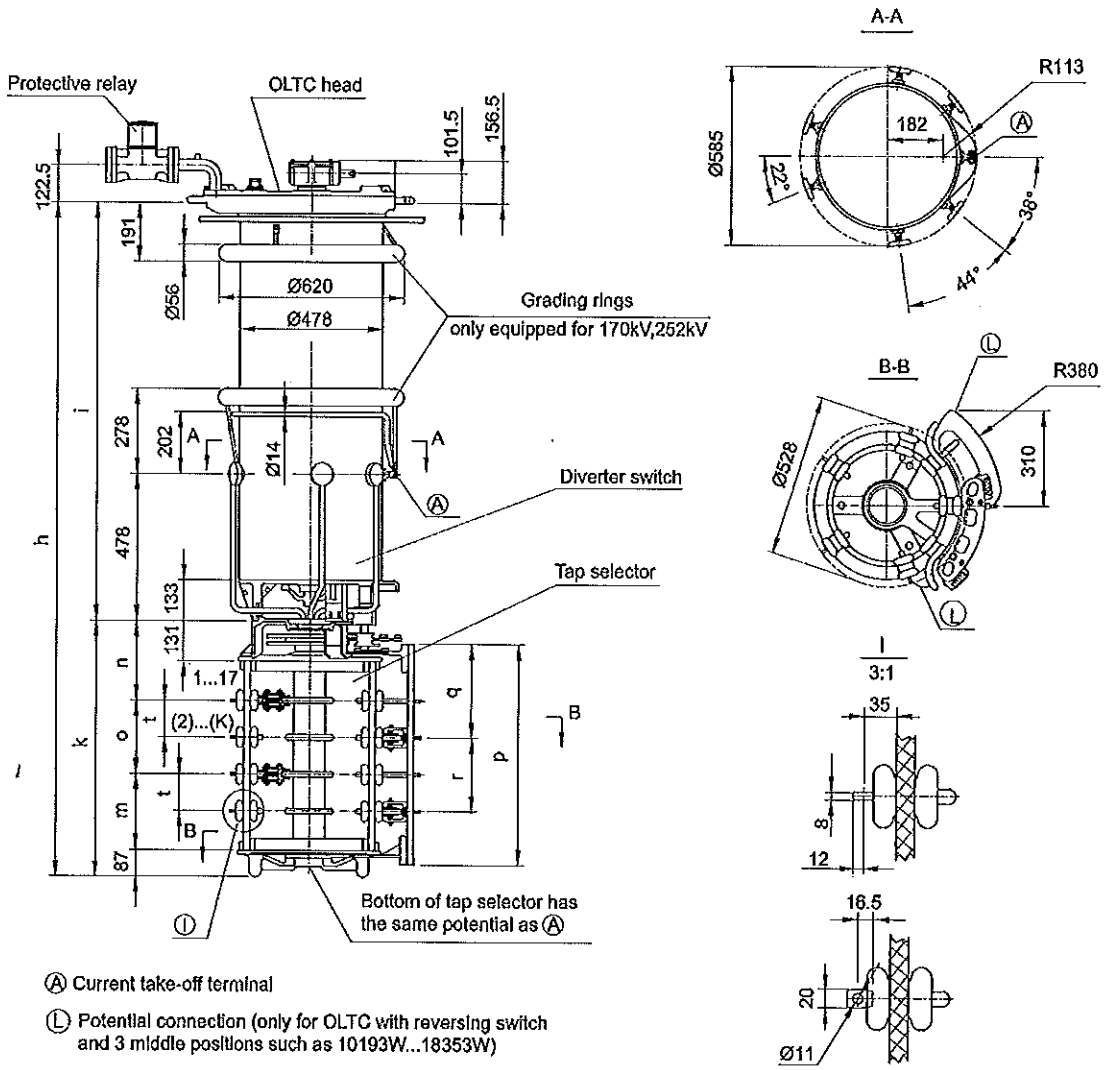


Ⓐ Current take-off terminal

Model		CM2II500/600-72.5-252/B				CM2II500/600-72.5-252/C				CM2II500/600-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1707	1837	1967	2067	1832	1962	2092	2192	2157	2287	2417	2517
	l	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	707				832				1157			
	n	233				258				323			
	o	190				240				370			
	t	95				120				185			
	m	197				247				377			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		194	219	239	259	195	220	240	260	198	223	243	263
Weight (kg)		260				265				275			

Unit: mm

9.5. CM2 II 500 / 600 with reversing switch,overall dimensions



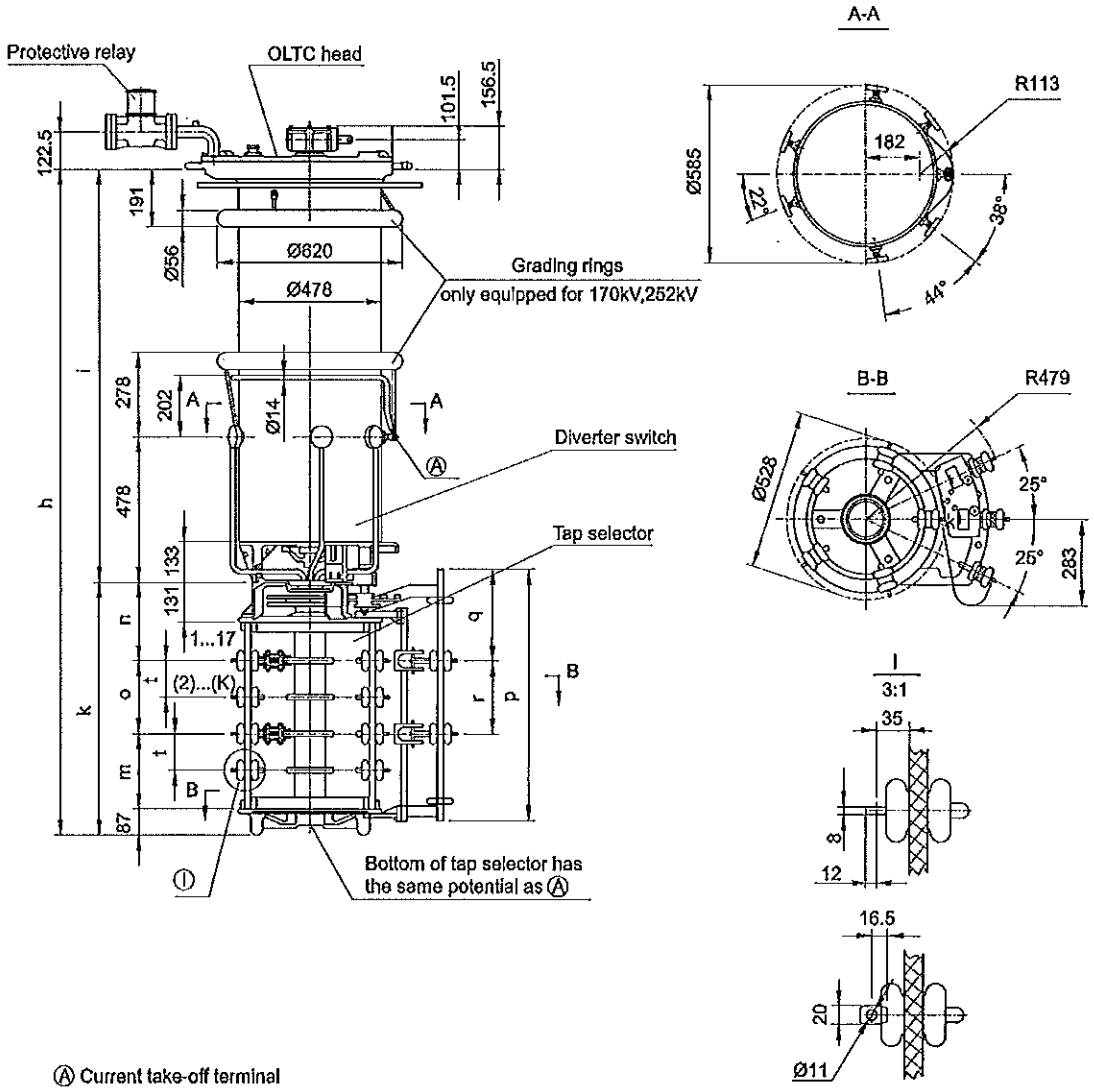
Ⓐ Current take-off terminal

Ⓛ Potential connection (only for OLTC with reversing switch and 3 middle positions such as 10193W...18353W)

Model		CM2 II 500/600-72.5-252/B				CM2 II 500/600-72.5-252/C				CM2II500/600-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1707	1837	1987	2067	1832	1962	2092	2192	2157	2287	2417	2517
	i	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	707				832				1157			
	n	233				258				323			
	o	190				240				370			
	t	95				120				185			
	m	197				247				377			
	r	190				240				370			
	q	255				305				435			
	p	783				958				1413			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		199	224	244	264	200	225	245	265	207	232	252	272
Weight (kg)		275				285				310			

Unit: mm

9.6. CM2 II 500 / 600 with coarse change-over selector, overall dimensions

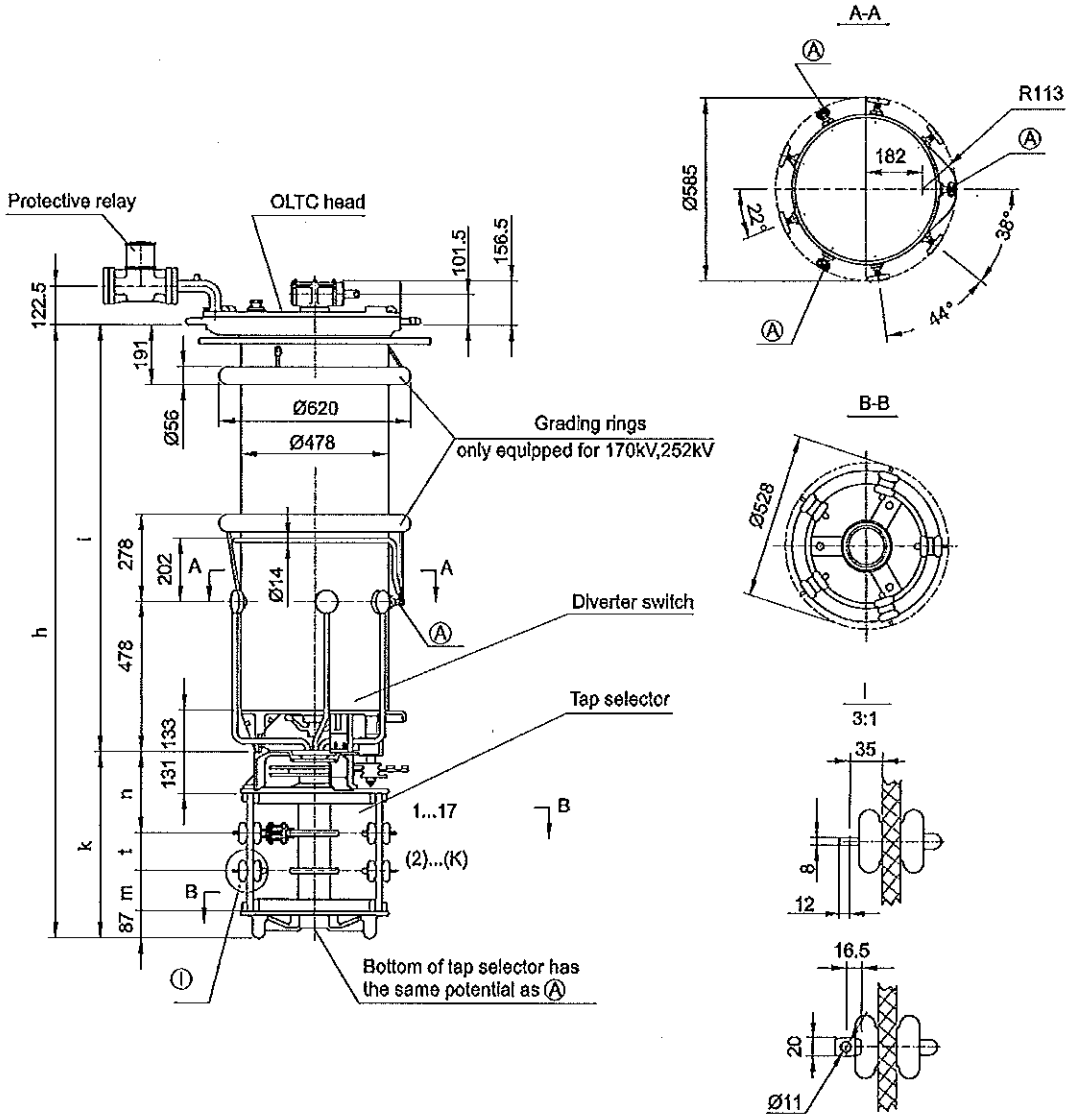


Ⓐ Current take-off terminal

Model		CM2 II 500/600-72.5-252/B				CM2 II 500/600-72.5-252/C				CM2 II 500/600-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1707	1837	1967	2067	1832	1962	2092	2192	2157	2287	2417	2517
	l	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	707				832				1157			
	n	233				258				323			
	o	190				240				370			
	t	95				120				185			
	m	197				247				377			
	r	190				240				370			
	q	276.5				301.5				366.5			
	p	892				1067				1522			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		199	224	244	264	199	224	244	264	207	232	252	272
Weight (kg)		275				280				305			

Unit: mm

9.7. CM2 I 500 / 600 without change-over selector, overall dimensions

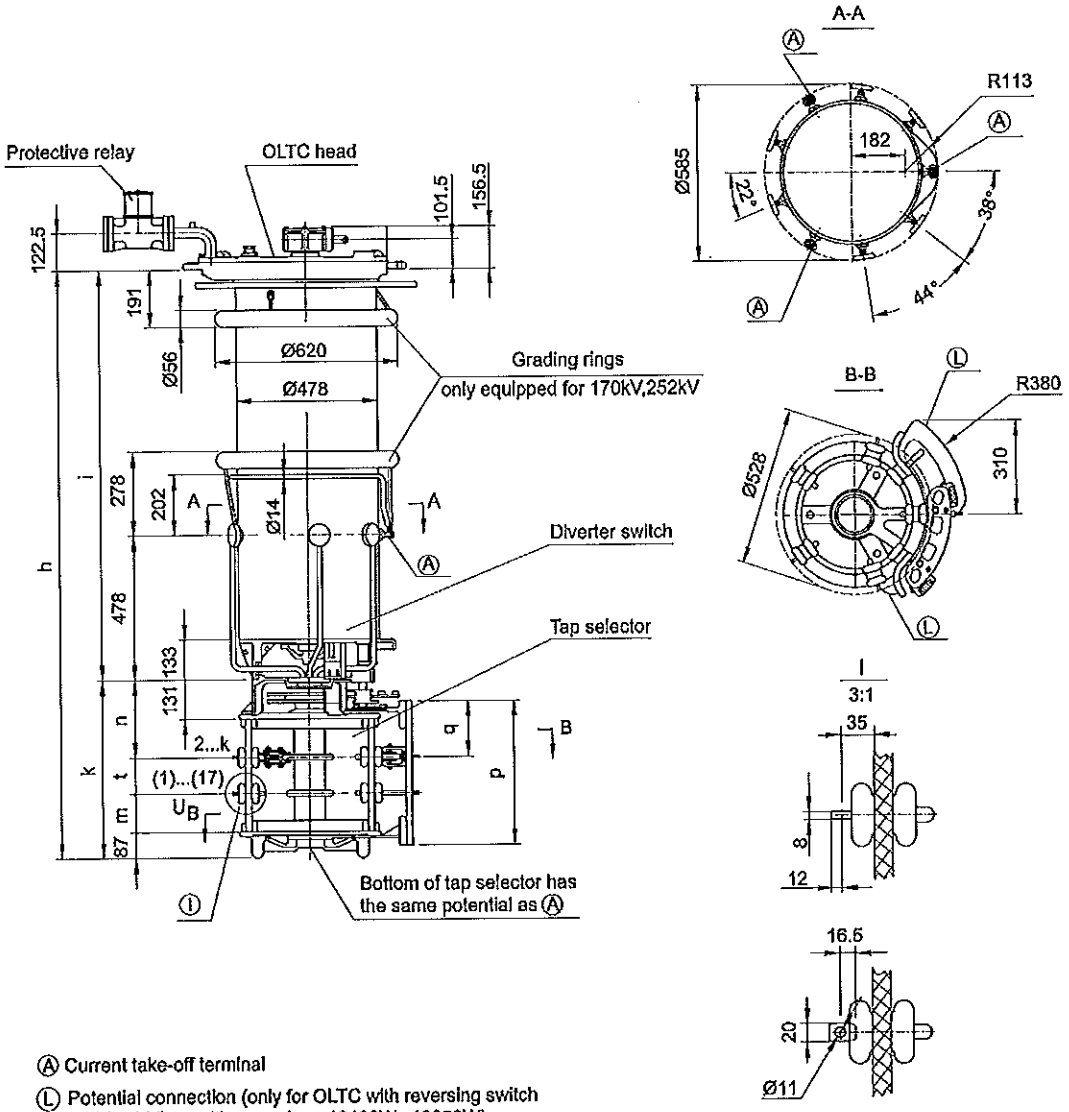


Ⓐ Current take-off terminal

Model		CM2 I 500/600-72.5-252/B				CM2 I 500/600-72.5-252/C				CM2 I 500/600-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1517	1647	1777	1877	1592	1722	1852	1952	1787	1917	2047	2147
	I	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	517				592				787			
	n	233				258				323			
	t	95				120				185			
	m	102				127				192			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		189	214	234	254	189	214	234	254	190	215	235	255
Weight (kg)		240				240				245			

Unit: mm

9.8. CM2 I 500 / 600 with reversing switch, overall dimensions



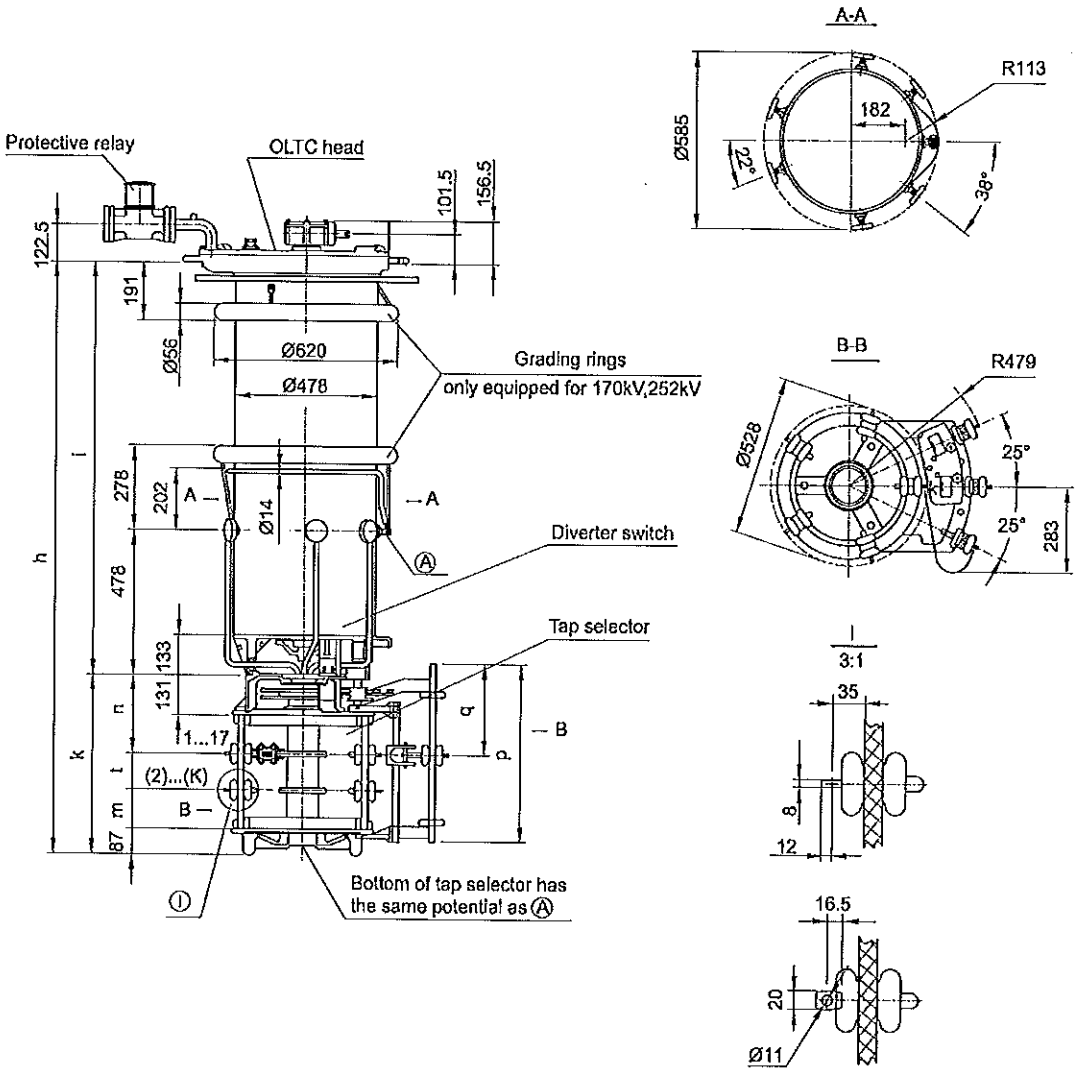
Ⓐ Current take-off terminal

Ⓛ Potential connection (only for OLTC with reversing switch and 3 middle positions such as 10193W...18353W)

Model		CM2 I 500/600-72.5-252/B				CM2 I 500/600-72.5-252/C				CM2 I 500/600-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1517	1647	1777	1877	1592	1722	1852	1952	1787	1917	2047	2147
	i	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	517				592				787			
	n	233				258				323			
	m	102				127				192			
	t	95				120				185			
	q	160				185				250			
	p	403				478				673			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		191	216	244	264	192	217	237	257	193	218	238	258
Weight (kg)		250				255				260			

Unit: mm

9.9. CM2 I 500 / 600 with coarse change-over selector, overall dimensions

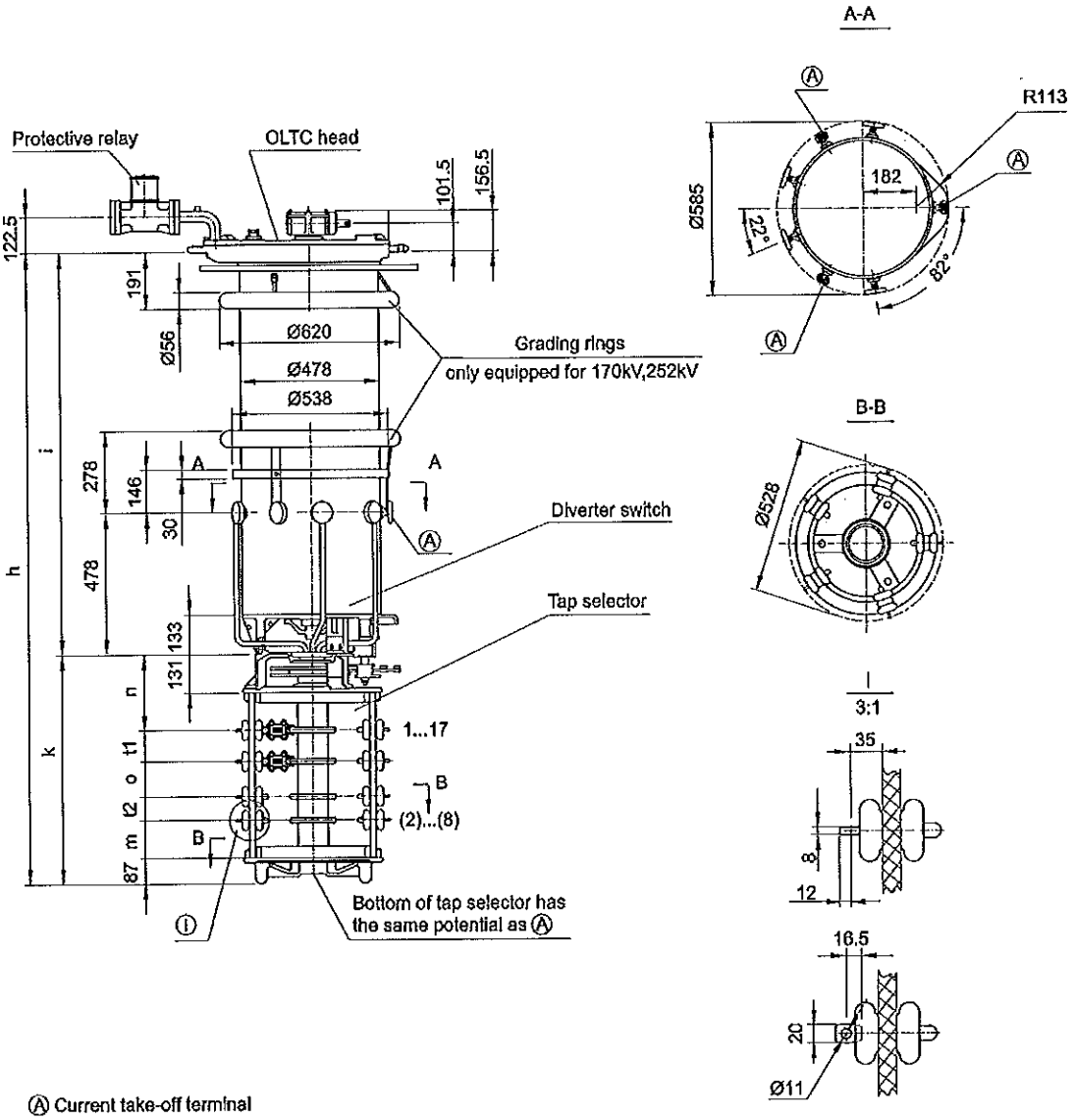


Ⓐ Current take-off terminal

Model		CM2 I 500/600-72.5-252/B				CM2 I 500/600-72.5-252/C				CM2 I 500/600-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1517	1647	1777	1877	1592	1722	1852	1952	1787	1917	2047	2147
	i	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	517				592				787			
	n	233				258				323			
	m	102				127				192			
	t	95				120				185			
	q	276.5				301.5				366.5			
	p	512				587				782			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		193	218	238	258	193	218	238	258	195	220	240	260
Weight (kg)		260				260				265			

Unit: mm

9.10. CM2 I 800 without change-over selector, overall dimensions

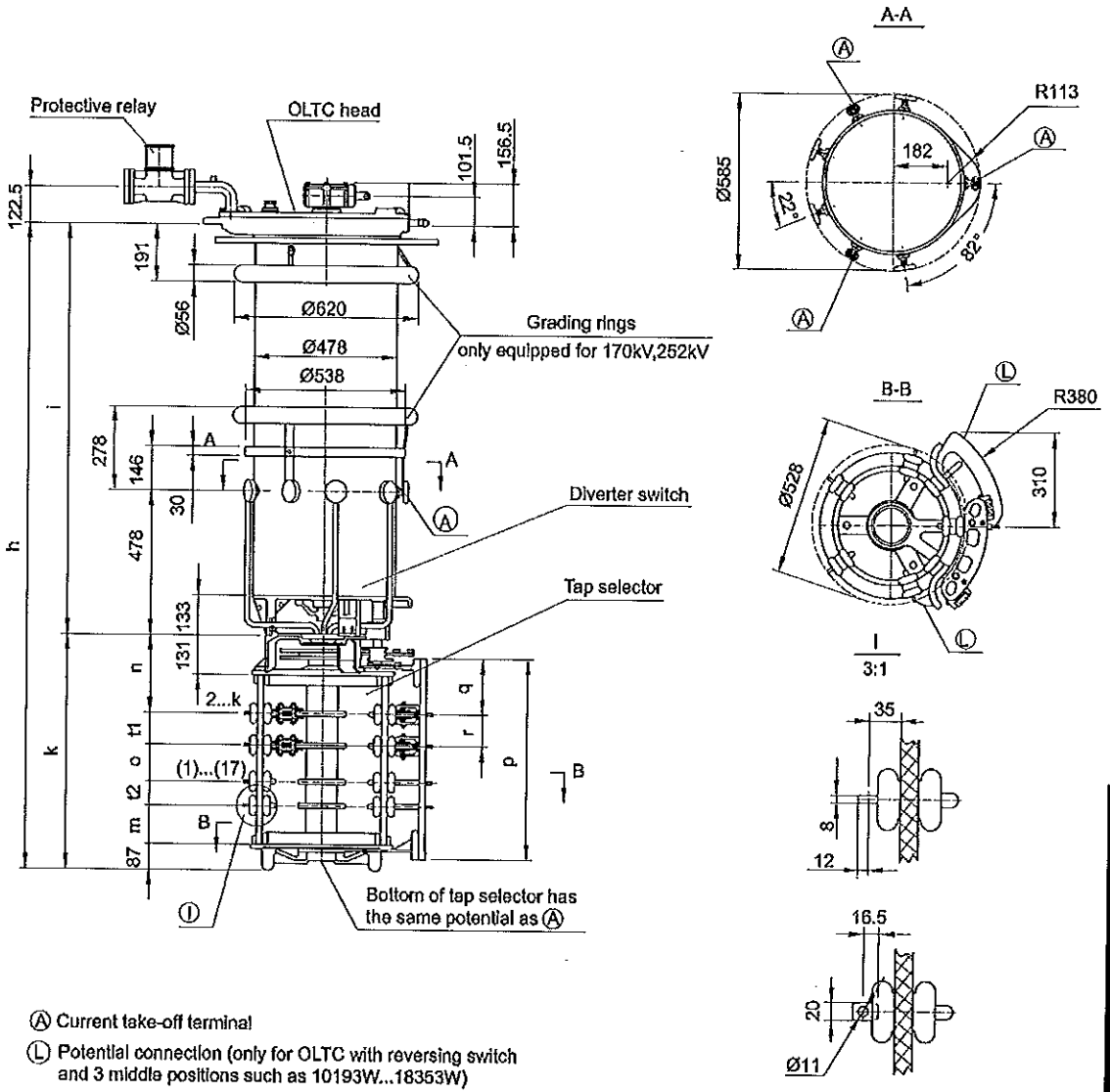


Ⓐ Current take-off terminal

Model		CM2 I 800-72.5-252/B				CM2 I 800-72.5-252/C				CM2 I 800-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1702	1832	1962	2062	1777	1907	2037	2137	1972	2102	2232	2332
	I	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	702				777				972			
	n	233				258				323			
	o	95				120				185			
	m	102				127				192			
	t1	105				105				105			
	t2	80				80				80			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		191	216	236	256	191	216	236	256	193	218	238	258
Weight (kg)		250				250				260			

Unit: mm

9.11. CM2 I 800 with reversing switch, overall dimensions



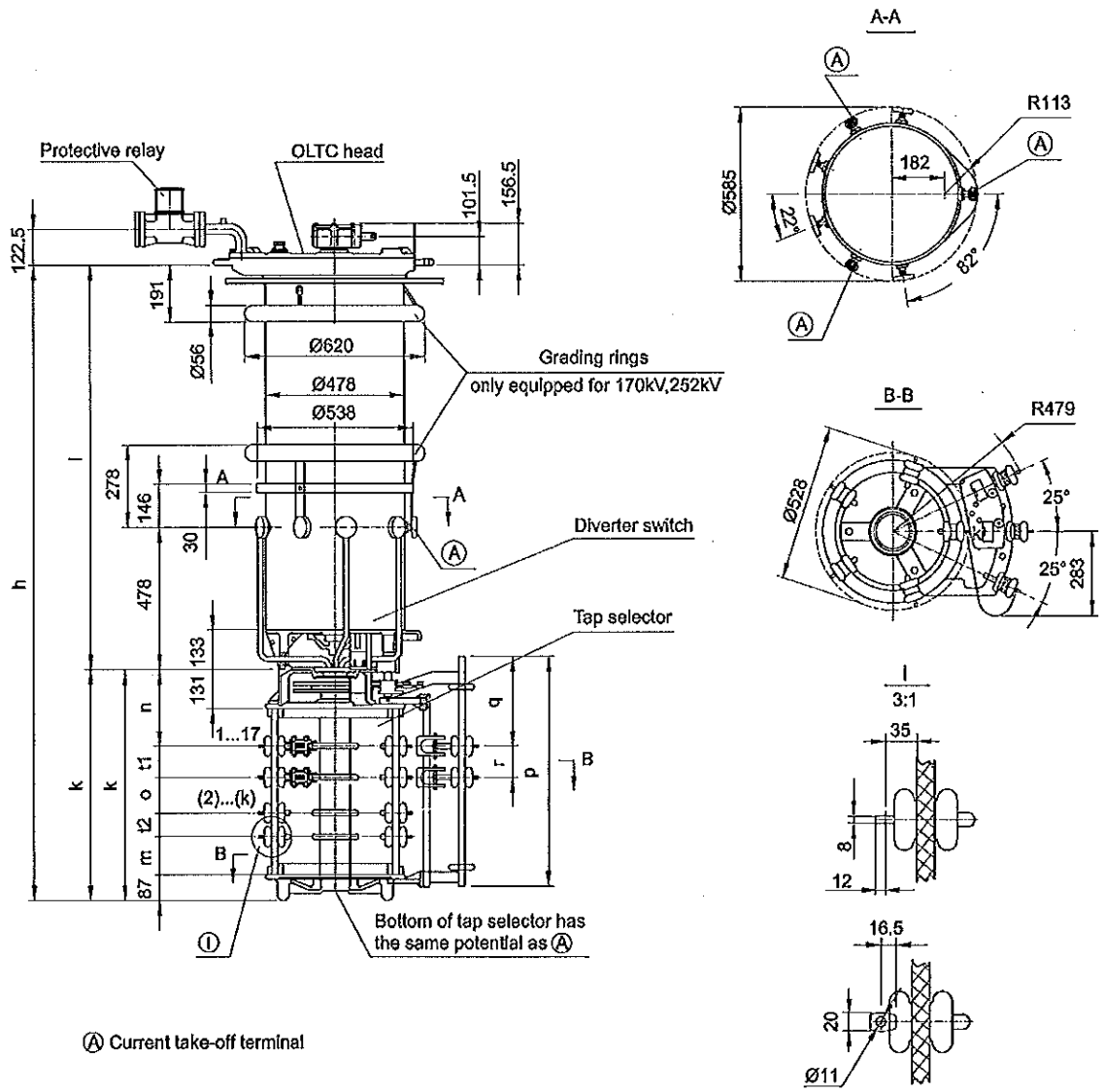
Ⓐ Current take-off terminal

Ⓛ Potential connection (only for OLTC with reversing switch and 3 middle positions such as 10193W...18353W)

Model		CM21800-72.5-252/B				CM21800-72.5-252/C				CM21800-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1702	1832	1962	2062	1777	1907	2037	2137	1972	2102	2232	2332
	I	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	702				777				972			
	n	233				258				323			
	o	95				120				185			
	m	102				127				192			
	t1	105				105				105			
	t2	80				80				80			
	r	105				105				105			
	q	160				185				250			
	p	588				663				858			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		195	220	240	260	196	221	241	261	199	224	244	264
Weight (kg)		265				270				275			

Unit: mm

9.12. CM2 I 800 with coarse change-over selector, overall dimensions

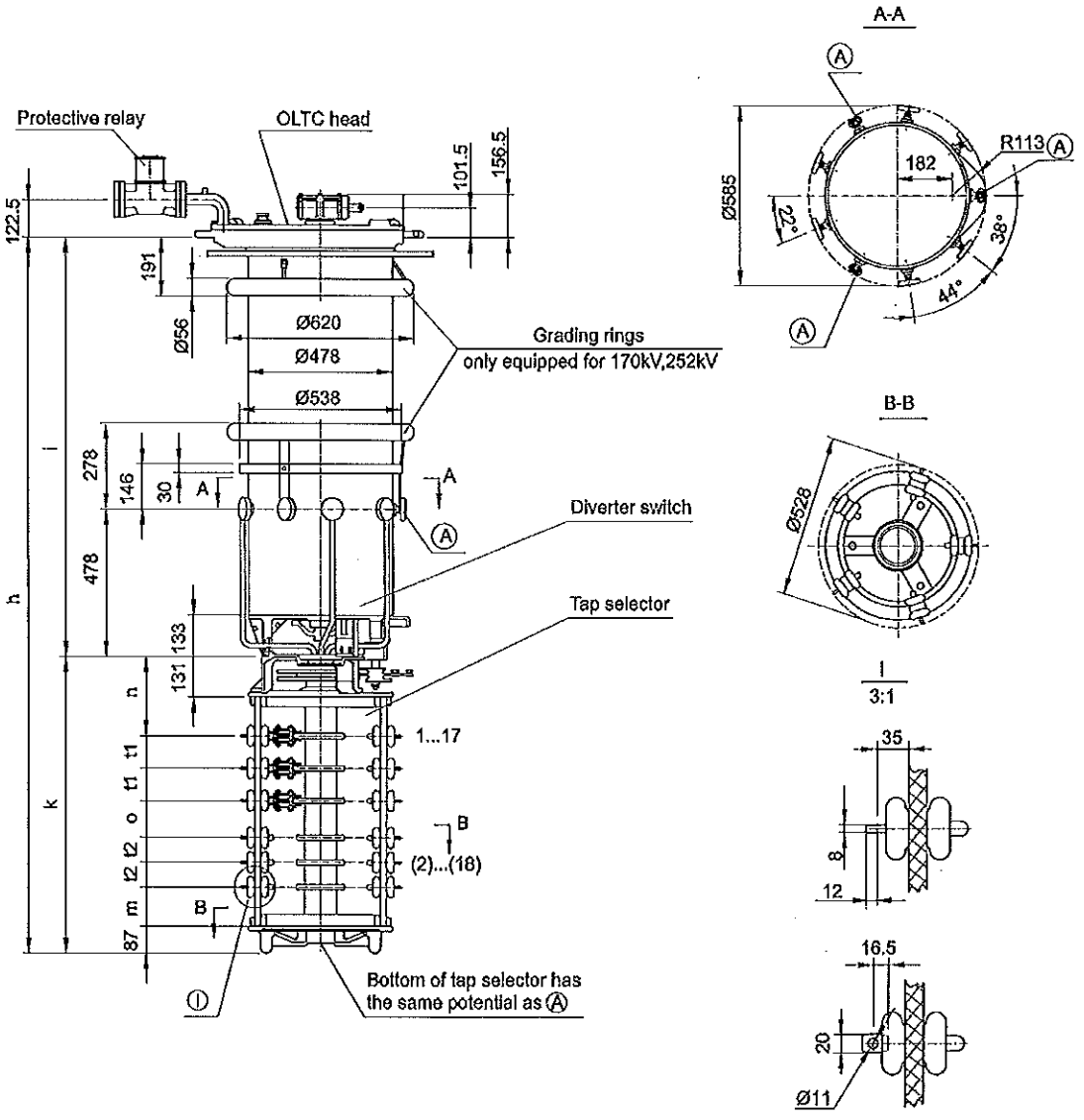


Ⓐ Current take-off terminal

Model		CM2 I 800-72.5-252/B				CM2 I 800-72.5-252/C				CM2 I 800-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1702	1832	1962	2062	1777	1907	2037	2137	1972	2102	2232	2332
	l	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	702				777				972			
	n	233				258				323			
	o	95				120				185			
	m	102				127				192			
	t1	105				105				105			
	t2	80				80				80			
	r	105				105				105			
	q	276.5				301.5				366.5			
	p	697				772				967			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		196	221	241	261	196	221	241	261	199	224	244	264
Weight (kg)		270				270				280			

Unit: mm

9.13. CM2 I 1200 / 1500 without change-over selector, overall dimensions

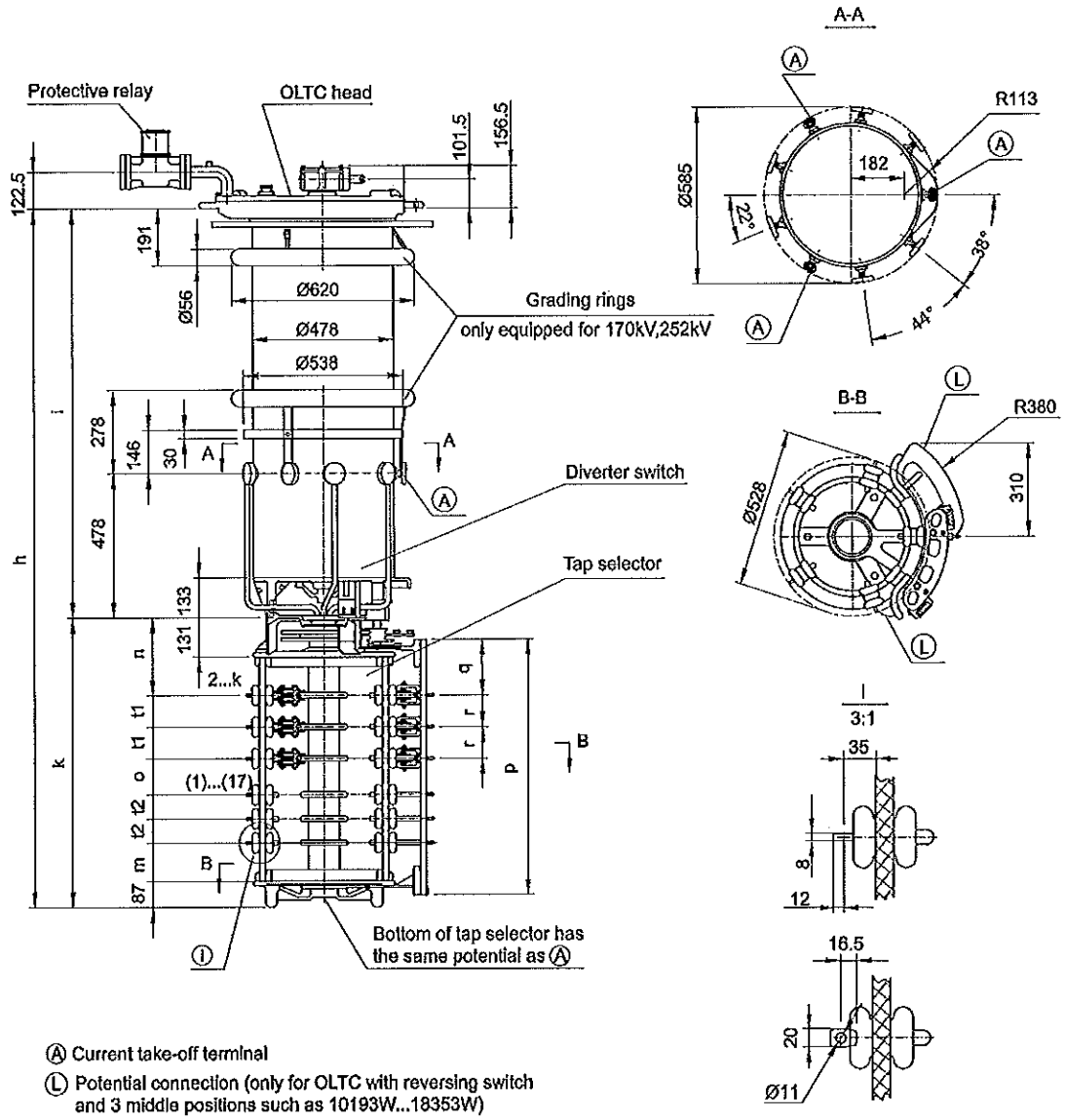


Ⓐ Current take-off terminal

Model		CM2 I 1200/1500-72.5-252/B				CM2 I 1200/1500-72.5-252/C				CM2 I 1200/1500-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1887	2017	2147	2247	1962	2092	2222	2322	2157	2287	2417	2517
	I	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	887				962				1157			
	n	233				258				323			
	o	95				120				185			
	t1	105				105				105			
	t2	80				80				80			
	m	102				127				192			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		194	219	239	259	194	219	239	259	195	221	241	261
Weight (kg)		260				260				270			

Unit: mm

9.14. CM2 I 1200 / 1500 with reversing switch, overall dimensions



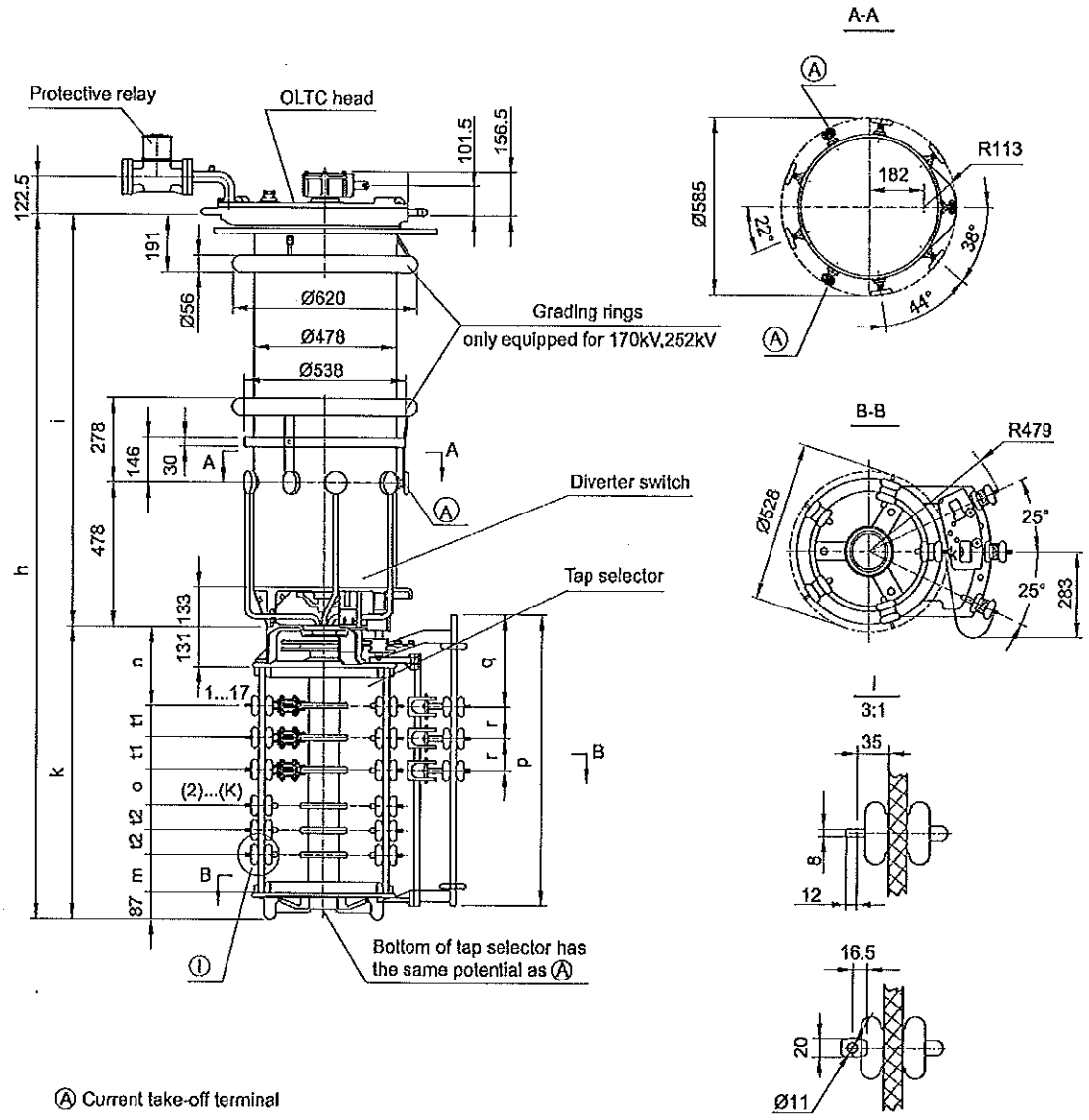
Ⓐ Current take-off terminal

Ⓛ Potential connection (only for OLTC with reversing switch and 3 middle positions such as 10193W...18353W)

Model		CM2 I 1200/1500-72.5-252/B				CM2 I 1200/1500-72.5-252/C				CM2I1200/1500-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1887	2017	2147	2247	1962	2092	2222	2322	2157	2287	2417	2517
	i	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	887				962				1157			
	n	233				258				323			
	o	95				120				185			
	t1	105				105				105			
	t2	80				80				80			
	m	102				127				192			
	r	105				105				105			
	q	160				185				250			
	p	773				848				1043			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		199	224	244	264	200	225	245	265	202	227	247	267
Weight (kg)		280				280				290			

Unit: mm

9.15. CM2 I 1200 / 1500 with coarse change-over selector, overall dimensions

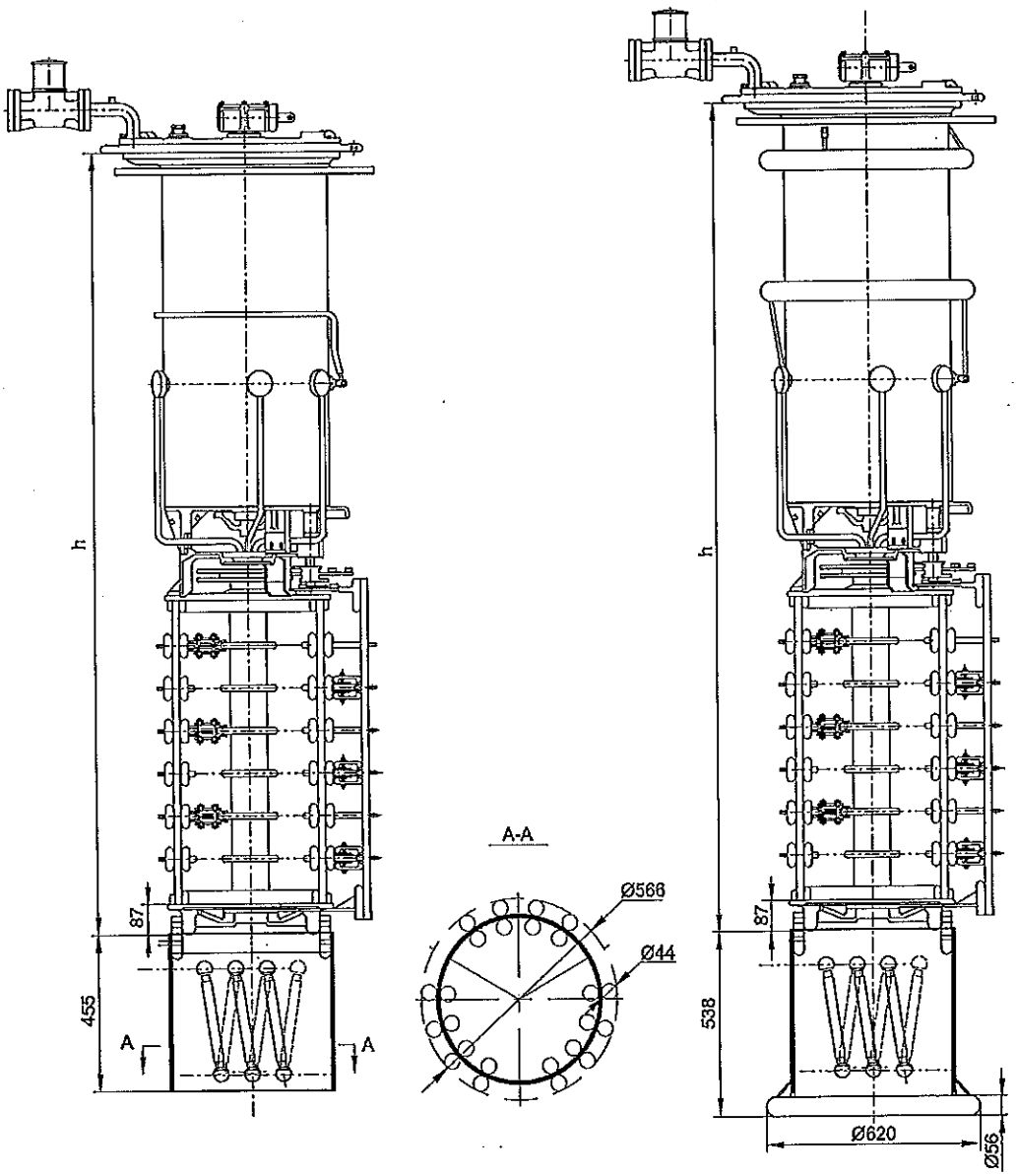


Ⓐ Current take-off terminal

Model		CM2 I 1200/1500-72.5-252/B				CM2 I 1200/1500-72.5-252/C				CM2 I 1200/1500-72.5-252/D(DE)			
U_m in kV		72.5	126	170	252	72.5	126	170	252	72.5	126	170	252
Dimensions (mm)	h	1887	2017	2147	2247	1962	2092	2222	2322	2157	2287	2417	2517
	I	1000	1130	1260	1360	1000	1130	1260	1360	1000	1130	1260	1360
	k	887				962				1157			
	n	233				258				323			
	o	95				120				185			
	t1	105				105				105			
	t2	80				80				80			
	m	102				127				192			
	r	105				105				105			
	q	278.5				301.5				366.5			
	p	882				957				1152			
Oil filling (dm³)		130	150	170	190	130	150	170	190	130	150	170	190
Displacement (dm³)		200	225	245	265	200	225	245	265	204	229	249	269
Weight (kg)		285				285				295			

Unit: mm

9.16. CM2 OLTC mounted with tie-in resistor, overall dimensions



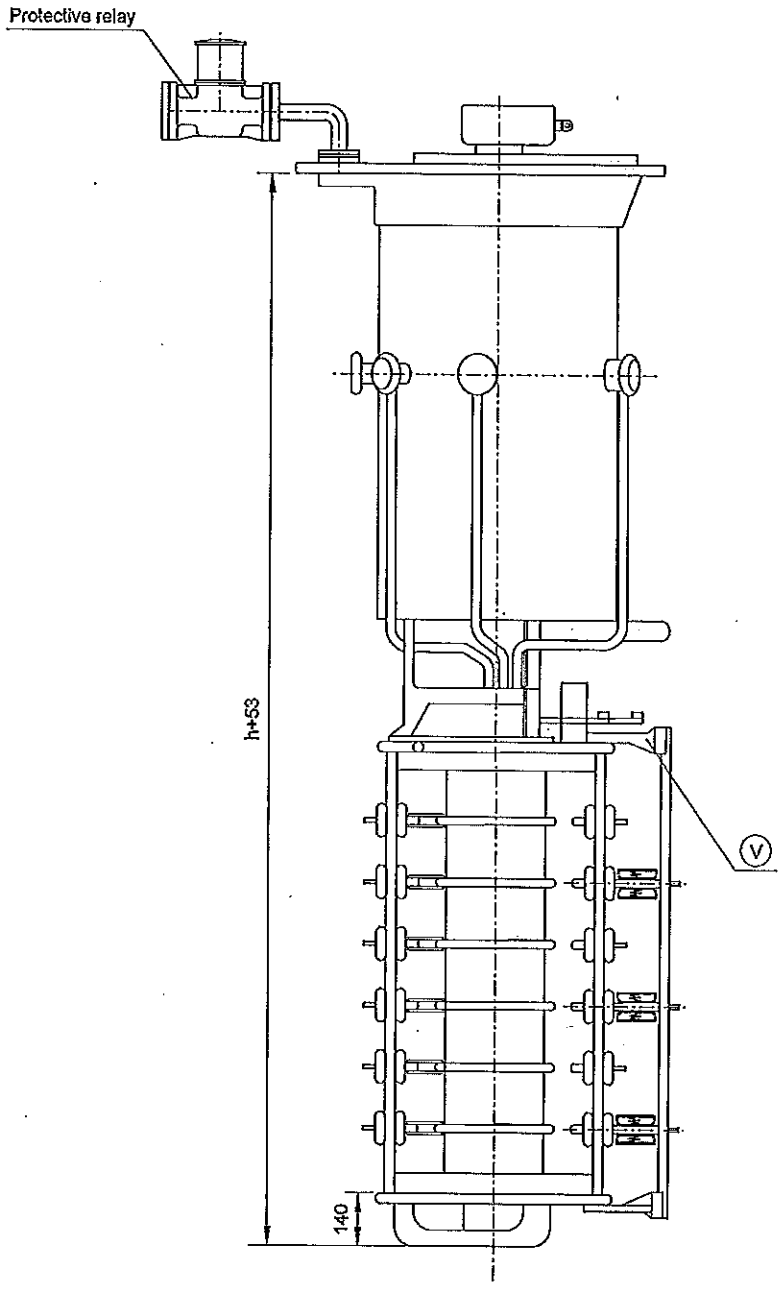
$U_m \leqslant 126kV$

$U_m \geqslant 170kV$

h——the OLTC height excluding tie-in resistor .
Special design may depend on the requirement

Unit: mm

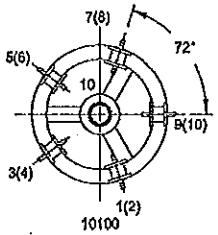
9.17. CM2 OLTC General layout Drawing (With insulated bottom)



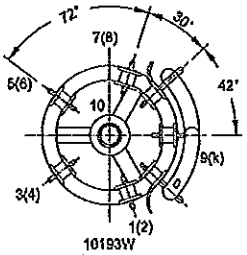
1.The dimension 140 is that with insulation bottom.
2.With insulation bottom, the total height of OLTC will increase by 53mm.
3.Models with insulation bottom only for 10 pitch.

Unit: mm

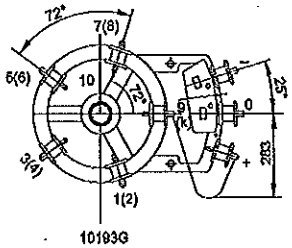
9.18. CM2 tap selector contacts arrangement



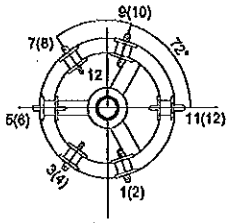
10100
(9Steps)



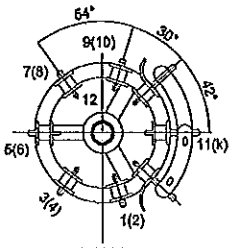
10193W
(±8Steps)



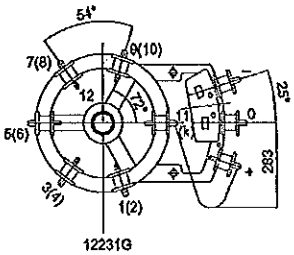
10193G
(±8Steps)



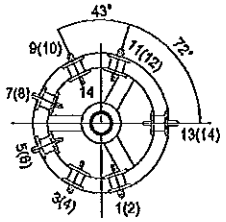
12120
(11Steps)



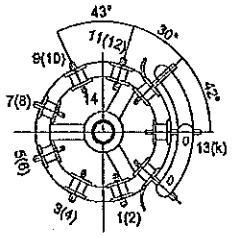
12231W
(±11Steps)



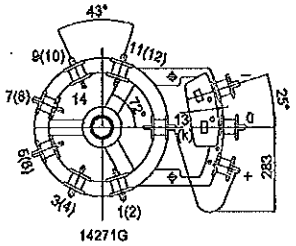
12231G
(±11Steps)



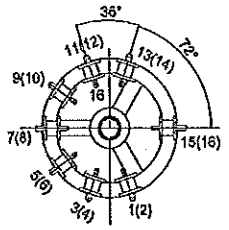
14140
(13Steps)



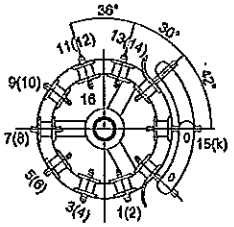
14271W
(±13Steps)



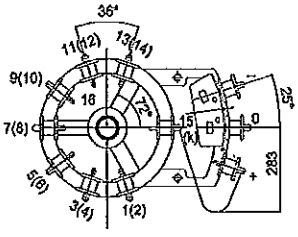
14271G
(±13Steps)



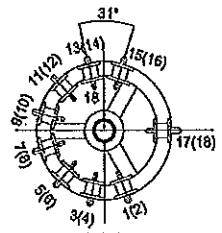
16160
(15Steps)



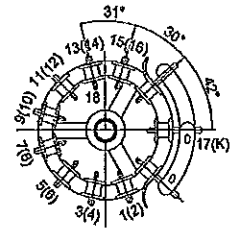
16311W
(±15Steps)



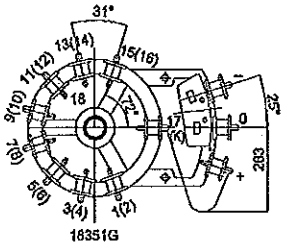
16311G
(±15Steps)



16180
(17Steps)



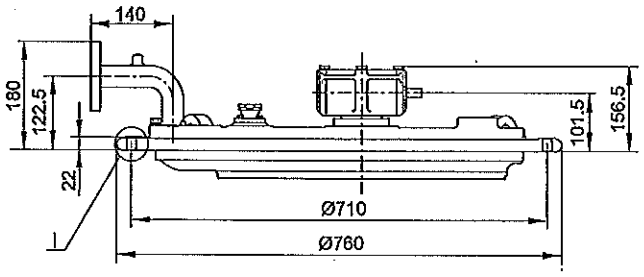
16351W
(±17Steps)



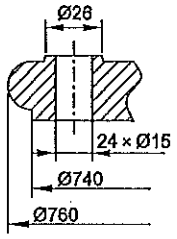
16351G
(±17Steps)

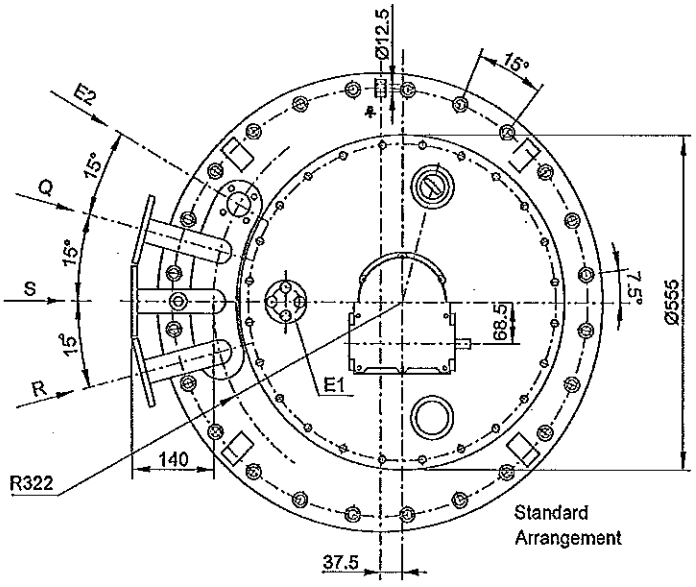
Unit: mm

9.19. CM2 OLTC head flange for standard tank type, overall dimensions



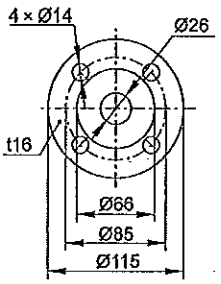
I: Magnified figure



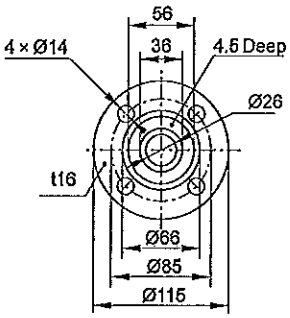


Standard Arrangement

R
Connection pipe flange



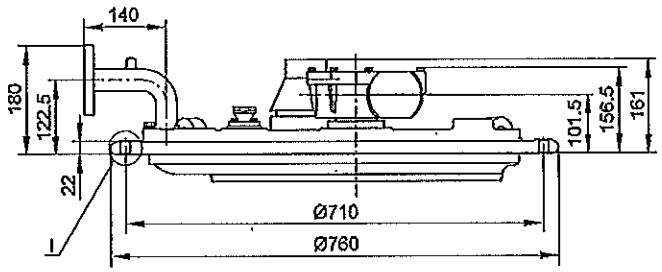
S, Q (With groove)
Connection pipe flange



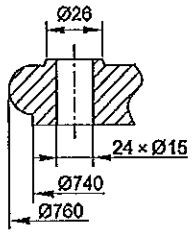
E1: Bleeding for on-load tap changer
E2: Bleeding for transformer oil tank
R: Connection flange for protective relay
S: Connection flange for oil suction pipe
Q: Connection flange for oil return pipe

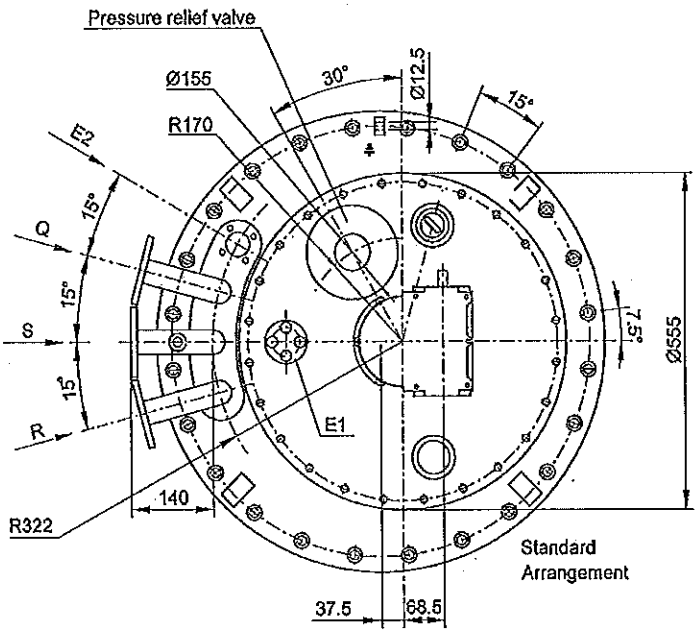
Unit: mm

9.20. CM2 OLTC head flange with pressure relief valve, overall dimensions



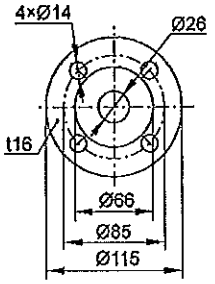
I: Magnified figure



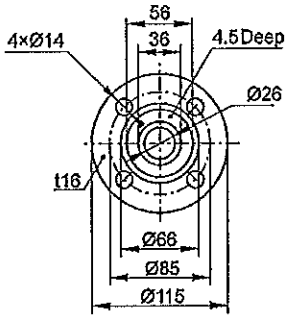


Standard Arrangement

R
Connection pipe flange



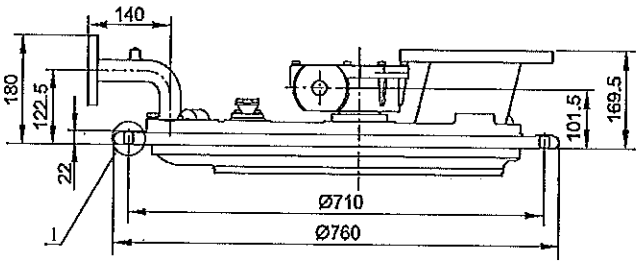
S,Q (With groove)
Connection pipe flange



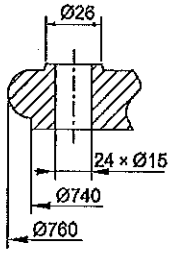
E1: Bleeding for on-load tap changer
E2: Bleeding for transformer oil tank
R: Connection flange for protective relay
S: Connection flange for oil suction pipe
Q: Connection flange for oil return pipe

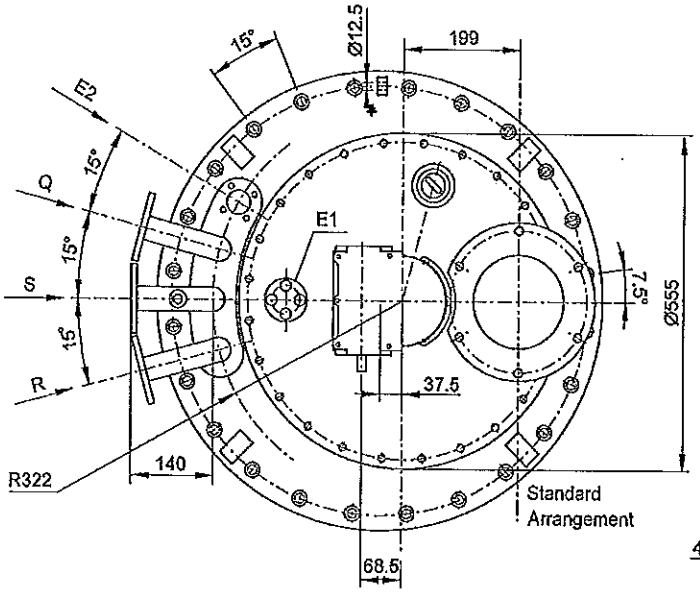
Unit: mm

9.21. CM2 OLTC head flange with pressure relief valve, overall dimensions(with raised seat)

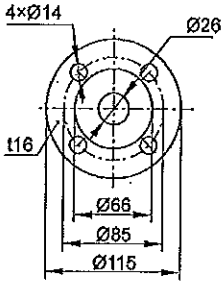


I: Magnified figure

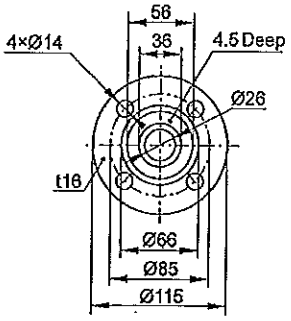




R
Connection pipe flange



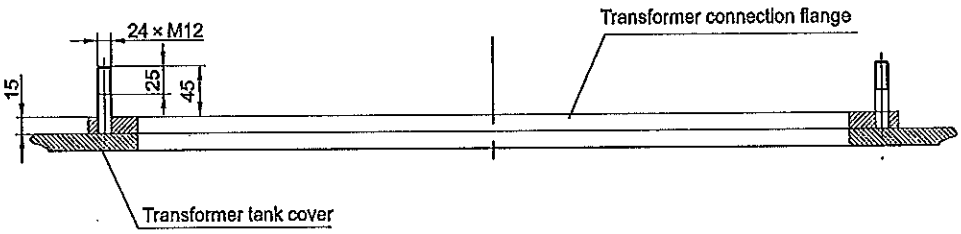
S,Q (With groove)
Connection pipe flange

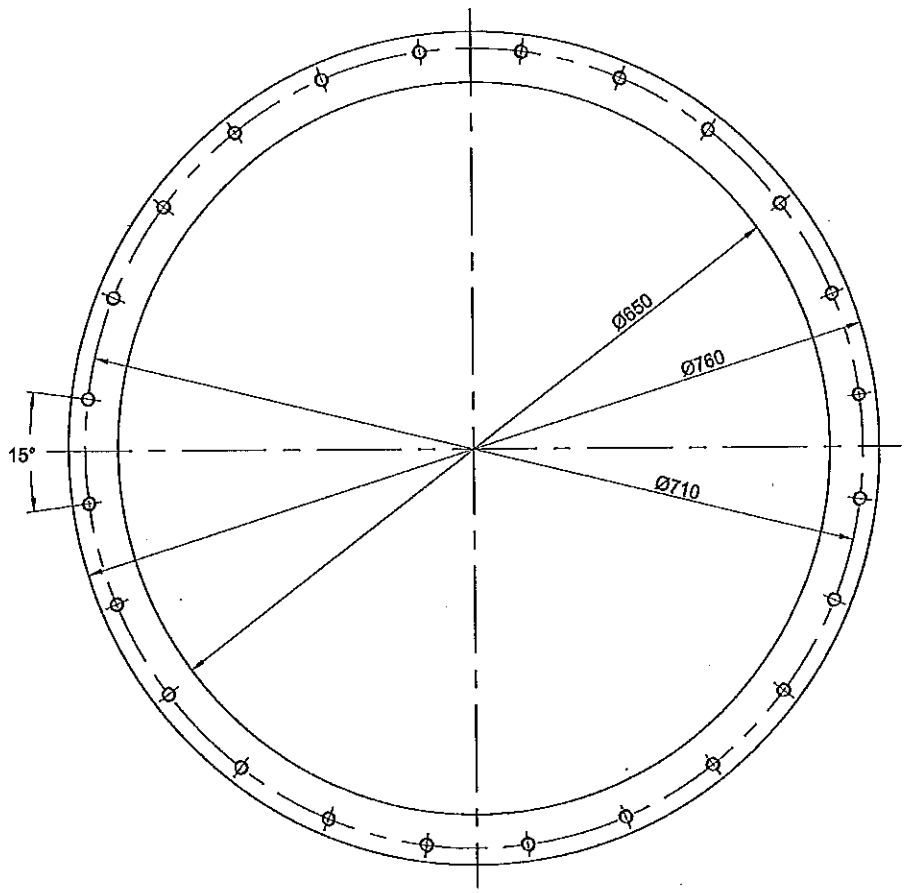


E1: Bleeding for on-load tap changer
E2: Bleeding for transformer oil tank
R: Connection flange for protective relay
S: Connection flange for oil suction pipe
Q: Connection flange for oil return pipe

Unit: mm

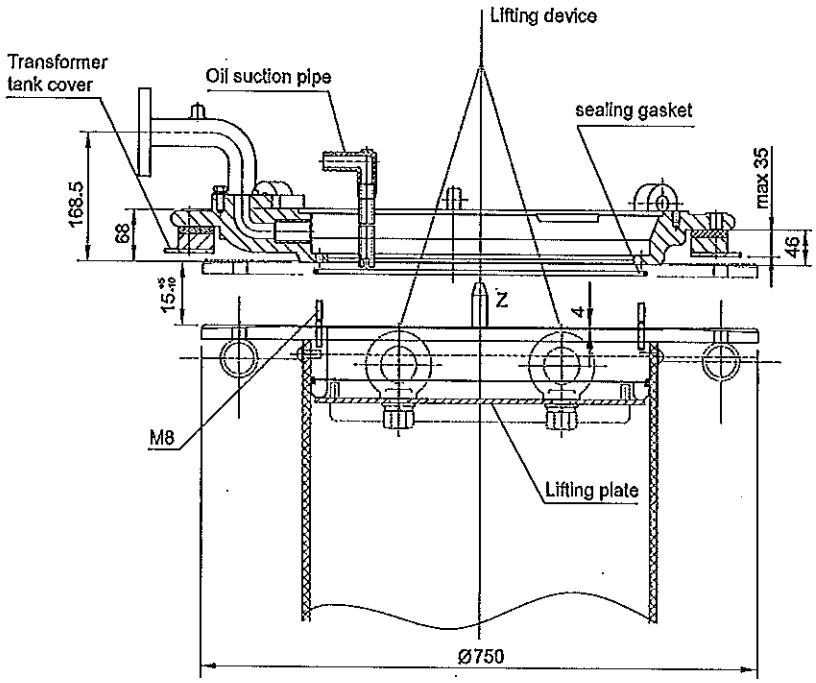
9.22. Transformer connection flange for CM2 OLTC, overall dimensions

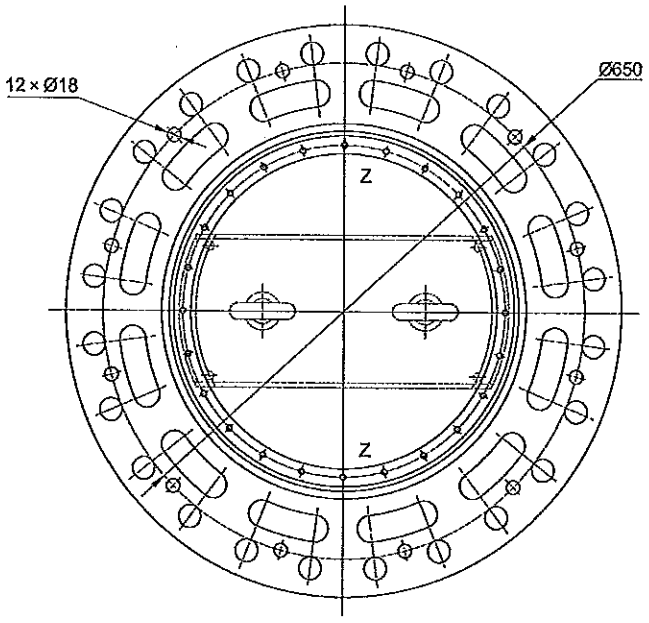




Unit: mm

9.23. CM2 OLTC head flange installation for bell-type, overall dimensions

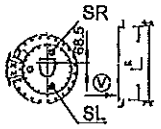




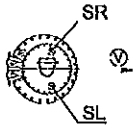
Unit: mm

9.24. Upper gear unit, arrangement and swiveling range

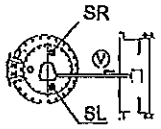
Left



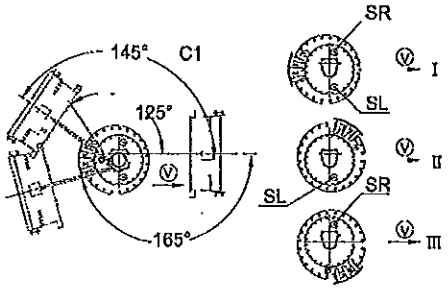
Drive shaft left output, swiveling range



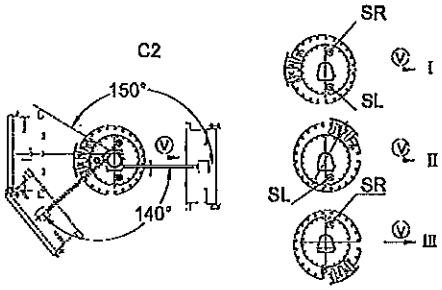
Right



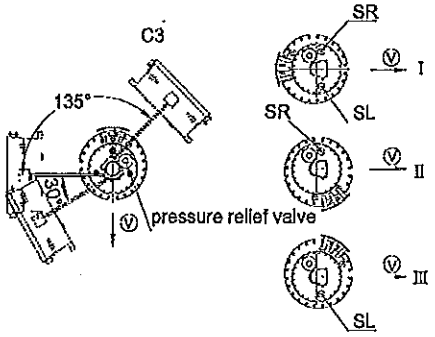
Drive shaft right output, swiveling range



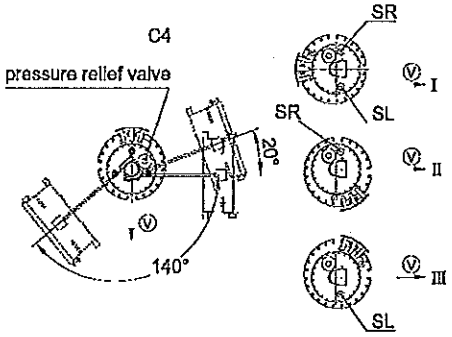
Drive shaft left output, with pressure relief valve, swiveling range



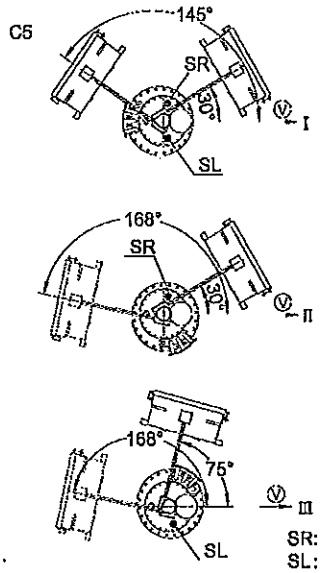
Drive shaft right output, with pressure relief valve, swiveling range

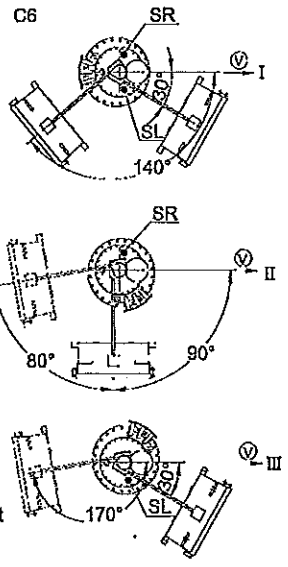


Drive shaft left output, with elevated holder for pressure relief valve, swiveling range



Drive shaft right output, with elevated holder for pressure relief valve, swiveling range

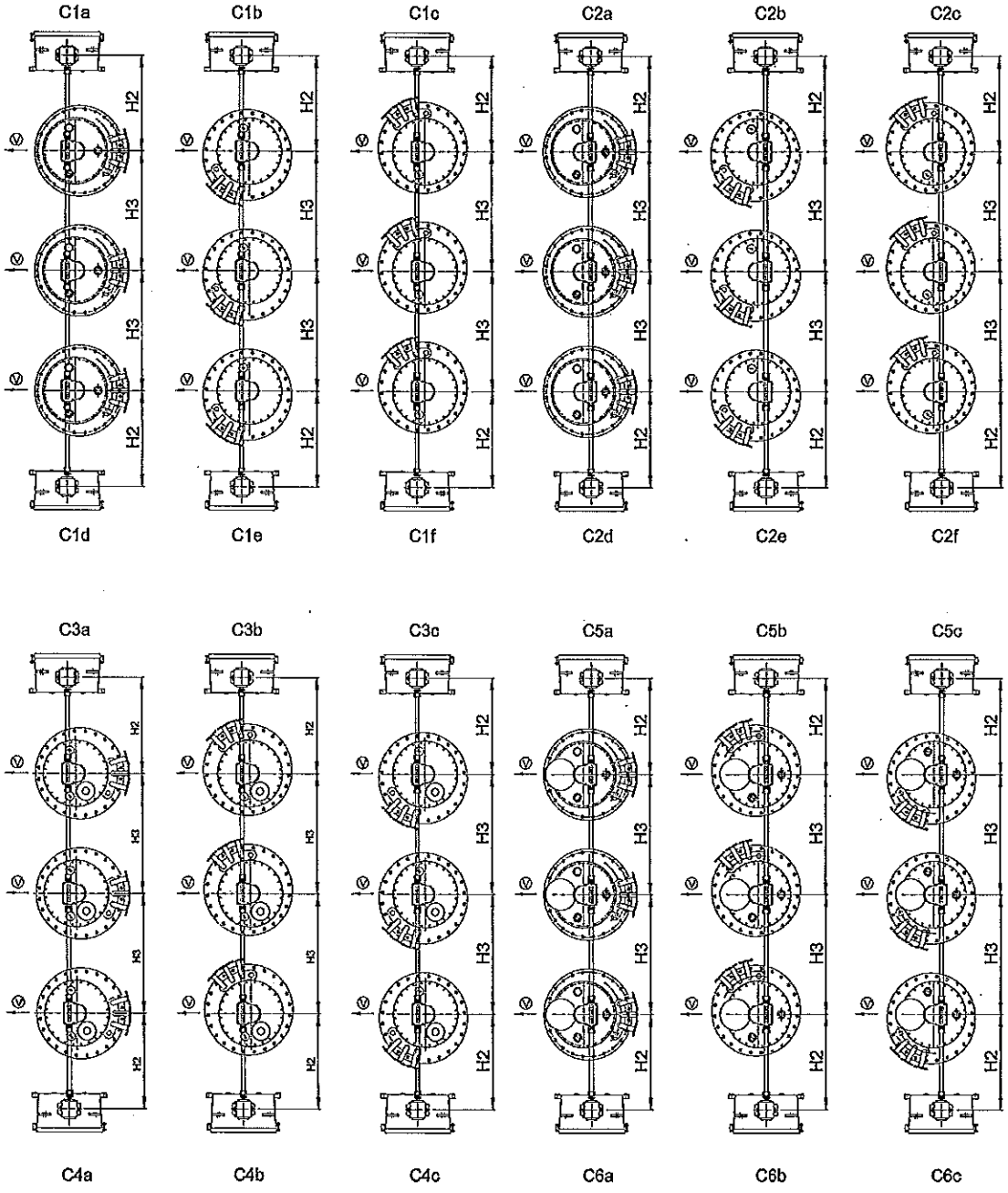




SR: Inspection window on the right
SL: Inspection window on the left
Ⓥ: Tap selector driving side

Unit: mm

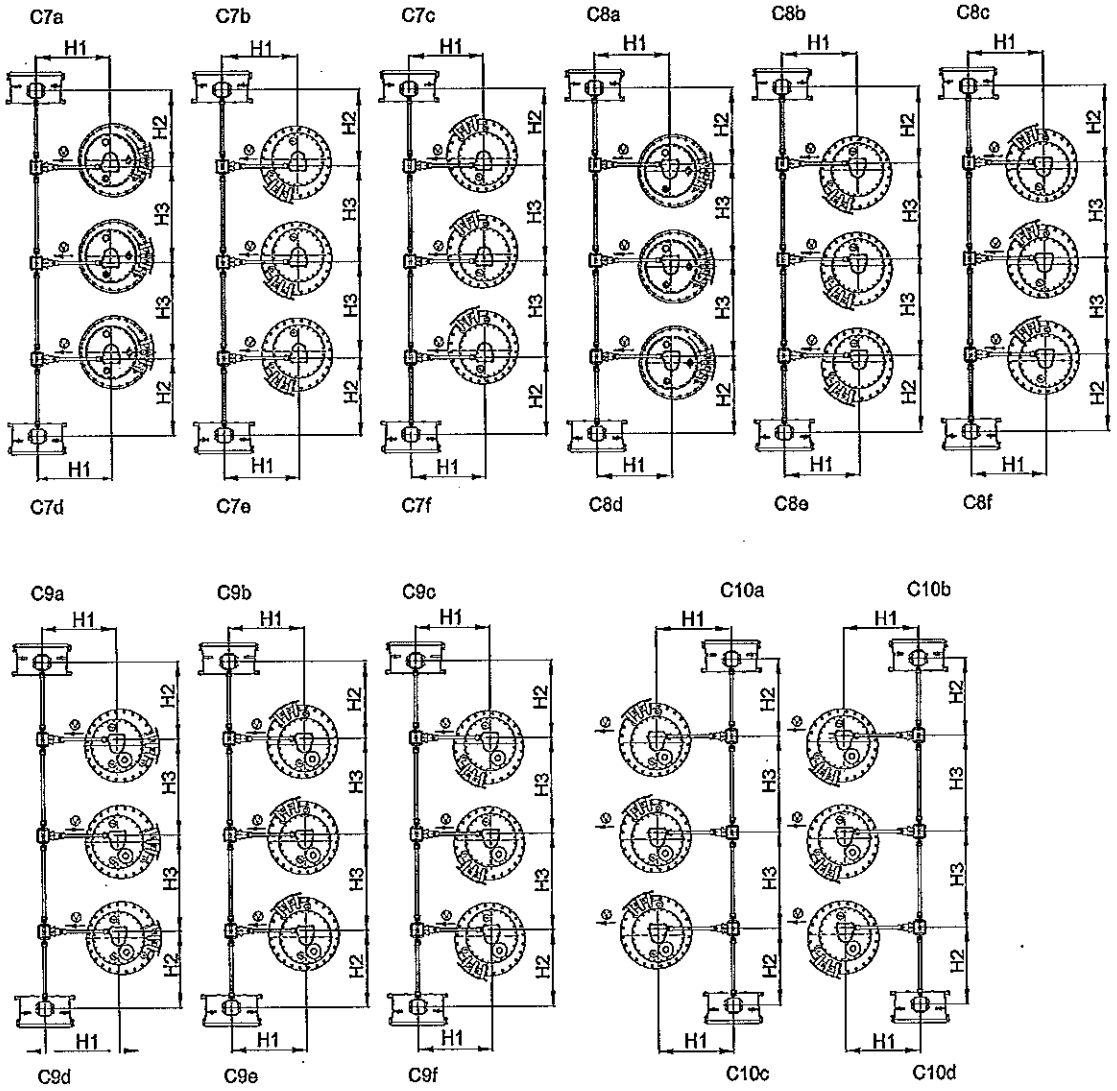
9.25-1. CM2 OLTC arrangement drawing-1



Item \ Dimensions	H1>	H2>	H3>
Min. mechanical size	535	515	840

Unit: mm

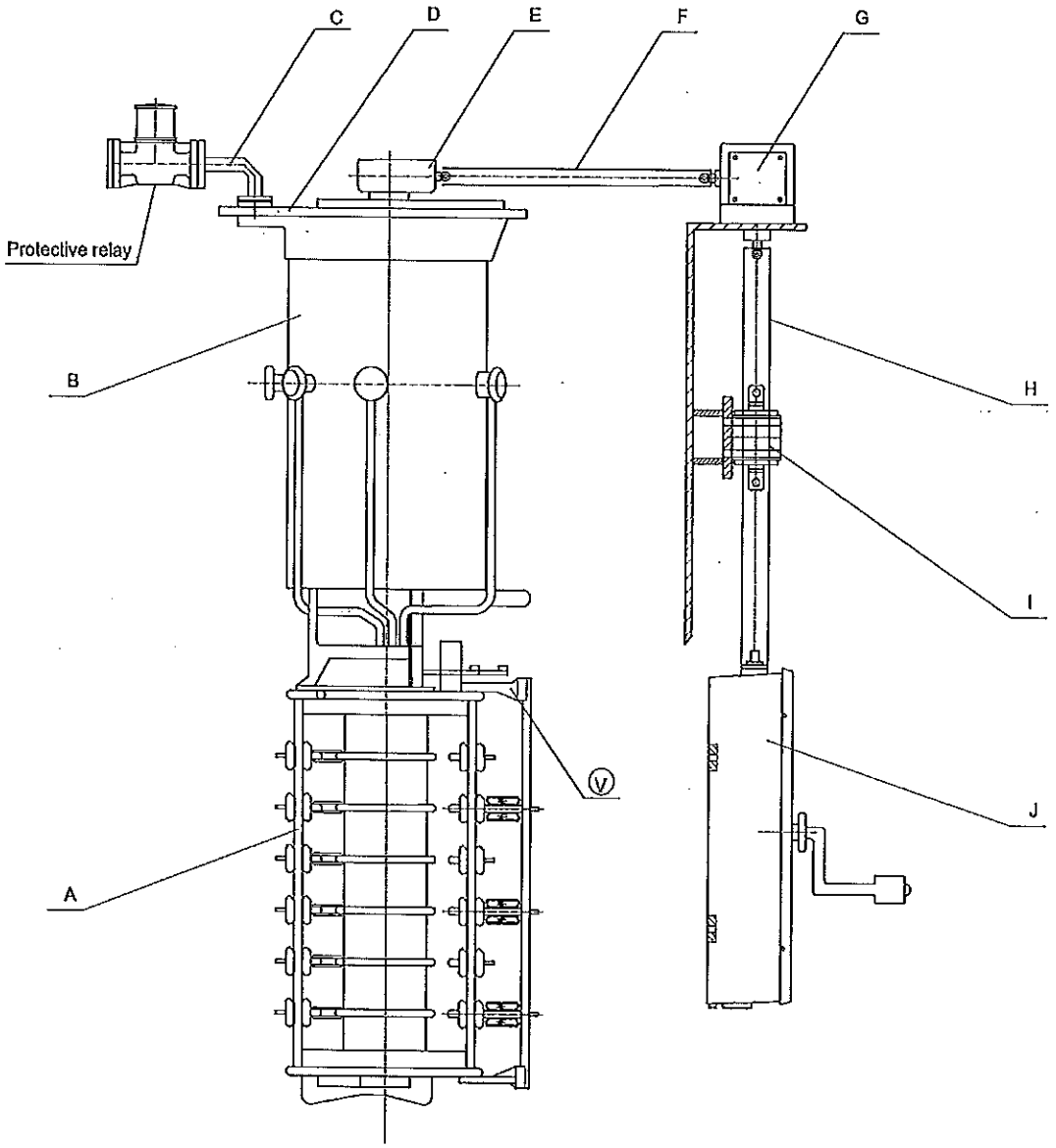
9.25-2. CM2 OLTC arrangement drawing-2



Item \ Dimensions	H1>	H2>	H3>
Min. mechanical size	535	515	840

Unit: mm

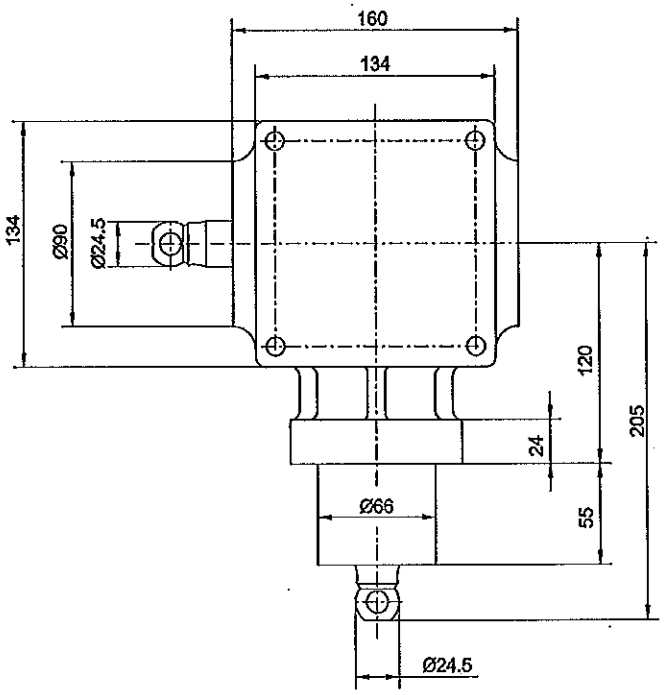
9.26. CM2 OLTC, general layout drawing

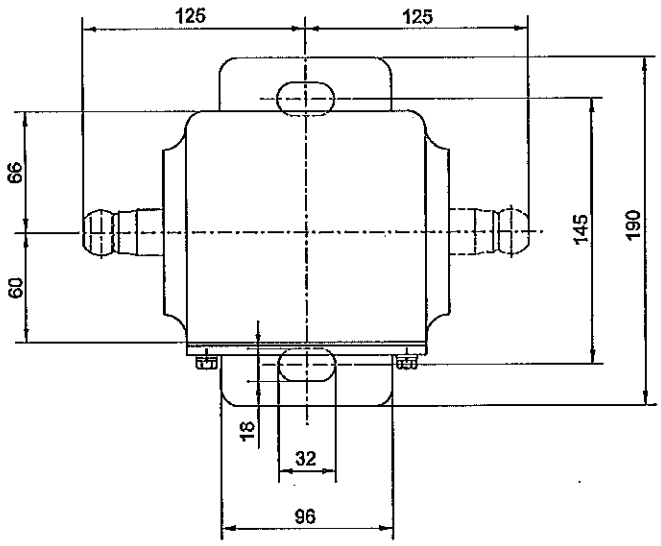


A: Tap selector
B: Diverter switch oil compartment
C: Pipe connections (R,S,Q,E2)
D: Tap changer head cover
E: Upper gear unit
F: Horizontal drive shaft
G: Bevel gear unit
H: Vertical drive shaft
I: Intermediate bearing (applied when shaft >2000mm only)
J: Motor drive unit
V: Driving side of tap selector

Unit: mm

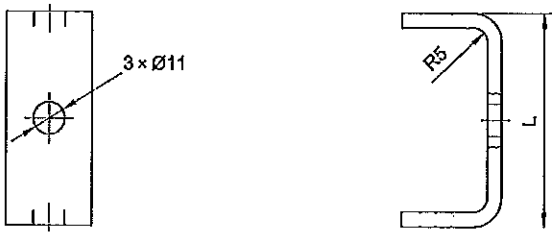
9.27. Bevel gear unit, overall & installation dimensions

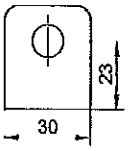




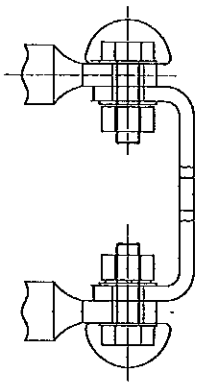
Unit: mm

9.28. CM2 I 800 / 1200 / 1500 OLTC, parallel connection plate of tap selector terminals, overall dimensions

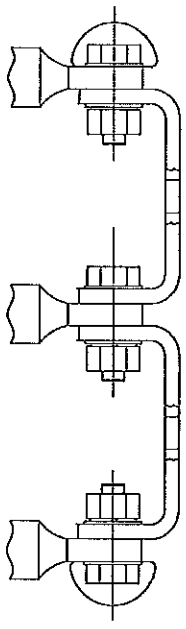




Connection plate



CM2I 800 contacts connection drawing

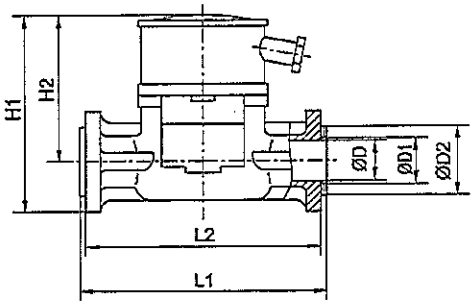


CM2I 1200/1500 contacts connection drawing

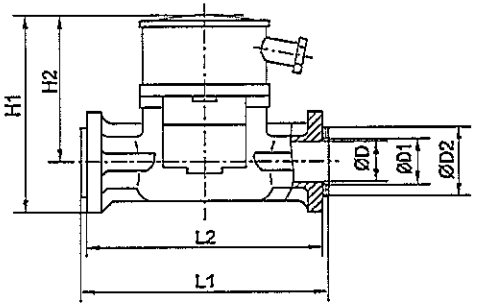
Unit: mm

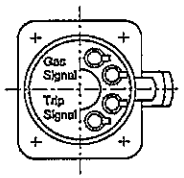
9.29. Protective relay, overall & installation dimensions

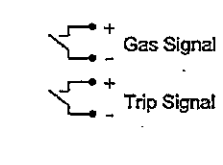
Type QJ4-25A protective relay

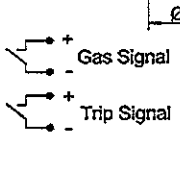


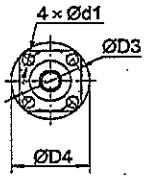
Type QJ4-25 protective relay







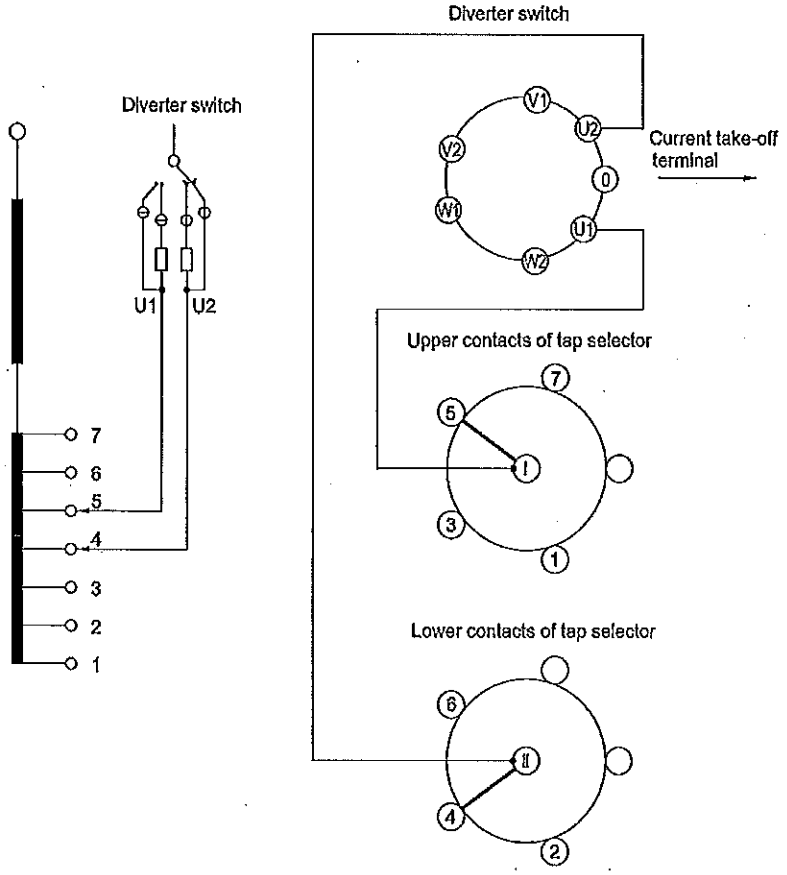




Model	D	D1	D2	D3	D4	d1	H1	H2	L1	L2	Note
QJ4-25A	25	35	65	85	115	14	215	153	208	200	1 pair of gas signal and 1 pair of trip signal, gas release device connected to man position
QJ4-25	25	35	65	85	115	14	215	153	208	200	1 pair of gas signal and 1 pair of trip signal

Unit: mm

9.30. CM2(10070) operating position table and connection diagram

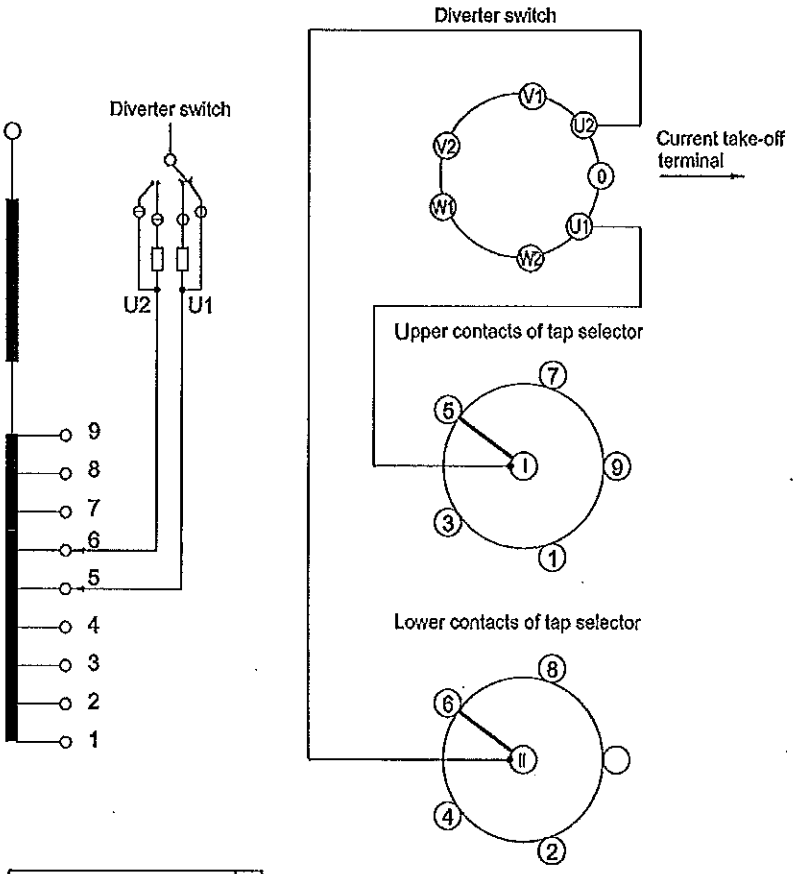


Operation position number	7
Different voltage number	7
Set position •	4

Tap selector contact position	1	2	3	4	5	6	7
Display position	1	2	3	4	5	6	7

• Drawing is shown at the set position

9.31. CM2(10090) operating position table and connection diagram

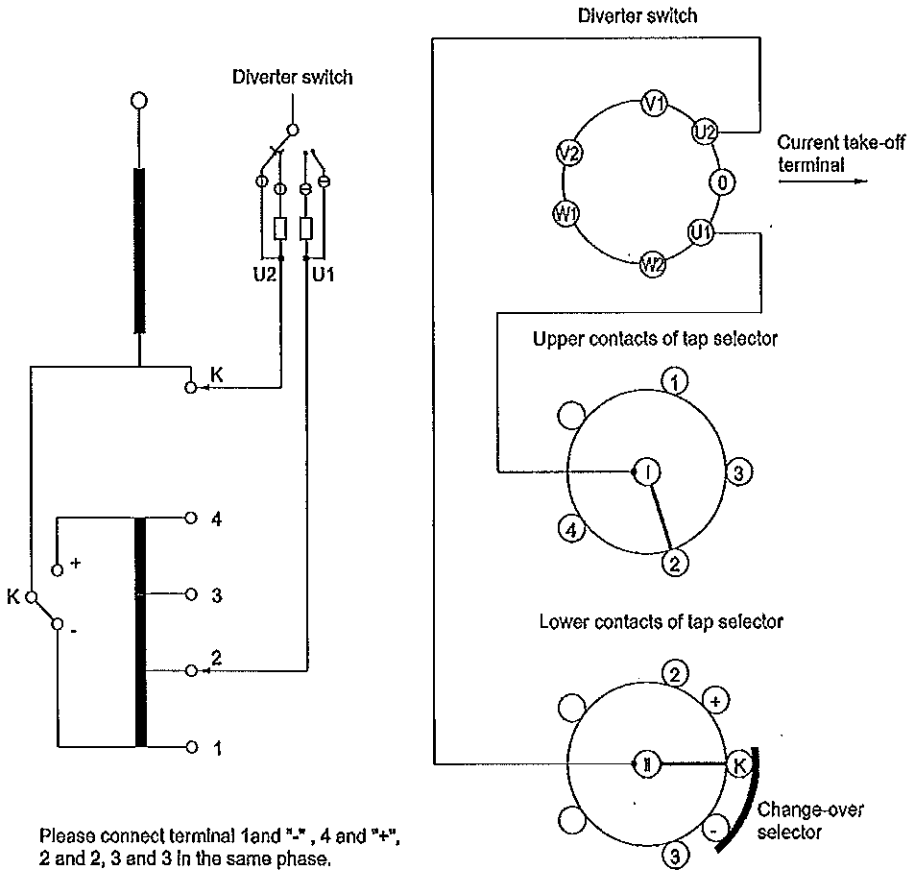


Operation position number	9
Different voltage number	9
Set position •	5

Tap selector contact position	1	2	3	4	5	6	7	8	9
Display position	1	2	3	4	5	6	7	8	9

• Drawing is shown at the set position

9.32. CM2(10071W) operating position table and connection diagram



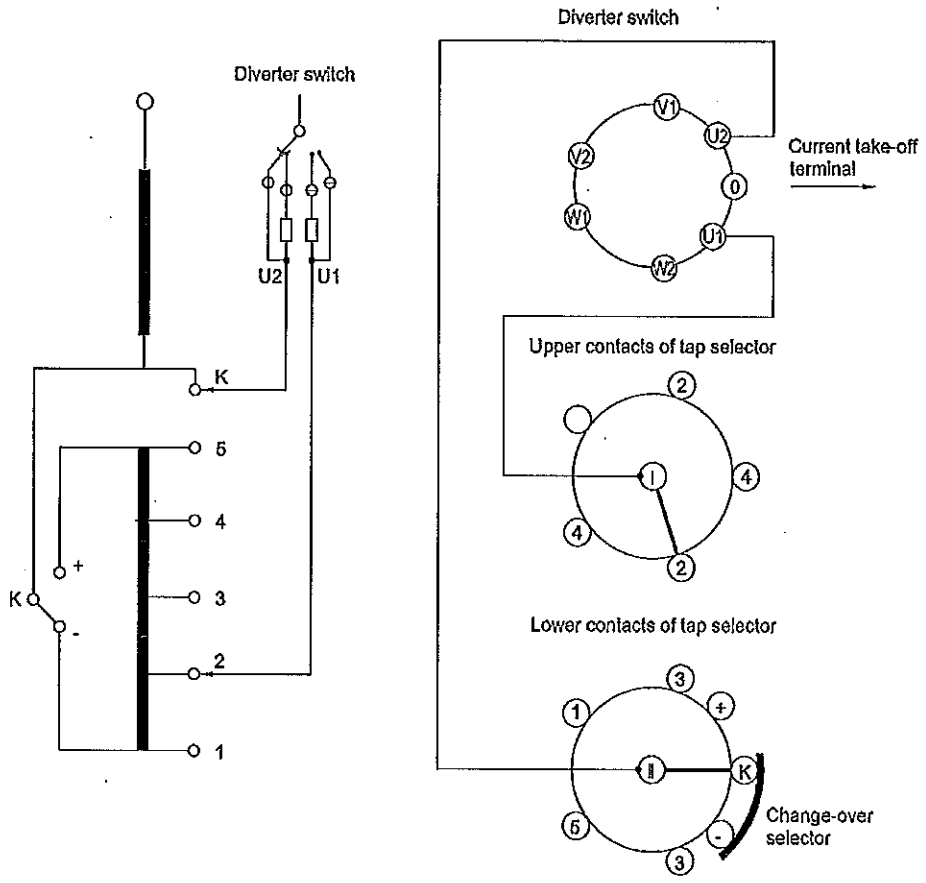
Please connect terminal 1and "-" , 4 and "+", 2 and 2, 3 and 3 in the same phase.

Operation position number	7
Different voltage number	7
Set position •	4

Change-over selector location	K+					K-	
Tap changer position	1	2	3	4	5	6	7
Tap selector contact position	1	2	3	K	2	3	4
Display position	1	2	3	4	5	6	7

• Drawing is shown at the set position

9.33. CM2(10091W) operating position table and connection diagram



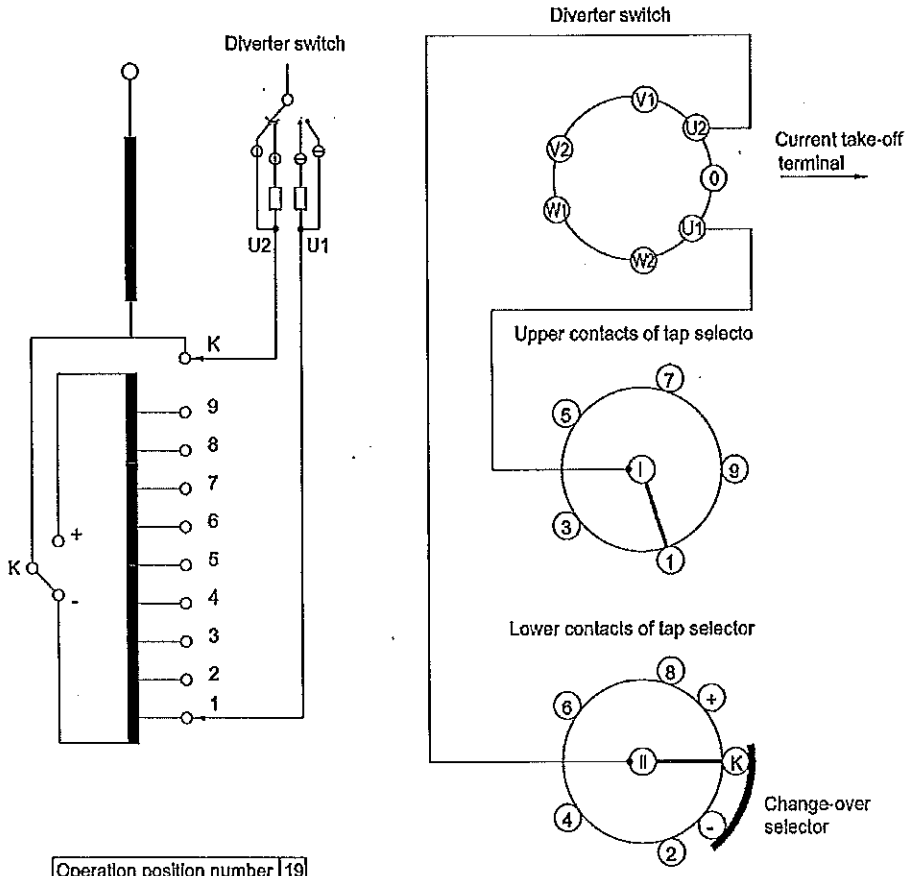
Please connect terminal 1 and "-",5 and "+",
2 and 2, 3 and 3, 4 and 4 in the same phase.

Operation position number	9
Different voltage number	9
Set position •	5

Change-over selector location	K+						K-		
Tap changer position	1	2	3	4	5	6	7	8	9
Tap selector contact position	1	2	3	4	K	2	3	4	5
Display position	1	2	3	4	5	6	7	8	9

• Drawing is shown at the set position

9.34. CM2(10191W) operating position table and connection diagram

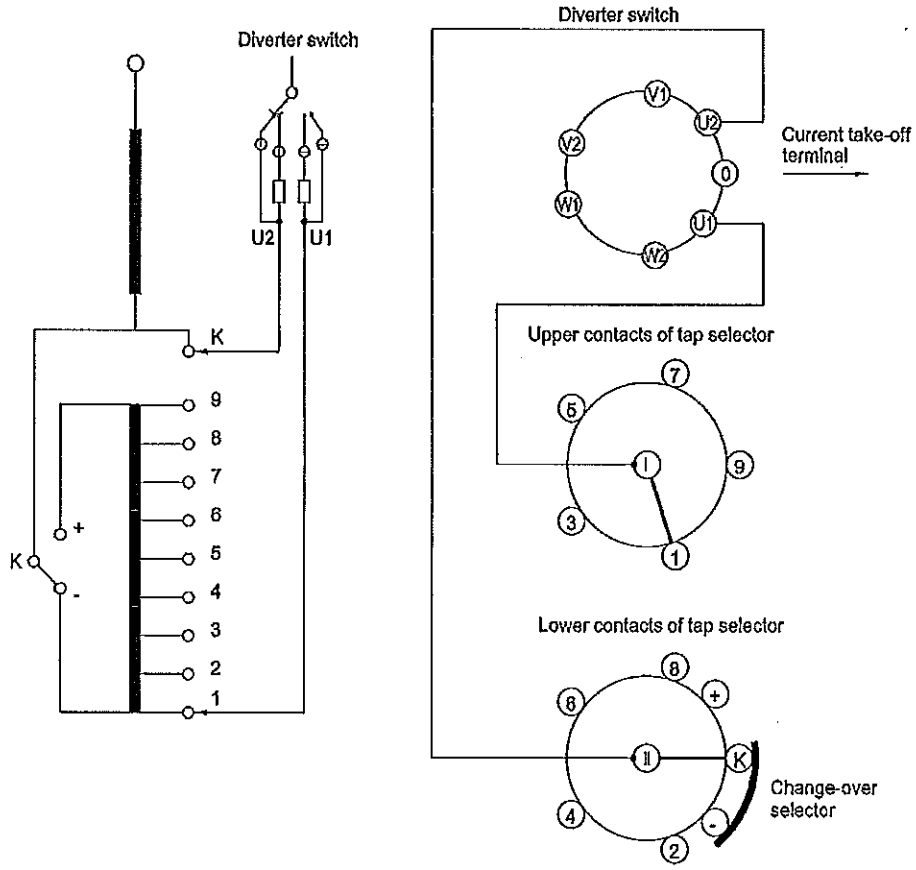


Operation position number	19
Different voltage number	19
Set position •	10

Change-over selector location	K+									K-									
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Tap selector contact position	1	2	3	4	5	6	7	8	9	K	1	2	3	4	5	6	7	8	9
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

• Drawing is shown at the set position

9.35. CM2(10193W) operating position table and connection diagram

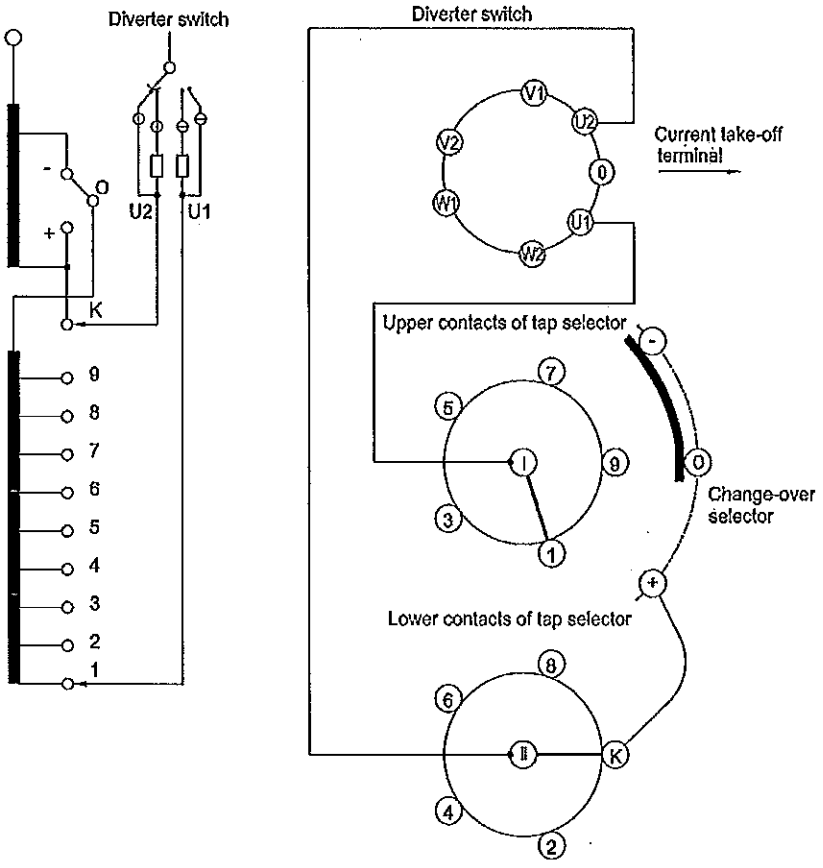


Operation position number	19
Different voltage number	17
Set position •	9b

Change-over selector location	K+									K-									
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Tap selector contact position	1	2	3	4	5	6	7	8	9	K	1	2	3	4	5	6	7	8	9
Display position	1	2	3	4	5	6	7	8	9a	9b	9c	10	11	12	13	14	15	16	17

• Drawing is shown at the set position

9.36. CM2(10191G) operating position table and connection diagram

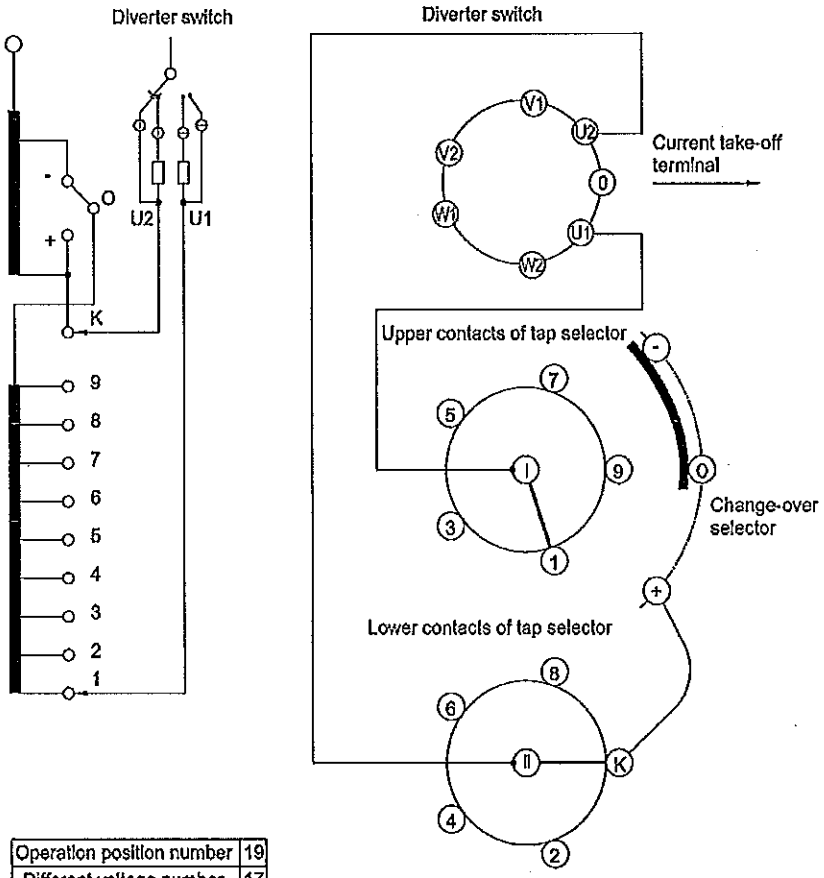


Operation position number	19
Different voltage number	19
Set position •	10

Change-over selector location	0+									0-									
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Tap selector contact position	1	2	3	4	5	6	7	8	9	K	1	2	3	4	5	6	7	8	9
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

• Drawing is shown at the set position

9.37. CM2(10193G) operating position table and connection diagram

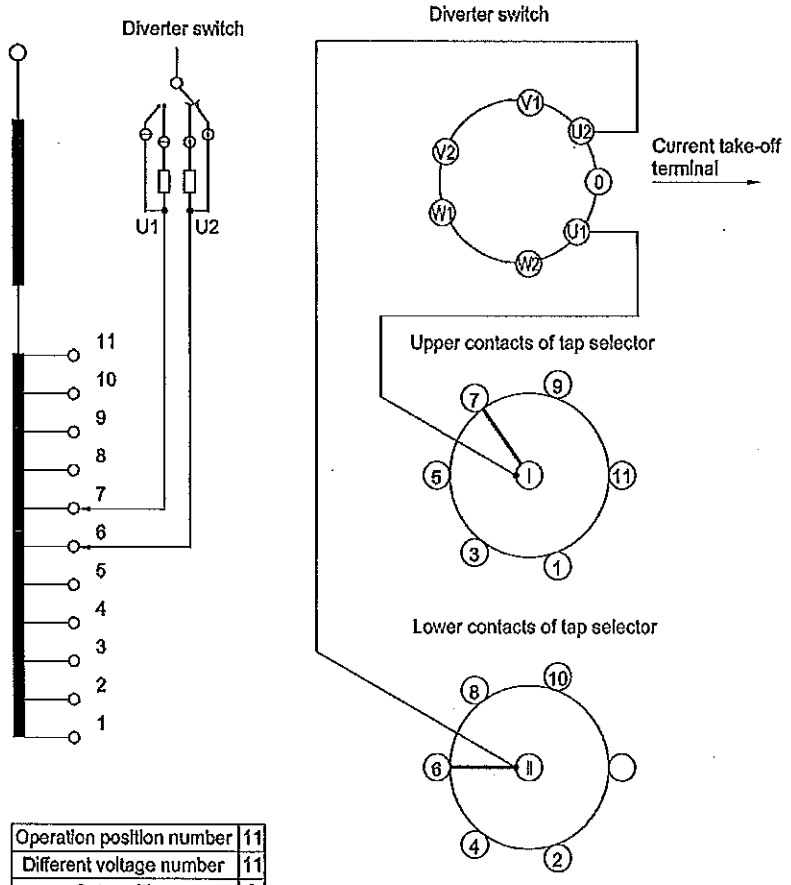


Operation position number	19
Different voltage number	17
Set position •	9b

Change-over selector location	0+																		0-
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Tap selector contact position	1	2	3	4	5	6	7	8	9	K	1	2	3	4	5	6	7	8	9
Display position	1	2	3	4	5	6	7	8	9a	9b	9c	10	11	12	13	14	15	16	17

• Drawing is shown at the set position

9.38. CM2(12110) operating position table and connection diagram

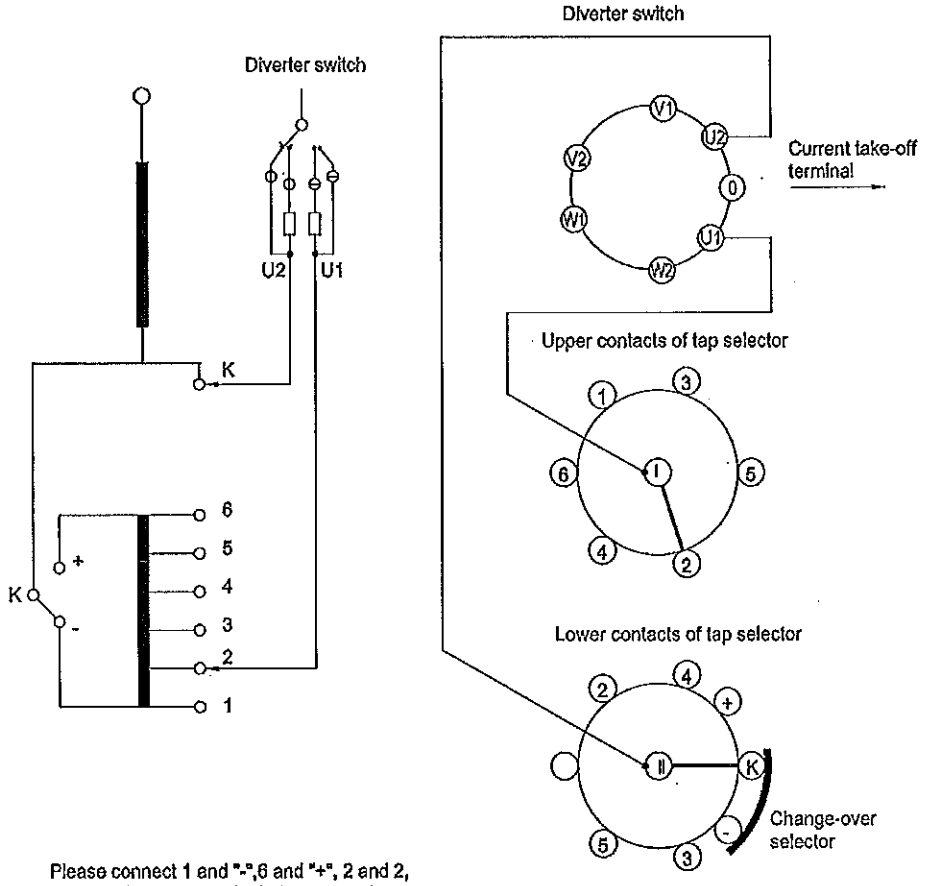


Operation position number	11
Different voltage number	11
Set position •	6

Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11
Display position	1	2	3	4	5	6	7	8	9	10	11

• Drawing is shown at the set position

9.39. CM2(12111W) operating position table and connection diagram



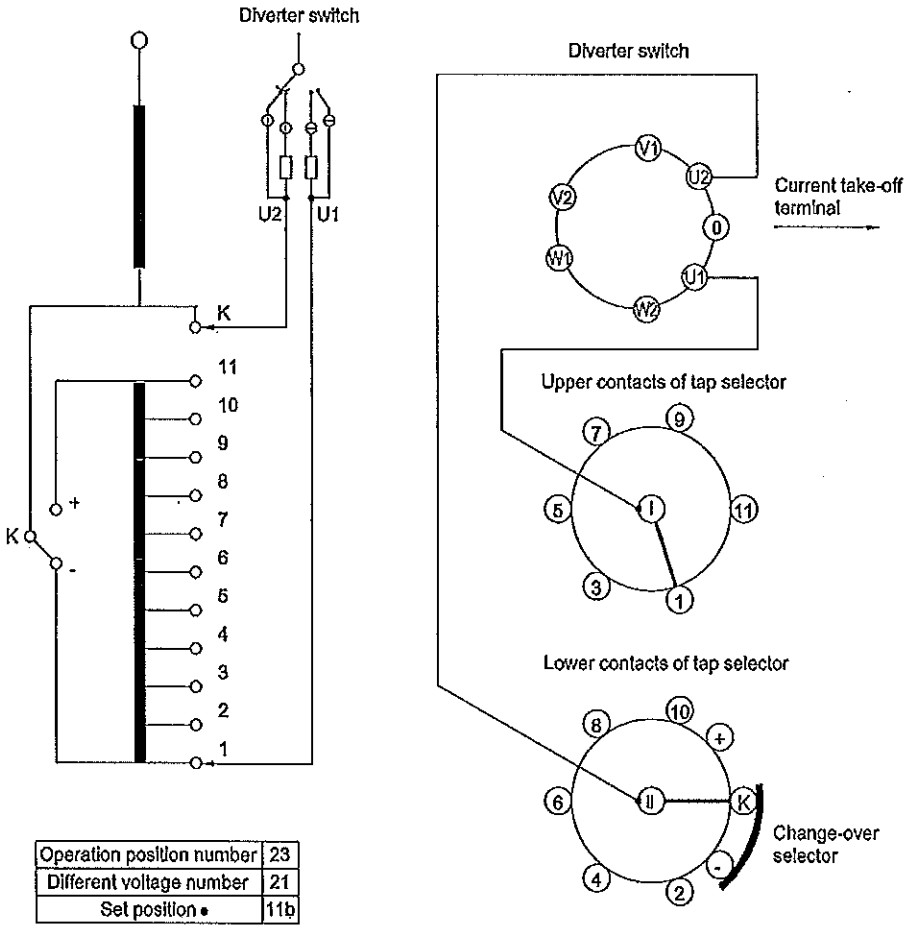
Please connect 1 and "-",6 and "+", 2 and 2, 3 and 3, 4 and 4, 5 and 6 in the same phase.

Operation position number	11
Different voltage number	11
Set position •	6

Change-over selector location	K+					K-					
Tap changer position	1	2	3	4	5	6	7	8	9	10	11
Tap selector contact position	1	2	3	4	5	K	2	3	4	5	6
Display position	1	2	3	4	5	6	7	8	9	10	11

• Drawing is shown at the set position

9.40. CM2(12233W) operating position table and connection diagram

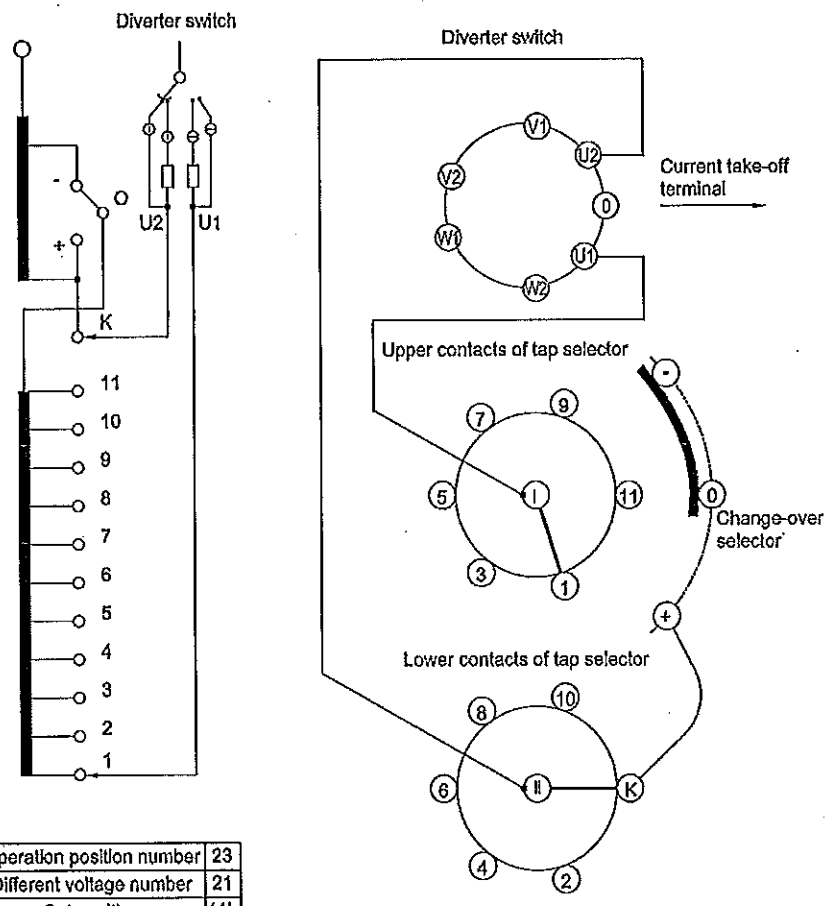


Operation position number	23
Different voltage number	21
Set position •	11b

Change-over selector location	K+												K-										
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	K	1	2	3	4	5	6	7	8	9	10	11
Display position	1	2	3	4	5	6	7	8	9	10	11a	11b	11c	12	13	14	15	16	17	18	19	20	21

• Drawing is shown at the set position

9.41. CM2(12233G) operating position table and connection diagram

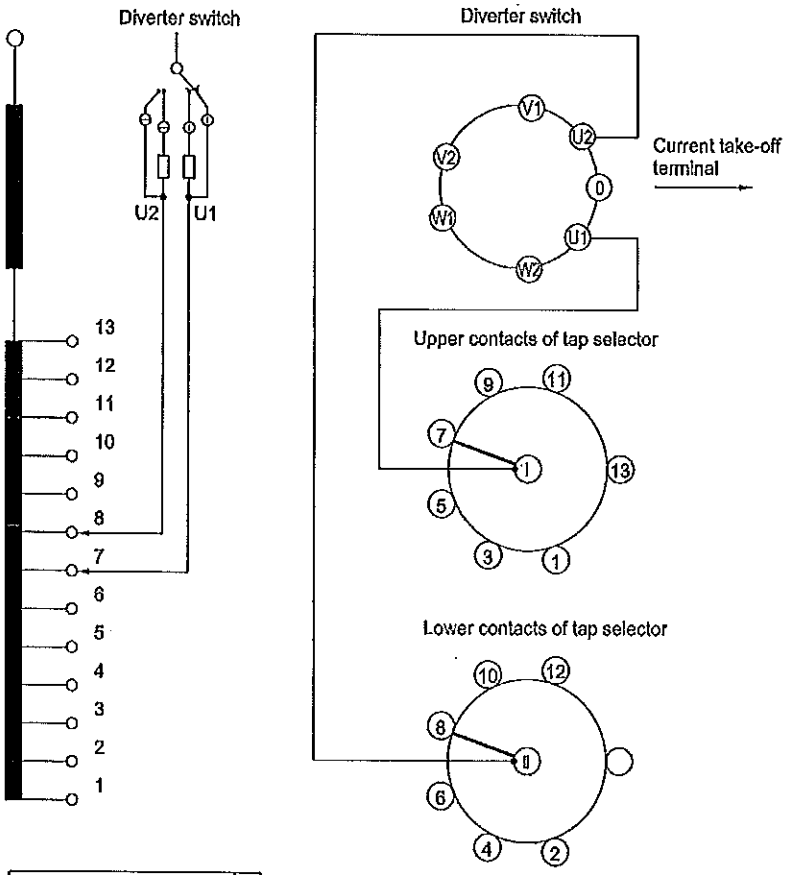


Operation position number	23
Different voltage number	21
Set position •	11b

Change-over selector location	0 +												0 -										
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	K	1	2	3	4	5	6	7	8	9	10	11
Display position	1	2	3	4	5	6	7	8	9	10	11a	11b	11c	12	13	14	15	16	17	18	19	20	21

• Drawing is shown at the set position

9.42. CM2(14130) operating position table and connection diagram

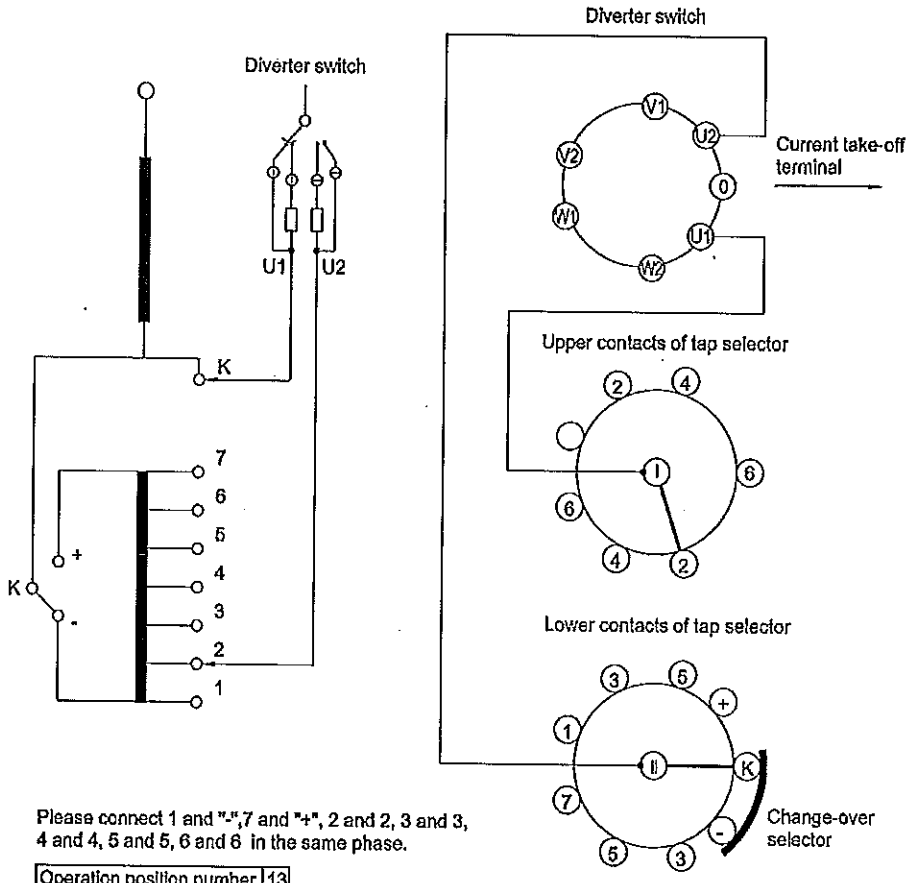


Operation position number	13
Different voltage number	13
Set position •	7

Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	12	13
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13

• Drawing is shown at the set position

9.43. CM2(14131W) operating position table and connection diagram



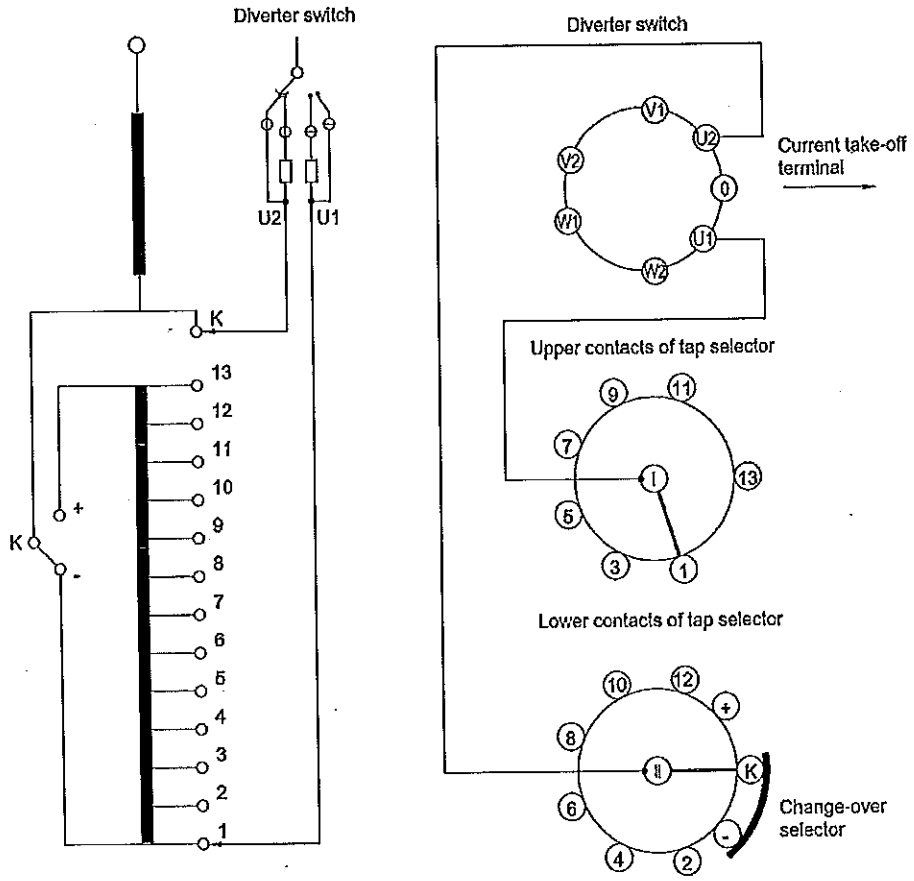
Please connect 1 and "-",7 and "+", 2 and 2, 3 and 3, 4 and 4, 5 and 5, 6 and 6 in the same phase.

Operation position number	13
Different voltage number	13
Set position •	7

Change-over selector location	K+							K-					
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13
Tap selector contact position	1	2	3	4	5	6	K	2	3	4	5	6	7
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13

• Drawing is shown at the set position

9.44. CM2(14273W) operating position table and connection diagram

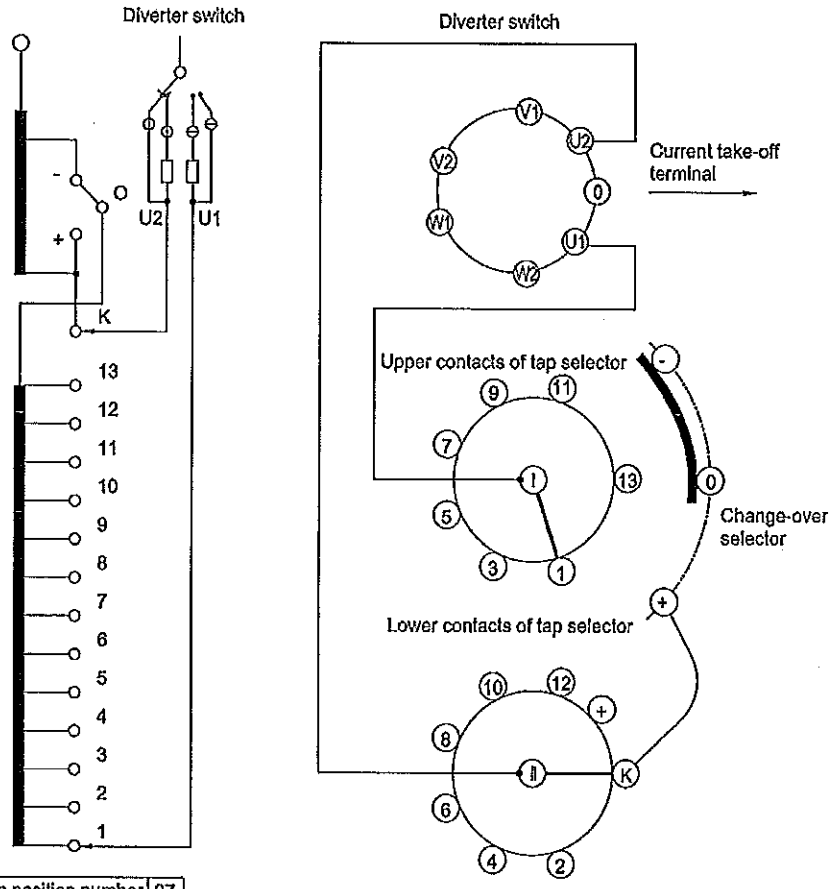


Operation position number	27
Different voltage number	25
Set position •	13b

Change-over selector location	K+													K-												
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	12	13	K	1	2	3	4	5	6	7	8	9	10	11	12	13
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13a	13b	13c	14	15	16	17	18	19	20	21	22	23	24	25

• Drawing is shown at the set position

9.45. CM2(14273G) operating position table and connection diagram

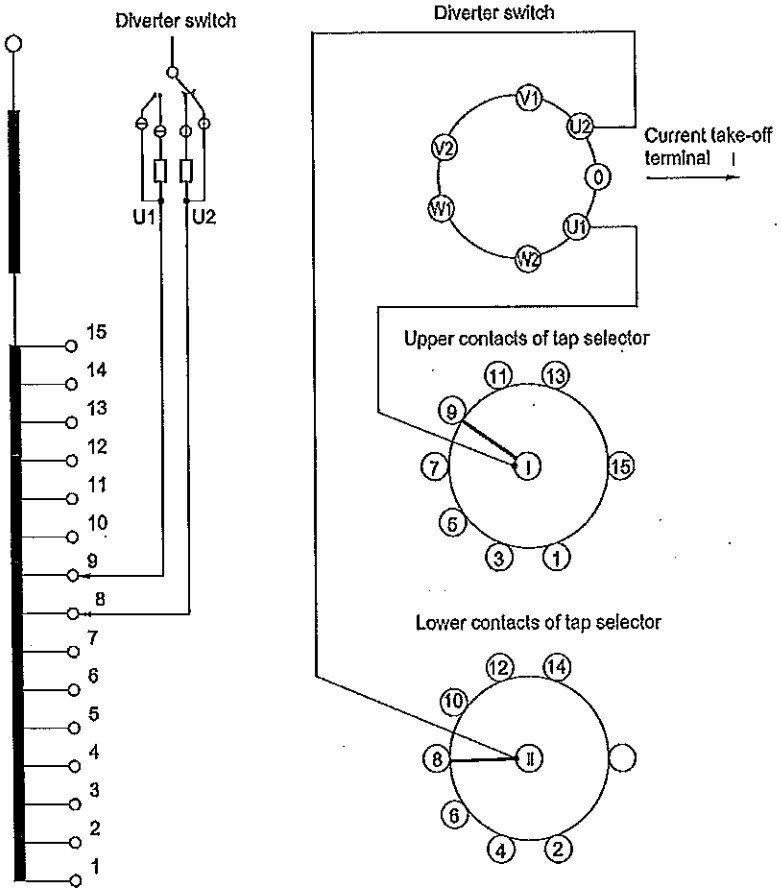


Operation position number	27
Different voltage number	25
Set position •	13b

Change-over selector location	0+													0-												
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	12	13	K	1	2	3	4	5	6	7	8	9	10	11	12	13
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13a	13b	13c	14	15	16	17	18	19	20	21	22	23	24	25

• Drawing is shown at the set position

9.46. CM2(16150) operating position table and connection diagram

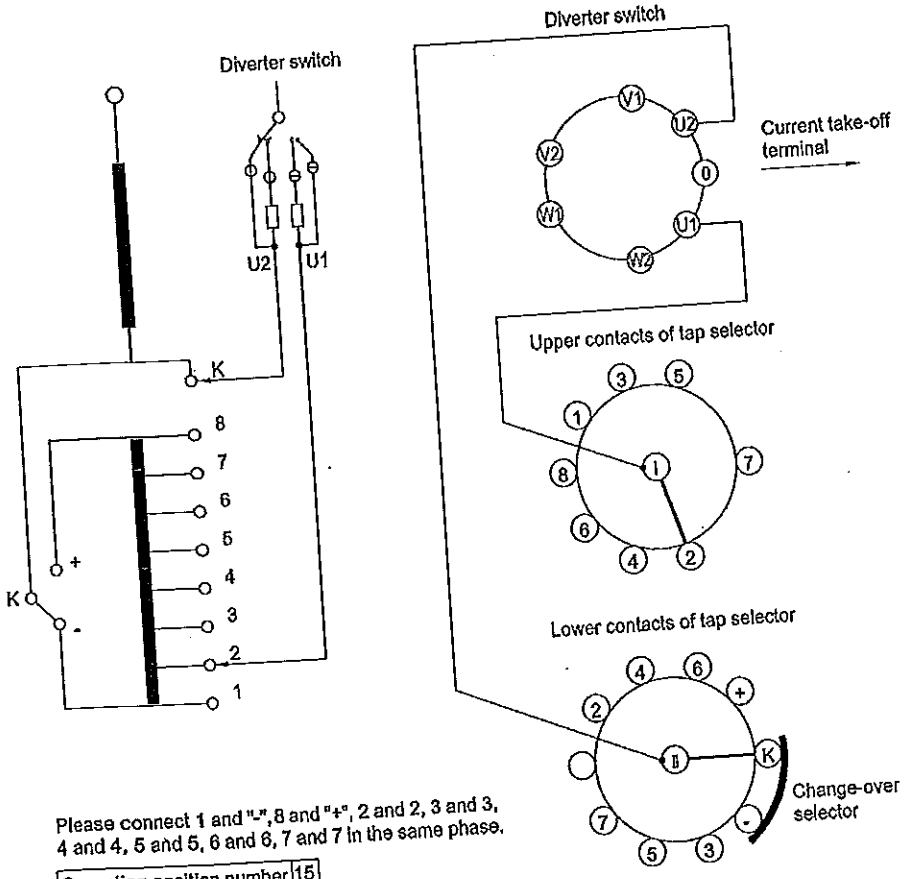


Operation position number	15
Different voltage number	15
Set position ●	8

Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

● Drawing is shown at the set position

9.47. CM2(16151W) operating position table and connection diagram



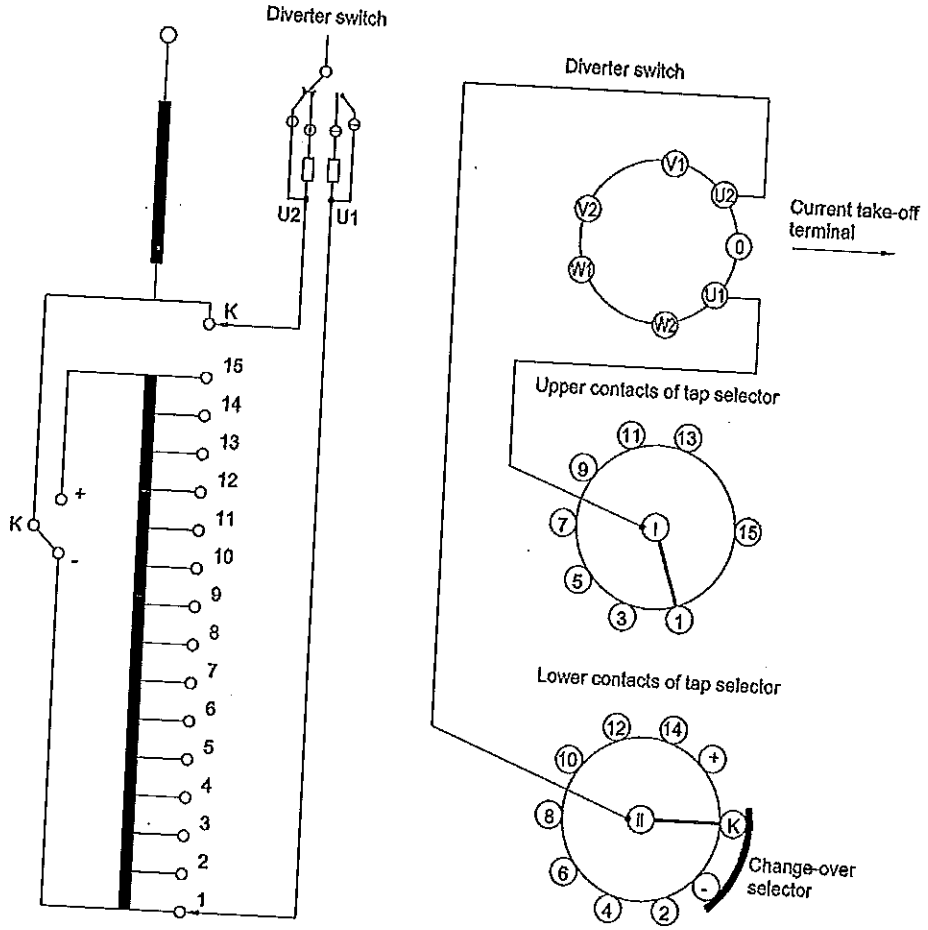
Please connect 1 and "-",8 and "+", 2 and 2, 3 and 3, 4 and 4, 5 and 5, 6 and 6, 7 and 7 in the same phase.

Operation position number	15
Different voltage number	15
Set position •	8

Change-over selector location	K+								K-						
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Tap selector contact position	1	2	3	4	5	6	7	K	2	3	4	5	6	7	8
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

• Drawing is shown at the set position

9.48. CM2(16313W) operating position table and connection diagram

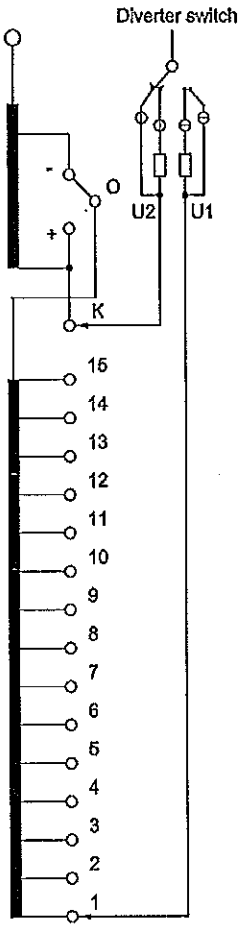


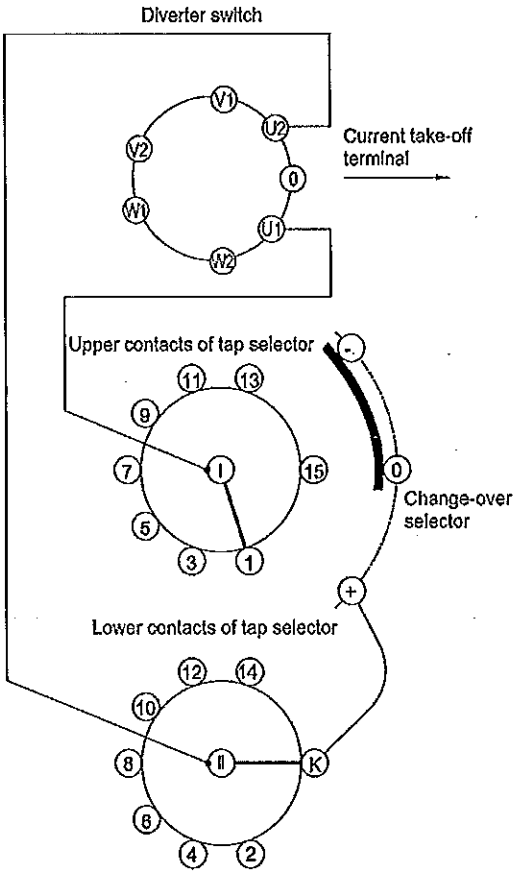
Operation position number	31
Different voltage number	29
Set position•	15b

Change-over selector location	K+																K-														
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	K	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15a	15b	15c	16	17	18	19	20	21	22	23	24	25	26	27	28	29

• Drawing is shown at the set position

9.49. CM2(16313G) operating position table and connection diagram



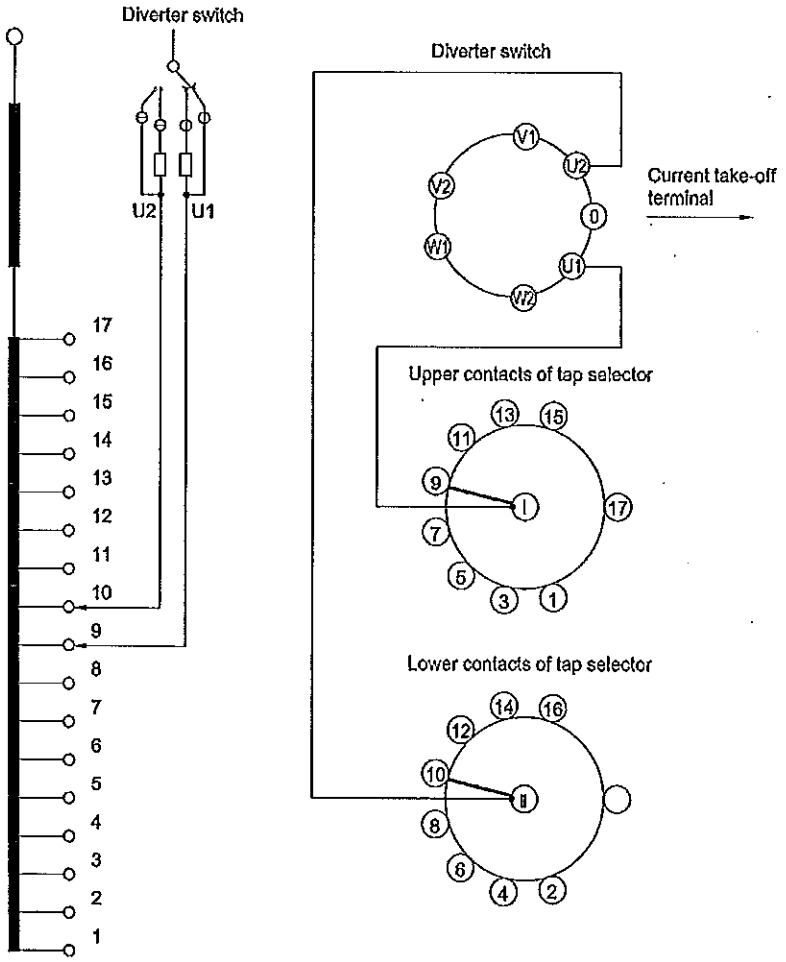


Operation position number	31
Different voltage number	29
Set position •	15b

Change-over selector location	0+															0-														
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	K	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15a	15b	15c	16	17	18	19	20	21	22	23	24	25	26	27	28	29

• Drawing is shown at the set position

9.50. CM2(18170) operating position table and connection diagram

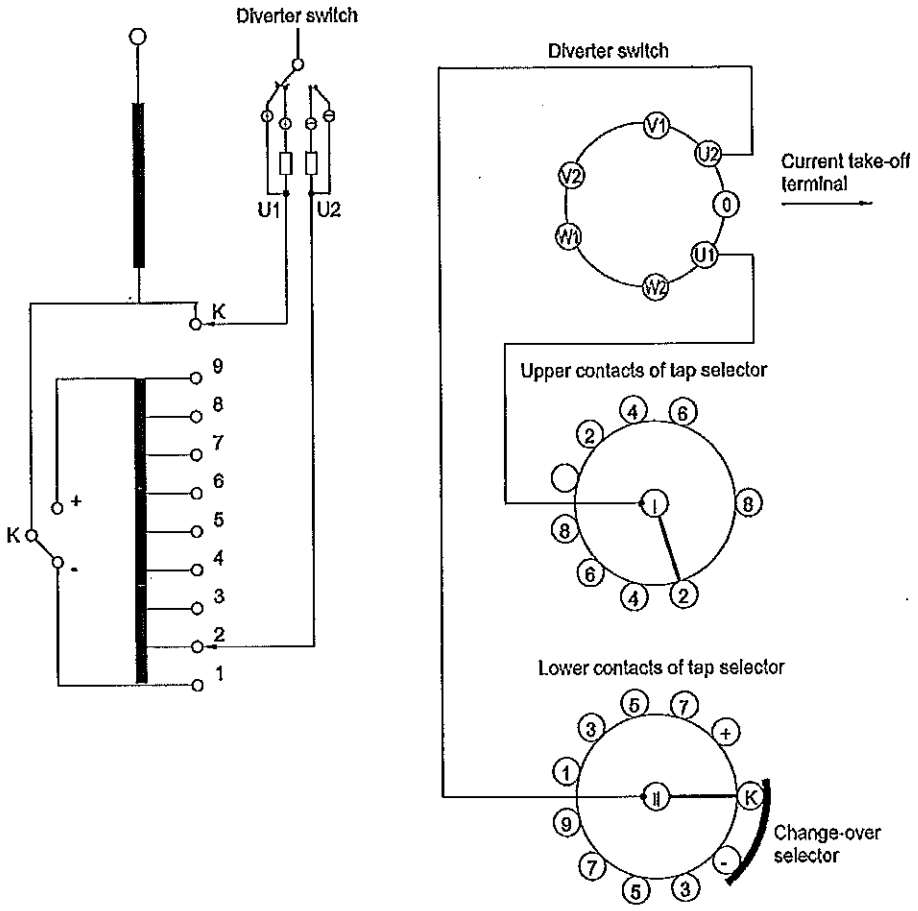


Operation position number	17
Different voltage number	17
Set position ●	9

Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

● Drawing is shown at the set position

9.51. CM2(18171W) operating position table and connection diagram



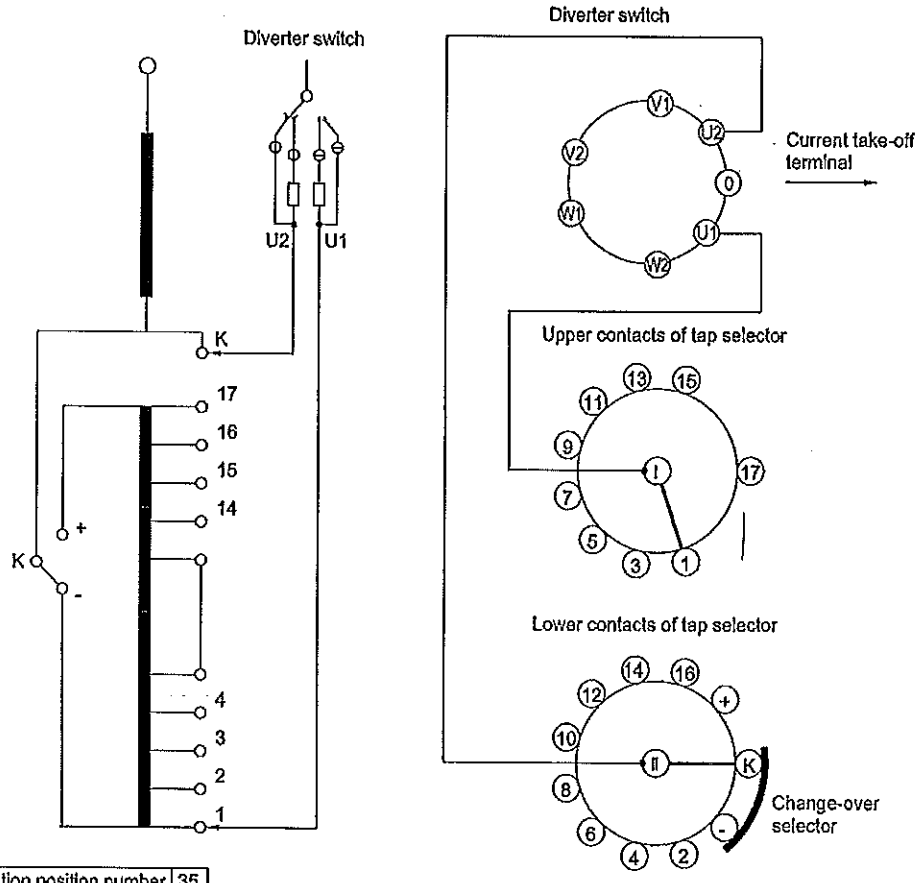
Please connect 1 and "-",9 and "+", 2 and 2, 3 and 3,
4 and 4, 5 and 5, 6 and 6, 7 and 7, 8 and 8 in the same phase.

Operation position number	17
Different voltage number	17
Set position •	9

Change-over selector location	K+								K-								
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Tap selector contact position	1	2	3	4	5	6	7	8	K	2	3	4	5	6	7	8	9
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

• Drawing is shown at the set position

9.52. CM2(18353W) operating position table and connection diagram

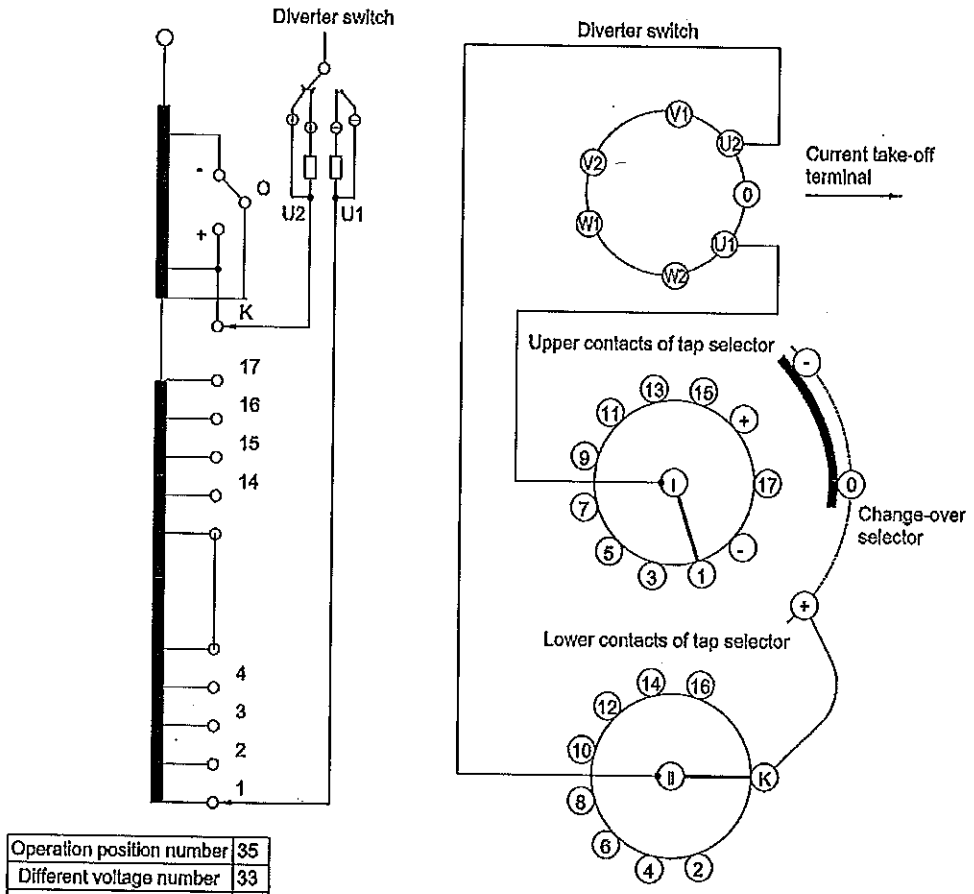


Operation position number	35
Different voltage number	33
Set position •	17b

Change-over selector location	K+															K-																	
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	k	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17a	17b	17c	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33

• Drawing is shown at the set position

9.53. CM2(18353G) operating position table and connection diagram



Operation position number	35
Different voltage number	33
Set position •	17b

Change-over selector location	0+																0-																
Tap changer position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Tap selector contact position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	k	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Display position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17a	17b	17c	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33

• Drawing is shown at the set position

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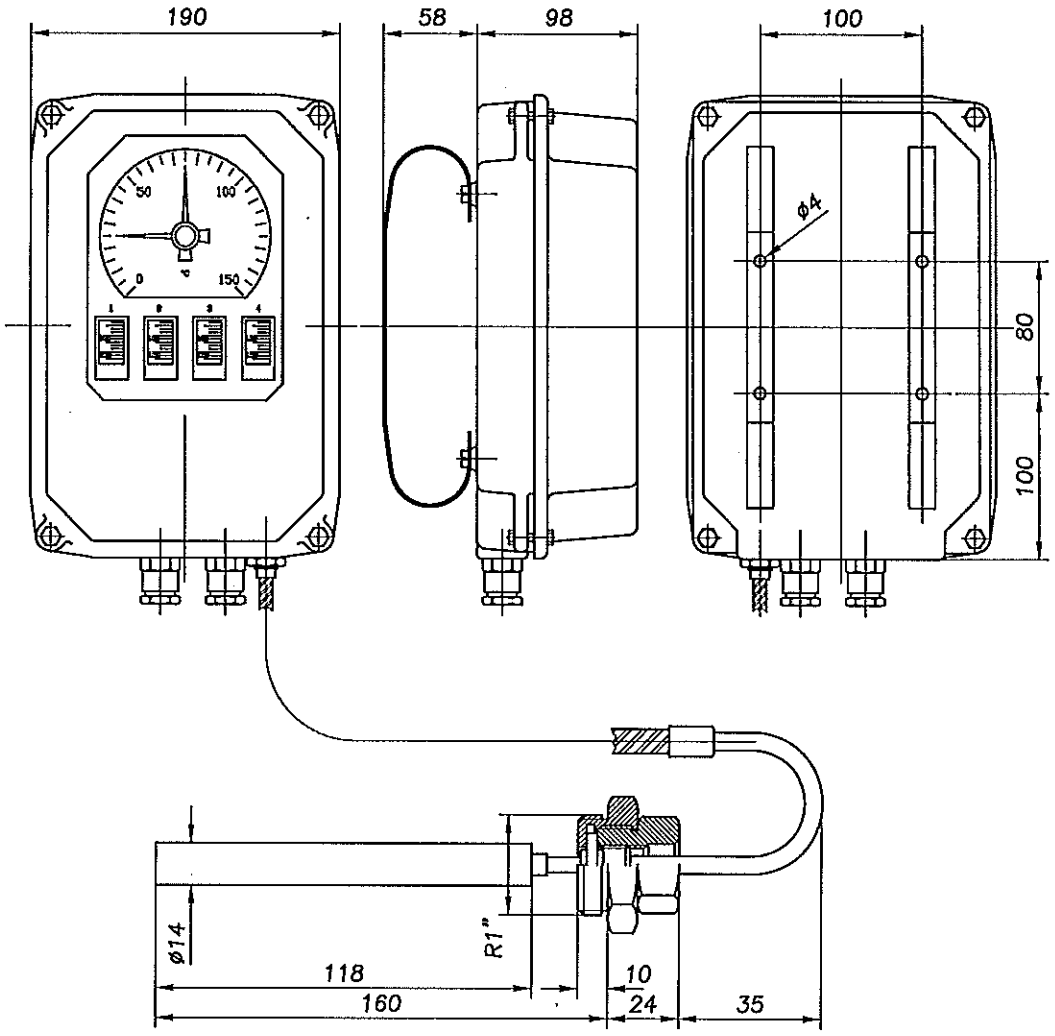
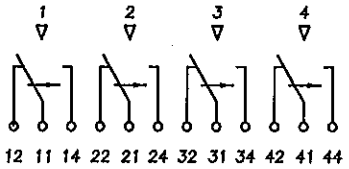
Printing: FEB.2010

ETRA 33 ENERGETSKI TRANSFORMATORJI, d.o.o.	**OIL TEMPERATURE INDICATOR - AKM**	**PNA-6.40.31** Revision: 1 Date: 1. 8. 2005



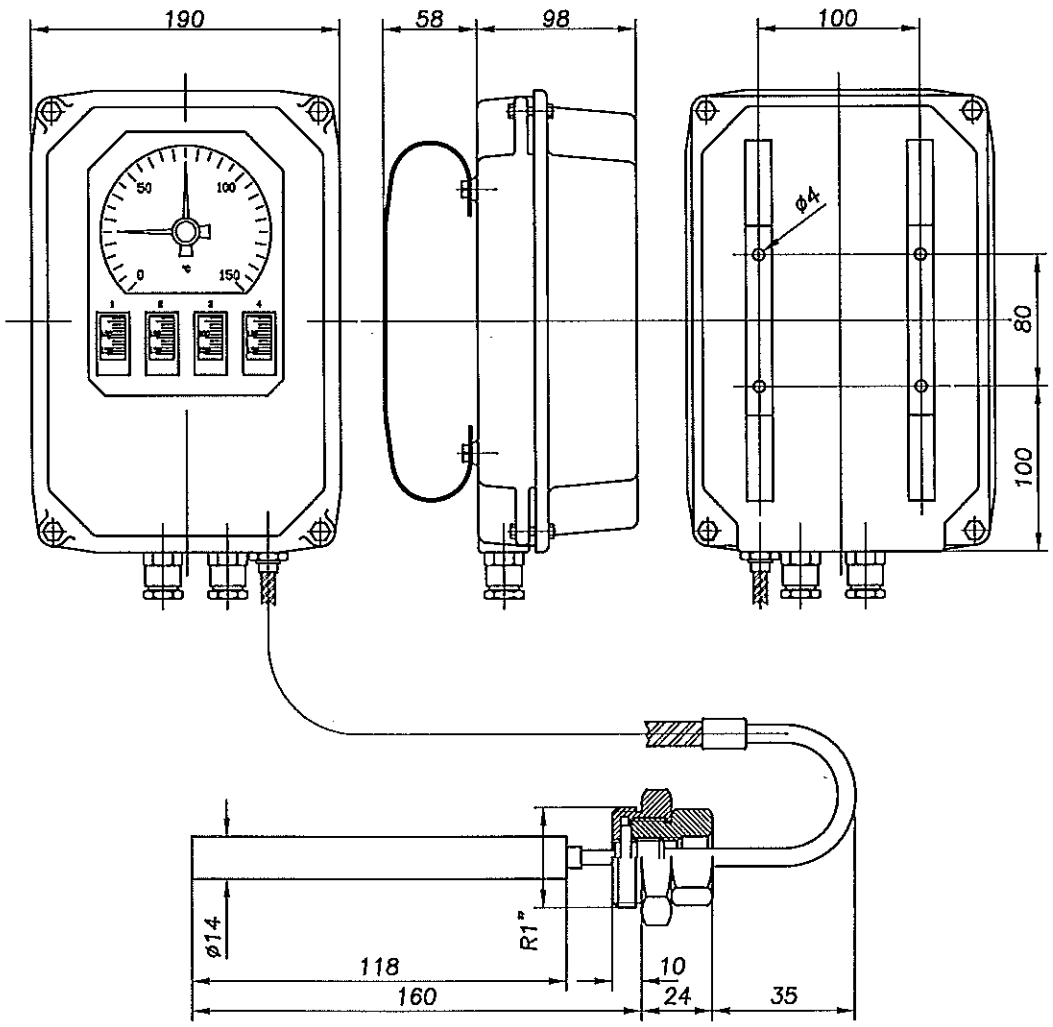
CONTACT DIAGRAM:



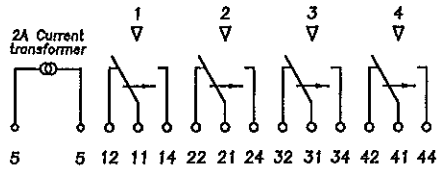
CHARACTERISTICS

1. *TYPE: AKM 34 4 01 15 – 6.0*
2. *PROTECTION MODE: IP –65*
3. *SWITCHING ELEMENT: 4 CHANGE–OVER SWITCHES*
4. *BREAKING CAPACITY: 15A, 250V, 40–60Hz*
5. *INSULATION TEST: AC 2.0kV, 1min*

ETRA 33 ENERGETSKI TRANSFORMATORJI, d.o.o.	**WINDING TEMPERATURE INDICATOR - AKM**	**PNA-6.40.41** Revision: 2 Date: 3. 4. 2006



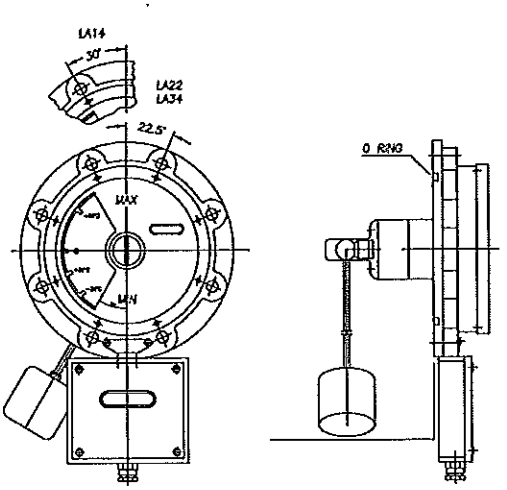
CONTACT DIAGRAM:



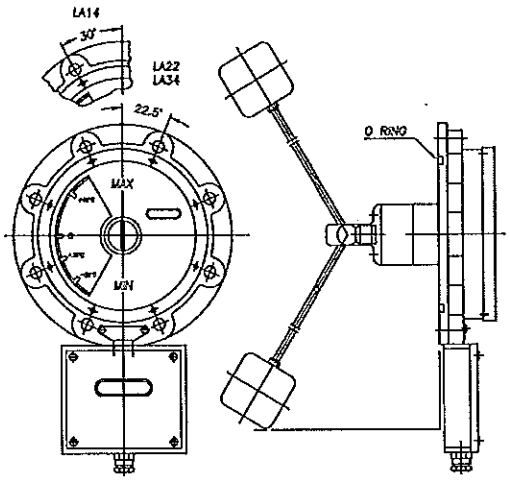
CHARACTERISTICS:

1. *TYPE: AKM 35 4 01 15 – 6.0*
2. *PROTECTION MODE: IP –65*
3. *SWITCHING ELEMENT: 4 CHANGE–OVER SWITCHES*
4. *BREAKING CAPACITY: 15 A, 250 V, 40–60 Hz*
5. *INSULATION TEST: AC 2.0 kV, 1min*

KOLEKTOR ETRA d.o.o.	OIL LEVEL INDICATORS type LA and LB	PNA-6.40.17 Revision: 3 Date: 20.03.2013



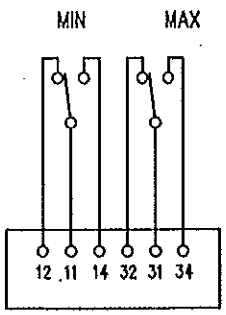
Oil level indicator type LA



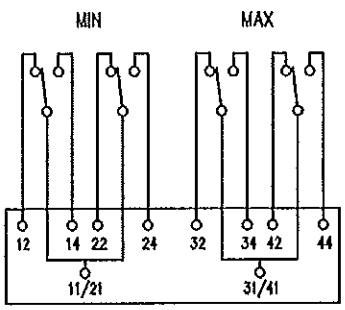
Oil level indicator type LB

TEHNICAL SPECIFICATION	
Standard specification	EN 50216-5
Indicator type	Level gauge with magnetic joint
Dial size	Ø140 mm, Ø220 mm or Ø340 mm
Min / Max level	Dial shows all red / Dial shows all white
Reference marks	-20°C, +20°C, +85°C, special marks available on request
Breaking capacity	3 A, 125/250 V AC (resistive) 0.5 A, 125 V DC (inductive load) 0.25 A, 250 V DC (inductive load)
Cable gland	M25x1,5 mm
Insulation test	2.5 kV AC, 50/60 Hz, 1 min
Degree of protection	IP 55
Ambient temperature	Between -25 °C and +60°C
Manufacturer	COMEM, Italy

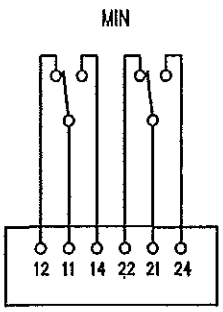
Wiring Diagrams



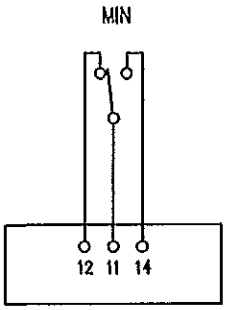
Scheme X
1 contact on min. level
1 contact on max. level



Scheme W
2 contacts on min. level
2 contacts on max. level



Scheme Y
2 contacts on min. level



Scheme K
1 contact on min. level

KOLEKTOR ETRA d.o.o.	DEHYDRATING BREATHERS COMEM type: DA, DB and 1MB	PNA-6.40.63 Revision: 3 Date: 11. 03. 2013

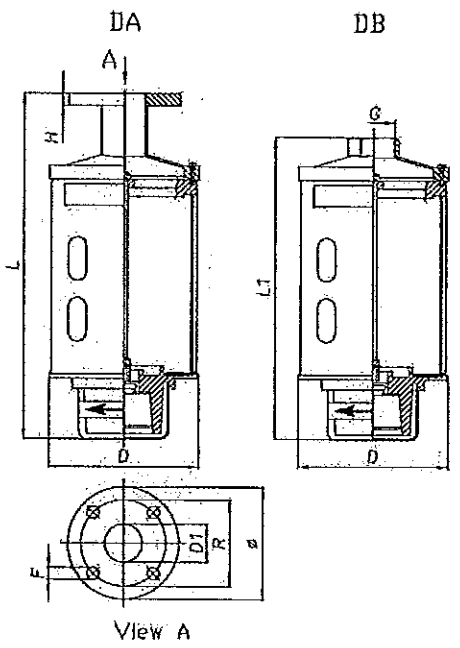


Fig. 1: Dehydrating breathers types DA and DB

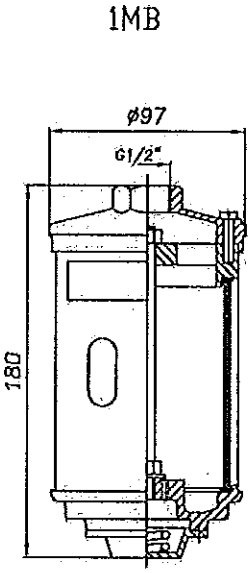


Fig. 2: Dehydrating breather type 1MB

Code	Max. oil quantity (ton)	Silicagel		Dimensions (mm)									Weight (kg)	
		(dm^3)	(kg)	L	L1	D1	H	Ø	R	F	G	D	Type DA	Type DB
2	2	0,95	0,76	265	210	30	12	100	75	12	G 1"	140	3	2,7
3	6	2,75	2,2	360	310	44	14	130	100	14	G 1 ½"	175	5,4	4,95
4	15	6,5	5,2	610	560	44	14	130	100	14	G 1 ½"	175	9,35	8,75
5	30	13,3	10,6	675	625	57	15	140	110	14	G 2"	220	16,7	16,5
6	40	19	15,2	895	845	57	15	140	110	14	G 2"	220	22,5	22,2

Table 1: Dehydrating Breathers types DA and DB

Code	Max. oil quantity (ton)	Silicagel (dm^3)	Silicagel (kg)	Weight (kg)
1MB	1,4	0,47	0,38	1,15

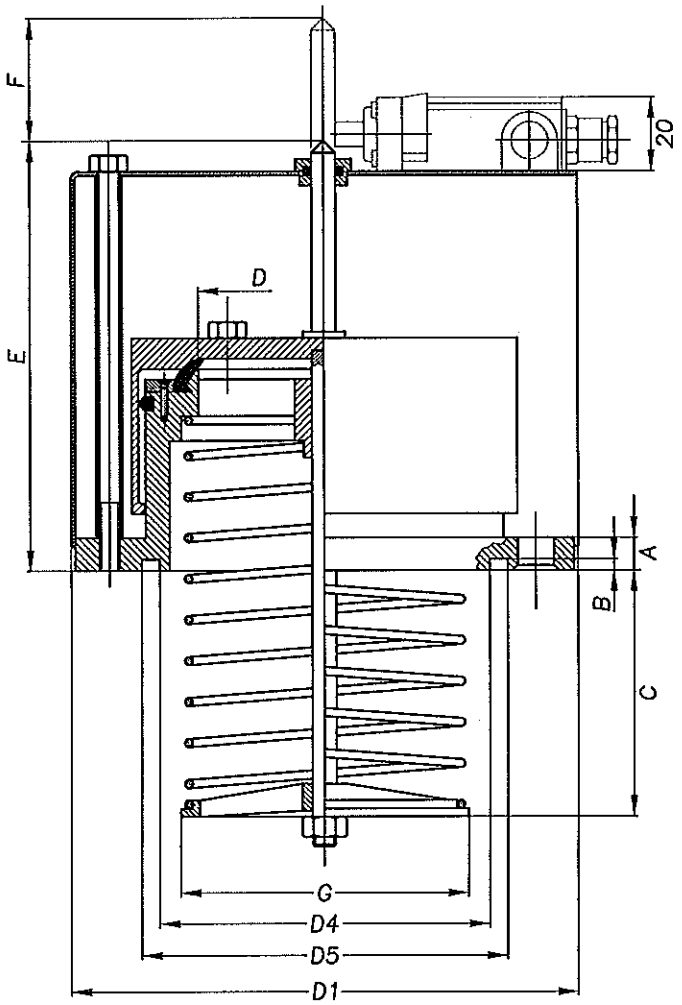
Table 2: Dehydrating breather type 1MB

Description

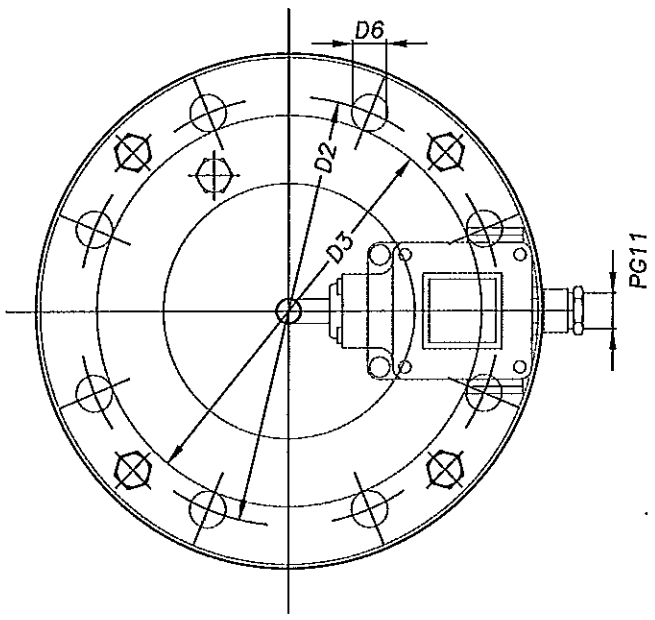
Dehydrating breathers are used to absorb moisture from the air drawn into transformers due to thermal contraction of the oil and prevents its contamination by moisture. The breathers contain silicagel (silicon dioxide) in granular form, which is able to absorb about 35-40% of its own weight of water. When the silicagel is saturated with moisture, its colour changes. As the half of the quantity of the silicagel is saturated, it should be replaced by dry granules. The colour variations are shown on label on the dehydrator.

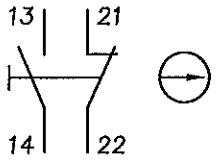
The upper and lower parts of the dehydrator consist of compact, corrosion-proof aluminium castings. The transparent tube containing silicagel is made of polycarbonate, resistant to oil, UV light and tropical as well as marine climates. For mechanical protection, the tube is protected by a stainless steel cylinder with openings allowing visual inspection of the silicagel. The closing system at the bottom prevents constant air contacts with the silicagel. This closing system can be hydraulic (DA and DB types) or mechanical (1MB type), and it allows air passage in both directions only when there is a different pressure inside and outside the transformer (300 Pa for inlet air and 500 Pa for outlet air).

ETRA 33 ENERGETSKI TRANSFORMATORJI, d.o.o.	**CONTROL VALVES OF THE INTERNAL PRESURE OF TANKS COMEM**	**PNA-6.40.23** Revision: 4 Date: 26. 2. 2009



Tip	50T	80T	125T
A	14	16	16
B	4	4	5
C max	74	110	120
D	ø49	ø80	ø125
D1	ø165	ø200	ø278
D2	ø125	ø160	ø210
D3	ø106	ø143	ø190
D4	ø85	ø117	ø164
D5	ø99	ø131	ø182
D6	4xø18	4xø18	8xø18
E	130	140	210
F max	16	32	62
G	ø62	ø100	ø155
I	ø175	ø210	ø288





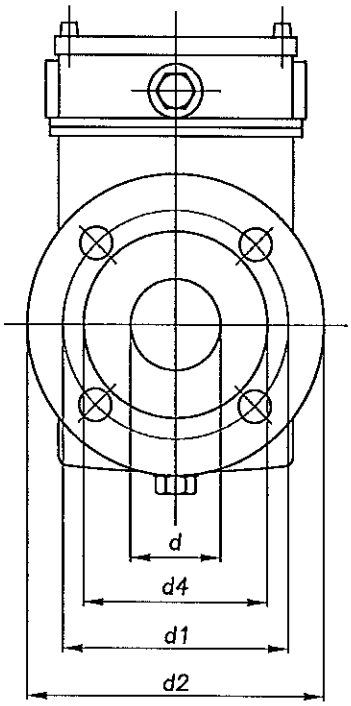
IP 66

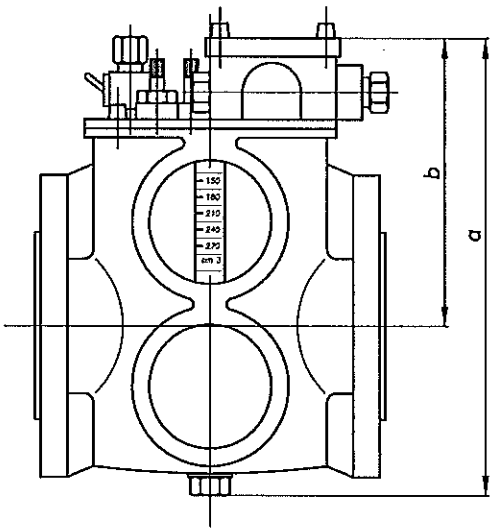
Breaking capacity:
voltage 230 V AC
current 2 A
cosφ > 0,5

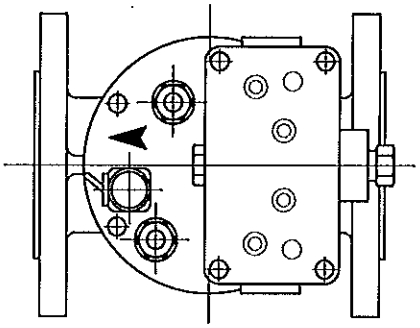
voltage 24–220 V DC
current 2 A
breaking capacity:
100 mA L/R< 40 ms

Test voltage: 2 kV AC, 1 min

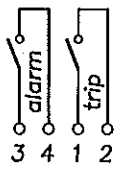
ETRA 33 ENERGETSKI TRANSFORMATORJI, d.o.o.	**BUCHOLZ RELAYS COMEM**	**PNA-6.40.52** Revision: 1 Date: 1. 8. 2005







CONTACT DIAGRAM

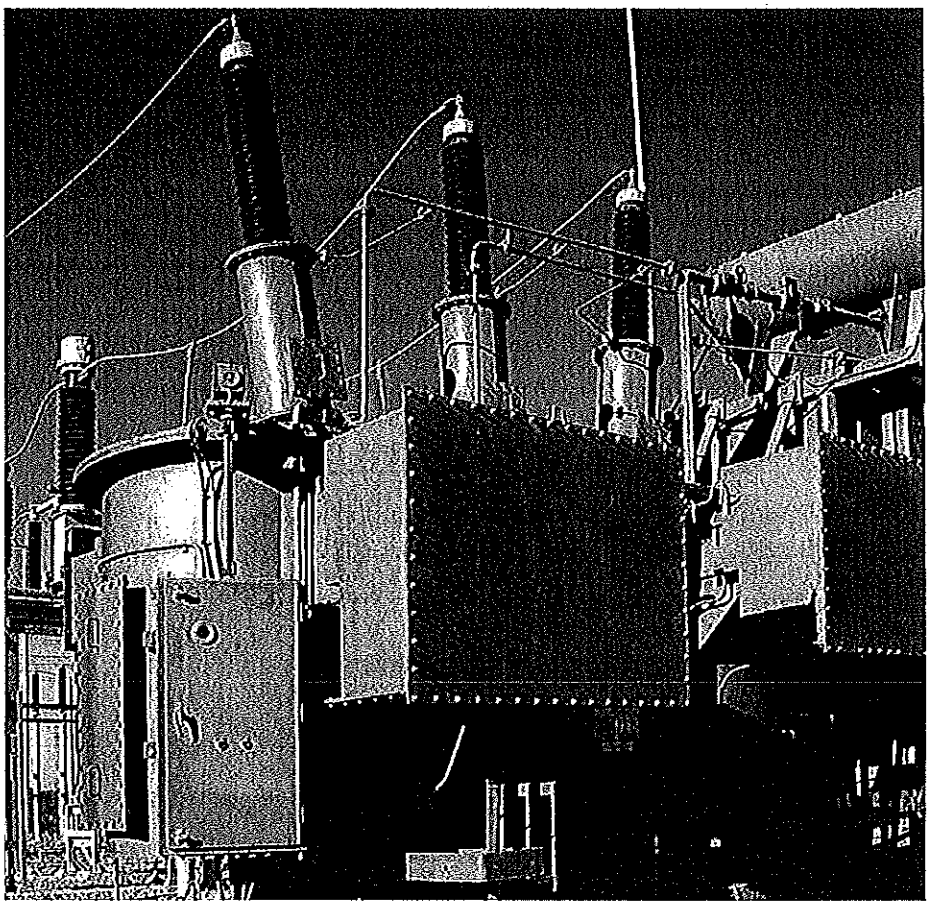


CHARACTERISTICS:

1. PROTECTION MODE: IP-55
2. OIL VELOCITY: 100 cm/sec (operating of trip contact)
3. SWITCHING ELEMENT: 2 CONTACTS
4. CONTACT TYPE: A (normally open)
5. BREAKING CAPACITY: 2 A, 250 V, AC cos ø 0.4±25%
   : 2 A, 250 V, DC L/R=40 ms ±15%
6. INSULATION TEST: AC 2.0 kV, 1 min

TYPE	a	b	d	d1	d2	d4	mass [kg]
BR50	250	168	50	125	165	102	3.7
BR80	303	193	80	160	200	138	4.8

LUMASENSE™
TECHNOLOGIES



LumaSMART

Fluoroptic-Based Winding Hot Spot Temperature Sensor for Generation, Transmission and Distribution Transformers

LumaSMART is the fifth generation Fluoroptic®-based thermometry system from LumaSense. By providing direct and real-time winding hotspot measurements, utilities can:

- Implement Dynamic Loading
- Extend the Life of Transformers
- Reduce Costly Failures
- Maximize Safe Performance

Exceptional Reliability and Accuracy in Winding Hot Spots Temperature Monitoring

LumaSense Technologies' LumaSMART winding hot spot temperature system is the most advanced and reliable real-time monitoring solution available today. LumaSense is the leader in Fluoroptic® (FOT) Technology, with decades of proven expertise. The LumaSMART FOT hot spot monitoring systems provide accurate, real-time temperature readings for protection and control of your critical power transformer assets.

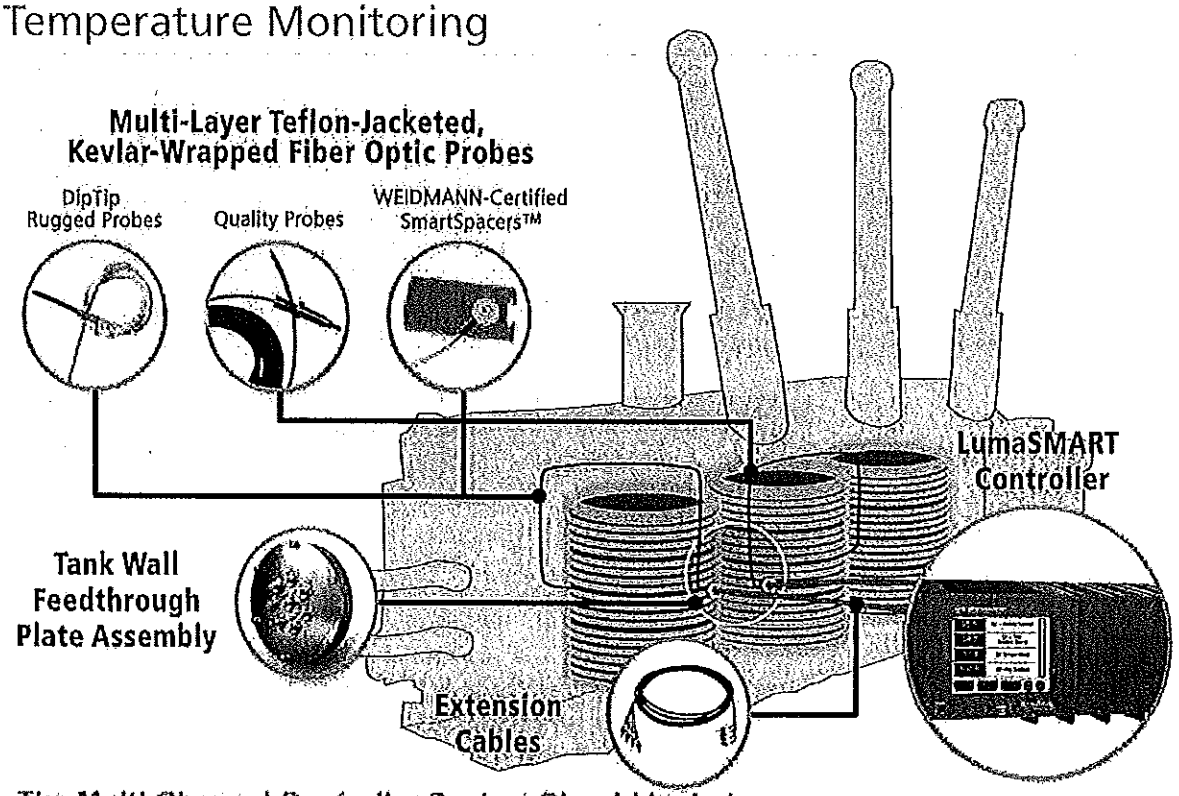
LumaSense's PFA teflon-jacketed Fluoroptic probes are considered the standard in the industry. **Featuring five-layer protection in their fiber optic encapsulation for 99% installation success,** they are specially designed to withstand harsh environments without deteriorating physically or affecting the accuracy of the temperature measurement.

LumaSense Technologies' LUXTRON brand is the world leader in fiber optic temperature measurement in transformers. With more than 30 years of fiber optic experience, LumaSense continues to lead the way in innovation of new, robust technology.

Measuring Hot Spot Winding Temperature

Transformers often take the brunt of an overload condition. **Monitoring the transformer winding hot spot is critical to safeguard your transformer from damage and extend its usage.** Transformer life is directly related to the life of the internal paper insulation. The insulating paper's life is directly affected by its exposure to high temperature. The highest temperature on the windings is the Winding Hot Spot, where the insulating paper will deteriorate first. Conventional methods simulate or calculate this temperature, but do not accurately measure it. The only true way of knowing the actual temperature is through real-time fiber optic measurement. Our reliable, accurate monitors quickly detect and respond to hot spot conditions, triggering alarms and relays to protect your most valuable assets.

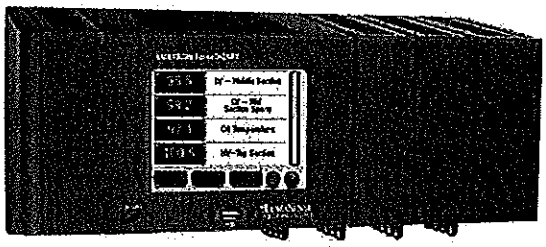
Smart Grid Power Transformer Hot Spots Temperature Monitoring



The Multi-Channel Controller System Should Include:

- LumaSMART Multi-Channel Smart Controller
- Fluoroptic Probes
  - Quality Probes
  - DipTip Rugged Probes
- Extension Cables
  - Single Fiber Extension
  - Four-Fiber Extension
- Tank Wall Feedthrough Plate Assembly
  - Stainless Steel Bolted Plate
  - Individual Tank Wall Feedthroughs
- Optional Accessories
  - NEMA 4 Enclosure
  - WEIDMANN-Certified SmartSacers™
  - NEMA 12 Tank Wall Cover Box
  - Internal and External Plug Assemblies
  - LUXTRON 812 Handheld Unit

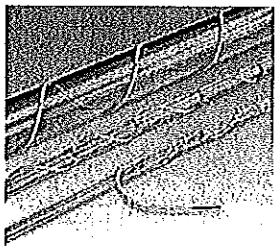
The LumaSMART Controller



LumaSense Technologies' LumaSMART controller is the newest innovation from the leader in FOT technology. Building on the proven performance of the ThermAsset2, this monitor provides all of the capabilities of its predecessor while adding smart grid capabilities, an innovative touch screen and extended channel and relay capabilities.

- Easily adaptable to user-specific needs with 4 to 16 channels and 0, 8 or 16 Form-C programmable relays
- ±2°C accuracy over the entire temperature range for the life of transformer with no calibration
- No drift, no calibration required
- Analog outputs and Modbus, DNP3, ASCII and IEC61850 communication capability standard
- RS-232C and RS-485, Ethernet and USB serial outputs
- Light source lasts the life of the transformer
- Interactive touch screen display for alarms, notifications and set-up
- Equipped with 2GB standard data storage for transformer lifetime memory storage
- On-board diagnostics troubleshooting guidance

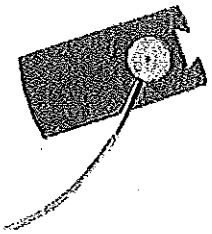
Fluoroptic Probes



The measurement performance of LUXTRON probes exceeds common temperature sensors in environments with high voltage, radio frequency interference (RFI), electromagnetic interference (EMI) or corrosive and above boiling point liquids. Our robust probes are designed for ease of installation and have a greater than 99% installation success rate.

- Industry standard LUXTRON Quality Probes™ and DipTip Rugged Probes™
- Viton O-ring connector for protection against leaks
- PFA Teflon®-jacketed design with Kevlar® construction
- Immune to RF and EMI and Electrically Non-Conductive
- Most robust, well-built fiber optic probes on the market
- Insulated with five layers for superior protection
- DipTip Rugged Probes don't require double installations
- Dielectrically tested to ensure safe, accurage performance
- Chemically inert and compatible with many aggressive chemicals
- Intrinsically safe, stable and drift-free
- Available in various lengths (1m to 16m standard)

WEIDMANN-Certified SmartSpacers™
Our sensor tips can be supplied with WEIDMANN-certified SmartSpacers. All WEIDMANN-certified components including adhesives and assemblies meet strict manufacturing process controls and are shipped with a certificate of compliance outlining that the component has met the five-part WEIDMANN certification process. Available with LumaSense DipTip Rugged Probes™.

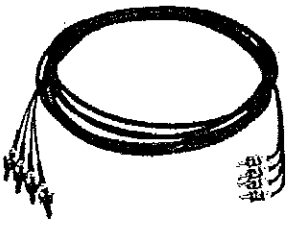


Extensions

LumaSense offers multiple fiber optic extensions options to connect the probes from the tank wall plate to the instrument.

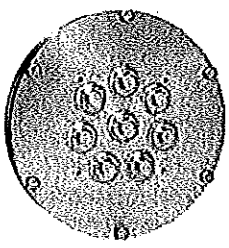
Single Fiber Extension
- Hard Clad Silica fiber jacketed in PVC and Kevlar®
- Available in lengths of 5, 10, 15 or 20 meters or custom lengths by request up to 50 meters
- SMA connector includes Viton O-ring for protection against leaks

Four-Fiber Extension
- Four fiber cable subunits and a central Kevlar® strength member in one PVC outer jacket
- Each subunit features Hytrel® and Kevlar® over Hard Clad Silica fiber
- Available in lengths of 5, 10, 15 or 20 meters or custom lengths by request up to 50 meters
- Viton O-ring connectors for protection against leaks
- Available in low temperature construction also



Tank Wall Plate Assembly

LumaSense provides welded tank wall feedthrough plate assemblies. Each tank wall plate features our proprietary welded feedthroughs on a stainless steel plate, with a carbon steel backing ring and Viton O-ring for maximum protection against leaks.



Technical Data

Performance

Number of Channels	4 to 16 (in increments of 2)
Temperature Range	-30 to 230°C
Accuracy	±2°C over entire temperature range for life of transformer without calibration
Display Response Time	1 sec
Measurement Resolution	0.1°C
Precision	±0.5°C
Light Source Life Span	Life of the transformer
EMI/RFI Susceptibility	Complete immunity

Interface

Display	5.7-inch interactive touch screen
Probe Signal Strength Readout	Accessible for all channels
Diagnostics	On-board self diagnostics and troubleshooting guide

Environmental Specifications

Operating Temperature	-30 to 70°C
Storage Temperature	-35 to 75°C

Communication

Analog Output	Choice of 4-20mA or 0-1mA
Serial Output	RS-232C and RS-485, Ethernet, USB
Relays	0, 8 or 16 Form-C programmable relays
System Status Relay	1 Form-C relay
Communications	Modbus ASCII, Modbus RTU, DNP3.0, ASCII and IEC61850 Standard
Probes	Accepts LUXTRON Rugged and Quality Probes
Data Storage	2 GB of data at 1 minute intervals on all channels, as well as error codes and relay statuses. Retains approximately 40 years of data.

Electrical

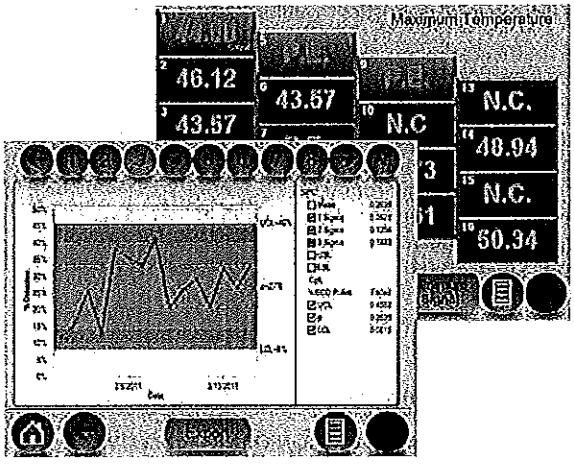
Input Power	90 to 264 VAC or 127 to 370 VDC, 47 to 63 Hz
Surge Protection	4000V (IEEE C37.90.1-2002)
Consumption	108 W (maximum)

Physical

Mounting	Rack, panel or wall mount available

Innovative On-Board Software

The LumaSMART's innovative on-board software gives a color-coded visual display of all connected probes. Using the touch screen exclusively offered by LumaSense, you can customize channel labels, configure alarms and relays and download data logs. In addition, the diagnostic feature allows you to easily test your configured relay settings by simulating alarm conditions. Our software also allows for trending and data analysis of temperatures measured.



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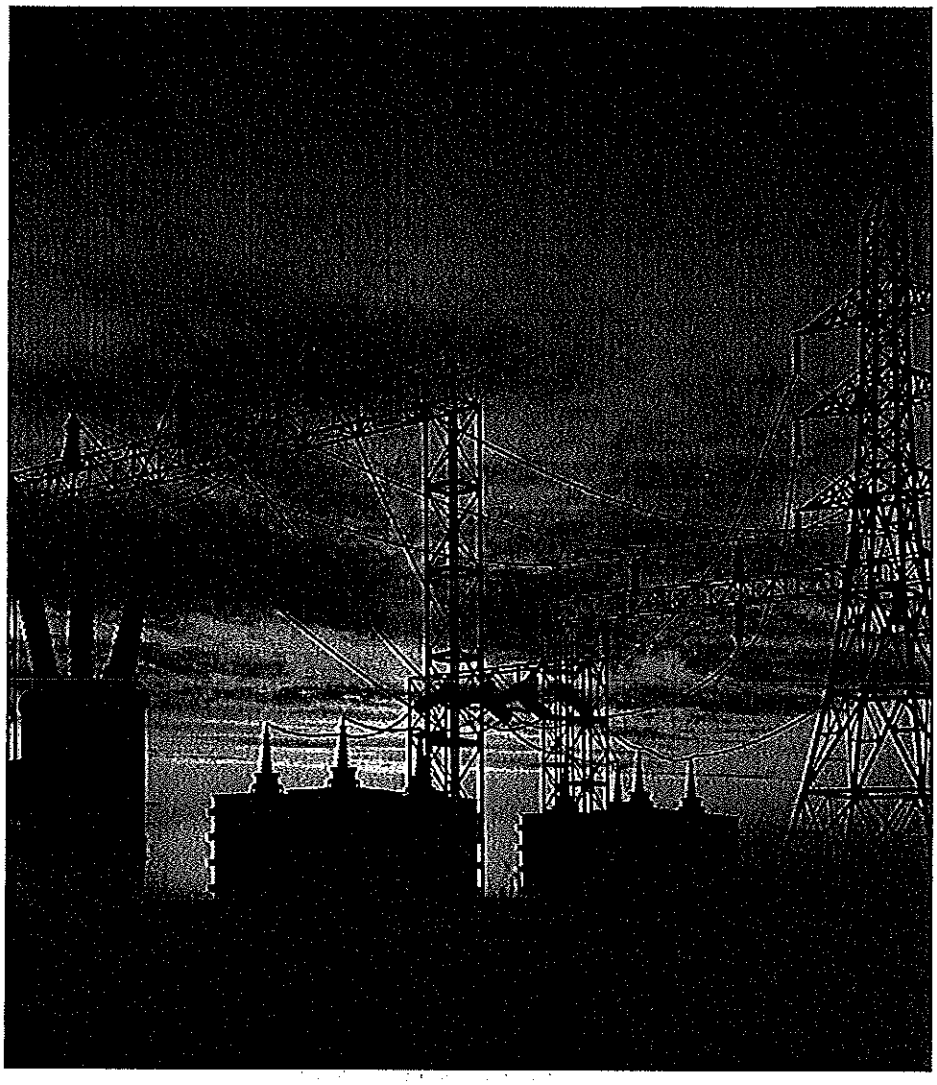
LumaSMART Brochure Rev. 01/31/12

LUMASENSE® TECHNOLOGIES



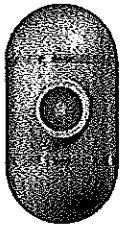
SmartDGA® Monitoring Solutions

Cost-effective and accurate gas detection solutions based on Non-Dispersive Infrared (NDIR) sensor technology to measure fault gases in transformers or load tap changers (LTC's)

- Identify potential faults prior to failures (reducing unplanned outages and associated costs)
- Reduce the number and frequency of LTC maintenance cycles, thereby increasing uptime and maximum efficiency of the LTC
- Proactively investigate premature aging or the cause of faults of a transformer

Protect critical assets through comprehensive analysis of transformer fault conditions with online SmartDGA® monitors

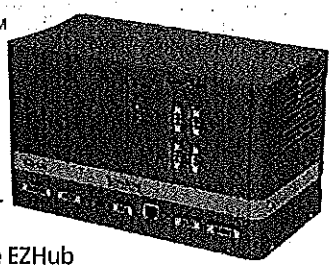
SmartDGA® Instruments



The SmartDGA® family of instruments is the industry's most cost effective Dissolved Gas Analysis (DGA) solution, designed to be the most flexible and to provide the best user experience available. Each model has been designed using state-of-the-art Non-Dispersive Infrared (NDIR) technology. The continuous online DGA values reported by the SmartDGA® instrument quickly identify potential fault conditions through monitoring of key gas levels and ratios.

- **SmartDGA Gauge™** is the industry's first dedicated online Load Tap Changer (LTC) condition monitor. The Gauge measures and records Methane, Acetylene, and Ethylene plus moisture to assess LTC health.
- **SmartDGA Guard™** provides a cost effective early warning monitoring system of potential transformer failures. The Guard measures and records Hydrogen, Acetylene, Carbon Dioxide, and Carbon Monoxide plus moisture to provide an early diagnostics tool.
- **SmartDGA Guide™** provides comprehensive online DGA results that enable diagnostic techniques. The Guide measures and reports nine (9) DGA gases plus moisture in an instrument that vastly reduces total cost of ownership of an on-line monitoring system.

SmartDGA EZHub™

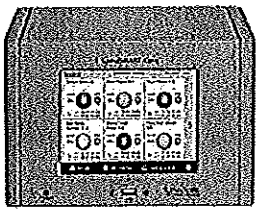


The SmartDGA EZHub™ unit is the central intelligence for the SmartDGA® system. A fully configured unit is capable of handling the power and communication needs for the SmartDGA® system. The EZHub can support a Gauge instrument for the LTC and a Guard or Guide instrument for the transformer. All interface functions and interconnects are provided in the EZHub device as well as internal memory, and four (4) relays with bright LED indicators to indicate Caution, Warning, and Alarm gas level, rate, and ratio conditions. The fourth relay provides status information on the SmartDGA system itself.

Key Functional Features

- Each SmartDGA® package includes the instrument, mounting hardware, connection cable, the SmartDGA EZHub™ unit, and SmartDGA Viewer Software.
- Versatile mounting configurations – including single and dual valve mount. Inline mounting is available for LTC filter system or non-valve mounting for a transformer. The SmartDGA® instrument can be mounted in a vertical or horizontal position.
- Extremely cost effective – total cost of ownership is a fraction of the cost of other instruments and installation can be accomplished in just hours.
- No consumables, carrier gases, or scheduled calibration required.
- Sunlight visible indicators for Caution, Warning, and Alarm conditions. Has Status Relay notification and corrective action triggering to ensure optimal system operations.
- Packages available for LTC monitoring with specific interfaces for common LTC filter models. SmartDGA Gauge monitors and displays gases for Duval triangle 2 for LTC.
- Communications supported via all major protocols common in the electric power industry such as Modbus RTU, DNP 3.0, and IEC 61850 with the optional *i*Core.

LumaSMART *i*Core™ (Optional)

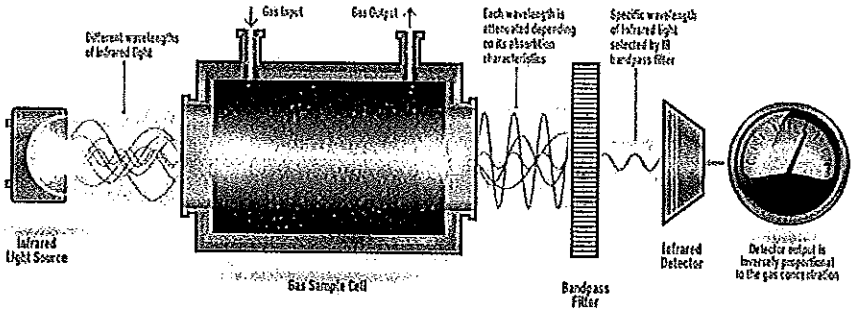


The LumaSmart *i*Core™ controller provides a local interactive touch screen display of DGA data collected from the SmartDGA EZHub™ using the DGA Viewer™ software. The DGA Viewer™ software allows for on-site viewing of DGA data collected from the SmartDGA® instruments. The software provides a local means to set and create operational levels for caution, warning and alarm conditions. Additionally, the LumaSmart *i*Core™ device provides communications to external systems using RS485 or Ethernet. Each LumaSmart *i*Core™ device enables connectivity to multiple EZHub™ units (up to a maximum of 4 using either the Ethernet or RS-485 connection).

40+ Years of Experience with NDIR

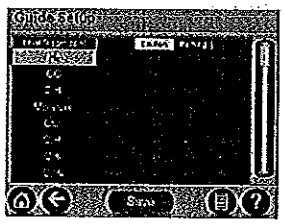
LumaSense is the industry leader in the use of Non-Dispersive Infrared (NDIR) technologies and has deployed thousands of systems in the field. With over 40 years of experience, LumaSense has redefined the way gases are measured.

Non-Dispersive Infrared (NDIR) quantifies known gases. Building upon the fundamental science behind how molecules interact with light, LumaSense Technologies' ANDROS® brand pioneered NDIR gas analysis for automotive emissions and patient monitoring. NDIR is the heart of our suite of SmartDGA® products designed for the Energy industry to perform Dissolved Gas Analysis (DGA) of transformers and load tap changers (LTCs). With ANDROS® NDIR modules, the cost of gas measurement is greatly reduced because our modules can measure multiple gases and field calibration is not needed.

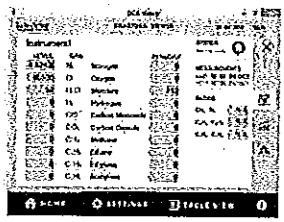


DGA Viewer™ software

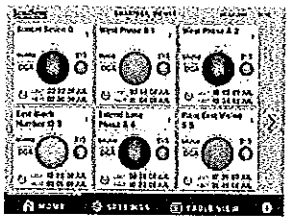
The DGA Viewer™ software allows users to configure systems using various set-up tools and view data being captured by the SmartDGA® instrument.



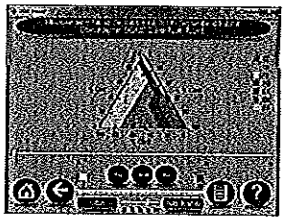
Device Configuration
Customized gas detection levels of Caution, Warning, and Alarm values. Included are user-configurable settings for each gas Rate of Change detection levels. Ratio setpoint activation is also available.



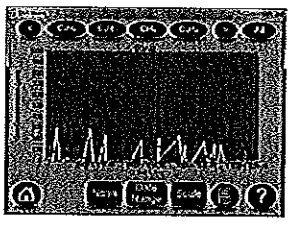
Details Screen
Review Gas levels and PPM/day as well as Ratios in a single screen. The last and next measurement date and times are also visible.



DGA Dashboard
The DGA Viewer™ software displays all connected instruments with status as well as the last and next sampling times.



Duval Triangle
Visual diagnostic tool divided into fault zones based on the types of electrical and thermal faults as defined in Duval triangle type 1 and 2 for transformers and LTCs respectively.



Trends
The Trends screen displays all detected gases via a trend graph over a user-selectable period of time. Each gas can be individually displayed or all 9 gases can be displayed at once.

SmartDGA™ System Technical Data

Instrument Specifications

NDIR Gas Phase Sensor Accuracy	± 5% or ± LDL, whichever is greater
Reporting Rate	Every 24 hours - default, user selectable from approximately 3 hours to 7 days.
Measurement Range	Minimum value is the lower detectable limit after settling-in period after initial installation which may take up to 1 week, maximum value is the upper limit of accurate response
Moisture Accuracy	± 3 ppm or ± 2% RS
Oil Pressure	up to 45 psig (3 bar)
Enclosure Rating	IP 55
Sunlight visible indicators for condition codes **Note:** Indicators normally flash on for 5 seconds, off for 15 seconds	• Green - Normal • Yellow - Caution • Blue - Warning • Red - Alarm • Red/Blue - System Status Error • Green/Yellow - Loss of Communication

Environmental

	SmartDGA® Instrument	SmartDGA EZHub™	LumaSMART iCore™
Operating Temperature*	-50 to 55 °C	-50 to 55 °C	-40 to 70 °C
Storage Temperature	-50 to 70 °C	-50 to 70 °C	-40 to 75 °C
Storage Humidity (non-condensing)	1–99% RH	1–99% RH	1–99% RH
Dimensions (L x H x D)	16.4" x 8.6" dia.	10.3" x 5.7" x 6"	8.7" x 7.4" x 6.6"
Weight	18.74 lbs	6.61 lbs	11.02 lbs

Certifications and Standards (Instrument & SmartDGA EZHub™)

Emissions / Immunity	EN 61000-6-2 (2005) +C1 EN 61000-6-4 (2007) +A1 EN 61000-3-2 (2006) +A1 EN 61000-3-3 (2008)
Environmental / Vibration	ETSI EN 300 019-2-4
Surge Protection	4000V (IEEE C37.90.1-2002)

SmartDGA® Instrument Gas Measurements (Min-Max)

Gas	Gauge	Guard	Guide
Acetylene (C_2H_2)	0.5–50,000 ppm	0.5–10,000 ppm	0.5–10,000 ppm
Ethylene (C_2H_4)	2–50,000 ppm		2–50,000 ppm
Carbon Monoxide (CO)		10–10,000 ppm	10–10,000 ppm
Moisture (RS)	1–99%	1–99%	1–99 %
Hydrogen (H_2)		5–10,000 ppm	5–10,000 ppm
Carbon Dioxide (CO_2)		10–20,000 ppm	10–20,000 ppm
Methane (CH_4)	2–50,000 ppm		2–50,000 ppm
Ethane (C_2H_6)			2–20,000 ppm
Oxygen (O_2)			500–50,000 ppm
Nitrogen (N_2)			5,000–100,000 ppm

SmartDGA EZHub™ & LumaSMART iCore™ Specifications

Power Supplied to EZHub & iCore	90 ~ 264 VAC, 127 ~ 370 VDC, 47 ~ 63 Hz, 6.5 A max
Power Supplied to Instrument	48 VDC ~ 4.16 A max
Memory	Up to 40+ years worth of data storage available with optional iCore
Data Export *(Available with EZHub and iCore/PC)*	Export of results to date in a single file onto a USB memory stick. When using iCore/PC, user can select date range; when using EZHub port, all data is exported
Available Communications *(Available with EZHub)*	Proprietary communications via RS485 and Ethernet connections to DGA Viewer software
Optional Communications *(Modbus available with PC, others available with iCore)*	IEC61850, DNP3, and Modbus protocols for up to 3 EZHubs
Alarm Contacts EZHub	3 programmable relay outputs (Type C, NO/NC) for caution, warning, & alarm
EZHub & iCore	One (1) alarm relay output for system status (Type C, NO/NC)
Relay Contact Ratings	Single phase alarm relays (8 A, 250 VAC; 5 A, 30 VDC)

Standard Accessories (included in system order)

- Mounting Hardware - includes single valve, dual valve or off transformer installation kit
- Connection Cable - 10 m standard (additional lengths and cold weather options available)
- DGA Viewer™ software

Optional Accessories

- LumaSMART iCore™
- NEMA4x Enclosure (for the LumaSMART iCore™ controller and/or SmartDGA EZHub™ unit)

*For operating temperatures less than -20° C, the cold weather cable is required. For operating in environments where the temperature routinely exceeds 40° C, the high temperature accessory is recommended to prevent premature aging and reduction of component lifetime. Temperatures are based upon air temperatures for unit installation in shaded location.

LumaSense Technologies — Awakening Your 6th Sense

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SmartDGA Brochure-EN - Rev. 01/20/2015

KOLEKTOR ETRA d.o.o.	INHIBITED TRANSFORMER OIL TYPE HYVOLT III	PNA-3.50.24 Revision: 1 Date: 08. 03. 2012

TECHNICAL PROPERTIES

TEST DESCRIPTION	TEST METHOD	SPECIFICATIONS MIN	SPECIFICATIONS MAX	MARKETING VALUES
Function				
Viscosity, mm^2/s at 40°C	ISO 3104		12.0	9.2
Viscosity, mm^2/s at -30°C	ISO 3104		1800	924
Pour Point, °C	ISO 3016		-40	-65
Water Content, mg/kg	IEC 60814		30	13
Breakdown Voltage, kV, Before treatment	IEC 60156	30		57
Breakdown Voltage, kV, After treatment	IEC 60156	70		73
Density at 20°C, g/ml	ISO 12185		0.895	0.875
DDF at 90°C	IEC 60247		0.005	0.001
Refining/Stability				
Appearance	ERTM-2	PASS		PASS
Acidity, mg KOH/g	IEC 62021-1		0.01	<0.01
Interfacial Tension, mN/m	ASTM D 971	40		48
Corrosive Sulfur	DIN 51353	Noncorrosive		Noncorrosive
Corrosive Sulfur	ASTM D 1275, B	Noncorrosive		Noncorrosive
Corrosive Sulfur	IEC 62535	Noncorrosive		Noncorrosive
DBDS	IEC 62697-1	Not detected		Not detected
Inhibitors, wt%	IEC 60666	0.08	0.40	0.37
Metal Passivator Additives	IEC 60666	Not detected		Not detected
Sulfur, wt%	IEC 14596		0.15	0.008
Furfural Content, mg/kg	IEC 61198		0.05	<0.05
Carbon Type Analysis, %	IR-Brandes			
Ca				9
Cn				44
Cp				47
Performance				
Oxidation Stability at 120°C, 500 hours	IEC 61125, C			
Total Acidity, mg KOH/g			0.30	0.01
Sludge, %			0.05	0.02
DDF at 90°C			0.050	0.013
Health, Safety and Environment				
Flash Point, PMCC, °C	ISO 2719	135		141
PCA Content, %	BS 2000 Part 346		3	<3
PCB Content	IEC 61619	Not detected		Not detected

***Hyvolt III** is a product of Ergon Refining, Inc.*
This inhibited electrical insulating oil is produced from a severely hydrotreated naphthenic oil to meet the specification requirements defined in IEC 60296:2012, special applications.
As per IEC 60296:2012, this product contains no undeclared additives.

ELEKTROINŠTITUT MILAN VIDMAR

Our sign: 1626-4/15

To whom it may concern,

Ljubljana, June 18th, 2015

Subject: **Test supervision declaration**

We Milan Vidmar Electric Power Research Institute, accredited in accordance
SIST EN ISO/IEC 17025:2005,
hereby declare,
that we supervised routine, type and special tests performed on the transformers
SN 78947,74273
and confirm that tests were performed according to IEC 60076.

Director:

Boris Žitnik, Ph. D. E. E.

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenija

Enclosures:
Transformer test report - 78947,74273
Lightning impulse test - 78947,74273
Heat run test - 78947,74273

на бланка на ЕИМВ Електроинститут Милан Видмар

До всички заинтересовани

наш знак: 1626-4/15

Любляна, 18 юни 2015

относно: Декларация за супервизиране на изпитвания/тестове

Ние, изследователски електроинститут Милан Видмар, акредитирани в съответствие с акредитационен документ СИСТ ЕН ИСО/ИЕЦ 17025:2005 (IEC 17025:2005), с настоящото декларираме, че под наш контрол са извършени рутинни, типови и специални тестове на трансформатори със серийни номера: 78947 и 74273 и потвърждаваме, че тези тестове и изпитания са проведени в съответствие със стандарт ИЕЦ 60076 (IEC 60076).

Печат на Електроинститут Милан Видмар

Директор: /подписът не се чете/

Д-р. Борис Житник

Приложения:

Изпитвателен протокол на трансформатор - 78947, 74273

Изпитване с мълниев импулс - 78947, 74273

Изпитване на прегряване - 78947, 74273

ИНСТИТУТ ЗА ЕЛЕКТРОГОСПОДАРТСТВО ИН ЕЛЕКТРОИНДУСТИЮ

1000 Любляна, Словения, ул. Хайдрихова 2, п.п. 285, тел. +38614743601, факс: +38614253326

Бизнес профил НЛБ д.д. Любляна 02924-0012833094, Идентификационен номер: СИ11781939

Преводът на български език е извършен от Стефан Минчев

KOLEKTOR ETRA d.o.o.	**MERILNI LIST TRANSFORMATORJA** *TRANSFORMER TEST REPORT*

Naročnik: Purchaser:	Proizvajalec: Manufacturer:	Preizkušeno po: Tested in acordance with:	Leto izdelave: Year of manufacture:
Alstom Power Systems for TEŠ Slovenija	KOLEKTOR ETRA ENERGETSKI TRANSFORMATORJI d.o.o.	*IEC 60076*	*2012*

TEHNIČNI PODATKI
TECHNICAL RATING

	Transformator: Transformer:	Regulacijsko stikalo: Tap-changer:	Komandna omarica reg. st.: Tap-changer motor drive unit:
Tip: Type:	*RT 40000-115,5*	*MR - V III 300Y*	*MR - ED100S*
Tov. št.: Ser. No.:	*78947*	*133 5902*	*133 5902*
Št. načrta: Diagram No.:	*3447*		

Navitje; Winding:		*VN - HV*	*VN_N - HV_N*	*NN - LV*		
Stopnja izolacije: *Um*	*[kV]*	*123*	*123*	*12*		
Insulation level: *LI / AC*	*[kV]*	*550 / 230*	*550 / 230*	*75 / 28*		
Nazivna moč; Rated power:	*[kVA]*	*40.000*		*40.000*		
Nazivna napetost; Rated voltage:	*[V]*	*+ 8 x 1,25%*				
		115.500		*11.000*		
		- 8 x 1,25%				
Nazivni tok; Rated current:	*[A]*	*199,9*		*2.100*		

Frekvenca: Frequency:	Število faz: No. of phases:	Vezna skupina: Vector group:	Sistem hlajenja: Cooling method:
50 Hz	*3*	*YNd5*	*ONAN / ONAF*
Skupna masa *[t]*: Total weight *[t]*:	Masa olja *[t]*: Weight of oil *[t]*:		Tip izolacijskega olja: Type of isolation oil:
59,0	*14,1*		*Shell Diala S3 ZX-I*

OPOMBE: *ONAF - 40 MVA*
NOTES: *ONAN - 24 MVA*

KOLEKTOR ETRA d.o.o.
Šlandrova ulica 10
SI-1231 Ljubljana-Črnuče, Slovenija

I/ 134/12

Prelzkusom je prisostvoval:
The test was carried out in presence of:

Mr. Gil Attuyer - Alstom
Mr. Benoit Le Mintier - Alstom
Mr. Sandi Dolšak - TEŠ
Mr. Miro Bugeza - ELEK
Mr. Mladen Iglič - ELMV

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenija

Meritve opravil: Tested by: *Franc Štempelj*
Primož Dimnik
Ljubljana: *2011-12-05*

Pregledal: Checked by:
Ljubljana:

Odobril: Approved:
Ljubljana:

KOLEKTOR KOLEKTOR ETRA d.o.o.	MERILNI LIST TRANSFORMATORJA TRANSFORMER TEST REPORT	
Transformator: Transformer:	RT 40000-115,5	Tov. št.: Ser. No.: 78947

SPISEK MERITEV IN PREIZKUSOV
LIST OF MEASUREMENTS AND TESTS

1.0	Meritev prestavnega razmerja Measurement of voltage ratio		☑
1.1	Meritev magnetilnih tokov pri 400 V, 50 Hz No-load current at 400 V, 50 Hz		☑
2.0	Meritev ohmskih upornosti navitij Measurement of winding resistance		☑
3.1	Meritev izgub in toka praznega teka Measurement of no-load loss and no-load current		☑
3.2	Meritev izgub in napetosti kratkega stika Measurement of load loss and impedance voltage		☑
4.1	Preizkus z napetostjo iz tujega vira Separate-source voltage withstand test		☑
4.2	Preizkus z inducirano napetostjo (ACSD, ACLD) Induced AC withstand voltage test (ACSD, ACLD)		☑
4.3	Meritev izolacijske upornosti Measurements of insulation resistance		☑
4.4	Meritev prebojne trdnosti izolacijskega olja Measurements of dielectric strength of insulating oil		☑
5.0	Preizkus regulacijskega stikala Tests on on-load tap-changer		☑
7.0	Meritev izgub hladilnega sistema Measurement of power consumption of cooling system		☑
11.0	Meritev kapacitivnosti in tg δ Measurements of capacity and dissipation factor tg δ		☑
12.0	Meritev stresane induktivnosti Measurements of leakage inductance		☑
13.0	Meritev nivoja hrupa Measurement of sound level		☑
15.0	Spisek elementov na transformatorju List of elements on transformer		☑
16.0	Preizkus komandne - signalne omarice Test of control - signal cubicle		☑
17.0	Funkcionalni preizkus elementov na transformatorju Functional test of elements on transformer		☑
19.0	Meritve na vgrajenih tokovnih transformatorjih Measurement on built-in current transformers		☑
20.0	Frekvenčna karakteristika transformatorja Frequency response of transformer		☑
21.0	Preizkus segrevanja Temperature-rise test	S 61/12	☑
22.0	Preizkus z udarno napetostjo Impulse voltage test	UP 100/12	☑

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenija

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MERILNI LIST TRANSFORMATORJA
TRANSFORMER TEST REPORT

Transformator: / Transformer:	RT 40000-115,5	Tov. št.: / Ser. No.:	78947

1.0 MERITEV PRESTAVNEGA RAZMERJA IN VEZNE SKUPINE / MEASUREMENT OF VOLTAGE RATIO AND VECTOR GROUP

- IEC 60076-1 (clause 6, 9, 10.3)

Vezna skupina / Vector group: **YNd5** VN - NN; HV - LV

Poz. stik.: / Tap pos.:	Računska napetost: / Calculated voltage: U_1 [kV]	U_2 [kV]	Konstanta: / Constant: $[U_2 / U_1 \times k]$	Izmerjeno odstopanje; Measured deviations: [%] 1U - 2U	[%] 1V - 2V	[%] 1W - 2W
1	127.050		149,961	+0,05	+0,05	+0,05
2	125.606		151,685	+0,08	+0,08	+0,08
3	124.163		153,449	+0,10	+0,10	+0,10
4	122.719		155,254	+0,11	+0,11	+0,11
5	121.275		157,102	+0,12	+0,12	+0,12
6	119.831		158,995	+0,13	+0,13	+0,13
7	118.388		160,934	+0,15	+0,15	+0,15
8	116.944		162,921	+0,16	+0,16	+0,16
9	115.500	11.000	164,957	+0,18	+0,18	+0,18
10	114.056		167,045	+0,22	+0,22	+0,22
11	112.613		169,187	+0,24	+0,24	+0,24
12	111.169		171,384	+0,25	+0,25	+0,25
13	109.725		173,639	+0,27	+0,27	+0,27
14	108.281		175,954	+0,30	+0,30	+0,30
15	106.838		178,332	+0,32	+0,32	+0,32
16	105.394		180,775	+0,33	+0,33	+0,33
17	103.950		183,286	+0,34	+0,34	+0,34

Vezna skupina / Vector group:

Poz. stik.: / Tap pos.:	Računska napetost: / Calculated voltage: U_1 [kV]	U_2 [kV]	Konstanta: / Constant: $[U_2 / U_1 \times k]$	Izmerjeno odstopanje; Measured deviations: [%]	[%]	[%]

Merilna oprema; Measuring equipment:
- merilnik prestavnega razmerja Iskra, tip MPRT, točnosti ± 0,05 %
- turns ratio meter Iskra, type MPRT, accuracy ± 0,05 %

1.1 MERITEV MAGNETILNIH TOKOV pri 3 x 400 V, 50 Hz / NO-LOAD CURRENT at 3 x 400 V, 50 Hz

Poz. stik.: / Tap pos.:	Navitje: / Winding:	Faza A - U [mA] / Phase A - U [mA]	Faza B - V [mA] / Phase B - V [mA]	Faza C - W [mA] / Phase C - W [mA]
9	VN - HV	5,2	2,8	5,1
"	NN - LV	210	195	250

Merilna oprema; Measuring equipment:
- univerzalni instrument točnosti ± 0,5 %
- multimeter accuracy ± 0,5 %

KOLEKTOR KOLEKTOR ETRA d.o.o.	MERILNI LIST TRANSFORMATORJA TRANSFORMER TEST REPORT	
Transformator: Transformer:	RT 40000-115,5	Tov. št.: Ser. No.: 78947

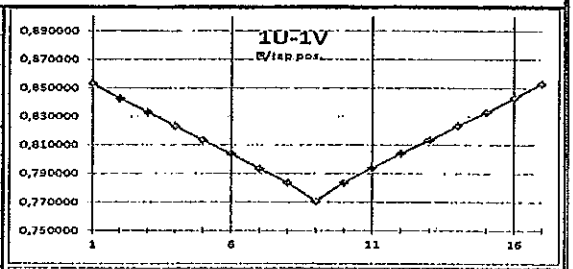
2.0 MERITEV OHMSKIH UPORNOSTI NAVITIJ / MEASUREMENT OF WINDING RESISTANCE

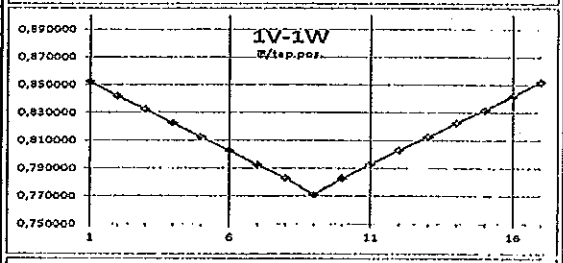
- IEC 60076-1 (clause 10.2)

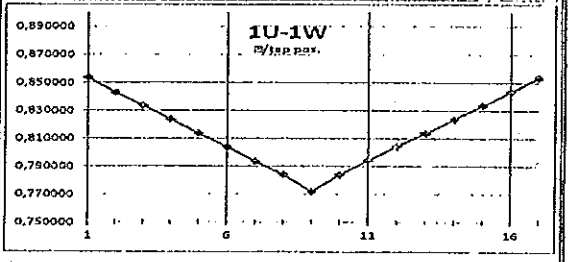
Temperatura - Temperature ϑ: 21 °C

VN navitje / HV winding — I_{test} 20 A

Poz. stik.: Tap pos.:	1U - 1V [Ω]	1V - 1W	1U - 1W
1	0,853217	0,852210	0,853510
2	0,842571	0,841853	0,842961
3	0,833276	0,832281	0,833608
4	0,823464	0,822569	0,823858
5	0,813318	0,812245	0,813650
6	0,803645	0,802634	0,804031
7	0,793220	0,792295	0,793516
8	0,783602	0,782749	0,784059
9	0,770767	0,770970	0,771764
10	0,783506	0,782524	0,783921
11	0,793898	0,792825	0,794242
12	0,803825	0,802936	0,804327
13	0,813557	0,812386	0,813876
14	0,823474	0,822455	0,823945
15	0,833004	0,831854	0,833472
16	0,843068	0,842064	0,843620
17	0,853151	0,851980	0,853529







NN navitje / LV winding — I_{test} 20 A

Poz. stik.: Tap pos.:	2U - 2V [Ω]	2V - 2W [Ω]	2U - 2W [Ω]
--	0,007177	0,007197	0,007199

Poz. stik.: Tap pos.:			I_{test}

Poz. stik.: Tap pos.:	[Ω]	[Ω]	I_{test} [Ω]
--			

Poz. stik.: Tap pos.:	[Ω]	[Ω]	I_{test} [Ω]
--			

Merilna oprema; Measuring equipment:
- merilnik ohmske upornosti Tettex, tip 2283, točnost ± 0,06 %
- resistance meter Tettex, type 2283, accuracy ± 0,06 %

KOLEKTOR
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MERILNI LIST TRANSFORMATORJA
TRANSFORMER TEST REPORT

Transformator: Transformer:	RT 40000-115,5	Tov. št.: Ser. No.:	78947

3.1 MERITEV IZGUB IN TOKA PRAZNEGA TEKA
MEASUREMENT OF NO-LOAD LOSS AND NO-LOAD CURRENT
- IEC 60076-1 (clause 9, 10.5)

Napetost priključena; Voltage supply to: NN1 / LV1 (tap pos. 9) — Frekvenca; Frequency: 50 Hz

Napetost; Voltage:	$U_{rm^*1,11}$	[%]	90	100	110
	$U_{rm^*1,11}$	[V]	9.900	11.000	12.100
	U_{rms}	[V]	9.867	10.934	11.943
Tok; Current:	I_{rms} A	[A]	1,082	1,651	3,517
	I_{rms} B	[A]	1,148	1,606	3,313
	I_{rms} C	[A]	1,576	2,221	4,297
	I_o	[A]	1,268	1,826	3,709
	I_o	[%]	0,060	0,087	0,177
Fazni kot; Phase angle:	cos φ	[ ]	0,861831	0,704971	0,414801
Mer. izgube; Measur. loss:	P_{Fe}	[W]	18.682	24.366	31.803
Kor. izgube; Corrected loss:	P_{Feo}	[W]	18.754	24.527	32.245

3.2 MERITEV IZGUB IN NAPETOSTI KRATKEGA STIKA
MEASUREMENT OF LOAD LOSS AND IMPEDANCE VOLTAGE
- IEC 60076-1 (clause 9, 10.4)

Temperatura; Temperature: 21 °C — Frekvenca; Frequency: 50 Hz

Napajano - kratko skljenjeno: Supply - short circuited:			HV - LV	HV - LV	HV - LV
Pozicija stikala; Tap position:			1	9	17
Tok; Current:	I_m	[A]	178,27	199,06	202,08
Napetost; Voltage:	U_m	[V]	12.912	11.107	8.794
Izgube; Loss:	P_m	[W]	105.020	107.790	103.330
Preračun na nazivni tok navitja. - Calculated at winding nominal current.					
Moč; Power:	S_n	[kVA]	40.000	40.000	40.000
Tok; Current:	I_n	[A]	181,8	199,9	222,2
Napetost; Voltage:	U_k	[V]	13.165	11.156	9.668
Izgube; Loss:	P_k	[W]	109.179	108.748	124.883
Preračun na referenčno temperaturo 75 °C. – Calculated at reference temperature 75 °C.					
I^2R izgube; I^2R loss:	P_Ω	[W]	108.758	113.567	134.028
D. izg.; Stray loss:	P_d	[W]	15.993	12.357	11.728
Izgube; Loss:	P_k	[W]	124.751	125.924	145.756
Krat. nap.: Impedance voltage:	U_k	[%]	10,36	9,66	9,30
	U_R	[%]	0,31	0,31	0,36
	U_X	[%]	10,36	9,66	9,30

3.3 REZULTATI MERITEV IZGUB
RESULTS OF LOSS MEASUREMENTS
- IEC 60076-1 (clause 9)

	Poz.; Tap:	S_n [kVA]	P_{Fe} [kW]	P_{k75} [kW]	P_{tot} [kW]	$P_{coil.s.}$ [kW]	I_o [%]	U_{k75} [%]
Garantirano: Guaranteed:	1	40.000						
	9	40.000	25,0 (+15%)	130,0(+15%)	155,0(+10%)		0,15 (+30%)	9,0 (±10%)
	17	40.000		150,0(+15%)				
Merjeno: Measured:	1	40.000		124,751	149,278			10,36
	9	40.000	24,527	125,924	150,451		0,087	9,66
	17	40.000		145,756	170,283			9,30

Merilna oprema; Measuring equipment:
- močnostni analizator Norma, tip D6000, točnosti ± 0,05 %; - power analyzer Norma, type D6000, accuracy ± 0,05 %
- merilni napetostni pretvornik Tettex, točnosti ± 0,1 %; - measuring voltage transducer Tettex, accuracy ± 0,1 %
- merilni tokovni transformator CdC, točnosti ± 0,2 % - measuring current transformer CdC, accuracy ± 0,2 %

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4

KOLEKTOR ETRA KOLEKTOR ETRA d.o.o.	**MERILNI LIST TRANSFORMATORJA** *TRANSFORMER TEST REPORT*	
Transformator: Transformer:	*RT 40000-115,5*	Tov. št.: Ser. No.: *78947*

4.1 PREIZKUS Z IZMENIČNO NAPETOSTJO IZ TUJEGA VIRA / SEPARATE SOURCE AC WITHSTAND VOLTAGE TEST

- IEC 60076-3 (clause 11)

Med; Between	U [$kV_{peak/\sqrt{2}}$]	f [Hz]	t [s]	C [pF]	I_c [A]
HV - LV + M	230	50	60		
LV - HV + M	28	50	60		

Merilna oprema; Measuring equipment:
- AC voltmeter Haefely, tip DMI 551, točnosti ± 0.5 %
- AC voltmeter Haefely, type DMI 651, accuracy ± 0.5 %

OPOMBA; NOTE:
M - ozemljeni deli
M - ground

4.2 PREIZKUS Z INDUCIRANO NAPETOSTJO (ACSD, ACLD) / INDUCED OVERVOLTAGE WITHSTAND TEST (ACSD), ACLD)

- IEC 60076-3 (clause 7.3, 12)

4.2.1 Transformator s polno izolacijo VN navitja (Um ≤ 72, 5 kV) / Transformer with uniformly insulated HV winding (Um ≤ 72, 5 kV)

- IEC 60076-3 (clause 7.3, 12.1)

Položaj reg. stikala; Tap changer pos.:

Napajano navitje; Supply winding	U_n [kV] NN; LV	U_{test} [kV] NN; LV	U_{test} [kV] VN; HV	f [Hz]	t [s]	

4.2.2 Transformator z znižano izolacijo VN navitja / Transformer with non-uniformly insulated HV winding

- IEC 60076-3 (clause 7.3, 12.3)

Položaj reg. stikala; Tap changer pos.:

Napajano navitje; Supply winding	U_n [kV] NN;LV phase - phase	U_{test} [kV] NN;LV phase - phase	U_{test} [kV] VN;HV phase - earth	U_{test} [kV] N N - earth	f [Hz]	t [s]

k =

Merilna oprema; Measuring equipment:
- močnostni analizator Norma, tip D6000, točnosti ± 0,05 %; - power analyzer Norma, type D6000, accuracy ± 0,05 %
- merilni napetostni pretvornik Tettex, točnosti ± 0,1 %; - measuring voltage transducer Tettex, accuracy ± 0,1 %
- merilni tokovni transformator CdC, točnosti ± 0,2 %; - measuring current transformer CdC, accuracy ± 0,2 %
- merilnik delnih praznjen Lemke, tip LDS-6; - partial discharge instrument Lemke, tip LDS-6

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4.2.3 MERITEV DELNIH PRAZNJENJ / PARTIAL DISCHARGE MEASUREMENT

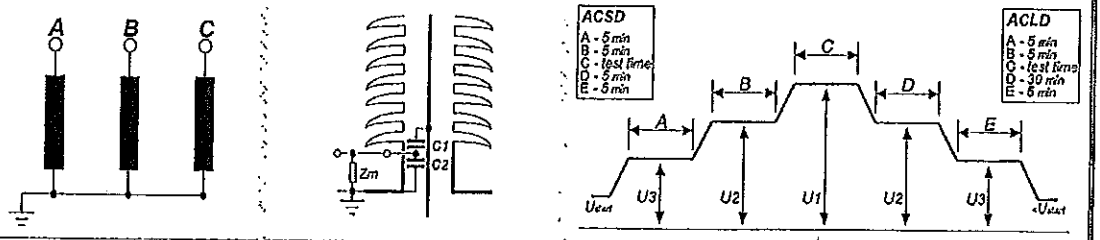
- IEC 60076-3 (clause 12)
- IEC 60270

Trifazno preizkušanje z meritvijo delnih praznjenj
Three-phase test with measurement of partial discharges

Položaj reg. stikala; Tap changer pos.:	9	Napajano navitje; Supply winding:	LV	Tip preizkusa; Test type:	ACSD

U_m	123	[kV]	- najvišja nap. opreme na VN navitju; highest voltage for equipment on HV winding
LI/AC	550 / 230	[kV]	- stopnja izolacije VN navitja; insulation level HV winding
U_1 (HV)	230/ √3 = 133	[kV]	- IEC 60076-3, tabela D.1; IEC 6076-3, table D.1
U_2 (HV)	160 / √3 = 92	[kV]	- IEC 60076-3, tabela D.1; IEC 6076-3, table D.1
U_3 (HV)	135 / √3 = 78	[kV]	- IEC 60076-3, (1,1 x U_m / √3)
f_{Um}	300	[Hz]	- napajalna frekvenca; supply frequency
$q_{o\ (calib.)}$	100	[pC]	- kalibracijska vrednost; calibration value
f_m	100 - 400	[kHz]	- merilna frekvenca; measuring frequency
Filter:	wide band		

Časovni interval; Time sequence ↓		U_1 VN - HV [kV]	U_1 NN - LV [kV]	Priključki; Terminals A / U [pC]	B / V [pC]	C / W [pC]	[pC]	[pC]	[pC]	Dovoljeno Allowed [pC]
Osnovne motnje: Background noise:		0	0	16	14	15				< 50
										--
A ↓	1 min	135 / 78	13,0	17	45	23				< 100
	5 min			19	18	23				
B ↓	1 min	160 / 92	15,4	19	19	24				< 300
	5 min			23	25	25				
C	20 sec	230 / 133	22,0	22	34	23				--
D ↓	1 min	160 / 92	15,4	25	21	19				< 300
	5 min			19	23	24				
E ↓	1 min	135 / 78	13,0	19	21	19				< 100
	5 min			23	25	20				
										--
Osnovne motnje: Background noise:		0	0	15	14	14				< 50



Simetrični tri fazni priklop. *Simetrical three-phase connection.*

Merjenje na kapacitivnem skoz. *Circuit for measure. on capac. bushing.*

Časovni intervali preizkusne napetosti. *Time sequence for application of test voltage.*

Merilna oprema; *Measuring equipment:*
- močnostni analizator Norma, tip D6000, točnosti ± 0,05 %; - power analyzer Norma, type D6000, accuracy ± 0,05 %
- merilni napetostni pretvornik Teltex TMS 581, točnosti ± 0,10 %; - measuring voltage transducer Teltex TMS 581, accuracy ± 0,10 %
- merilni tokovni transformator Teltex TMS 582, točnosti ± 0,11 %; - measuring current transformer Teltex TMS 582, accuracy ± 0,11 %
- merilnik delnih praznjen Lemke, tip LDS-6; - partial discharge instrument Lemke, tip LDS-6

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4.3 MERITEV IZOLACIJSKE UPORNOSTI / MEASUREMENTS OF INSULATION RESISTANCE

- IEC 60076-1 (clause 10.1.3)

Med; Between	$R_{(30\,s)}$ [MΩ]	$R_{(60\,s)}$ [MΩ]	$R_{(150\,s)}$ [MΩ]	$R_{(600\,s)}$ [MΩ]	$DAR_{(R_{60\,s}/R_{30\,s})}$	U [kV$_{DC}$]	t [°C]
HV - LV + M		46.500			1,03	2,5	21
LV - HV + M		25.800			1,28	2,5	21
m. core - M		20.400			1,29	1,0	21
core clamp - M		18.300			1,23	1,0	21

Merilna oprema; Measuring equipment:
- merilnik izolacijske upornosti Megger MIT 1020, točnosti ± 5 %
- isulation resistance meter Megger MIT 1020, accuracy ± 5 %

OPOMBA; NOTE
M - ozemljeni deli
M - ground

4.4 MERITEV PREBOJNE TRDNOSTI IZOLACIJSKEGA OLJA / MEASUREMENTS OF DIELECTRIC STRENGTH OF INSULATING OIL

- IEC 156

Tip izolacijskega olja: Shell Diala S3 ZX-I
Type of insolation oil:

Razmak med iskriščem preskusne naprave je 2.5 mm.
Distance between gaps of oil tester is 2.5 mm.

Mesto odvzema: Test sample taken from:	1 [kV]	2 [kV]	3 [kV]	4 [kV]	5 [kV]	6 [kV]	M [kV]	
middle of transformer tank	78,3	83,7	73,4	76,0	79,2	75,7	77,7	

Merilna oprema; Measuring equipment:
- merilna naprava Bauer, tip DTA-E 100;
- measuring device Bauer, type DTA-E 100

5.0 PREIZKUS REGULACIJSKEGA STIKALA / TESTS ON ON-LOAD TAP-CHANGER

- IEC 60076-1 (clause 10.6)

a.	8 kompletnih ciklov operacij z nevzbujenim transformatorjem 8 complete operating cycles with the transformer not energized	☑
b.	1 kompleten cikel operacij z nevzbujenim transformatorjem, pri 85% pomožni napajalni napetosti with the tansformer un-energized, and with the auxiliary voltage reduced to 85% of its rated value, one complete cycle of operation	☑
c.	1 kompleten cikel operacij z vzbujenim transformatorjem v praznem teku pri nazivni frekvenci in nazivni napetosti 1 complete operating cycle with transformer at rated voltage and frequency, at no-load	☑
d.	10 delovanj regulacijskega stikala s ± 2 stopnjama regulacije z vsake strani glavnega odcepa, pri čim bližjem nazivnem toku transformatorja, z enim kratko vezanim navitjem 10 tap-change operations with ±2 steps on either side of the principal tapping with as far as possible the rated current of the transformer, with one winding short-circuited	☑

☑ preizkus opravljen
test O.K.

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7.0 MERITEV IZGUB HLADILNEGA SISTEMA
MEASUREMENT OF POWER CONSUMPTION OF COOLING SYSTEM

Hladilni sistem ima: Cooling system includes:	4	ventilatorje; fans:	Klima - AVT 630
	/	črpalki; oil pumps:	/
	/	izmenjevalec; exchanger:	/

	U [V]	I [A]	P [W]	f [Hz]		U [V]	I [A]	P [W]	f [Hz]
M1	3 x 400	1,07	117	50					
M2	3 x 400	1,08	121	50					
M3	3 x 400	1,08	121	50					
M4	3 x 400	1,04	119	50					

	U [V]	I [A]	P [W]	f [Hz]
∑ M1..M4	3 x 400	4,27	478	50

Merilna oprema; Measuring equipment:

- širokopasovni močnostni analizator Norma, tip D6000, točnosti ± 0,05 %
- wide band power analyzer Norma, type D6000, accuracy ± 0,05 %

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11.0 MERITEV KAPACITIVNOSTI IN tg δ
MEASUREMENTS OF CAPACITY AND DISSIPATION FACTOR tg δ

- IEC 60076-1 (clause 10.1.3)

	vezava connection	U [kV]	pos. (I - II)	N [Ω]	R_3 [Ω]	R_4 [kΩ]	C_4 [μF]		C_X [pF]	tg δ [%]
1	HV - LV + M	10	II	∞	3,52	1/K	0,1801		9.044	0,180
2	LV - HV + M	10	II	∞	1,70	1/K	0,1901		18.726	0,190
3										
4										
5										
6										
7										
8										
1										
2										
3										
4										
5										
6										
7										
8										

Testni pogoji; Test condition:

C_N: 100,01 pF | t: 21 °C | p: kPa

Formule za izračun; Formulas for equation:

$C_X = C_N * R_4 / R_3$ [F]

pos I → $tg\delta = R_4 * \omega * C4 * 100$ [%] $[C_4 \rightarrow \mu F]$

pos II → $tg\delta = 0.01 * C_4 * 100$ [%] $[C_4 \rightarrow \mu F]$

OPOMBA; NOTE
M - ozemljeni del
M - ground

Merilna oprema; Measuring equipment:
- Schering most tip 2801, po vezavi 1a
- Schering Bridge type 2801, Arrangement 1a

12.0 MERITEV STRESANE INDUKTIVNOSTI
MEASUREMENTS OF LEAKAGE INDUCTANCE

	vezava connection	I [A]	pos. (I - II)	R_2 [Ω]	R_3 [Ω]	R_3 ext [Ω]	R_4 [kΩ]	C_4 [μF]	Lx [mH]	Δ_{Lx} [%]
1	1U-1V (2U+2V+2W)	0,4	I	10.000	5,0	--	127,0	0,4839	24,20	0,373
2	1V-1W (2U+2V+2W)	0,4	I	10.000	5,0	--	133,5	0,4813	24,07	-0,166
3	1U-1W (2U+2V+2W)	0,4	I	10.000	5,0	--	132,2	0,4811	24,06	-0,207
4										
5										
6										
7										
8										
9										

Testni pogoji; Test condition:

poz. stikala; tap range: 9 | (..) navitje kratko sklenjeno; winding short circuit

Formule za izračun; Formulas for equation:

$L_x = R_2 * R_3 * C_4$ [H] $\Delta_{Lx} = ((L_{AN} * 100)/(L_{AN} + L_{BN} + L_{CN}/3)) - 100$ [%]

Merilna oprema; Measuring equipment:
- Schering most tip 2801, po vezavi 2c
- Schering Bridge type 2801, Arrangement 2c

EIMV

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13.1 MERITEV NIVOJA HRUPA - Metoda zvočnega tlaka
MEASUREMENT OF SOUND LEVEL - Sound pressure method

- IEC 60076-10

pri nazivni napetosti, ONAN, razdalja 0,3 m; at nominal voltage, ONAN, distance 0,3 m

Napajano: Supply:	LV	Poz. stikala: Tap range:	9	Frekvenca: Frequency:	50 Hz

	okol. amb.	transformator transformer 1/3	transformator transformer 2/3		okol. amb.	transformator transformer 1/3	transformator transformer 2/3		okol. amb.	transformator transformer 1/3	transformator transformer 2/3
	L_{pAI} dB(A)	L_{pAI} dB(A)	L_{pAI} dB(A)		L_{pAI} dB(A)	L_{pAI} dB(A)	L_{pAI} dB(A)		L_{pAI} dB(A)	L_{pAI} dB(A)	L_{pAI} dB(A)
1		51,5	53,0	14		57,4	48,8	27			
2		50,4	53,2	15		60,6	52,7	28			
3		51,4	56,6	16		55,1	51,6	29			
4		57,2	55,0	17		51,9	52,1	30			
5		57,3	54,8	18		55,1	51,1	31			
6		58,5	55,8	19		53,5	49,9	32			
7		57,5	50,3	20				33			
8		54,1	52,8	21				34			
9		50,6	52,6	22				35			
10		53,6	60,4	23				36			
11		56,5	58,1	24				37			
12		51,3	55,0	25				38			
13		52,3	50,3	26				39			

Povprečna izmerjena kvadratna vrednost Quadratic mean sound level	L_{pAO}	55,0	dB(A)
Povprečna izmerjena vrednost okolice Average level of background noise	L_{bgA}	30	dB(A)
Srednji akustični dušilni koficient Average acoustic absorption coefficient	α	0,35	
Skupna površina testnega prostora Total area of the surface of the test room	S_v	4650	m^2
Popravek zaradi vpliva prostora (≤ 7 dB) Environmental correction (≤ 7 dB)	K	0,6	dB
Popravek zaradi vpliva osnovnega hrupa Background correction		0,0	dB(A)
Kor. A-utežna povp. raven zvočnega tlaka Corrected A-weighted sound pressure level	L_{pA}	54,4	dB(A)
Garant. A-utežna povp. raven zvočnega tlaka Guaranteed A-weighted sound pressure level	L_{pA}	≤72	dB(A)
Merilna razdalja Measurement distance	X	0,3	m
Dolžina merilne linije Length of the prescribed contour	l_m	19	m
Višina transformatorskega kotla Height of the transformer tank	h	2,7	m
Ekvivalentna površina Area of the effective surface	S	64,1	m^2
A-utežna raven zvočne moči A-weighted sound power level	L_{WA}	72,5	dB(A)
Garant. A-utežna raven zvočne moči Guaranteed A-weighted sound power level	L_{WA}	--	dB(A)

Formule za izračun;
Formulas for equation:

$$L_{pAO} = 10\lg\left[\frac{1}{N}\sum_{i=1}^{N} 10^{0,1L_{pAi}}\right]$$

$$A = \alpha * S_v$$

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

$$L_{pA} = 10\lg\left[10^{0,1L_{pAO}} - 10^{0,1L_{bgA}}\right] - K$$

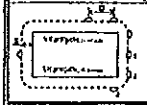
$$L_{WA} = \overline{L}_{pA} + 10*\log_{10}S$$

$$S = 1{,}25\times h\times l_m \rightarrow 0.3m$$

$$S = (h+2)\times l_m \rightarrow 2m$$

$$S = (h+1)\times l_m \rightarrow 1m$$

Merilne točke; Measuring points:



1,2,3, .. m. točke; m. points
D = 1m
X = ONAN 0,3 m
ONAF 2,0 m
AN 1,0 m

Opomba; Note:
trafo: 6/48 kV

Merilna oprema; Measuring equipment:
- *merilnik šuma B&K, tip 2250; kalibrator B&K, tip 4331, točnosti ± 0,30 dB*
- *measuring instrument B&K, type 2250; calibretor B&K, type 4331, accuracy ± 0,30 dB*

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Transformator: Transformer:	*RT 40000-115,5*	Tov. št.: Ser. No.:	*78947*

13.2 *MERITEV NIVOJA HRUPA - Metoda zvočnega tlaka* / *MEASUREMENT OF SOUND LEVEL - Sound pressure method*

- IEC 60076-10

pri nazivni napetosti, ONAF, razdalja 2 m; *at nominal voltage, ONAF, distance 2 m*

Napajano: Supply:	*LV1*	Poz. stikala: Tap range:	*9*	Frekvenca: Frequency:	*50 Hz*

	okol. amb.	transformator transformer 1/3		2/3			okol. amb.	transformator transformer 1/3		2/3			okol. amb.	transformator transformer 1/3		2/3	
	L_{pAi} dB(A)	L_{pAi} dB(A)		L_{pAi} dB(A)			L_{pAi} dB(A)	L_{pAi} dB(A)		L_{pAi} dB(A)			L_{pAi} dB(A)	L_{pAi} dB(A)		L_{pAi} dB(A)	
1		60,7		61,4		14		62,4		63,6		27		62,6		61,4	
2		60,8		61,7		15		62,0		63,8		28		62,3		61,2	
3		61,8		61,7		16		62,0		62,6		29		61,2		60,1	
4		61,3		62,7		17		62,3		63,3		30					
5		61,8		61,3		18		61,7		62,8		31					
6		62,3		62,1		19		61,3		62,2		32					
7		61,3		62,8		20		61,8		61,6		33					
8		62,1		63,4		21		61,8		62,7		34					
9		62,5		62,1		22		62,0		62,9		35					
10		61,5		61,7		23		62,3		63,2		36					
11		61,5		60,7		24		62,1		62,7		37					
12		61,4		62,3		25		61,4		62,1		38					
13		62,2		63,5		26		62,1		61,4		39					

Povprečna izmerjena kvadratna vrednost / Quadratic mean sound level	L_{pAO}	62,1	dB(A)
Povprečna izmerjena vrednost okolice / Average level of background noise	L_{bgA}	30	dB(A)
Srednji akustični dušilni koificient / Average acoustic absorption coefficient	α	0,35	
Skupna površina testnega prostora / Total area of the surface of the test room	S_v	4650	m^2
Popravek zaradi vpliva prostora (≤ 7 dB) / Environmental correction (≤ 7 dB)	K	1,3	dB
Popravek zaradi vpliva osnovnega hrupa / Background correction		0,0	dB(A)
Kor. A-utežna povp. raven zvočnega tlaka / Corrected A-weighted sound pressure level	L_{pA}	60,8	dB(A)
Garant. A-utežna povp. raven zvočnega tlaka / Guaranteed A-weighted sound pressure level	L_{pA}	≤72	dB(A)
Merilna razdalja / Measurement distance	X	2,0	m
Dolžina merilne linije / Length of the prescribed contour	l_m	29	m
Višina transformatorskega kotla / Height of the transformer tank	h	2,7	m
Ekvivalentna površina / Area of the effective surface	S	136,3	m^2
A-utežna raven zvočne moči / A-weighted sound power level	L_{WA}	82,2	dB(A)
Garant. A-utežna raven zvočne moči / Guaranteed A-weighted sound power level	L_{WA}	--	dB(A)

Formule za izračun;
Formulas for equation:

$$L_{pA0} = 10\lg\left[\frac{1}{N}\sum_{i=1}^{N}10^{0,1L_{pAi}}\right]$$

$$A = \alpha * S_V$$

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

$$L_{pA} = 10\lg\left[10^{0,1L_{pA0}} - 10^{0,1L_{bgA}}\right] - K$$

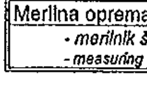
$$L_{WA} = \overline{L}_{pA} + 10*\log_{10}S$$

$$S = 1,25 \times h \times l_m \rightarrow 0.3m$$

$$S = (h+2) \times l_m \rightarrow 2m$$

$$S = (h+1) \times l_m \rightarrow 1m$$

Merilne točke; Measuring points:



1,2,3, .. m. točke; m. points
D = 1m
X = ONAN 0,3 m
ONAF 2,0 m
AN 1,0 m

Opomba; Note:
trafo: 6/48 kV

Merilna oprema; Measuring equipment:
- *merilnik šuma B&K, tip 2250; kalibrator B&K, tip 4331, točnost ± 0,30 dB*
- *measuring instrument B&K, type 2250; calibrator B&K, type 4331, accuracy ± 0,30 dB*

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Transformator: Transformer:	RT 40000-115,5	Tov. št.: Ser. No.:	78947

15.0 SPISEK ELEMENTOV NA TRANSFORMATORJU / LIST OF ELEMENTS ON TRANSFORMER

		Oznaka Label	Tip Type	Tov. št. Ser. No.	Opombe Notes	
1	Skoznik Bushing	1N	ABB - GOB 650	25006003/02		
2	Skoznik Bushing	1U 1V 1W	ABB - GOB 650	25006003/04 25006003/03 25006003/01		
3	Komandna omarica Control cubicle	B00	Rittal – AE1016			
4	Plinski rele Gas relay	B01	Comem – BR 80	051587		
5	Zaščitni rele reg. stikala Protective relay O.L.T.C.	B02	MR – RS 2001			
6	Kazalo olja za transformator Oil level indicator for transformer	B03	Comem - LB22			
7	Kazalo olja za reg. stikalo Oil level indicator for O.L.T.C.	B04	Comem - LB22			
8	Termična slika - VN Winding temp. indicator - HV	B05	AB Kihlstrom - 35	140380-9	75/80/113/118 °C	H = 1,10 gH = 26 K R = 1,0 Ω
9	Kontaktni termometer Oil temperature indicator	B06	AB Kihlstrom - 34	354487-3	50/60/95/100 °C	
10	Uporovni termometer Resistance thermometer	B09	Elplast - Pt 100			
11	Uporovni termometer Resistance thermometer	B10	Elplast - Pt 100			
12	Varnostni ventil Pressure relief valve	B07	Comem - 126			
13	Zaščitni rele reg. stikala Protective relay O.L.T.C.	B08	Comem - 50T			
14	Tokovni transformator Current transformer	CT1	250/2A; 10 VA	122718001	Cl 3; Fs5	In 1V
15	Tokovni transformator Current transformer	CT11..13	250/1A; 30 VA	122719001 122719002 122719003	5P20	In 1U In 1V In 1W
16	Tokovni transformator Current transformer	CT14..16	250/1A; 30 VA	122719004 122719005 122719006	5P20	In 1U In 1V In 1W
17	Tokovni transformator Current transformer	CT17, 18	250/1A; 30 VA	122719007 122719008	5P20	In 1N
18	Tokovni transformator Current transformer	CT19..21	250/2A; 10 VA	122718002 122718003 122718004	Cl 3; Fs5	In 1U In 1V In 1W
19	Monitor plina in vlage v olju Fault gas and moisture in oil monitor		GE Power System - Hydran	1202418848		
20						

16.0 PREIZKUS KOMANDNE - SIGNALNE OMARICE / TEST OF CONTROL - SIGNAL CUBICLE

☑ Elementi so preizkušeni na osnovi načrta (na vratih omarice).
The functional test has been performed according to the drawing (on cubicle door).
Preizkus ožičenja z izmenično napetostjo 2 kV v trajanju 60 sek.
Auxilliary wiring insulation test by 2 kV in duration 60 s

☑ preizkus opravljen
test O.K.

17.0 FUNKCIONALNI PREIZKUS ELEMENTOV NA TRANSF. / FUNCTIONAL TEST OF ELEMENTS ON TRANSFORMER

☑ Elementi so preizkušeni na osnovi načrta (na vratih omarice).
The functional test has been performed according to the drawing (on cubicle door).

☑ preizkus opravljen
test O.K.

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenija

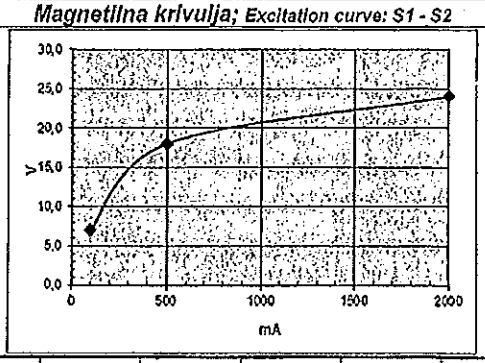
KOLEKTOR ETRA d.o.o.	MERILNI LIST TRANSFORMATORJA TRANSFORMER TEST REPORT

Transformator: Transformer:	RT 40000-115,5	Tov. št.: Ser. No.:	78947

19.0 MERITVE NA VGRAJENIH TOKOVNIH TRANSFORMATORJIH / MEASUREMENT ON BUILT-IN CURRENT TRANSFORMERS

Podatki; Ratings:	
Tov. številka; Ser. No.:	see 15.0 - list of el. on transf.
Razmerje; Ratio:	250/2 A
Moč; Power:	10 VA
Klasa; Class:	3
Fs	5
Int. oznaka; Int. designation:	CT1
Montiran v; Mounted in:	1V
Sponke: Terminals:	P1-P2 / S1-S2
Meritve in preizkusi: Measurements and tests:	
R [Ω]:	0,429
R_{ISO} (at 1000VDC) [MΩ]:	56.200
k:	125
Polariteta; Polarity:	O.K.

Magnetilna krivulja; Excitation curve: S1 - S2



mA	20	50	100	500	2000
V	-	-	7	18	24

Podatki; Ratings:	
Tov. številka; Ser. No.:	
Razmerje; Ratio:	
Moč; Power:	
Klasa; Class:	
Fs	
Int. oznaka; Int. designation:	
Montiran v; Mounted in:	
Sponke: Terminals:	
Meritve in preizkusi: Measurements and tests:	
R [Ω]:	
R_{ISO} (at 1000VDC) [MΩ]:	
k:	
Polariteta; Polarity:	

Magnetilna krivulja; Excitation curve: S1 - S2

mA	20	50	100	500	2000
V	-				

Podatki; Ratings:	
Tov. številka; Ser. No.:	
Razmerje; Ratio:	
Moč; Power:	
Klasa; Class:	
Fs	
Int. oznaka; Int. designation:	
Montiran v; Mounted in:	
Sponke: Terminals:	
Meritve in preizkusi: Measurements and tests:	
R [Ω]:	
R_{ISO} (at 1000VDC) [MΩ]:	
k:	
Polariteta; Polarity:	

Magnetilna krivulja; Excitation curve: S1 - S2

mA	20	50	100	500	2000
V	-				

Vse meritve in preizkusi so opravljeni na sponkah v priključni omarici
All measurements and tests are carried out at terminals in the terminal cubicle.

Merilna oprema; Measuring equipment:

- močnostni analizator Norma, tip D6000, točnosti ± 0,05 %; - power analyzer Norma, type D6000, accuracy ± 0,05 %
- merilnik ohmske upornosti Raytech, tip Micro Junior 2, točnosti ± 0,1 %; - resistance meter Raytech, type Micro Junior 2, accuracy ± 0,1 %
- merilnik prest. razmerja Haefely, tip TTR 2795, točnosti ± 0,2 %; - transformer turns ratio meter Haefely, type TTR 2795, accuracy ± 0,2 %

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenia

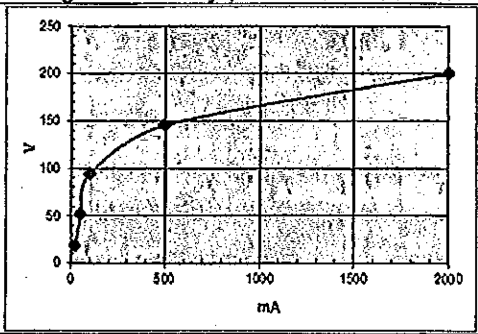
KOLEKTOR KOLEKTOR ETRA d.o.o.	**MERILNI LIST TRANSFORMATORJA** *TRANSFORMER TEST REPORT*

Transformator: Transformer:	*RT 40000-115,5*	Tov. št.: Ser. No.:	*78947*

19.0 *MERITVE NA VGRAJENIH TOKOVNIH TRANSFORMATORJIH* *MEASUREMENT ON BUILT-IN CURRENT TRANSFORMERS*

Podatki; Ratings:	
Tov. številka; Ser. No.:	*see 15.0 - list of el. on transf.*
Razmerje; Ratio:	*250/1 A*
Moč; Power:	*30 VA*
Klasa; Class:	*5P20*
Fs	
Int. oznaka; Int. designation:	*CT11*
Montiran v; Mounted in:	*1U*
Sponke; Terminals:	*P1-P2 / S1-S2*
Meritve in preizkusi: *Measurements and tests:*	
R *[Ω]*:	*0,926*
R_{ISO} *(at 1000VDC) [MΩ]*:	*40.100*
k:	*250*
Polariteta; Polarity:	*O.K.*

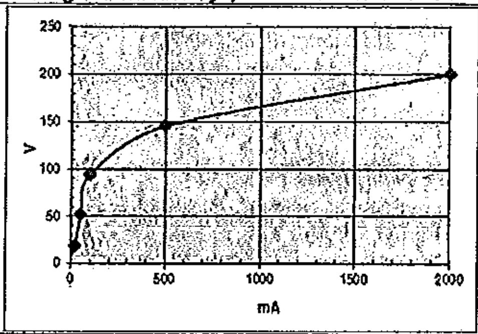
Magnetilna krivulja; *Excitation curve: S1 - S2*



mA	20	50	100	500	2000
V	18	51	94	145	200

Podatki; Ratings:	
Tov. številka; Ser. No.:	*see 15.0 - list of el. on transf.*
Razmerje; Ratio:	*250/1 A*
Moč; Power:	*30 VA*
Klasa; Class:	*5P20*
Fs	
Int. oznaka; Int. designation:	*CT12*
Montiran v; Mounted in:	*1V*
Sponke; Terminals:	*P1-P2 / S1-S2*
Meritve in preizkusi: *Measurements and tests:*	
R *[Ω]*:	*0,916*
R_{ISO} *(at 1000VDC) [MΩ]*:	*35.200*
k:	*250*
Polariteta; Polarity:	*O.K.*

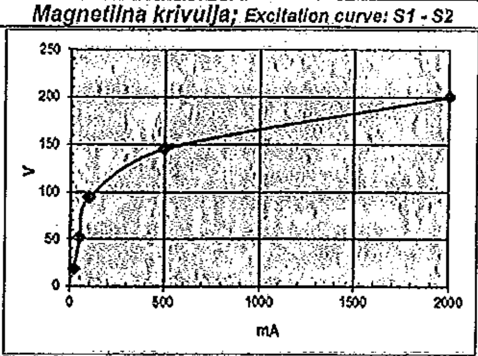
Magnetilna krivulja; *Excitation curve: S1 - S2*



mA	20	50	100	500	2000
V	18	51	94	145	200

Podatki; Ratings:	
Tov. številka; Ser. No.:	*see 15.0 - list of el. on transf.*
Razmerje; Ratio:	*250/1 A*
Moč; Power:	*30 VA*
Klasa; Class:	*5P20*
Fs	
Int. oznaka; Int. designation:	*CT13*
Montiran v; Mounted in:	*1W*
Sponke; Terminals:	*P1-P2 / S1-S2*
Meritve in preizkusi: *Measurements and tests:*	
R *[Ω]*:	*0,913*
R_{ISO} *(at 1000VDC) [MΩ]*:	*36.600*
k:	*250*
Polariteta; Polarity:	*O.K.*

Magnetilna krivulja; *Excitation curve: S1 - S2*



mA	20	50	100	500	2000
V	18	51	94	145	200

Vse meritve in preizkusi so opravljeni na sponkah v priključni omarici
All measurements and tests are carried out at terminals in the terminal cubicle.

Merilna oprema; Measuring equipment:
- *močnostni analizator Norma, tip D6000, točnosti ± 0,05 %; - power analyzer Norma, type D6000, accuracy ± 0,05 %*
- *merilnik ohmske upornosti Raytech, tip Micro Junior 2, točnosti ± 0,1 %; - resistance meter Raytech, type Mikro Junior 2, accuracy ± 0,1 %*
- *merilnik prest. razmerja Haefely, tip TTR 2795, točnosti ± 0,2 %; - transformer turns ratio meter Haefely, type TTR 2795, accuracy ± 0,2 %*

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana

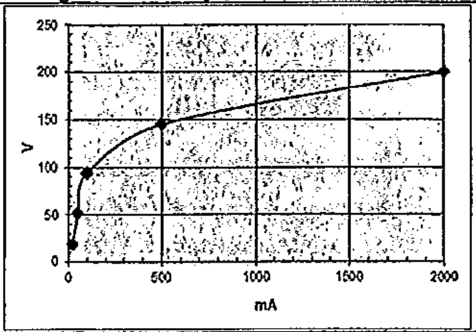
KOLEKTOR KOLEKTOR ETRA d.o.o.	**MERILNI LIST TRANSFORMATORJA** *TRANSFORMER TEST REPORT*

Transformator: Transformer:	*RT 40000-115,5*	Tov. št.: Ser. No.:	*78947*

19.0 MERITVE NA VGRAJENIH TOKOVNIH TRANSFORMATORJIH
MEASUREMENT ON BUILT-IN CURRENT TRANSFORMERS

Podatki; Ratings:	
Tov. številka; Ser. No.:	*see 15.0 - list of el. on transf.*
Razmerje; Ratio:	*250/1 A*
Moč; Power:	*10 VA*
Klasa; Class:	*5P20*
Fs	
Int. oznaka; Int. designation:	*CT14*
Montiran v; Mounted in:	*1U*
Sponke; Terminals:	*P1-P2 / S1-S2*
Meritve in preizkusi: Measurements and tests:	
R [Ω]:	*0,928*
R_{ISO} (at 1000VDC) [MΩ]:	*27.900*
k:	*250*
Polariteta; Polarity:	*O.K.*

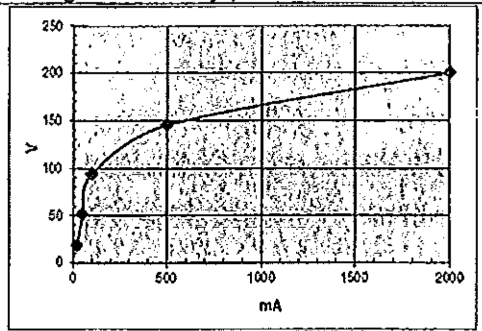
Magnetilna krivulja; Excitation curve: S1 - S2



mA	20	50	100	500	2000
V	18	51	94	145	200

Podatki; Ratings:	
Tov. številka; Ser. No.:	*see 15.0 - list of el. on transf.*
Razmerje; Ratio:	*250/1 A*
Moč; Power:	*10 VA*
Klasa; Class:	*5P20*
Fs	
Int. oznaka; Int. designation:	*CT15*
Montiran v; Mounted in:	*1V*
Sponke; Terminals:	*P1-P2 / S1-S2*
Meritve in preizkusi: Measurements and tests:	
R [Ω]:	*0,921*
R_{ISO} (at 1000VDC) [MΩ]:	*29.900*
k:	*250*
Polariteta; Polarity:	*O.K.*

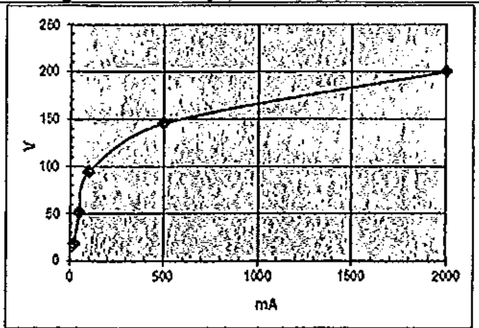
Magnetilna krivulja; Excitation curve: S1 - S2



mA	20	50	100	500	2000
V	18	51	94	145	200

Podatki; Ratings:	
Tov. številka; Ser. No.:	*see 15.0 - list of el. on transf.*
Razmerje; Ratio:	*250/1 A*
Moč; Power:	*10 VA*
Klasa; Class:	*5P20*
Fs	
Int. oznaka; Int. designation:	*CT16*
Montiran v; Mounted in:	*1W*
Sponke; Terminals:	*P1-P2 / S1-S2*
Meritve in preizkusi: Measurements and tests:	
R [Ω]:	*0,910*
R_{ISO} (at 1000VDC) [MΩ]:	*30.100*
k:	*250*
Polariteta; Polarity:	*O.K.*

Magnetilna krivulja; Excitation curve: S1 - S2



mA	20	50	100	500	2000
V	18	51	94	145	200

Vse meritve in preizkusi so opravljeni na sponkah v priključni omarici!
All measurements and tests are carried out at terminals in the terminal cubicle.

Merilna oprema; Measuring equipment:
- *močnostni analizator Norma, tip D6000, točnost ± 0,05 %; - power analyzer Norma, type D6000, accuracy ± 0,05 %*
- *merilnik ohmske upornosti Raytech, tip Micro Junior 2, točnost ± 0,1 %; - resistance meter Raytech, type Micro Junior 2, accuracy ± 0,1 %*
- *merilnik prest. razmerja Haefely, tip TTR 2795, točnost ± 0,2 %; - transformer turns ratio meter Haefely, type TTR 2795, accuracy ± 0,2 %*

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenija

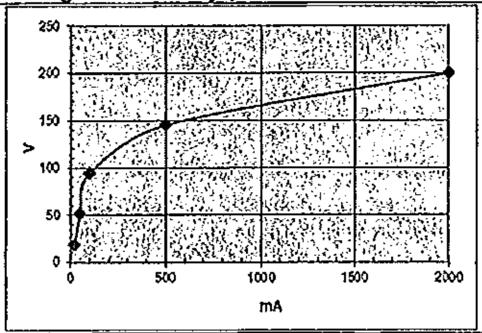
KOLEKTOR KOLEKTOR ETRA d.o.o.	MERILNI LIST TRANSFORMATORJA TRANSFORMER TEST REPORT

Transformator: / Transformer:	RT 40000-115,5	Tov. št.: / Ser. No.:	78947

19.0 MERITVE NA VGRAJENIH TOKOVNIH TRANSFORMATORJIH
MEASUREMENT ON BUILT-IN CURRENT TRANSFORMERS

Podatki; Ratings:	
Tov. številka; Ser. No.:	see 15.0 - list of el. on transf.
Razmerje; Ratio:	250/1 A
Moč; Power:	30 VA
Klasa; Class:	5P20
Fs	
Int. oznaka; Int. designation:	CT17
Montiran v; Mounted in:	1N
Sponke; Terminals:	P1-P2 / S1-S2
Meritve in preizkusi: Measurements and tests:	
R [Ω]:	0,904
R_{ISO} (at 1000VDC) [MΩ]:	34,400
k:	250
Polariteta; Polarity:	O.K.

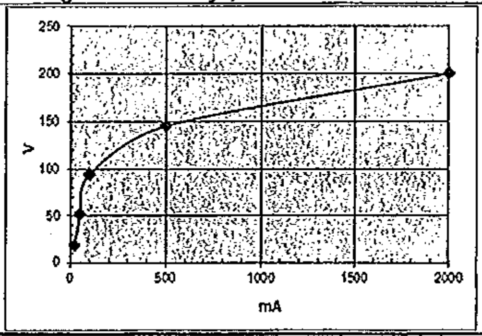
Magnetilna krivulja; Excitation curve: S1 - S2



mA	20	50	100	500	2000
V	18	51	94	145	200

Podatki; Ratings:	
Tov. številka; Ser. No.:	see 15.0 - list of el. on transf.
Razmerje; Ratio:	250/1 A
Moč; Power:	30 VA
Klasa; Class:	5P20
Fs	
Int. oznaka; Int. designation:	CT18
Montiran v; Mounted in:	1N
Sponke; Terminals:	P1-P2 / S1-S2
Meritve in preizkusi: Measurements and tests:	
R [Ω]:	0,909
R_{ISO} (at 1000VDC) [MΩ]:	37,500
k:	250
Polariteta; Polarity:	O.K.

Magnetilna krivulja; Excitation curve: S1 - S2



mA	20	50	100	500	2000
V	18	51	94	145	200

Podatki; Ratings:	
Tov. številka; Ser. No.:	
Razmerje; Ratio:	
Moč; Power:	
Klasa; Class:	
Fs	
Int. oznaka; Int. designation:	
Montiran v; Mounted in:	
Sponke; Terminals:	
Meritve in preizkusi: Measurements and tests:	
R [Ω]:	
R_{ISO} (at 1000VDC) [MΩ]:	
k:	
Polariteta; Polarity:	

Magnetilna krivulja; Excitation curve: S1 - S2

mA	20	50	100	500	2000
V	-				

Vse meritve in preizkusi so opravljeni na sponkah v priključni omarici
All measurements and tests are carried out at terminals in the terminal cubicle.

Merilna oprema; Measuring equipment:
- močnostni analizator Norma, tip D6000, točnosti ± 0,05 %; - power analyzer Norma, type D6000, accuracy ± 0,05 %
- merilnik ohmske upornosti Raytech, tip Micro Junior 2, točnosti ± 0,1 %; - resistance meter Raytech, type Micro Junior 2, accuracy ± 0,1 %
- merilnik prest. razmerja Haefely, tip TTR 2795, točnosti ± 0,2 %; - transformer turns ratio meter Haefely, type TTR 2795, accuracy ± 0,2 %

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenija

KOLEKTOR
KOLEKTOR ETRA d.o.o.

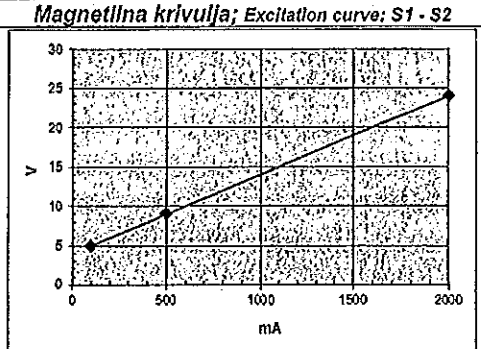
MERILNI LIST TRANSFORMATORJA
TRANSFORMER TEST REPORT

Transformator: Transformer:	RT 40000-115,5	Tov. št.: Ser. No.:	78947

19.0 MERITVE NA VGRAJENIH TOKOVNIH TRANSFORMATORJIH
MEASUREMENT ON BUILT-IN CURRENT TRANSFORMERS

Podatki; Ratings:	
Tov. številka; Ser. No.:	see 15.0 - list of el. on transf.
Razmerje; Ratio:	250/2 A
Moč; Power:	10 VA
Klasa; Class:	3
Fs	5
Int. oznaka; Int. designation:	CT19
Montiran v; Mounted in:	1U
Sponke: Terminals:	P1-P2 / S1-S2
Meritve in preizkusi: Measurements and tests:	
R [Ω]:	0,387
R_{ISO} (at 1000VDC) [MΩ]:	28.300
k:	125
Polariteta; Polarity:	O.K.

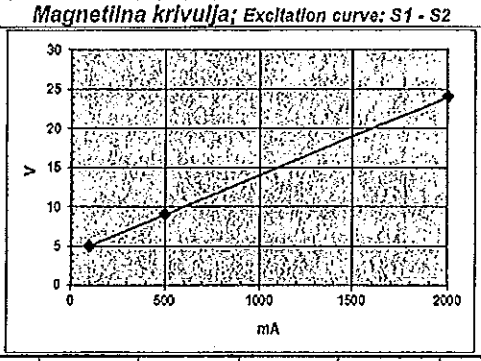
Magnetilna krivulja; Excitation curve: S1 - S2



mA	20	50	100	500	2000
V	-	-	5	9	24

Podatki; Ratings:	
Tov. številka; Ser. No.:	see 15.0 - list of el. on transf.
Razmerje; Ratio:	250/2 A
Moč; Power:	10 VA
Klasa; Class:	3
Fs	5
Int. oznaka; Int. designation:	CT20
Montiran v; Mounted in:	1V
Sponke: Terminals:	P1-P2 / S1-S2
Meritve in preizkusi: Measurements and tests:	
R [Ω]:	0,378
R_{ISO} (at 1000VDC) [MΩ]:	27.100
k:	125
Polariteta; Polarity:	O.K.

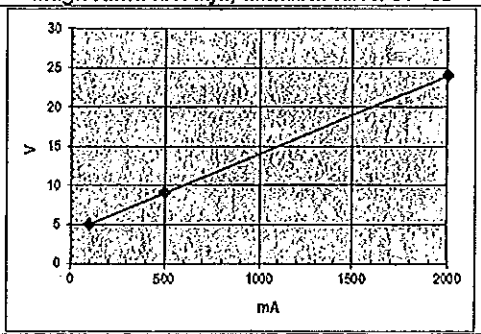
Magnetilna krivulja; Excitation curve: S1 - S2



mA	20	50	100	500	2000
V	-	-	5	9	24

Podatki; Ratings:	
Tov. številka; Ser. No.:	see 15.0 - list of el. on transf.
Razmerje; Ratio:	250/2 A
Moč; Power:	10 VA
Klasa; Class:	3
Fs	5
Int. oznaka; Int. designation:	CT21
Montiran v; Mounted in:	1W
Sponke: Terminals:	P1-P2 / S1-S2
Meritve in preizkusi: Measurements and tests:	
R [Ω]:	0,365
R_{ISO} (at 1000VDC) [MΩ]:	26.600
k:	125
Polariteta; Polarity:	O.K.

Magnetilna krivulja; Excitation curve: S1 - S2



mA	20	50	100	500	2000
V	-	-	5	9	24

Vse meritve in preizkusi so opravljeni na sponkah v priključni omarici!
All measurements and tests are carried out at terminals in the terminal cubicle.

Merilna oprema; Measuring equipment:

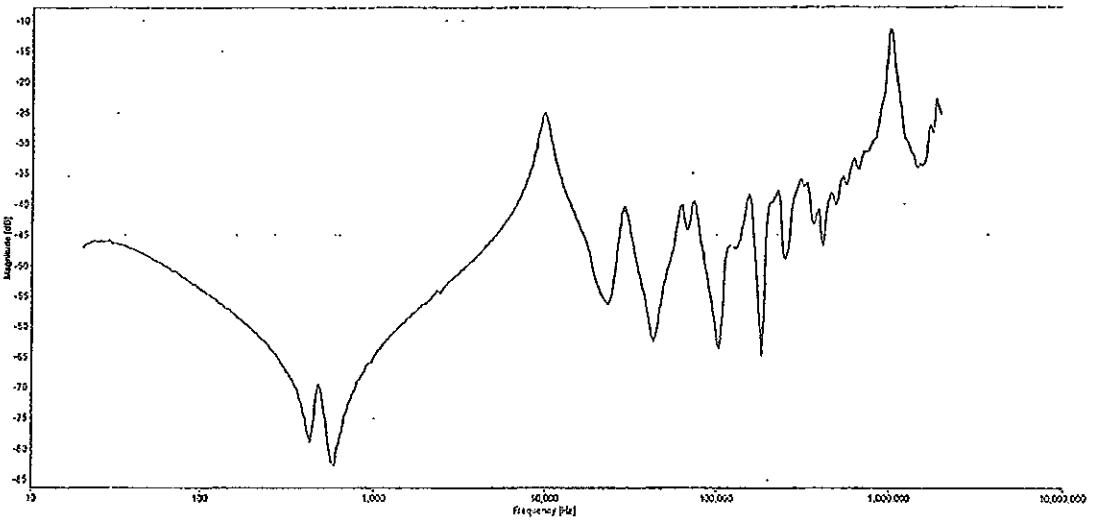
- *močnostni analizator Norma, tip D6000, točnosti ± 0,05 %; - power analyzer Norma, type D6000, accuracy ± 0,05 %*
- *merilnik ohmske upornosti Raytech, tip Micro Junior 2, točnosti ± 0,1 %; - resistance meter Raytech, type Micro Junior 2, accuracy ± 0,1 %*
- *merilnik prest. razmerja Haefely, tip TTR 2795, točnosti ± 0,2 %; - transformer turns ratio meter Haefely, type TTR 2795, accuracy ± 0,2 %*

KOLEKTOR ETRA d.o.o.	MERILNI LIST TRANSFORMATORJA TRANSFORMER TEST REPORT

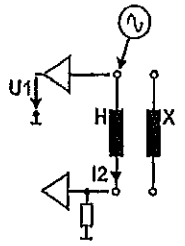
Transformator: Transformer:	RT 40000-115,5	Tov. št.: Ser. No.:	78947

20.0 FREKVENČNA KARAKTERISTIKA TRANSFORMATORJA / FREQUENCY RESPONSE OF TRANSFORMER

20.1	Faza; Phase:	1U	Frekvenca; Frequency:	20 Hz - 2 MHz		
Napajano; Supply:	1U - 1N	Pozicija stikala; Tap pos.:	1	Temperatura; Temperature:	21	°C
NN navitje: LV winding:	odprto / open	TN navitje: TV winding:	...			



Before all measurements and tests!



Merilna oprema; Measuring equipment:
- *frekvenčni analizator Tettex, tip FRA 5310;*
- *frequency analyzer Tettex, type FRA 5310*

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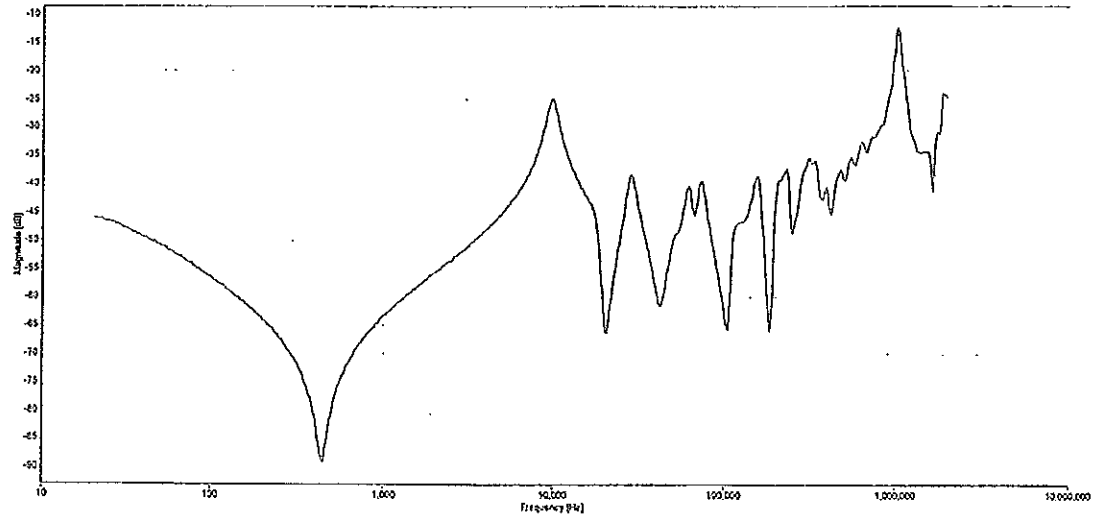
Hajdrihova 2, 1000 Ljubljana, Slovenija

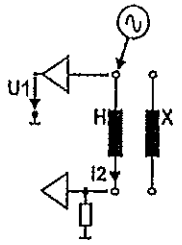
KOLEKTOR KOLEKTOR ETRA d.o.o.	MERILNI LIST TRANSFORMATORJA TRANSFORMER TEST REPORT	
Transformator: Transformer:	RT 40000-115,5	Tov. št.: Ser. No.: 78947

20.0 FREKVENČNA KARAKTERISTIKA TRANSFORMATORJA / FREQUENCY RESPONSE OF TRANSFORMER

20.2	Faza; Phase: 1V	Frekvenca; Frequency: 20 Hz - 2 MHz			
Napajano; Supply: 1V - 1N	Pozicija stikala; Tap pos.: 1	Temperatura; Temperature: 21 °C			
NN navitje: LV winding: odprto / open	TN navitje: TV winding: ...				



Before all measurements and tests!



Merilna oprema; Measuring equipment:
- *frekvenčni analizator Tettex, tip FRA 5310;*
- *frequency analyzer Tettex, type FRA 5310*

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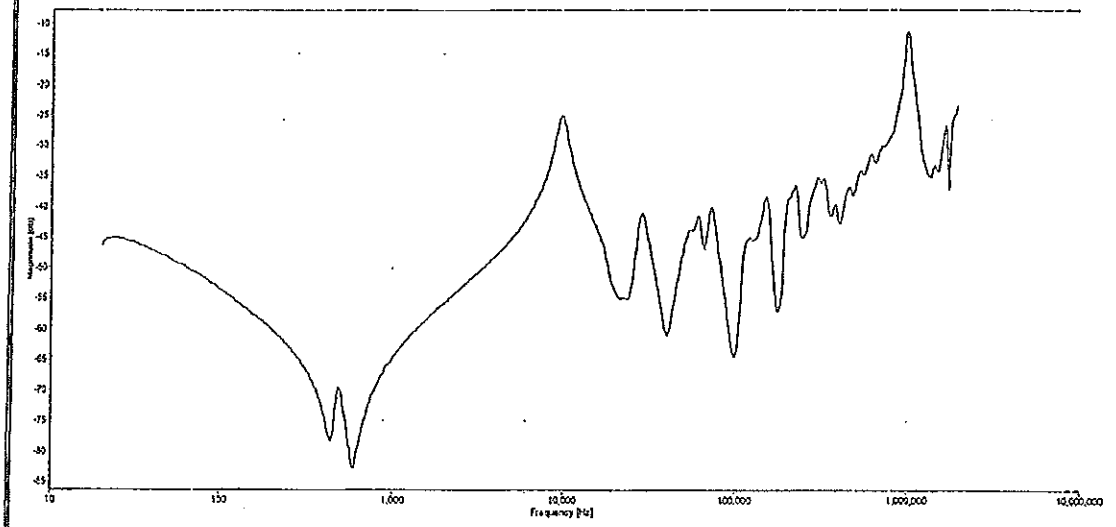
Hajdrihova 2, 1000 Ljubljana, Slovenia

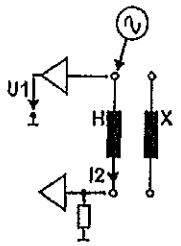
KOLEKTOR ETRA d.o.o.	MERILNI LIST TRANSFORMATORJA TRANSFORMER TEST REPORT

Transformator: Transformer:	RT 40000-115,5	Tov. št.: Ser. No.:	78947

20.0	FREKVENČNA KARAKTERISTIKA TRANSFORMATORJA FREQUENCY RESPONSE OF TRANSFORMER						
20.3	Faza; Phase:	1W	Frekvenca; Frequency:	20 Hz - 2 MHz			
Napajano; Supply:	1W - 1N	Pozicija stikala; Tap pos.:	1	Temperatura; Temperature:	21	°C	
NN navitje: LV winding:	odprto / open	TN navitje: TV winding:	...				



Before all measurements and tests!



Merilna oprema; Measuring equipment:
- *frekvenčni analizator Tettex, tip FRA 5310;*
- *frequency analyzer Tettex, type FRA 5310*

ELEKTROINŠTITUT
Hajdrihova 1, 1000

21.0 PREIZKUS SEGREVANJA; TEMPERATURE-RISE TEST

21.1 Tehnični podatki; Technical data:

Transformator tip: Transformer type:	RT 20000-110		Tovarniška št.: Serial No.:	74273	Št. načrta.: Draw. No.:	2966
		VN-navitje HV-winding	NN-navitje LV-winding		Vezalna skupina: Connection symbol:	YNd5
Nazivna moč: Rated power:	P_n [kVA]	20000	20000		Frekvenca: Frequency:	50 Hz
Nazivna napetost: Rated voltage:	U_n [kV]	110	6.3		Število faz: No. of phases:	3
Nazivni tok: Rated current:	I_n [A]	105.0	1832.9			

Hladilni medij: Dielectric type:	Nytro 10X	Tip hlajenja: Type of cooling:	ONAN / ONAF	Št. vent. / črpalk: No. fans / pumps:	2 / -
Tip vent.: Fan type:	Shorman - SH 600-8	Tip črpalk: Pump type:	-	Tip hladilnika: Cooler type:	-6 x FG

21.2 Predhodno merjeni podatki; Injection values:

			ONAN 12 MVA	
Stopnja regulacijskega stikala pri segr.: Tap changer position at test:	19			
Merjene izgube prostega teka Measured no load losses	P_0	[W]	12 149	
Merjene izgube kratkega stika pri 75 °C Measured load losses at 75 °C	P_k	[W]	41 176	
Skupne izgube med preizkusom Injected total losses	P_{tot}	[W]	53 325	
Nazivni tok VN navitja med preizkusom Injected current on HV winding	I_n	[A]	78.7	
Nazivni tok NN navitja med preizkusom Injected current on LV winding	I_n	[A]	1099.7	

21.3 Postopek preizkušanja; Test procedure:

Transformator se preizkuša po metodi kratkega stika.
The transformer is tested according to short-circuit method.

1. Transformator bremenimo s skupnimi izgubami (P_{tot}), dokler ne dosežemo temperaturne stabilizacije olja, kot jo predpisuje standard.
   The transformer is loaded with total losses (P_{tot}) until a steady - state oil temp. rise is established according to standard.
2. Po temperaturni stabilizaciji olja, navitje napajamo z nazivnim tokom (I_n) približno 1 uro.
   After a steady - state of oil rated current (I_n) is maintained constant for about 1 hour.
3. Po odklopu napajanja, posnamemo ohlajevalno krivuljo navitja in določimo srednjo nadtemperaturo navitja za vsako navitje posebej.
   After shutdown, cooling curve is recorded and average winding temperature rise is determined for each winding separately.

Preiskus je opravljen po priporočilih standarda SIST EN 60076-2 in po internih navodilih LO-8201.
The test is performed according to Standard IEC 60076-2 and internal test procedure LO-8201.

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenija
4

Meritve opravil:
Tested by:
Franc Štempelj

Ljubljana:
24. junij 2004

ETRA 33 ENERGETSKI TRANSFORMATORJI d.d.
Ljubljana, Šlandrova 10

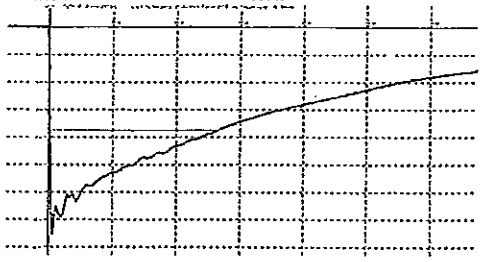
ETRA 33 Energetski transformatorji d.d.
Šlandrova 10, 1001 Ljubljana, p.p. 4956, Slovenija
tel. ++386 1 5302 800, fax ++386 1 5302 830, http://www.etra33.si

TEST REPORT

Impulse Analysing System by Haefely Test AG

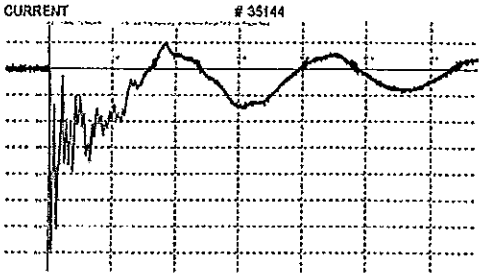
Page: 8; Tr. No.: 78947; Terminal: 2V; Tap. pos.: --

CH: 1
VOLTAGE # 35143



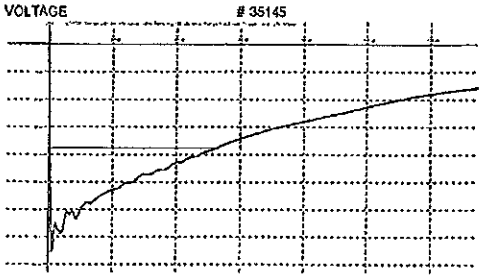
No. 24 LI full Upk -37.477 kV T1: 1.266 us T2: 53.104 us

CH: 2
CURRENT # 35144



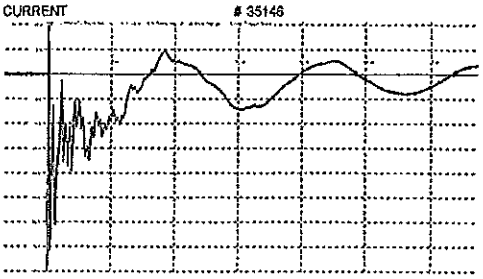
No. 24 LI full Ipk max -34.668 A Ipk min: 5.029 A

CH: 1
VOLTAGE # 35145



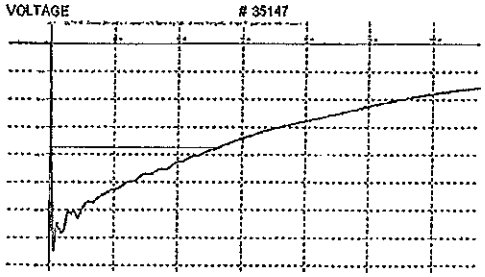
No. 25 LI full Upk -75.129 kV T1: 1.255 us T2: 53.045 us

CH: 2
CURRENT # 35146



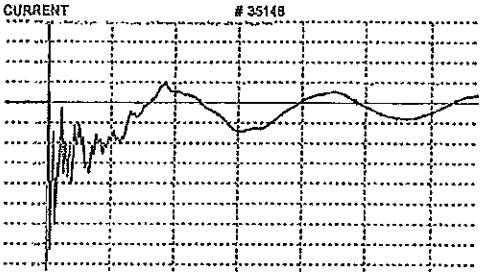
No. 25 LI full Ipk max -71.875 A Ipk min: 12.793 A

CH: 1
VOLTAGE # 35147



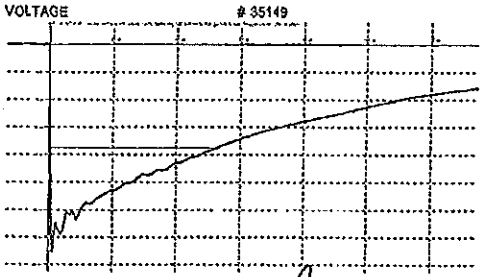
No. 26 LI full Upk -74.817 kV T1: 1.264 us T2: 53.139 us

CH: 2
CURRENT # 35148



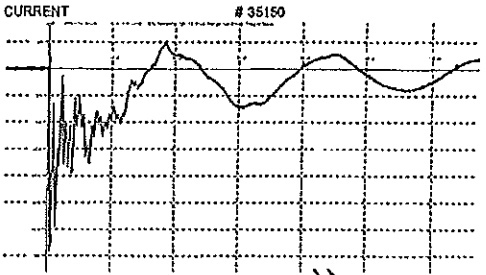
No. 26 LI full Ipk max -73.438 A Ipk min: 29.932 A

CH: 1
VOLTAGE # 35149



No. 27 LI full Upk -75.178 kV T1: 1.268 us T2: 53.121 us

CH: 2
CURRENT # 35150



No. 27 LI full Ipk max -68.555 A Ipk min: 9.814 A

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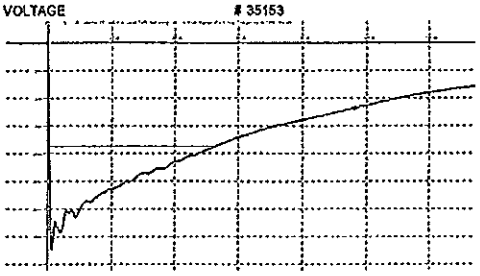
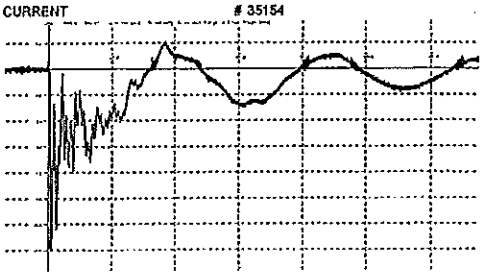
CH: 1
VOLTAGE # 35153



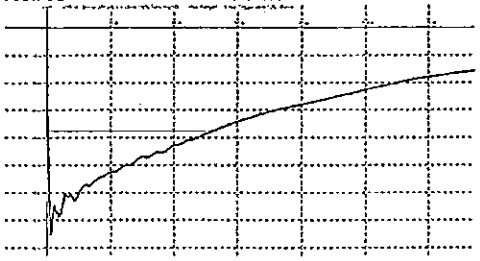
No. 28 LI full Upk: -37.392 kV T1: 1.272 us T2: 53.294 us

CH: 2
CURRENT # 35154



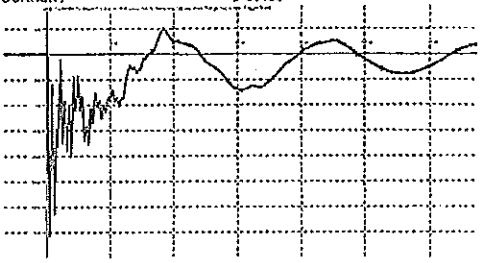
No. 28 LI full Ipk max: -35.156 A Ipk min: 5.273 A

CH: 1
VOLTAGE # 35155



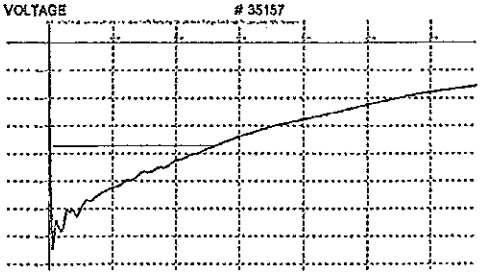
No. 29 LI full Upk: -75.474 kV T1: 1.276 us T2: 52.611 us

CH: 2
CURRENT # 35156



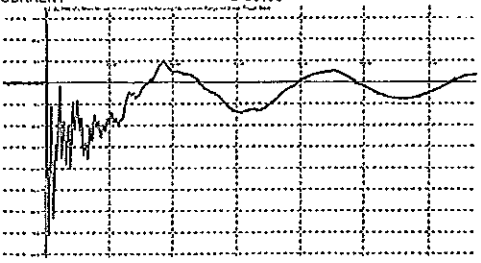
No. 29 LI full Ipk max: -71.631 A Ipk min: 10.400 A

CH: 1
VOLTAGE # 35157



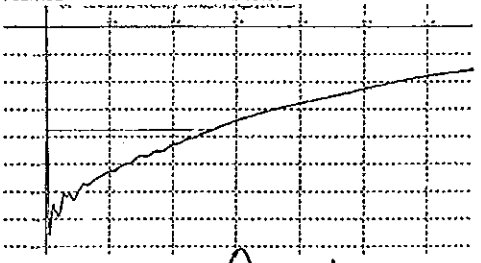
No. 30 LI full Upk: -74.827 kV T1: 1.274 us T2: 52.798 us

CH: 2
CURRENT # 35158



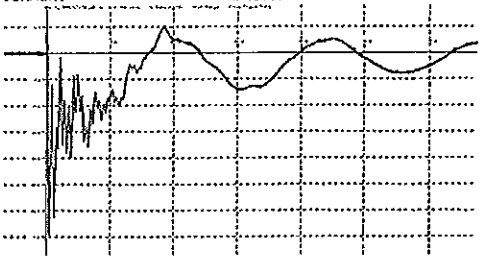
No. 30 LI full Ipk max: -71.240 A Ipk min: 25.586 A

CH: 1
VOLTAGE # 35159



No. 31 LI full Upk: -75.142 kV T1: 1.259 us T2: 52.877 us

CH: 2
CURRENT # 35160



No. 31 LI full Ipk max: -69.238 A Ipk min: 10.254 A

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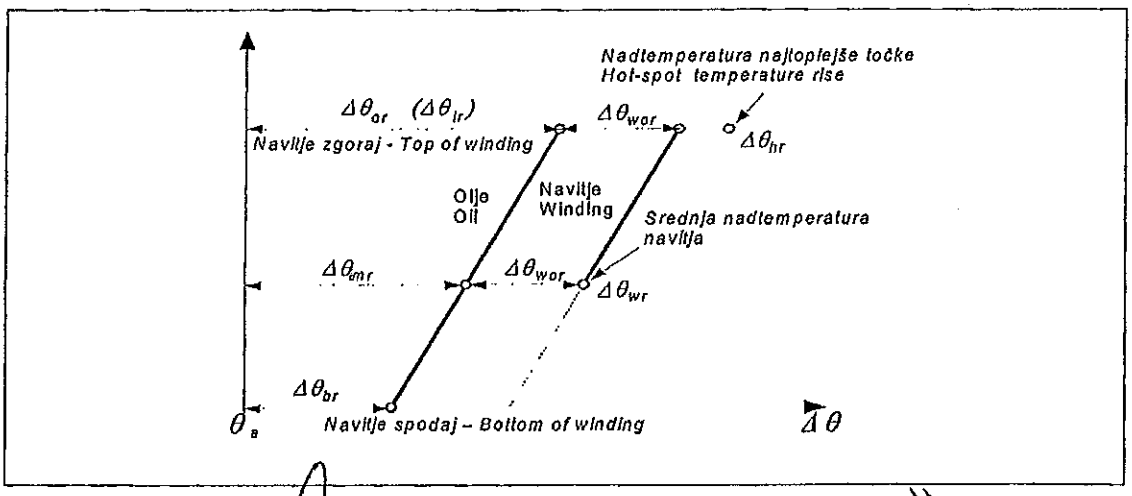
21.4 Rezultati segrevanja; Measured results:

Temperaturna stabilizacija olja s skupnimi izgubami - Steady - state of oil with total losses

		Izmerjeno Measured	Korekcija Corr.	Garant. Guaran.	
Maksimalna nadtemperatura olja Top oil temperature rise	[K]	45.7		60.0	$\Delta\theta_{or} = \theta_{or} - \theta_a$
Srednja nadtemperatura olja (P_{tot}) Average oil temperature rise (P_{tot})	[K]	36.8		--	$\Delta\theta_{mr} = \Delta\theta_{or} - ((\theta_{ir} - \theta_{br})/2)$
Temperaturna stabilizacija navitij z nazivnim tokom - Steady - state of windings with rated current					
Srednja nadtemperatura olja (I_n) Average oil temperature rise (I_n)	[K]	35.6		--	$\Delta\theta_{mr2} = \Delta\theta_{or2} - ((\theta_{ir2} - \theta_{br2})/2)$
Temp. razlika navitje-olje srednje (VN) Temp. difference winding to oil average (HV)	[K]	12.9			$\Delta\theta_{wor} = \Delta\theta_2 - \Delta\theta_{mr2}$
Srednja nadtemperatura navitja (VN) Average winding temperature rise (HV)	[K]	49.7		65.0	$\Delta\theta_{wr} = \Delta\theta_{wor} + \Delta\theta_{mr}$
Temp. razlika navitje-olje srednje (NN) Temp. difference winding to oil average (LV)	[K]	7.2			$\Delta\theta_{wor} = \Delta\theta_2 - \Delta\theta_{mr2}$
Srednja nadtemperatura navitja (NN) Average winding temperature rise (LV)	[K]	44.0		65.0	$\Delta\theta_{wr} = \Delta\theta_{wor} + \Delta\theta_{mr}$
Temp. razlika navitje-olje srednje Temp. difference winding to oil average	[K]				$\Delta\theta_{wor} = \Delta\theta_2 - \Delta\theta_{mr2}$
Srednja nadtemperatura navitja Average winding temperature rise	[K]				$\Delta\theta_{wr} = \Delta\theta_{wor} + \Delta\theta_{mr}$



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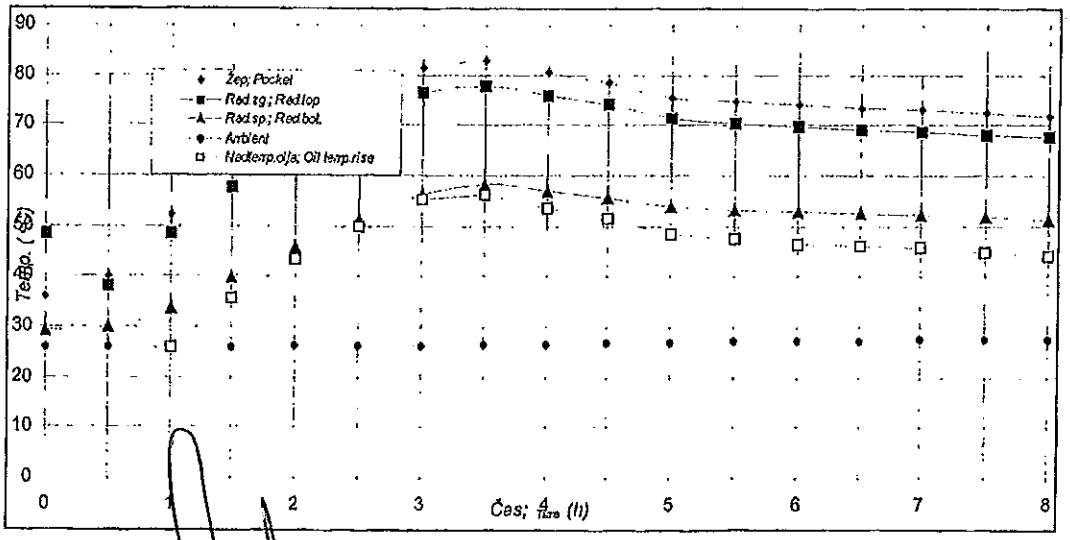
21.4 Temperaturne krivulje olje - ambient; Temperature curves oil - ambient

čas time h	merilne točke; measuring point 1 žep pocket °C	2 rad.-zg. r.-top °C	3 rad.-sp. r.-bot. °C	4 rad.-zg. r.-top °C	5 rad.-sp. r.-bot. °C	6 amb._1 amb._1 °C	7 amb._2 amb._2 °C	8 amb._3 amb._3 °C	rezultati; results (6/7/8) ambient amb. °C	(2,3-4,5) rez. rad. dif. rad. °C	hadtemp t. rise K	razlika dif. t. rise K	opombe; note
0	36.0	48.4	29.2	34.4	28.5	26.1	26.2	25.8	26.0				##
	40.2	38.0	29.9	38.2	30.4	26.1	26.2	25.8	26.0	8.0			*1.2 In*
1	52.2	48.7	33.7	48.8	34.0	26.2	26.3	25.8	26.1	14.9	***26.1***		*1.2 In*
	61.7	57.6	39.7	57.5	39.2	26.2	26.3	25.8	26.1	18.1	***35.6***	9.5	*1.2 In*
2	69.7	65.3	45.7	65.2	44.4	26.2	26.4	25.9	26.2	20.2	***43.5***	7.9	*1.2 In*
	76.2	71.5	51.4	71.3	49.6	26.3	26.4	26.0	26.2	20.9	***50.0***	6.4	*1.2 In*
3	81.6	76.6	56.3	76.7	54.1	26.4	26.6	26.1	26.4	21.5	***55.2***	5.3	*1.2 In*
	82.9	77.9	58.2	77.6	55.0	26.7	26.8	26.4	26.6	21.2	***56.3***	1.0	*Plot + fans*
4	80.5	76.0	56.8	75.4	53.9	26.8	27.0	26.5	26.8	20.4	***53.7***	-2.5	*Plot + fans*
	78.4	74.0	55.5	73.5	52.4	26.9	27.3	26.7	27.0	19.8	***51.4***	-2.3	*Plot + fans*
5	75.5	71.6	54.0	71.2	51.1	27.0	27.4	26.8	27.1	18.9	***48.4***	-3.0	*Plot + fans*
	74.7	70.5	53.4	70.3	59.8	27.1	27.5	27.0	27.2	13.8	***47.5***	-0.9	*Plot + fans*
6	74.0	69.7	53.0	69.5	50.1	27.4	27.6	27.1	27.4	18.1	***46.6***	-0.9	*Plot + fans*
	73.6	69.2	52.7	68.8	49.6	27.5	27.7	27.2	27.5	17.9	***46.1***	-0.5	*Plot + fans*
7	73.2	68.8	52.3	68.5	49.6	27.6	27.7	27.2	27.5	17.7	***45.7***	-0.4	*Plot + fans*
	72.5	68.2	51.9	68.1	49.3	27.7	27.8	27.3	27.6	17.6	***44.9***	-0.8	*In*
8	71.9	67.6	51.4	67.6	48.9	27.7	28.0	27.4	27.7	17.5	***44.2***	-0.7	*In*
9													
10													
11													
12													



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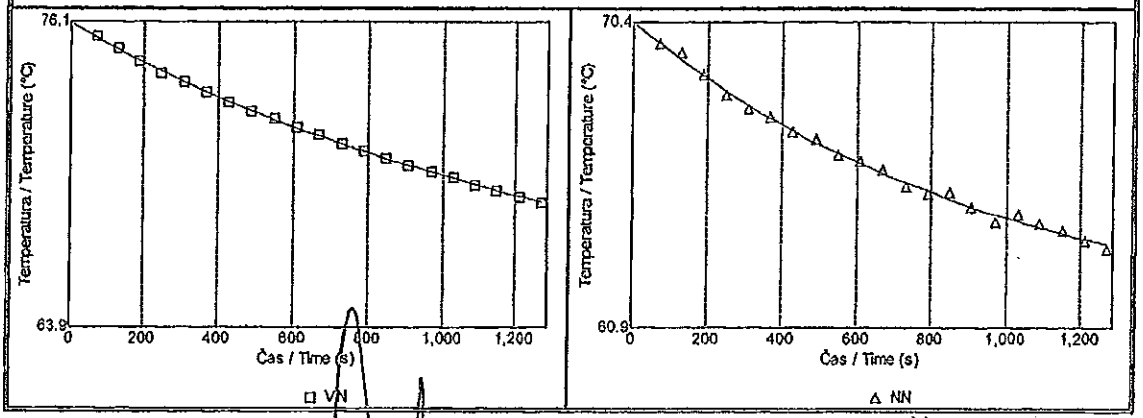
Hajdrihova 2, 1000 Ljubljana, Slovenija

21.5.1 Upornost merjena po končanem segrevanju (ONAN)
Resistance measured after finished temp. rise (ONAN)

Št. No.	VN navitje; HV winding			NN navitje; LV winding		
	[s]	[Ω]	[K]	[s]	[Ω]	[K]
1	69.1	2.688489	47.85	70.5	0.006598	42.02
2	129.1	2.684153	47.41	130.5	0.006592	41.83
3	189.1	2.679868	46.85	190.5	0.006577	41.07
4	249.1	2.675954	46.40	250.5	0.006563	40.43
5	309.1	2.672501	46.07	310.5	0.006554	40.08
6	369.1	2.669042	45.60	370.5	0.006549	39.78
7	429.1	2.665759	45.23	430.5	0.006539	39.30
8	489.1	2.662669	44.87	490.5	0.006533	39.05
9	549.1	2.659756	44.53	550.5	0.006523	38.57
10	609.1	2.656843	44.20	610.5	0.006519	38.41
11	669.1	2.654300	43.90	670.5	0.006513	38.11
12	729.1	2.651478	43.58	730.5	0.006502	37.63
13	789.1	2.648833	43.27	790.5	0.006497	37.38
14	849.1	2.646375	42.99	850.6	0.006498	37.44
15	909.1	2.643917	42.77	910.5	0.006488	37.03
16	969.1	2.641732	42.45	970.5	0.006479	36.53
17	1029.1	2.639735	42.22	1030.6	0.006484	36.76
18	1089.1	2.637272	41.94	1090.5	0.006478	36.48
19	1149.2	2.635269	41.70	1150.6	0.006473	36.26
20	1209.1	2.633266	41.47	1210.5	0.006466	35.92

21.5.2 Ohlajevalna krivulja navitja (ONAN)
Temperature curve of winding (ONAN)

	VN navitje HV winding	NN navitje LV winding		
θ_1 =	26.9	26.9	[°C]	- temperatura navitja v hladnem stanju - cold winding resistance temperature
R_1 =	2.267 513	0.005 671	[Ω]	- hladna upornost navitja - cold winding resistance
R_2 =	2.453 355	0.006 014	[Ω]	-upornost navitja po izklopu - winding resistence at shut - down
$\Delta\theta_2$ =	48.4	42.7	[K]	- srednja nadtemperatura navitja - average winding temperature rise
T_{au} =	24.1	16.3	[min]	- termična časovna konstanta navitja - winding time constant
g_r =	12.2	9.5	[K]	- temperatura razlika navitje-olje - winding-oil temperature diference



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21.6 Določitev temperature olja in navitja; Determination of the oil and winding temperature:

θ_a - Merjenje temperature okolice. Measurement of the ambient temperature.

Vrednost je povprečje 3 merilnih sond (2,3,4), lociranih 1 - 2 m od površine hladilnega sistema in na polovici višine hladilnega sistema. Pri WF hlajenjih merimo temperaturo hladilne vode na vstopu v hladilnik.

By means of 3 thermocouples (2,3,4), placed at 1 – 2m from the cooling surface, at half height of the cooling system. At WF cooling the temperature of water at entrance in cooler is measured.

θ_{or} - Merjenje maksimalne temperature olja. Top oil temperature measurement.

Vrednost je odčitana iz merilne sonde locirane v žepu na pokrovu transformatorja.

By means of thermocouple placed in pocket on the cover.

$\Delta\theta_{or}$ - Maksimalna nadtemperatura olja. Top oil temperature rise.

$$\Delta\theta_{or} = \theta_{or} - \theta_a$$

r – predstavlja veličine pri nazivni moči. Indicates rated quantity.

Če med preizkusom ni možno doseči skupnih izgub, se izvrši korekcija maksimalne nadtemperature olja po naslednji enačbi:

If the specified values of total losses have not been obtained during the test, the results shall be corrected according to the following relations:

$$\Delta\theta_{or} = \Delta\theta_o \left(\frac{totall\_losses}{test\_losses} \right)^x$$

$\Delta\theta_{or}$ nova korigirana nazivna vrednost (K)-new corrected rated value
$\Delta\theta_o$ - izmerjena vrednost (K)- measured value
X=1,0 za OF.. ali OD.. način hlajenja - OF.. or OD.. cooling
X=0,9 za ON.. način hlajenja – ON.. cooling
X=0,8.. distr. tr. pri $P_N \leq 2.5$ MVA – distr. tr. at $P_N \leq 2.5$ MVA

θ_{ir} θ_{br} - Merjenje temperature vstopnega in izstopnega olja hladilnega sistema. Top and bottom oil cooler temperature measurement.

V primeru kadar gre za hladilni aparat sestavljen iz več radiatorjev ali hladilnikov se vrednosti merita z dvema termo sondama: θ_{br} (št. 5,6) in θ_{ir} (št. 7,8). Termosondi (št. 5,6) sta locirani na izhodu iz hladilnega sistema in merita temperaturo izstopnega olja iz hladilnega sistema θ_{br}. Termosondi (št. 7,8) sta locirani na vhodu v hladilni sistem in merita temperaturo vstopnega olja v hladilni sistem θ_{ir}.

If several batteries of cooling equipment are fitted, two thermocouples are used: θ_{br} (No 5,6) and θ_{ir} (No 7,8). The botton oil temperature θ_{br} is determined by thermocouples (No 5,6) fitted in the return headers from coolers or radiators. The oil temperature θ_{ir} is determined by thermocouples (No 7,8) fitted in the inlet headers from coolers or radiators.

$\Delta\theta_{tmr}$ - Srednja nadtemperatura olja: Average oil temperature rise.

$$\Delta\theta_{tmr} = \theta_{or} - \left(\frac{\theta_{ir} - \theta_{br}}{2} \right) - \theta_a$$

Za distribucijske transformatorje moči ≤ 2,5 MVA s hlajenjem ONAN, z valovitim kotlom, oziroma z neločljivim hladilnim aparatom se lahko srednja nadtemperatura olja določi po enostavni relaciji: $\Delta\theta_{tmr} = 0{,}8\ \theta_{or}$.

For ONAN transformers up to 2,5 MVA, with plain or corrugated tanks or individual cooling tubes mounted directly on the tank, the average oil temperature rise above ambient air temperature may be taken 80% of the top oil temperature rise.

Po temperaturni stabilizaciji olja preizkus nadaljujemo tako, da tok znižamo na nazivno vrednost. To stanje vzdržujemo 1 uro in medtem merimo temperaturo olja in okolice.
Po pretečeni uri izmerimo ohmske upornosti navitij.

When the top oil temperature rise has been established, the test was immediately continoued with the test current, reduced to rated current for the winding combination conected. This condition is maintained for 1 hour, with continious observation of oil and cooling medium temperature. At the end of the hour, the resistances of the windings were measured.

$\Delta\theta_{wr}$ - Določitev srednje nadtemperature navitja. Determination of the average winding temperature rise.

Ohmska upornost se meri v trajanju 20 min po izklopu transformatorja. Vrednosti se avtomatično ekstrapolirajo na čas izklopa transformatorja t = 0, s pomočjo numeričnega računalniškega izračuna.

The winding resistance is measured in duration of 20 min. after transformer shutdown. With automatic extrapolation curve, values at the time of transformer shutdown t= 0 are defined by using a numerical method of extrapolation.

$$\theta_2 = \frac{R_2}{R_1}(235 + \theta_1) - 235$$

R_1 – ohmska upornost navitja pri θ_1 - winding resistance at θ_1
R_2 – ohmska upornost navitja pri θ_2 - winding resistance at θ_2

$\Delta\theta_{w0r}$ - Izračun temperaturne razlike navitje-olje srednje. Calculation of temperature difference winding to oil average.

$$\Delta\theta_{w0r} = \theta_2 - \theta_{tmr2}$$

Kjer je θ_{tmr2} srednja temperatura olja na koncu stabilizacije navitja z nazivnim tokom.

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Where the θ_{wr2} represents average temperature of oil at the end of rated current injection.

$$\theta_{lwr2} = \theta_{or2} - \left(\frac{\theta_{ir2} - \theta_{br2}}{2}\right)$$

Če med preizkusom ni možno doseči nazivnega toka, se izvrši korekcija temperaturne razlike navitje-olja srednje po naslednji enačbi:
If the specified values of rated current have not been obtained during the test, the results shall be corrected according to the following relations:

$$\Delta\theta_{w0r} = \Delta\theta_{w0}\left(\frac{rated\_current}{test\_current}\right)^{y}$$

$\Delta\theta_{Wor}$ - *nova korigirana vrednost (K) -- new corrected value (K)*
$\Delta\theta_{Wo}$ - *izmerjena vrednost (K) -- measured value (K)*
Y= 2.0 za OD.. način hlajenja – for OD.. cooling
Y=1.6 za ON.. in OF način hlajenja – for ON.. and OF.. cooling

$\Delta\theta_{wr}$ - ***Srednja nadtemperatura navitja.*** *Average temperature of winding.*

$$\Delta\theta_{wr} = \Delta\theta_{w0r} + \Delta\theta_{lwr}$$

$\Delta\theta_{hr}$ - ***Nadtemperatura najtoplejše točke.*** *Hot-spot temperature rise.*

$$\Delta\theta_{hr} = \Delta\theta_{or} + H\ g_r$$

H=1,1 distr. trans. ONAN ≤ 2,5 MVA
H=1,3 trans. > 2,5 MVA

Kjer je g_r temperaturna razlika navitje-olje. *Where the g_r represents winding to oil temperature difference.*

$$g_r = \theta_2 - \theta_0$$

θ_2 – ***temperatura navitja v trenutku odklopa.*** *The winding (extrapolated) temperature at instant of shutdown.*
θ_0 – ***srednja ekstrapolirana temperatura olja v navitju.*** *Average extrapolated temp. of the cooling oil in the windings.*

21.7 Merilna oprema; Measuring equipment:

Merilna oprema; Measuring equipment:

- *širokopasovni močnostni analizator Norma, tip D6000, točnosti ± 0.05 %*
- *vide band power analyzer Norma, type D6000, accuracy ± 0.05 %*
- *merilni tokovni in napetostni transformatorji CdC, točnosti ± 0.2 %*
- *measuring current and voltage transformer CdC, accuracy ± 0.2 %*
- *merilnik ohmske upornosti Tettex, tip 2283, točnosti ± 0.06 %*
- *resistance meter Tettex, type 2283, accuracy ± 0.06 %*

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21.0	PREIZKUS SEGREVANJA TEMPERATURE-RISE TEST	- IEC 60076-2

Tehnični podatki:
Technical data:

Transformator tip: Transformer type:	RT 40000-115,5	Tovarniška št.: Serial No.:	78947	Št. načrta.: Draw. No.:	3447
Vezna skupina: Vector group:	YNd5	Število faz: No. of phases:	3	Frekvenca: Frequency:	50 Hz

Navitje: Winding:		VN - HV	NN - LV				
Nazivna moč: Rated power:	[kVA]	40.000	40.000				
Nazivna napetost: Rated voltage:	[kV]	115,5	11				
Nazivni tok: Rated current:	[A]	199,9	2.100				

Hladilni medij: Dielectric type:	Shell Diala S3 ZX-I	Tip hlajenja: Type of cooling:	ONAN / ONAF
Tip hladilnika: Cooler type:	12 x FG 1100x15	Št. vent. / črpalk: No. fans / pumps:	4 / --
Tip vent.: Fan type:	Klima - AVS 630	Tip črpalk: Pump type:	--

Predhodno merjeni podatki:
Injection values:

Stopnja regulacijskega stikala pri segr.: Tap changer position at test:	17		ONAF 40 MVA	
Merjene izgube praznega teka: Measured no load losses:	P_0	[W]	24.527	
Merjene izgube kratkega stika pri 75 °C: Measured load losses at 75 °C:	P_k	[W]	145.756	
Skupne izgube med preizkusom: Injected total losses:	P_{tot}	[W]	170.283	
Tok VN navitja med preizkusom: Current on HV winding:	I_n	[A]	222,2	
	I_n	[A]		
Tok NN2 navitja med preizkusom: Current on LV2 winding:	I_n	[A]	2.100	

OPOMBE:
NOTE:

Meritve opravil:
Tested by: Franc Štempelj
Primož Dimnik

Ljubljana:
2012-12-07

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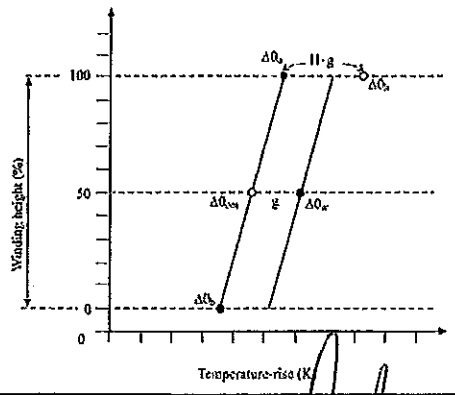
Rezultati segrevanja - ONAF:
Measured results - ONAF:

Temperaturna stabilizacija olja s skupnimi izgubami - Steady - state of oil with total losses

			Izmerjeno Measured	Korekcija Corrected	Garant. Guaran.	
Maksimalna nadtemperatura olja: Top oil temperature rise:	$\Delta\theta_o$	[K]	47,9		≤ 60,0	$\Delta\theta_o = \theta_o - \theta_a$
Srednja nadtemperatura olja (P_{tot}): Average oil temperature rise (P_{tot}):	$\Delta\theta_{om}$	[K]	39,9		--	$\Delta\theta_m = \Delta\theta_o - ((\theta_o - \theta_b)/2)$

Temperaturna stabilizacija navitij z nazivnim tokom - Steady - state of windings with rated current

			Izmerjeno Measured	Korekcija Corrected	Garant. Guaran.	
Srednja nadtemperatura olja (I_n) (VN): Average oil temperature rise (I_n) (HV):	$\Delta\theta_{om'}$	[K]	39,0		--	$\Delta\theta_{om'} = \Delta\theta_{b'} - ((\theta_{o'} - \theta_{b'})/2)$
Temp. razlika nav.- olje srednje (VN): Average winding gradient (HV):	g	[K]	17,1		--	$g = \Delta\theta_{w'} - \Delta\theta_{om'}$
Srednja nadtemperatura navitja (VN): Average winding temperature rise (HV):	$\Delta\theta_w$	[K]	57,0		≤ 65,0	$\Delta\theta_{w'} = \Delta\theta_{m'} + g$
Nadtemperatura najtoplejše točke (VN): Hot-spot temperature rise (HV):	$\Delta\theta_h$	[K]	66,7		≤ 78,0	$\Delta\theta_h = \Delta\theta_o + (g * H)$
Faktor najtoplejše točke (VN): Hot-spot faktor (HV):	H		1,10		--	računska vrednost (IEC 60076-2) calculated value (IEC 60076-2)
	$\Delta\theta_{om'}$	[K]			--	$\Delta\theta_{om'} = \Delta\theta_{b'} - ((\theta_{o'} - \theta_{b'})/2)$
	g	[K]			--	$g = \Delta\theta_{w'} - \Delta\theta_{om'}$
	$\Delta\theta_w$	[K]			≤ 65,0	$\Delta\theta_{w'} = \Delta\theta_{m'} + g$
	$\Delta\theta_h$	[K]			≤ 78,0	$\Delta\theta_h = \Delta\theta_o + (g * H)$
	H				--	računska vrednost (IEC 60076-2) calculated value (IEC 60076-2)
Srednja nadtemperatura olja (I_n) (NN): Average oil temperature rise (I_n) (LV):	$\Delta\theta_{om'}$	[K]	39,0		--	$\Delta\theta_{om'} = \Delta\theta_{b'} - ((\theta_{o'} - \theta_{b'})/2)$
Temp. razlika nav.- olje srednje (NN): Average winding gradient (LV):	g	[K]	15,5		--	$g = \Delta\theta_{w'} - \Delta\theta_{om'}$
Srednja nadtemperatura navitja (NN): Average winding temperature rise (LV):	$\Delta\theta_w$	[K]	55,4		≤ 65,0	$\Delta\theta_{w'} = \Delta\theta_{m'} + g$
Nadtemperatura najtoplejše točke (NN): Hot-spot temperature rise (LV):	$\Delta\theta_h$	[K]	65,7		≤ 78,0	$\Delta\theta_{h'} = \Delta\theta_o + (g * H)$
Faktor najtoplejše točke (NN): Hot-spot faktor (LV):	H		1,15		--	računska vrednost (IEC 60076-2) calculated value (IEC 60076-2)



$\Delta\theta_o$	top-liquid temperature rise
$\Delta\theta_{om}$	average-liquid temperature rise
$\Delta\theta_b$	bottom-liquid temperature rise
$\Delta\theta_w$	average-winding temperature rise at the instant of shutdown
$\Delta\theta_h$	hot-spot winding temperature rise
g	average termal gradient between winding and liquid
H	hot-spot factor

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Temperaturne krivulje olje - ambient
Temperature curves oil - ambient

	merilne točke; measuring point								rezultati; results				opombe; note		
	1	2	3	4	5	6	7	8	(6/7)	(2,3-4,5)					
čas	žep	rad.-zg	rad.-sp	rad.-zg	rad.-sp	amb._1	amb._2	amb._3	ambient	az. rad	hadlemp	razlika			
time	pocket	r.-top	r.-bot	r.-top	r.-bot	amb._1	amb._2	amb._3	amb.	dif. rad.	t. rise	dif. t. rise			
t	θ_o	θ_o	θ_b	θ_o	θ_b	θ_a	θ_a	θ_a	θ_a	$\Delta\theta_{om}$	$\Delta\theta_o$	Δ	*Inlet*	*Cooling*	*Cooler*
h	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	K	K	*value*	*method*	*sistem*
0:00	22,7	22,4	21,0	21,8	21,1	20,9	20,8	20,4	20,7				##		
0:30	30,6	27,5	21,0	26,6	21,1	20,9	20,9	20,5	20,8	6,0	***9,8***		*Ptot (170,3 kW)*	ONAF	closed
1:00	50,5	42,9	22,3	41,9	22,8	21,1	21,0	20,6	20,9	19,9	***29,6***	19,8	*Ptot (170,3 kW)*	ONAF	closed
1:30	65,3	55,3	24,3	53,9	25,3	21,4	21,4	20,9	21,2	29,8	***44,1***	14,5	*Ptot (170,3 kW)*	ONAF	closed
2:00	73,9	61,9	47,3	64,0	45,3	23,4	21,9	21,2	22,2	16,7	***51,7***	7,7	*Ptot (170,3 kW)*	ONAF	open
2:30	72,4	60,3	46,2	62,6	44,8	25,2	22,5	22,9	23,5	16,0	***48,9***	-2,9	*Ptot (170,3 kW)*	ONAF	open
3:00	72,1	60,1	46,1	62,4	44,7	25,5	22,4	23,4	23,8	15,9	***48,3***	-0,5	*Ptot (170,3 kW)*	ONAF	open
3:30	71,9	60,0	46,0	62,2	44,5	25,8	22,5	23,7	24,0	15,9	***47,9***	-0,4	*Ptot (170,3 kW)*	ONAF	open
4:00	71,9	60,0	46,0	62,3	44,5	26,1	22,6	24,2	24,3	15,9	***47,6***	-0,3	*Ptot (170,3 kW)*	ONAF	open
4:30	72,2	60,2	46,2	62,2	44,7	26,4	22,8	24,5	24,6	15,8	***47,6***	0,0	*Ptot (170,3 kW)*	ONAF	open
5:00	72,4	60,6	46,2	62,4	44,7	26,5	22,8	24,6	24,6	16,0	***47,8***	0,1	*Ptot (170,3 kW)*	ONAF	open
5:30	72,6	60,7	46,5	62,5	44,8	26,6	22,9	24,6	24,7	16,0	***47,9***	0,1	*Ptot (170,3 kW)*	ONAF	open
6:00	71,8	59,6	45,7	61,7	44,0	26,3	23,0	24,2	24,5	15,8	***47,3***	-0,6	*In (222,2 A)*	ONAF	open
6:30	71,0	58,5	45,3	61,1	44,0	26,3	22,9	24,2	24,5	15,2	***46,5***	-0,8	*In (222,2 A)*	ONAF	open
7:00															
7:30															
8:00															
8:30															
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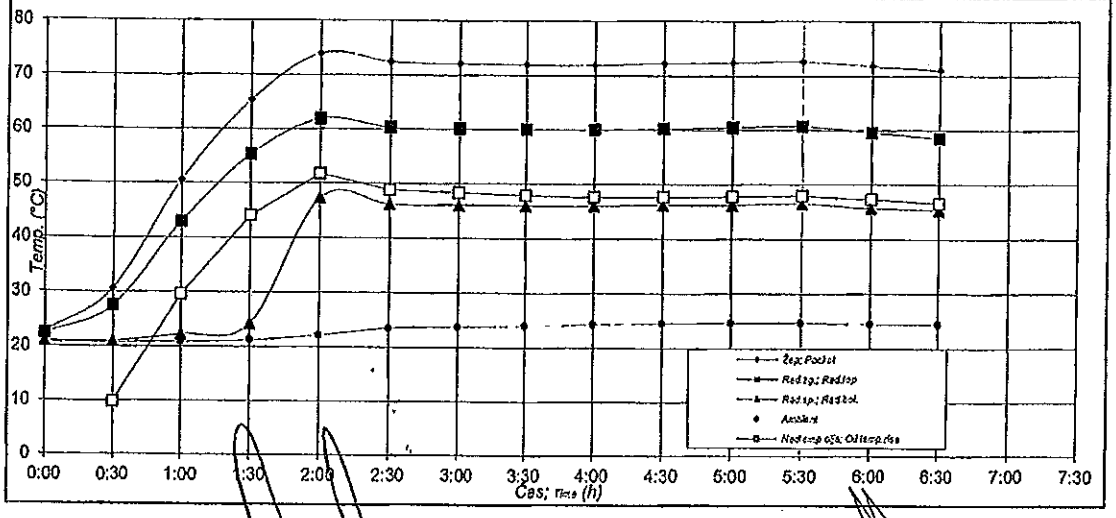

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Upornost merjena po končanem segrevanju - ONAF:
Resistance measured after finished temp. rise - ONAF:

Št. No.	VN navitje HV winding				NN navitje LV winding			
	t [s]	R_2 [Ω]	ΔR_2 [Ω]	$\Delta\theta_w$ [K]	t [s]	R_2 [Ω]	ΔR_2 [Ω]	$\Delta\theta_w$ [K]
0	0,0				0,0			
	≈	≈	≈	≈	≈	≈	≈	≈
1	73,5	1,033821		54,63	77,3	0,008619		52,12
2	103,5	1,031535		53,94	107,0	0,008587		50,97
3	133,5	1,029497		53,32	137,3	0,008555		49,81
4	163,5	1,027388		52,68	167,3	0,008532		48,98
5	193,5	1,025409		52,08	197,3	0,008509		48,13
6	223,5	1,023609		51,56	227,3	0,008482		47,16
7	253,5	1,021774		50,97	257,3	0,008466		46,58
8	283,5	1,020110		50,47	287,3	0,008444		45,79
9	313,5	1,018537		49,99	317,3	0,008431		45,33
10	343,5	1,016988		49,52	347,3	0,008415		44,73
11	373,5	1,015444		49,05	377,6	0,008400		44,20
12	403,5	1,014050		48,63	407,3	0,008385		43,66
13	433,5	1,012632		48,20	437,2	0,008369		43,08
14	463,5	1,011308		47,79	467,2	0,008357		42,65
15	493,5	1,010060		47,42	497,2	0,008349		42,36
16	523,5	1,008832		47,04	527,2	0,008335		41,84
17	553,5	1,007634		46,68	557,2	0,008325		41,53
18	583,5	1,006436		46,31	587,2	0,008317		41,21
19	613,5	1,005328		45,98	617,2	0,008304		40,76
20	643,5	1,004270		45,66	647,5	0,008301		40,61
21	673,5	1,003192		45,33	677,2	0,008290		40,20
22	703,5	1,002235		45,04	707,2	0,008285		40,02
23	733,5	1,001232		44,73	737,2	0,008276		39,73
24	763,5	1,000215		44,42	767,5	0,008267		39,38
25	793,5	0,999287		44,18	797,5	0,008258		39,05
26	823,5	0,998370		43,90	827,1	0,008252		38,87
27	853,5	0,997528		43,64	857,1	0,008246		38,66
28	883,5	0,996655		43,38	887,5	0,008239		38,41
29	913,5	0,995798		43,12	917,5	0,008232		38,17
30	943,5	0,994951		42,86	947,1	0,008226		37,93
31	973,5	0,994179		42,62	977,1	0,008222		37,80
32	1003,5	0,993417		42,39	1007,1	0,008220		37,73
33	1033,5	0,992615		42,15	1037,4	0,008212		37,45
34	1063,5	0,991838		41,91	1067,4	0,008204		37,13
35	1093,5	0,991081		41,68	1097,1	0,008203		37,09
36	1123,5	0,990439		41,49	1127,0	0,008196		36,86
37	1153,5	0,989672		41,25	1157,4	0,008188		36,59
38	1183,5	0,988980		41,08	1187,7	0,008187		36,58
39								
40								

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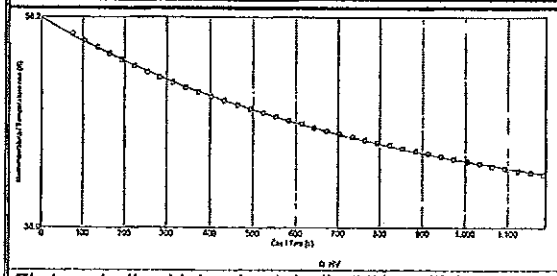
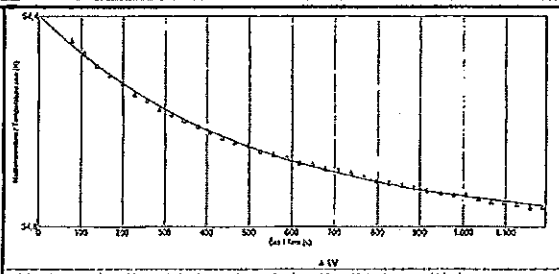
Ohlajevalna krivulja navitja - ONAF:
Winding cooling curve - ONAF:

	VN HV	NN LV				
θ_1 =	24,1	24,1			[°C]	- Temperatura navitja v hladnem stanju - Cold winding temperature
R_1 =	0,852871	0,007168			[Ω]	- Hladna upornost navitja - Cold winding resistance
	1U - 1V	2U - 2V			[ ]	- Upornost merjena na sponkah - The resistance measured on the terminals
R_2 =	1,034242	0,008648			[Ω]	- Upornost navitja po izklopu - Winding resistance at shut - down
$\Delta\theta_W$ =	56,1	54,5			[K]	- Srednja nadtemperatura navitja po izklopu - Average winding temperature rise at shut-down
A_0 =	36,0	34,8			[K]	- Ocenjena srednja nadtemperatura olja - Estimated average oil temperature
T_W =	14,6	8,6			[min]	- Ocenjena termična časovna konstanta navitja - Estimated winding time constant
Δt =	0,5	0,5			[min]	- Časovni interval - Time interval



Ekstrapolacija ohlajevalne krivulje (VN navitje)
Extrapolation of the cooling down curve (HV winding)



Ekstrapolacija ohlajevalne krivulje (NN navitje)
Extrapolation of the cooling down curve (LV winding)

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenija

ETRA 33
ENERGETSKI TRANSFORMATORJI d.d.
Ljubljana - SLOVENIJA

POROČILO - TEST REPORT

12 / 2004

22.0 PREIZKUS Z UDARNO NAPETOSTJO; IMPULSE VOLTAGE TEST

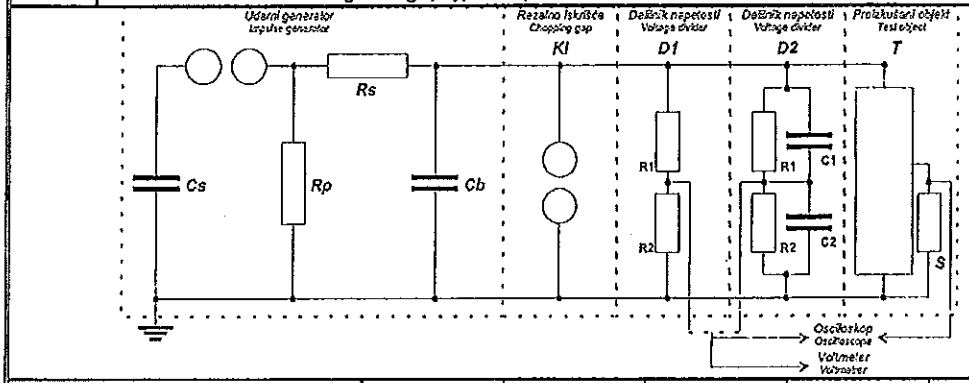
Tehnični podatki; Technical data:

Transformator tip : Transformer type :	RT 20000-110	Tovarniška št. : Serial No. :	74273	Št. načrta. : Draw. No. :	2966

		Navitje; Winding: VN - HV	NN – LV		
Nazivna moč; Nominal power:	[kVA]	20 000	20 000		
Nazivna napetost; Rated voltage:	[kV]	110	6.3		
Stopnja izolacije; Isulation level:		LI/AC 550/230	LI/AC 75/28		
Udarna napetost; Impulse test voltage:	[kV]	550	75		
Položaj stikala; Tap changer position:		1, 8, 19	-		

Vezna skupina; Vector group:	YNd5	Frekvenca; Frequency:	50 Hz	Število faz; No. of phases:	3
Oblika vala; Wave form:	[µs]	1.2/50	Temperatura; Temperature:	[°C]	24
Zračni tlak; Air pressure:	[kPa]				

22.1 Osnovna vezava udarnega kroga; Typical impulse test circuit:



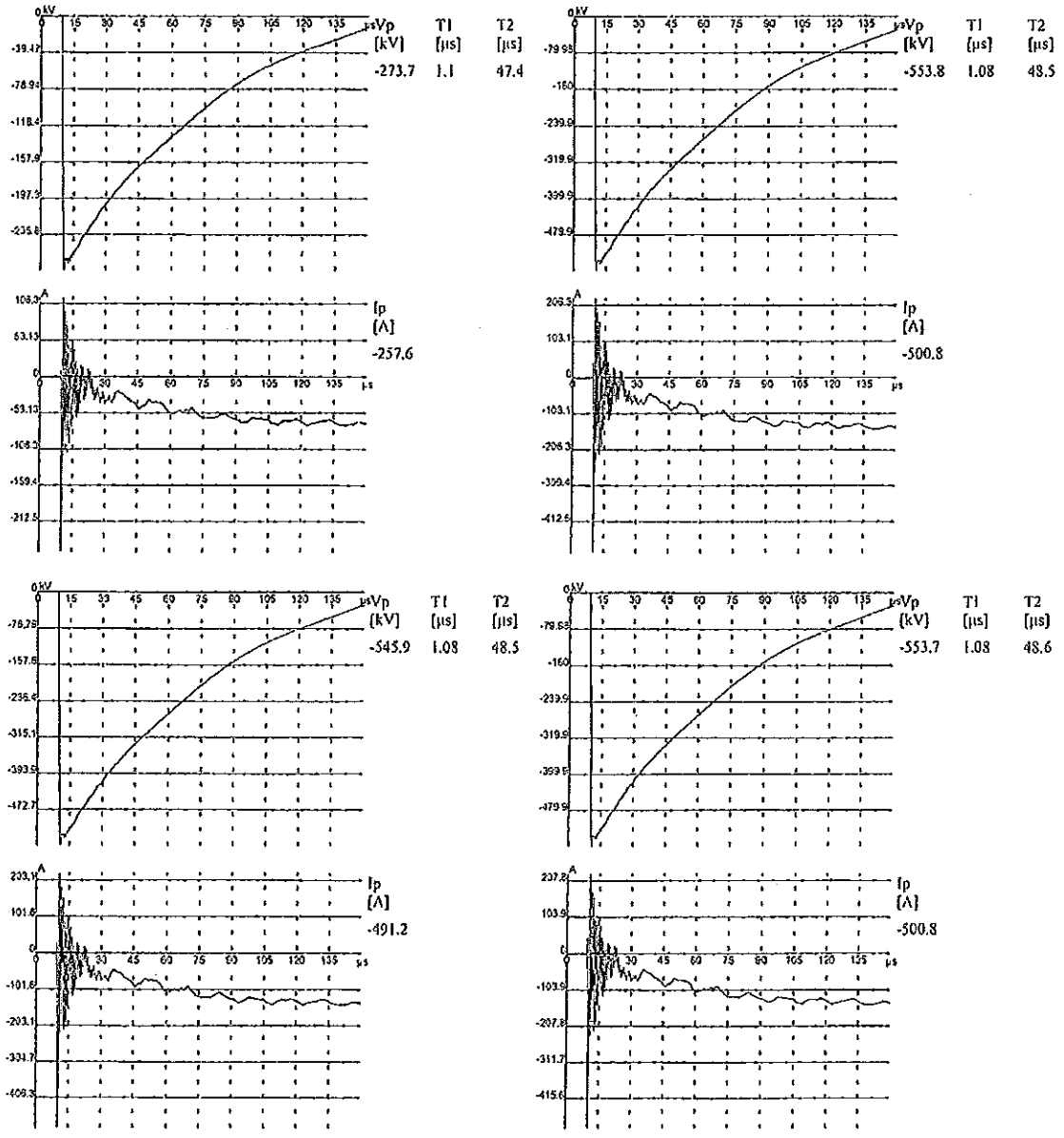
		za VN for HV	za NN for LV			
polariteta; polarity		neg.	neg.			
Ug	[kV]	1200 / 600	1200 / 200			
Par. / ser.	[ ]	1 / 6	3 / 2			
Cs stage	[µF]	1.0	3.0			
Rf stage	[Ω]	12	12			
Rt stage	[Ω]	1 x 75	2 x 75			
Ro + Lk	[Ω, µH]	150 / -	150 / --			
D	[kV]	1200	1200			
k (D)		956	956			
S	[Ω]	1.0	1.0 + 400			
S – priključen; connected		1N	2U – 2V – 2W			
polnilna nap.; charge volt.	[kV]	47.0 / 95.0	28.0 / 56.0			
razmak iskr.; sphere gap dist.	[mm]	20.2 / 44.0	11.1 / 24.2			

Meritve opravil:
Tested by: Franc Štampelj

Ljubljana: 22. junij 2004

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenija

TEST REPORT	ETRA33 d.d. Ljubljana / Slovenija
Impulse Voltage Test - Oscillograms :	Sheet no.: 2
Type: RT 20000-110	Serial No.: 74273
: Phase: 1U	Tap Changer Pos.: 1

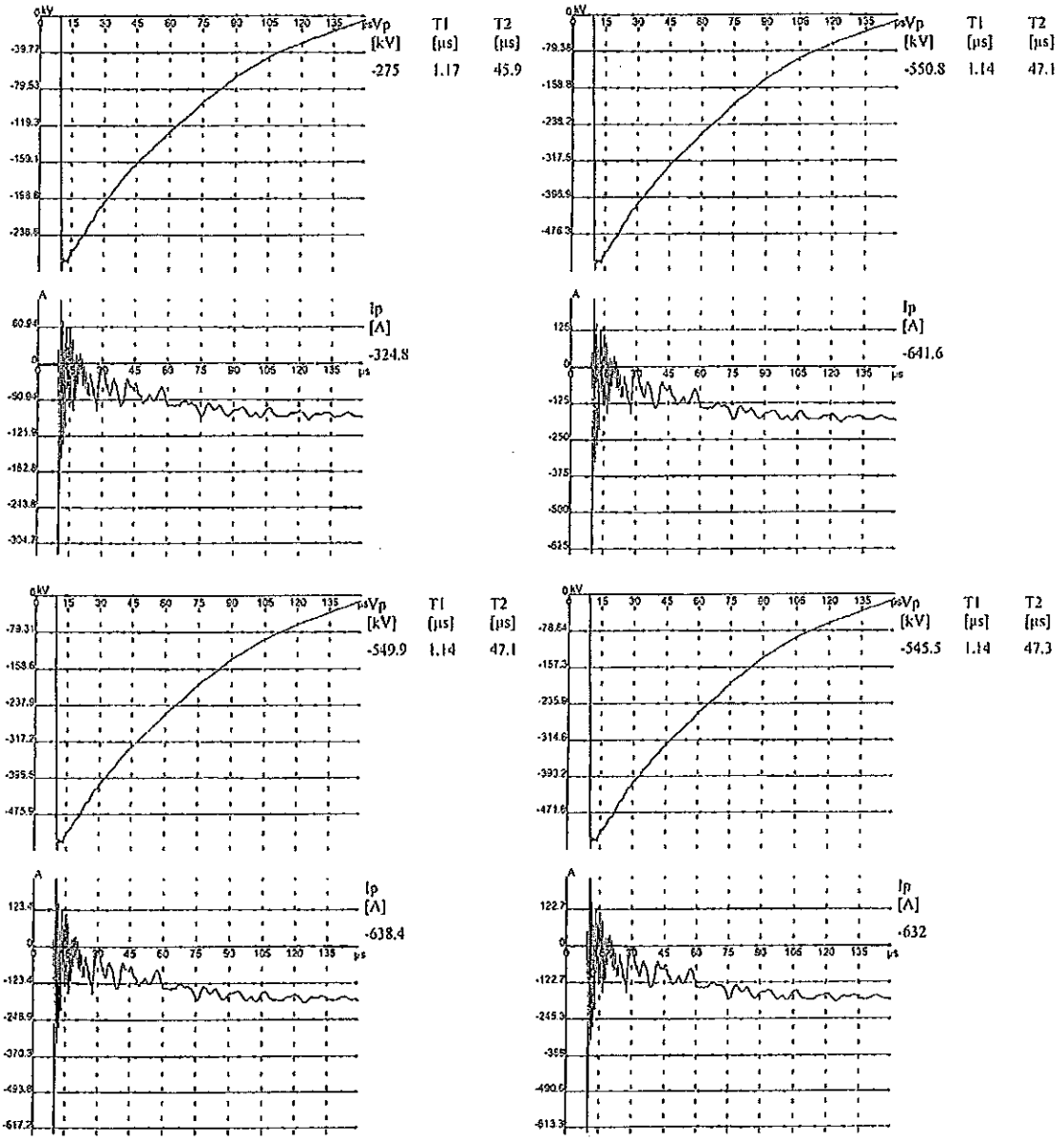


22 June 2004	Measured by:	Checked by:	Approved by:

Data Acquisition System by PASSONI & VILLA - MILAN - ITALY

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana

TEST REPORT	ETRA33 d.d. Ljubljana / Slovenija
Impulse Voltage Test - Oscillograms :	Sheet no.: 3
Type: RT 20000-110	Serial No.: 74273
: Phase: 1V	Tap Changer Pos.: 8

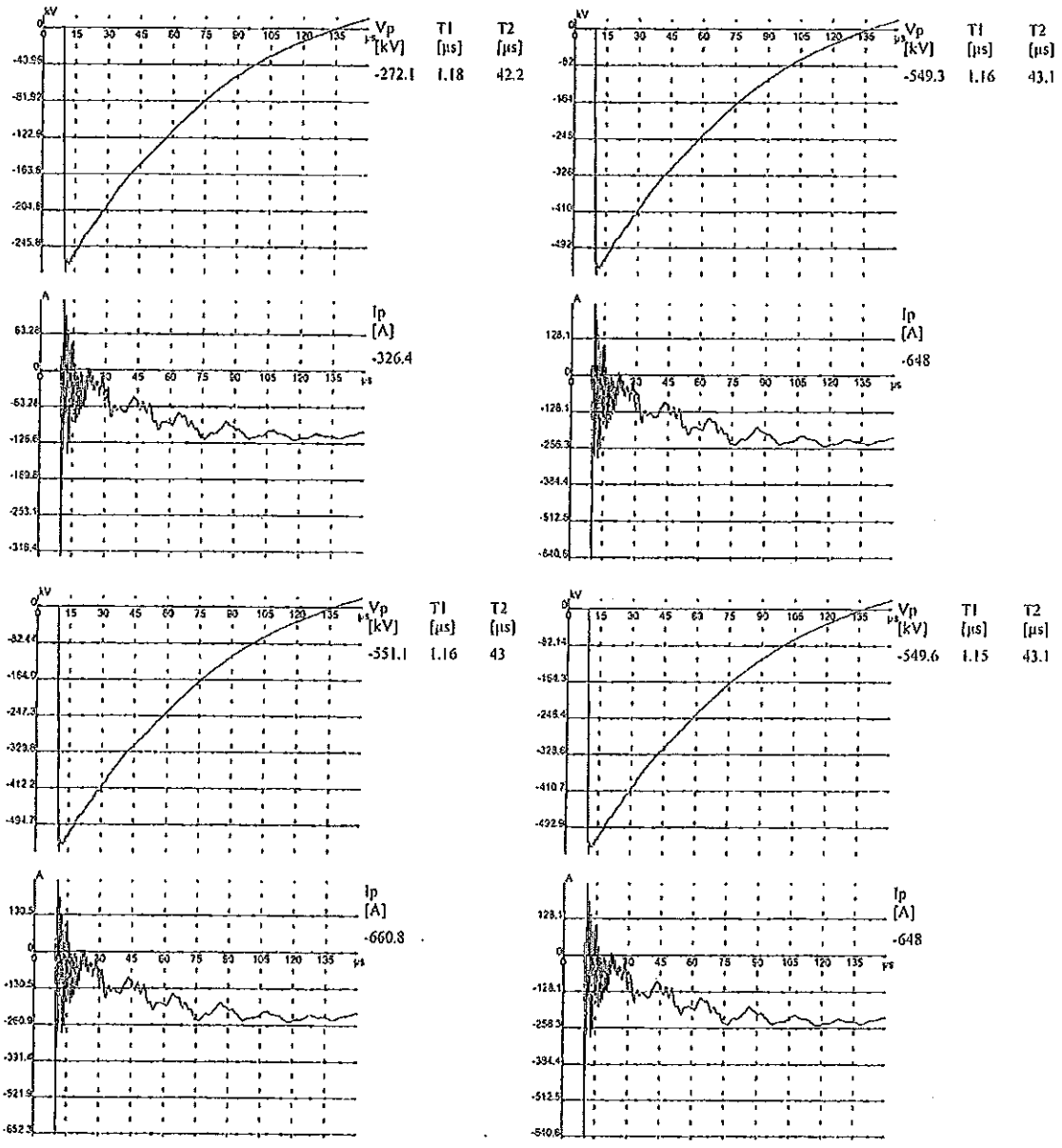


22 June 2004	Measured by:	Checked by:	Approved by:

Data Acquisition System by PASSONI & VILLA - MILAN - ITALY

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana

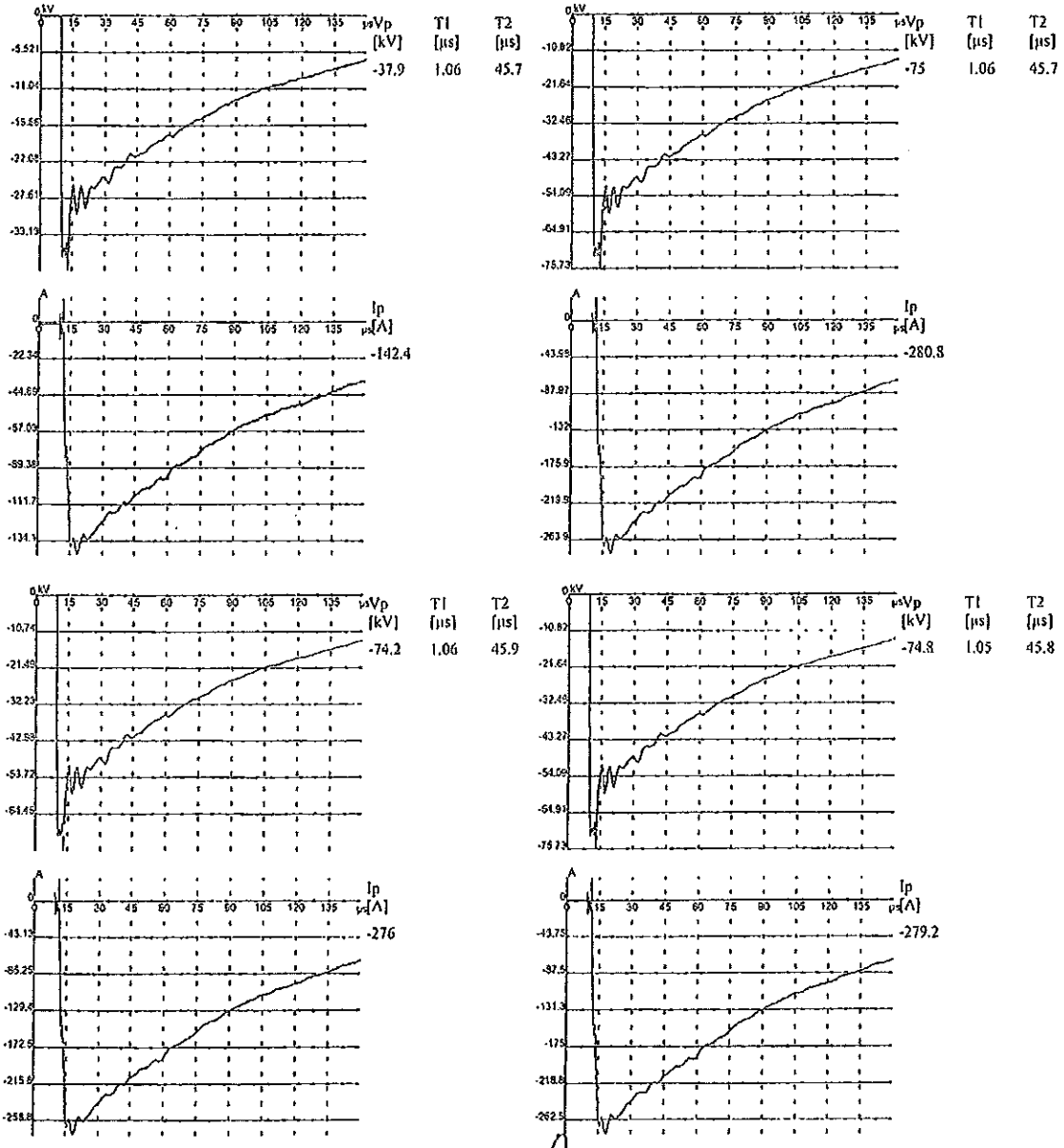
TEST REPORT	ETRA33 d.d. Ljubljana / Slovenija
Impulse Voltage Test - Oscillograms :	Sheet no.: 4
Type: RT 20000-110	Serial No.: 74273
: Phase: 1W	Tap Changer Pos.: 19



22 June 2004	Measured by:	Checked by:	Approved by:
Data Acquisition System by PASSONI & VILLA - MILAN - ITALY			

ELEKTROINŠTITUT
Hajdrihova 2, 1000

TEST REPORT	ETRA33 d.d. Ljubljana / Slovenija
Impulse Voltage Test - Oscillograms :	Sheet no.: 5
Type: RT 20000-110	Serial No.: 74273
: Phase: 2U	Tap Changer Pos.: --



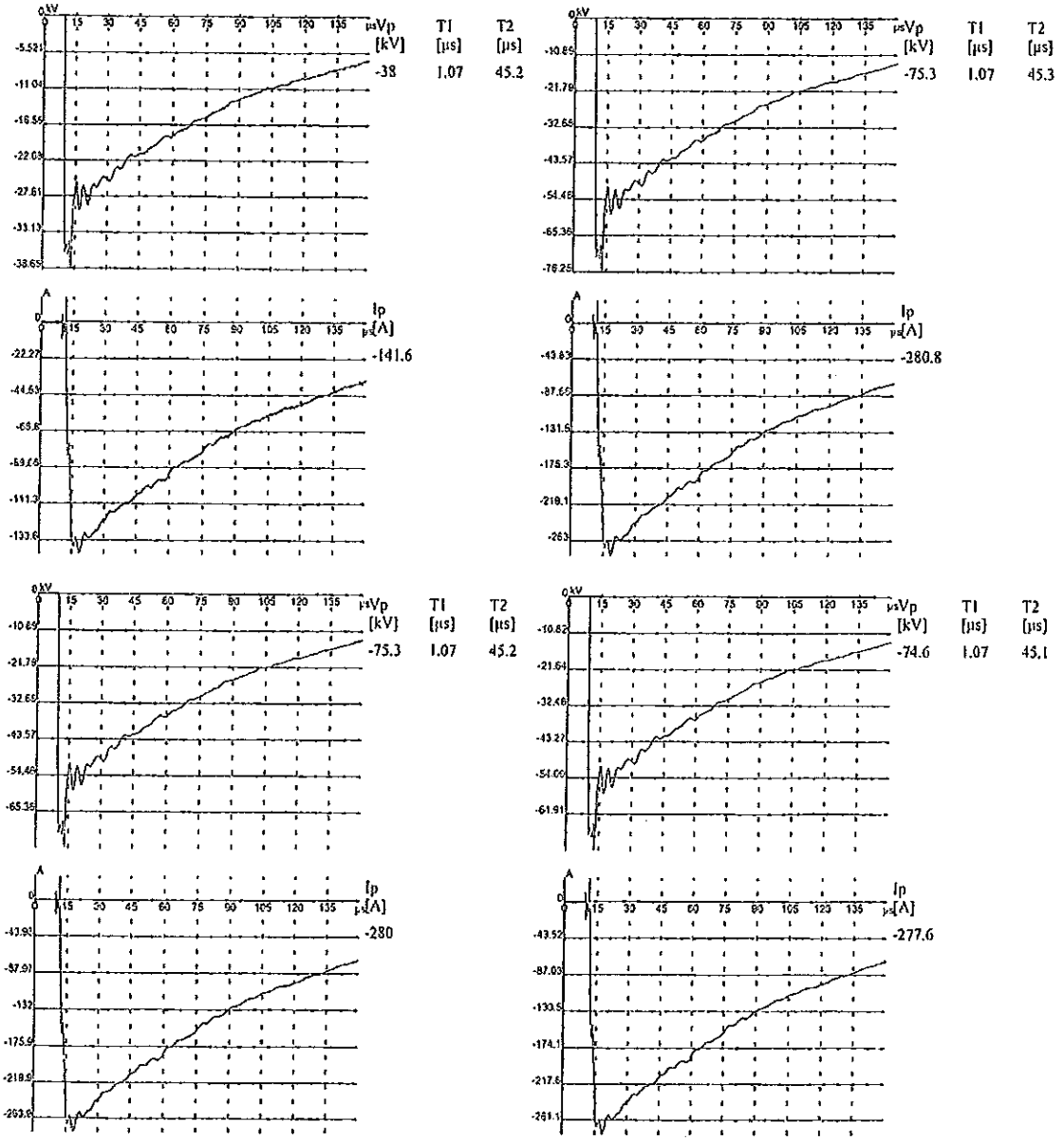
22 June 2004	Measured by:	Checked by:	Approved by:

Data Acquisition System by PASSONI & VILLA - MILAN - ITALY

4

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenia

TEST REPORT	ETRA33 d.d. Ljubljana / Slovenija
Impulse Voltage Test - Oscillograms :	Sheet no.: 6
Type: RT 20000-110	Serial No.: 74273
: Phase: 2V Tap Changer Pos.: --	

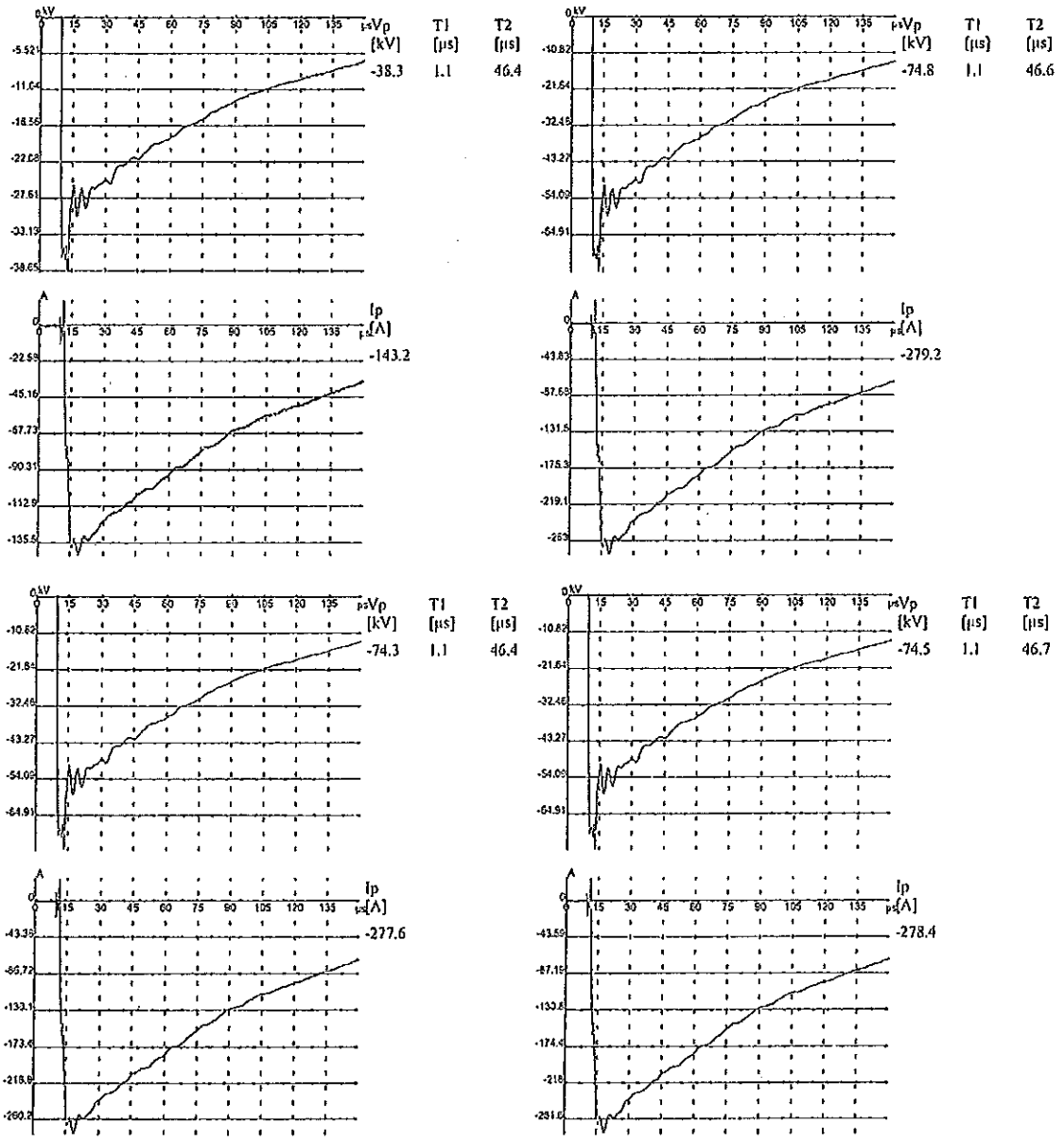


22 June 2004	Measured by:	Checked by:	Approved by:

Data Acquisition System by PASSONI & VILLA - MILAN - ITALY

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Sloven...

TEST REPORT	ETRA33 d.d. Ljubljana / Slovenija
Impulse Voltage Test - Oscillograms :	Sheet no.: 7
Type: RT 20000-110	Serial No.: 74273
: Phase: 2W	Tap Changer Pos.: --



22 June 2004	Measured by:	Checked by:	Approved by:
Data Acquisition System by PASSONI & VILLA - MILAN - ITALY			

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenia

KOLEKTOR ETRA d.o.o.	**POROČILO - TEST REPORT** 100 / 2012

22.0 PREIZKUS Z UDARNO NAPETOSTJO / LIGHTING IMPULSE VOLTAGE TEST

- IEC 60076-3 (clause 13)

Tehnični podatki: / **Technical date:**

Transformator tip: / Transformer type:	RT 40000-115,5	Tovarniška št.: / Serial No.:	78947	Št. načrta.: / Draw. No.:	3447
Vezna skupina: / Vector group:	YNd5	Število faz: / No. of phases:	3	Frekvenca: / Frequency:	50 Hz

Navitje; Winding:		VN - HV	VN_H - HV_H	NN - LV			
Stopnja izolacije: / Insulation level:	Um [kV]	123	123	12			
	LI/AC [kV]	550 / 230	550 / 230	75 /28			
Nazivna moč: / Rated power:	[kVA]	40.000		40.000			
Nazivna napetost: / Rated voltage:	[kV]	115,5		11			
Udarna nap. LI / LIC: / Impulse test voltage LI / LIC:	[kV]	550	550	75			
Priključki / Terminals:		1U; 1V; 1W	1N	2U; 2V; 2W			
Položaj stikala: / Tap changer position:		1; 9; 17	1				
Oblika vala: / Wave shape:		1,2/50 µs	1,2/50 µs	1,2/50 µs			
Čas rezanja: / Chopping time:		--	--	--			

Postopek preizkušanja: / **Test procedure:**

☑ - DA; YES
☒ - NE; NO

LI	☑	En poln udar pri znižani (50%) preizkusni napetosti.	One reduced (50%) level full impulse.
LI	☑	En poln udar pri polni preizkusni napetosti.	One full level full impulse.
LI + LIC	☒	En odrezan udar pri znižani (50%) preizkusni napetosti.	One reduced (50%) level chopped impulse.
LI + LIC	☒	Dva odrezana udara pri polni preizkusni napetosti.	Two full level chopped impulses.
LI	☒	En poln udar pri znižani (50%) preizkusni napetosti.	One reduced (50%) level full impulse.
LI	☑	Dva polna udara pri polni preizkusni napetosti.	Two full level full impulses.

OPOMBE:
NOTE:

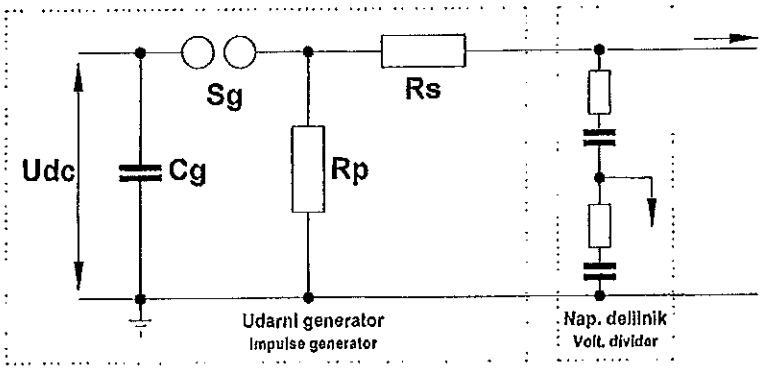
ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenija

Meritve opravil:
Tested by: *Franc Štempelj*
Primož Dimnik

Ljubljana: *2012-12-05*

KOLEKTOR
KOLEKTOR ETRA d.o.o.

Vezava udarnega generatorja:
Diagram of impulse generator:



		Za VN For HV	Za VN For HV	Za NN For LV			
Polariteta: Polarity:		negativ	negativ	negativ			
Število kaskad: No. of stage:		8s 1p	8s 1p	2s 4p			
Kapacitivnost: Capacitance:	[nF]	250	250	4000			
Serijska upornost: Series resistance:	[Ω]	6x20;2x60	8x20	20; 20			
Paralelna kapacitivnost: Paralel capacitance:	[nF]			2,2			
Paralelna upornost: Paralel resistance:	[Ω]	6x68; 2x68/2	8x68	68/5			
Delilnik napetosti: Voltage divider:		2000	2000	2000			
Razmerje delilnika: Measured ratio:	[Ω]	1483	1483	281,6			
Merilni shunt: Shunt:	[Ω]	0,5	0,5	0,5			
Shunt priključen na: Shunt connected to:		LV	LV	HV			
Dodatni upor: Additional resistance:	[Ω]						
Območje (LI): Range (LI):	[kV]	550	550	75			
Območje (LI$_{tc}$): Range (LI$_{tc}$):	[kV]	//	//	//			
Območje (LI): Range (LI):	[A]	200	1000	80			
Območje (LI$_{tc}$): Range (LI$_{tc}$):	[A]	//	//	//			

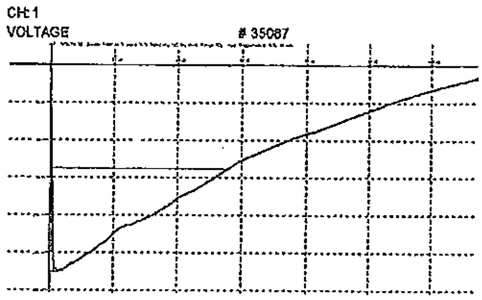
Merilna oprema; Measuring equipment:
- *Digitalni impulzni analizator Haefely HIAS 743-2 in GC 223*
- *Digital impulse analaysing system Haefely HIAS 743-2 and GC 223*

ELEKTROINŠTITUT M[illegible]
Hajdrihova 2, 1000 [illegible]

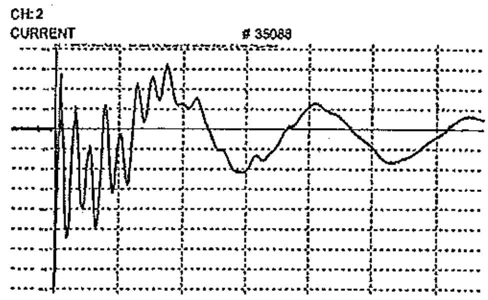
TEST REPORT

Impulse Analysing System by Haefely Test AG

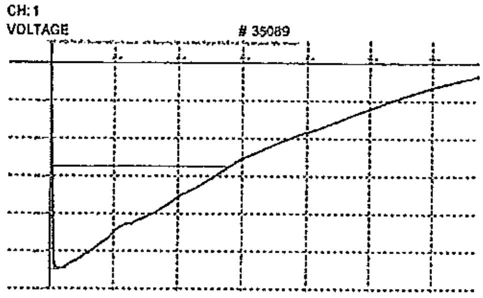
Page: 3; Tr. No.: 78947; Terminal: 1U; Tap. pos.: 1



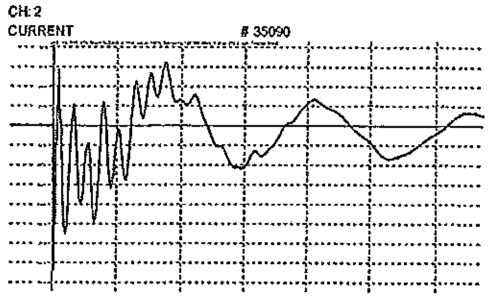
No. 1 LI full Upk: -275.324 kV T1: 1.271 us T2: 56.200 us



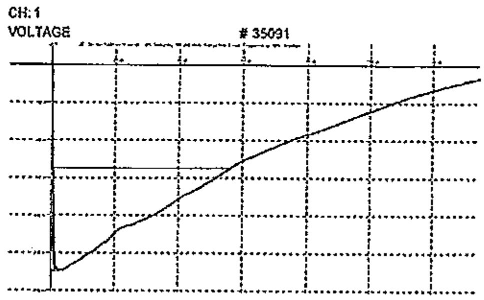
No. 1 LI full Ipk max: -71.960 A Ipk min: 32.532 A



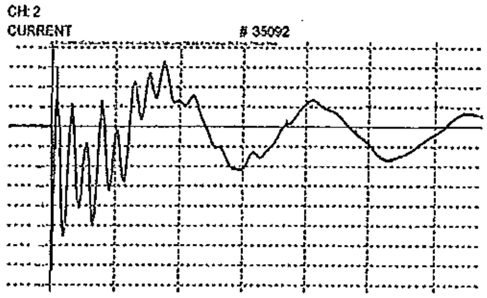
No. 2 LI full Upk: -548.567 kV T1: 1.265 us T2: 56.249 us



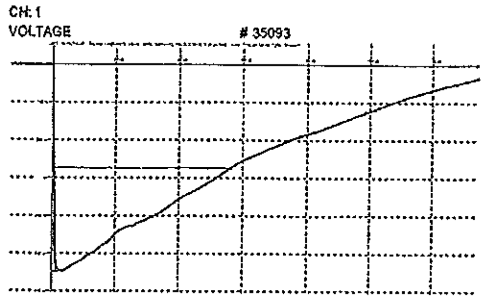
No. 2 LI full Ipk max: -147.627 A Ipk min: 64.697 A



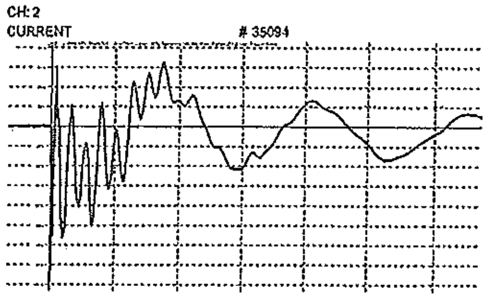
No. 3 LI full Upk: -550.323 kV T1: 1.275 us T2: 56.291 us



No. 3 LI full Ipk max: -145.366 A Ipk min: 65.063 A



No. 4 LI full Upk: -549.243 kV T1: 1.272 us T2: 56.346 us



No. 4 LI full Ipk max: -145.020 A Ipk min: 64.575 A

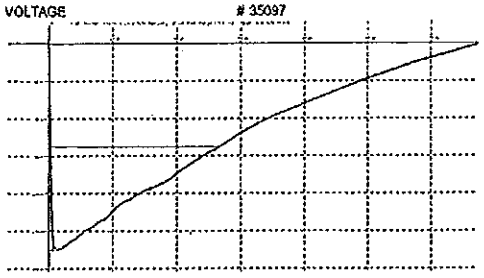
ELEKTROINSTITUT

TEST REPORT

Impulse Analysing System by Haefely Test AG

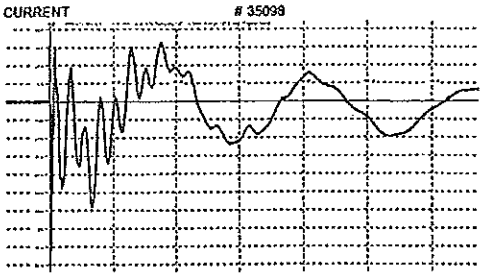
Page: 4; Tr. No.: 78947; Terminal: 1V; Tap. pos.: 9

CH:1
VOLTAGE # 35097



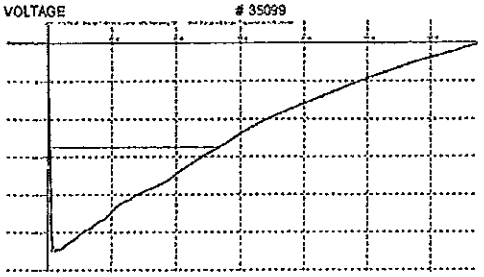
No. 5 LI full Upk: -276.646 kV T1: 1.272 us T2: 53.204 us

CH:2
CURRENT # 35098



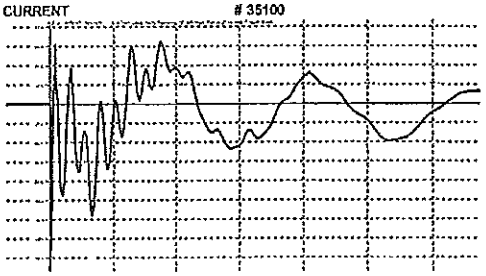
No. 5 LI full Ipk max: -82.397 A Ipk min: 32.593 A

CH:1
VOLTAGE # 35099



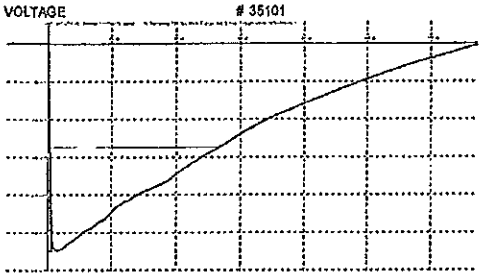
No. 6 LI full Upk: -549.114 kV T1: 1.274 us T2: 53.509 us

CH:2
CURRENT # 35100



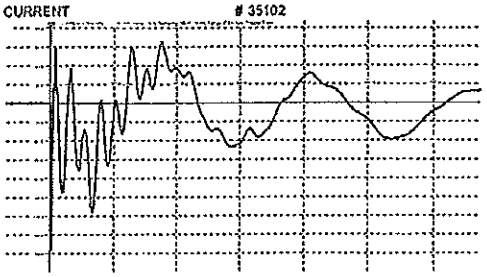
No. 6 LI full Ipk max: -152.954 A Ipk min: 64.697 A

CH:1
VOLTAGE # 35101



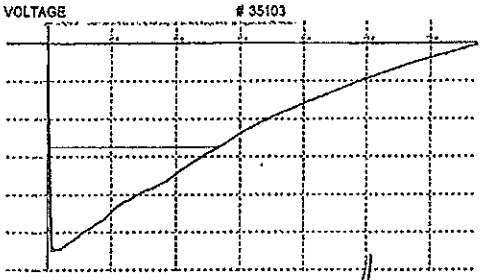
No. 7 LI full Upk: -549.939 kV T1: 1.270 us T2: 53.688 us

CH:2
CURRENT # 35102



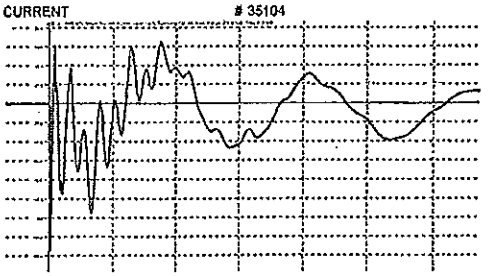
No. 7 LI full Ipk max: -157.637 A Ipk min: 64.941 A

CH:1
VOLTAGE # 35103



No. 8 LI full Upk: -549.419 kV T1: 1.270 us T2: 53.563 us

CH:2
CURRENT # 35104



No. 8 LI full Ipk max: -156.006 A Ipk min: 64.941 A

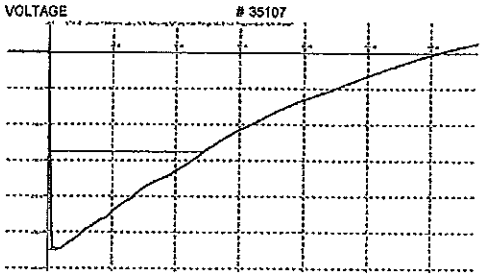
ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenia

TEST REPORT

Impulse Analysing System by Haefely Test AG

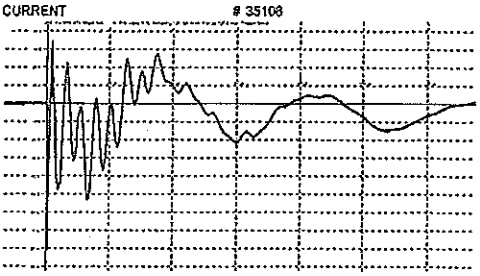
Page: 5; Tr. No.: 78947; Terminal: 1W; Tap. pos.: 17

CH: 1
VOLTAGE # 35107



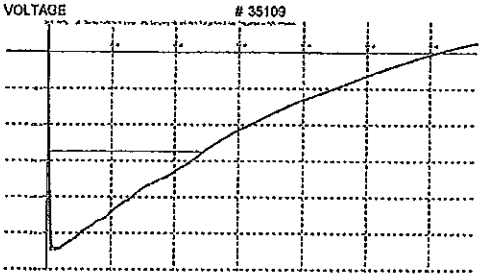
No. 9 LI full Upk: -278.206 kV T1: 1.268 us T2: 49.199 us

CH: 2
CURRENT # 35108



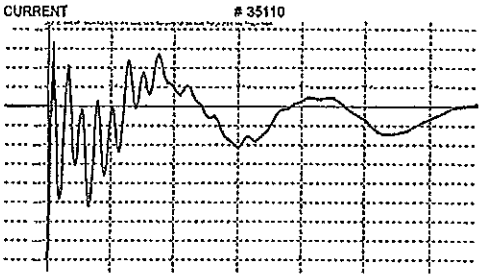
No. 9 LI full Ipk max: -60.627 A Ipk min: 33.936 A

CH: 1
VOLTAGE # 35109



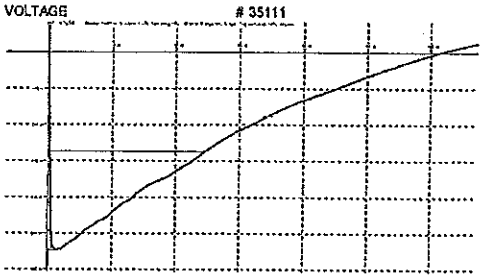
No. 10 LI full Upk: -548.463 kV T1: 1.272 us T2: 49.370 us

CH: 2
CURRENT # 35110



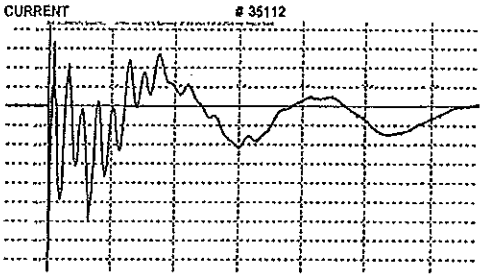
No. 10 LI full Ipk max: -151.245 A Ipk min: 68.406 A

CH: 1
VOLTAGE # 35111



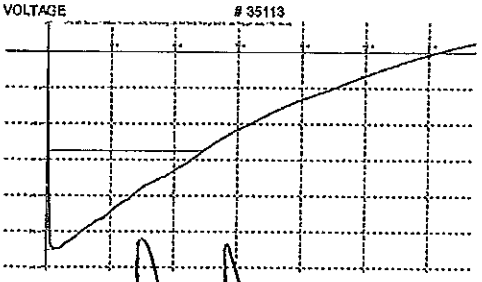
No. 11 LI full Upk: -549.581 kV T1: 1.280 us T2: 49.383 us

CH: 2
CURRENT # 35112



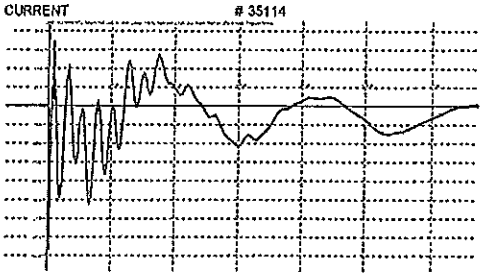
No. 11 LI full Ipk max: -150.879 A Ipk min: 66.528 A

CH: 1
VOLTAGE # 35113



No. 12 LI full Upk: -552.318 kV T1: 1.281 us T2: 49.418 us

CH: 2
CURRENT # 35114



No. 12 LI full Ipk max: -154.663 A Ipk min: 68.359 A

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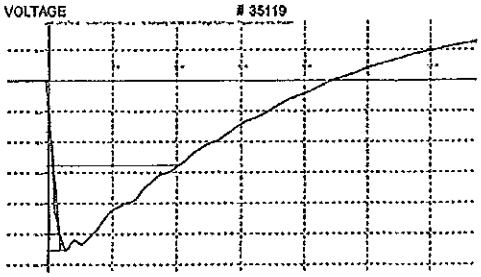
TEST REPORT

Impulse Analysing System by Haefely Test AG

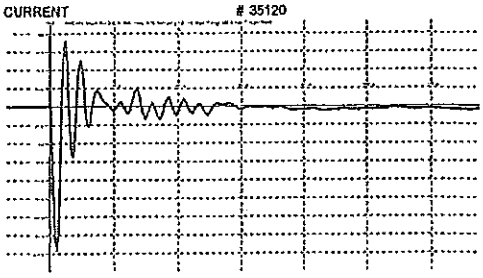
Page: 6; Tr. No.: 78947; Terminal: 1N; Tap. pos.: 1

CH: 1
VOLTAGE # 35119



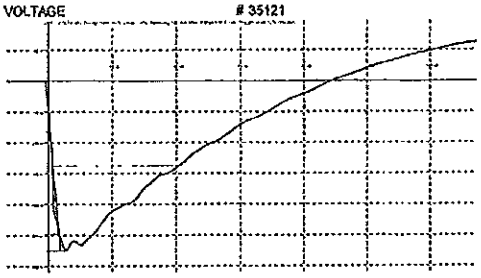
No. 14 LI full Upk: -276.406 kV T1: 4.720 us T2: 41.830 us

CH: 2
CURRENT # 35120



No. 14 LI full Ipk max: -389.688 A Ipk min: 176.938 A

CH: 1
VOLTAGE # 35121

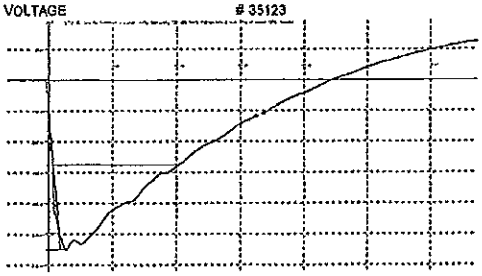


No. 15 LI full Upk: -548.798 kV T1: 4.725 us T2: 42.026 us

CH: 2
CURRENT # 35122

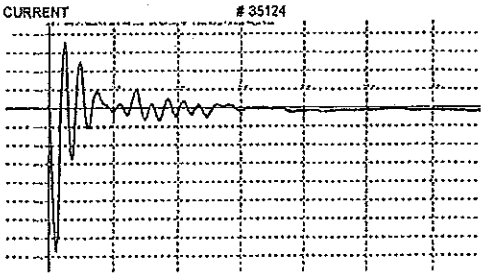
No. 15 LI full Ipk max: -773.350 A Ipk min: 355.605 A

CH: 1
VOLTAGE # 35123



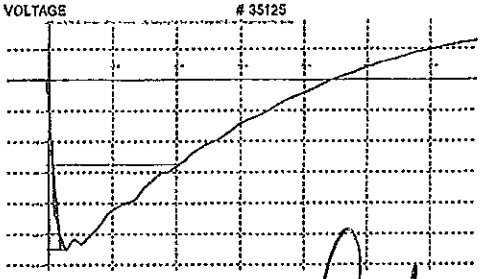
No. 16 LI full Upk: -549.892 kV T1: 4.725 us T2: 41.933 us

CH: 2
CURRENT # 35124



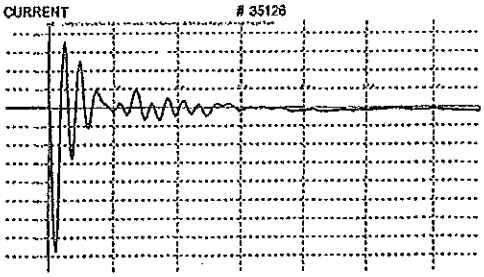
No. 16 LI full Ipk max: -770.669 A Ipk min: 353.760 A

CH: 1
VOLTAGE # 35125



No. 17 LI full Upk: -550.383 kV T1: 4.699 us T2: 41.667 us

CH: 2
CURRENT # 35126



No. 17 LI full Ipk max: -772.119 A Ipk min: 351.914 A

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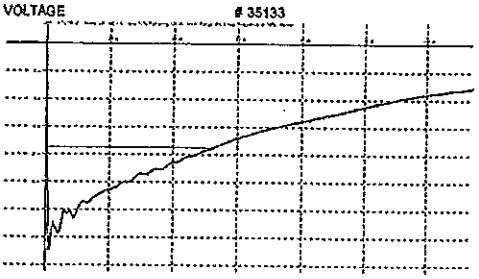
TEST REPORT

Impulse Analysing System by Haefely Test AG

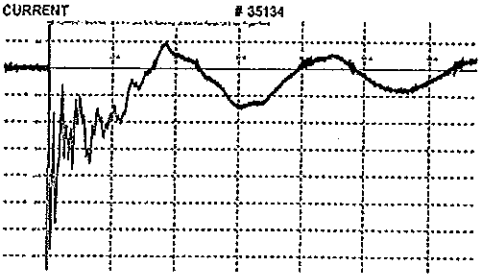
Page: 7; Tr. No.: 78947; Terminal: 2U; Tap. pos.: --

CH: 1
VOLTAGE
35133



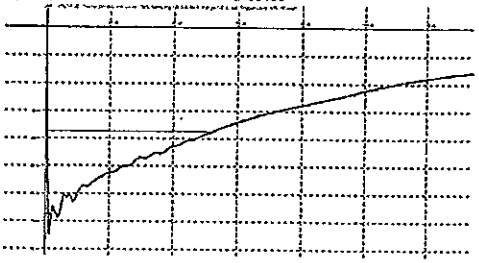
No. 20 LI full Upk: -37.397 kV T1: 1.277 us T2: 53.155 us

CH: 2
CURRENT
35134



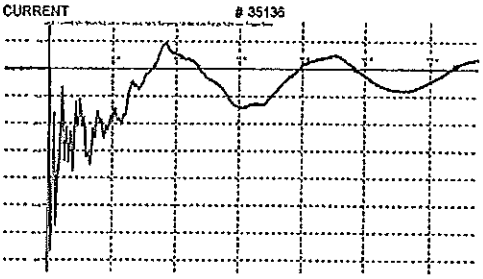
No. 20 LI full Ipk max: -33.887 A Ipk min: 4.932 A

CH: 1
VOLTAGE
35135



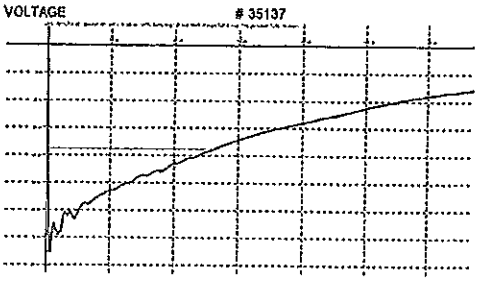
No. 21 LI full Upk: -75.013 kV T1: 1.268 us T2: 53.080 us

CH: 2
CURRENT
35136



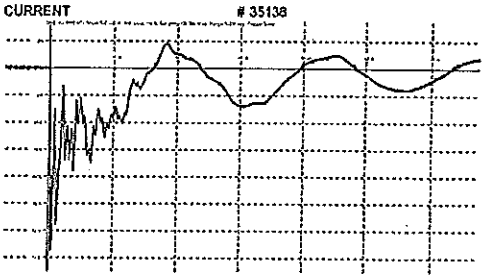
No. 21 LI full Ipk max: -66.650 A Ipk min: 9.473 A

CH: 1
VOLTAGE
35137



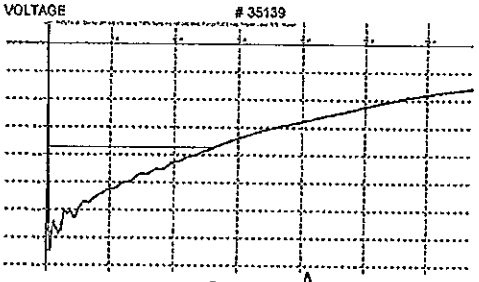
No. 22 LI full Upk: -75.077 kV T1: 1.252 us T2: 53.162 us

CH: 2
CURRENT
35138



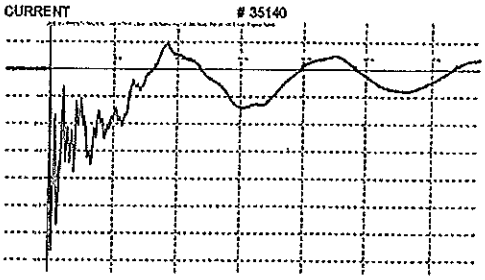
No. 22 LI full Ipk max: -67.480 A Ipk min: 9.570 A

CH: 1
VOLTAGE
35139



No. 23 LI full Upk: -74.977 kV T1: 1.272 us T2: 53.029 us

CH: 2
CURRENT
35140



No. 23 LI full Ipk max: -66.553 A Ipk min: 9.421 A

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TEST REPORT

Impulse Analysing System by Haefely Test AG

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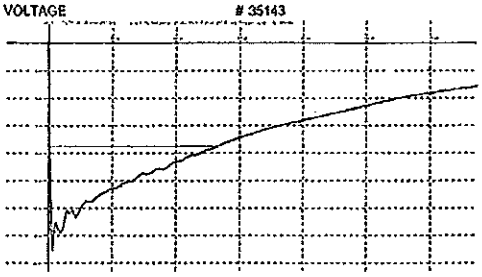
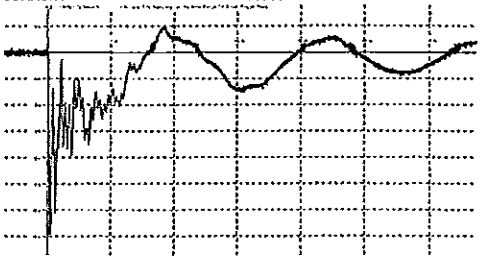
CH: 1
VOLTAGE # 35143



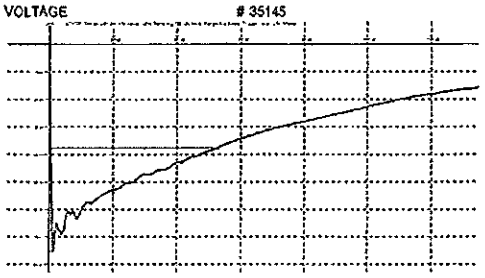
No. 24 LI full Upk: -37.477 kV T1: 1.266 us T2: 53.104 us

CH: 2
CURRENT # 35144



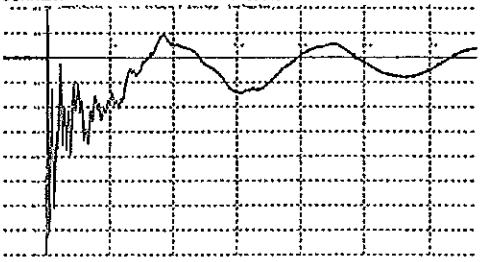
No. 24 LI full Ipk max: -34.668 A Ipk min: 5.029 A

CH: 1
VOLTAGE # 35145



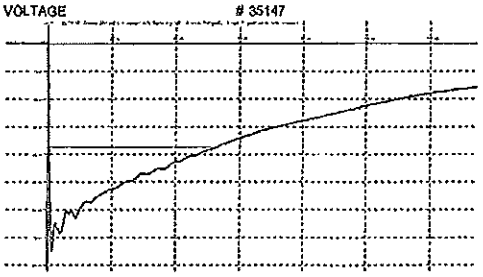
No. 25 LI full Upk: -75.129 kV T1: 1.255 us T2: 53.045 us

CH: 2
CURRENT # 35146



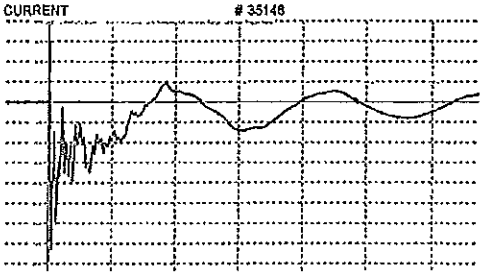
No. 25 LI full Ipk max: -71.675 A Ipk min: 12.793 A

CH: 1
VOLTAGE # 35147



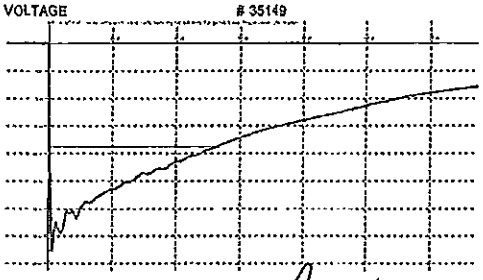
No. 26 LI full Upk: -74.617 kV T1: 1.264 us T2: 53.139 us

CH: 2
CURRENT # 35148



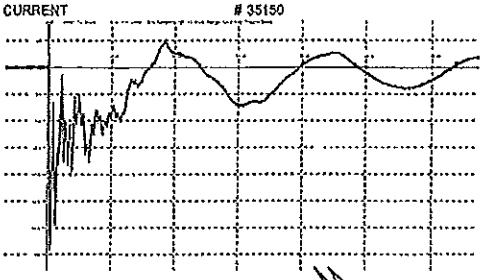
No. 26 LI full Ipk max: -73.438 A Ipk min: 29.932 A

CH: 1
VOLTAGE # 35149



No. 27 LI full Upk: -75.178 kV T1: 1.266 us T2: 53.121 us

CH: 2
CURRENT # 35150



No. 27 LI full Ipk max: -68.555 A Ipk min: 9.814 A

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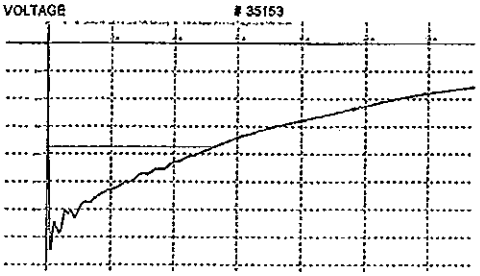
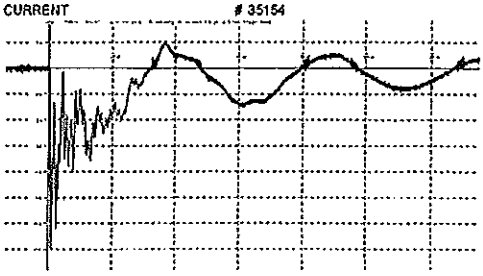
Hajdrihova 2, 1000 Ljubljana, SLO

CH: 1
VOLTAGE # 35153



No. 28 LI full Upk: -37.392 kV T1: 1.272 us T2: 53.294 us

CH: 2
CURRENT # 35154

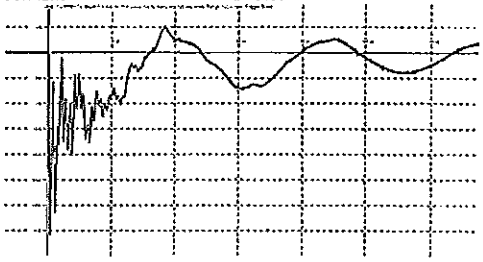


No. 28 LI full Ipk max: -35.156 A Ipk min: 5.273 A

CH: 1
VOLTAGE # 35155

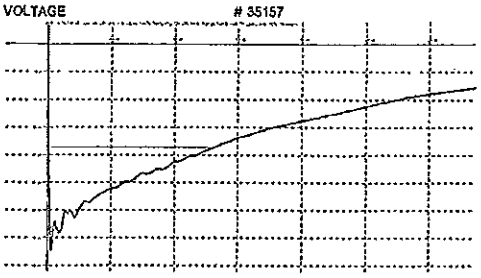
No. 29 LI full Upk: -75.474 kV T1: 1.276 us T2: 52.611 us

CH: 2
CURRENT # 35156



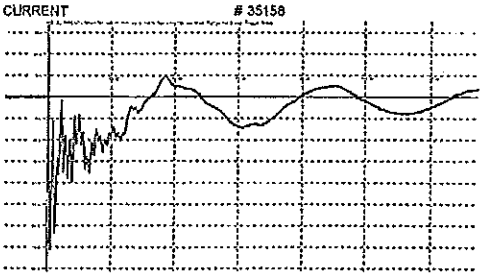
No. 29 LI full Ipk max: -71.631 A Ipk min: 10.400 A

CH: 1
VOLTAGE # 35157



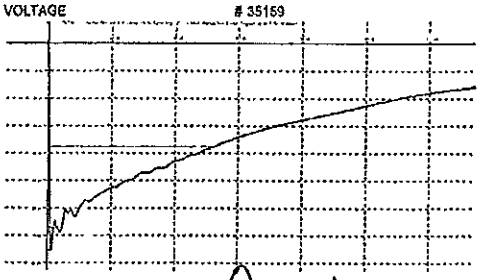
No. 30 LI full Upk: -74.827 kV T1: 1.274 us T2: 52.798 us

CH: 2
CURRENT # 35158



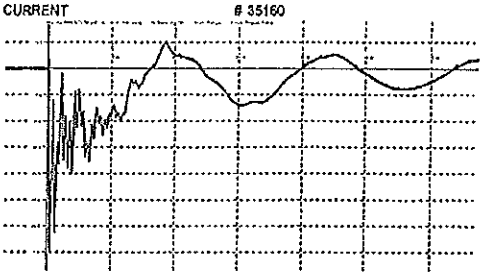
No. 30 LI full Ipk max: -71.240 A Ipk min: 25.586 A

CH: 1
VOLTAGE # 35159



No. 31 LI full Upk: -75.142 kV T1: 1.259 us T2: 52.877 us

CH: 2
CURRENT # 35160



No. 31 LI full Ipk max: -69.238 A Ipk min: 10.254 A

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Hajdrihova 2, 1000 Lj...

ETRA 33 ENERGETSKI TRANSFORMATORJI d.d. Ljubljana - SLOVENIJA	**MERILNI LIST TRANSFORMATORJA** **TRANSFORMER TEST REPORT**

Naročnik: Purchaser:	Proizvajalec: Manufacturer:	Preizkušeno po: Tested in acordance with:	Leto izdelave: Year of manufacture:
Termoelektrarna Trbovlje	ETRA 33 ENERGETSKI TRANSFORMATORJI d.d.	*EN 60076*	*2004*

TEHNIČNI PODATKI
TECHNICAL RATING

	Transformator: Transformer:	Regulacijsko stikalo: Tap-changer:	Komandna omarica reg. st.: Tap-changer motor drive unit:
Tip: Type:	*RT 20000-110*	*MR - MS III 300Y*	*MR - ED 100S*
Tov. št.: Ser. No.:	*74273*	*589 264*	*589 264*
Št. načrta: Diagram No.:	*2966*		

Navitje; Winding :		*VN - HV*	*NN - LV*			
Stopnja izolacije; *Um*	*[kV]*	*123*	*12*			
Insulation level : *LI / AC*	*[kV]*	*550 / 230*	*75 / 28*			
Nazivna moč; Rated power :	*[kVA]*	*20 000*	*20 000*			
Nazivna napetost; Rated voltage :	*[kV]*	*+ 7 x 1.82%*				
		110 000	*6 300*			
		- 11 x 1.82%				
Nazivni tok ; Rated current :	*[A]*	*105.0*	*1832.9*			

Frekvenca: Frequency:	Število faz: No. of phases:	Vezna skupina: Vector group:	Sistem hlajenja: Cooling method:
50 Hz	*3*	*YNd5*	*ONAN / ONAF*
Skupna masa *[t]*: Total weight *[t]*:	Masa olja *[t]*: Weight of oil *[t]*:		Tip izolacijskega olja: Type of isolation oil:
42.0	*10.5*		*Nynas Nytro 10X*

OPOMBE:
NOTES: *ONAN - 12 MVA*
ONAF - 20 MVA

I: 39/04

Preizkusom je prisostvoval:
The test was carried out in presence of:
g. Jože AHAC - TE Trbovlje
g. Anton URANKAR - TE Trbovlje
g. Damjan DETELA - TE Trbovlje
g. Marko KNEZ - TE Trbovlje
g. Mladen IGLIČ - EIMV

ELEKTROINŠTITUT MILAN VIDMAR
Hajdrihova 2, 1000 Ljubljana, Slovenija

Meritve opravil:
Tested by:
Franc Štempelj
Bojan Košir

Ljubljana:
22. junij 2004

ETRA 33 ENERGETSKI TRANSFORMATORJI d.d. Ljubljana - SLOVENIJA	**MERILNI LIST TRANSFORMATORJA** *TRANSFORMER TEST REPORT*	
Transformator: Transformer:	**RT 20000-110**	Tov. št.: Ser. No.: **74273**

SPISEK MERITEV IN PREIZKUSOV
LIST OF MEASUREMENTS AND TESTS

1.0	Meritev prestavnega razmerja *Measurement of voltage ratio*	☑
1.1	Meritev magnetilnih tokov pri 400 V, 50 Hz *No-load current at 400 V, 50 Hz*	☑
2.0	Meritev ohmskih upornosti navitij *Measurement of winding resistance*	☑
3.1	Meritev izgub in toka praznega teka *Measurement of no-load loss and no-load current*	☑
3.2	Meritev izgub in napetosti kratkega stika *Measurement of load loss and impedance voltage*	☑
3.3	Rezultati meritev izgub *Results of loss measurements*	☑
4.1	Preizkus z inducirano napetostjo *Induced AC withstand voltage test*	☑
4.2	Meritev delnih praznjenj *Partial discharge measurement*	☑
4.3	Preizkus z napetostjo iz tujega vira *Separate-source voltage withstand test*	☑
4.4	Meritev izolacijske upornosti *Measurements of insulation resistance*	☑
4.5	Meritev prebojne trdnosti izolacijskega olja *Measurements of dielectric strength of insulating oil*	☑
5.0	Preizkus regulacijskega stikala *Tests on on-load tap-changer*	☑
6.0	Meritev ničnе impedance *Measurement of zero_sequence impedance*	☑
7.0	Meritev izgub hladilnega sistema *Measurements of loss of cooling system*	☑
11.0	Meritev kapacitivnosti in tg δ *Measurements of capacity and dissipation factor tg δ*	☑
12.0	Meritev stresane induktivnosti *Measurements of leakage inductance*	☑
13.0	Meritev nivoja hrupa *Measurement of sound level*	☑
15.0	Spisek elementov na transformatorju *List of elements on transformer*	☑
16.0	Funkcionalni preizkus komandne omarice *Functional test of control cubicle*	☑
17.0	Funkcionalni preizkus elementov na transformatorju *Functional test of elements on transformer*	☑
18.0	Meritev višjeharmonskih tokov praznega teka *Measurements of the harmonics of the no-load current*	☑
19.0	Meritve na vgrajenih tokovnih transformatorjih *Measurement on built-in current transformers*	☑
21.0	Preizkus segrevanja *Temperature-rise test*	☑
22.0	Preizkus z udarno napetostjo *Impulse voltage test*	☑

☑ preizkus opravljen; test O.K.

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Hajdrihova 2, 1000 Ljubljana, Slovenija

ETRA 33
ENERGETSKI TRANSFORMATORJI d.d.
Ljubljana - SLOVENIJA

MERILNI LIST TRANSFORMATORJA
TRANSFORMER TEST REPORT

Transformator: / Transformer:	RT 20000-110	Tov. št.: / Ser. No.:	74273

1.0 MERITEV PRESTAVNEGA RAZMERJA IN VEZNE SKUPINE
MEASUREMENT OF VOLTAGE RATIO AND VECTOR GROUP

- IEC 60076-1 (clause 10.3)

Vezna skupina / Vector group: YNd5

Poz. stik.: Tap pos.:	Računska napetost: Calculated voltage: U_1 [V]	U_2 [V]	Konstanta: Constant: [$U_2 / U_1 \times k$]	Izmerjeno odstopanje: Measured deviations: 1U / 2U [%]	1V / 2V [%]	1W / 2W [%]
1	124 014		87.996	-0.22	-0.22	-0.22
2	122 012		89.440	-0.22	-0.22	-0.22
3	120 010		90.931	-0.21	-0.21	-0.21
4	118 008		92.474	-0.20	-0.20	-0.20
5	116 006		94.069	-0.19	-0.19	-0.19
6	114 004		95.720	-0.18	-0.18	-0.18
7	112 002		97.430	-0.17	-0.17	-0.17
8	110 000	6 300	99.203	-0.16	-0.16	-0.16
9	107 998		101.041	-0.15	-0.15	-0.15
10	105 996		102.949	-0.15	-0.15	-0.15
11	103 994		104.931	-0.14	-0.14	-0.14
12	101 992		106.989	-0.12	-0.12	-0.12
13	99 990		109.131	-0.11	-0.11	-0.11
14	97 988		111.359	-0.09	-0.09	-0.09
15	95 986		113.681	-0.08	-0.08	-0.08
16	93 984		116.101	-0.07	-0.07	-0.07
17	91 982		118.627	-0.06	-0.06	-0.06
18	89 980		121.265	-0.05	-0.05	-0.05
19	87 978		124.023	-0.04	-0.04	-0.04

Merilna oprema; Measuring equipment:
- merilnik prestavnega razmerja Končar, tip MK1, točnosti ± 0.05 %
- turns ratio meter Končar, type MK1, accuracy ± 0.05 %

1.1 MERITEV MAGNETILNIH TOKOV pri 400 V, 50 Hz
NO-LOAD CURRENT at 400 V, 50 Hz

Poz. stik.: Tap pos.:	Navitje: Winding:	Faza A [mA] Phase A [mA]	Faza B [mA] Phase B [mA]	Faza C [mA] Phase C [mA]
8	VN - HV	2.9	2.2	3.2
--	NN - LV	190	200	290

Merilna oprema; Measuring equipment:
- univerzalni instrument točnosti ± 0.5 %
- multimeter accuracy ± 0.5 %

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Transformator: / Transformer:	RT 20000-110	Tov. št.: / Ser. No.:	74273

2.0 MERITEV OHMSKIH UPORNOSTI NAVITIJ / MEASUREMENT OF WINDING RESISTANCE

- IEC 60076-1 (clause 10.2)

Temperatura - Temperature ϑ: 26 °C

Poz. stik.: / Tap pos.:	VN navitje / HV winding			I_{test} 11 A
	1U - 1V [Ω]	1V - 1W [Ω]	1U - 1W [Ω]	
1	2.281231	2.283006	2.282383	
2	2.227126	2.228447	2.228714	
3	2.171806	2.173172	2.173461	
4	2.117701	2.118964	2.118917	
5	2.063420	2.064412	2.063564	
6	2.008181	2.009795	2.008812	
7	1.953620	1.955487	1.955141	
8	1.898425	1.899892	1.900149	
9	1.843557	1.845145	1.845787	
10	1.785276	1.785839	1.786124	
11	1.842761	1.845557	1.844888	
12	1.898084	1.900802	1.899600	
13	1.952378	1.955212	1.953927	
14	2.007475	2.010348	2.008790	
15	2.062250	2.065051	2.063727	
16	2.116877	2.119731	2.118377	
17	2.172332	2.175034	2.173504	
18	2.226878	2.229644	2.228043	
19	2.281897	2.284537	2.283017	

Poz. stik.: / Tap pos.:	NN navitje / LV winding			I_{test} 11 A
	2U - 2V [Ω]	2V - 2W [Ω]	2U - 2W [Ω]	
	0.005654	0.005717	0.005722	

Merilna oprema; Measuring equipment:

- merilnik ohmske upornosti Tettex, tip 2283, točnosti ± 0.06 %
- resistance meter Tettex, type 2283, accuracy ± 0.06 %

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3.1 MERITEV IZGUB IN TOKA PRAZNEGA TEKA / MEASUREMENT OF NO-LOAD LOSS AND NO-LOAD CURRENT

- IEC 60076-1 (clause 10.5)

Napetost priključena; Voltage supply to: NN | Frekvenca; Frequency: 50 Hz

Napetost; Voltage:	$U_{rm^*1.11}$	[%]	90	100	110		
	$U_{rm^*1.11}$	[V]	5 670	6 300	6 930		
	U_{rms}	[V]	5 666	6 302	6 950		
Tok; Current:	I_{rms} U	[A]	0.99	1.23	2.46		
	I_{rms} V	[A]	0.78	1.06	2.41		
	I_{rms} W	[A]	1.23	1.59	3.17		
	I_o	[A]	1.001	1.297	2.684		
	I_o	[%]	0.054	0.071	0.146		
Mer. izgube; Measur. loss:	P_{Fe}	[W]	9 292	12 096	16 550		
Kor. izgube; Corrected loss:	P_{Fec}	[W]	9 337	12 149	16 659		

3.2 MERITEV IZGUB IN NAPETOSTI KRATKEGA STIKA / MEASUREMENT OF LOAD LOSS AND IMPEDANCE VOLTAGE

Temperatura - Temperature: 24 °C | Frekvenca - Frequency: 50 Hz

Napajano - kratko skljenjeno: Supply - short circuited:			VN - NN	VN - NN	VN - NN				
Pozicija stikala - Tap position:			1	8	19				
Tok - Current:	I_m	[A]	90.41	102.87	131.14				
Napetost - Voltage:	U_m	[V]	13 775	11 590	9 236				
Izgube - Loss:	P_{mCu}	[W]	71 530	71 070	99 640				
Korekcija - Correction:	P	[W]	-124	-161	-261				
Izgube - Loss:	P_{mCuC}	[W]	71 406	70 909	99 379				
Preračun na nazivni tok navitja. - Calcuated at winding nominal current.									
Moč - Power:	S_n	[kVA]	20 000	20 000	20 000				
Tok - Current:	I_n	[A]	93.1	105.0	131.2				
Napetost - Voltage:	U_k	[V]	14 186	11 827	9 243				
Izgube - Loss:	P_k	[W]	75 731	73 834	99 538				
Preračun na referenčno temperaturo 75 °C. – Calcuated at reference temperature 75 °C.									
I^2R izgube - I^2R loss:	$P_{\Omega 75}$	[W]	68 820	70 845	103 374				
Dod. izg. - Stray loss:	P_{d75}	[W]	15 233	12 235	11 004				
Izgube - Loss:	P_{Cu75}	[W]	84 054	83 080	114 378				
Kratk. nap.; Imp. voltage:	U_{k75}	[%]	11.44	10.75	10.51				

3.3 REZULTATI MERITEV IZGUB / RESULTS OF LOSS MEASUREMENTS

- IEC 60076-1 (clause 9)

	Pos.	S_n [kVA]	P_{Fe} [kW]	P_{Cu75} [kW]	P_{Tot} [kW]	I_o [%]	U_{k75} [%]
Garantirano: Guaranteed:	1	20 000					
	8	20 000	12.5 (+0%)	83.5 (+0%)	96.0 (+0%)	0.15 (+30%)	11.3 (±7.5%)
	19	20 000					
Merjeno: Measured:	1	20 000		84.054	96.203		11.44
	8	20 000	12.149	83.080	95.229	0.071	10.75
	19	20 000		114.378	126.527		10.51

Merilna oprema; Measuring equipment:
- širokopasovni moč. analizator Norma, tip D6000, točnosti ± 0.05 %
- wide band power analyzer Norma, type D6000, accuracy ± 0.05 %
- merilni tok. in nap. transfor. CdC, točnosti ± 0.2 %; - measuring current and voltage transformer CdC, accuracy ± 0.2 %

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4.1 PREIZKUS Z INDUCIRANO NAPETOSTJO
INDUCED OVERVOLTAGE WITHSTAND TEST

Položaj reg. stikala; Tap changer pos.: 8

4.1.1 Transformator s polno izolacijo VN navitja
Transformer with uniformly insulated HV winding - IEC 60076-3 (clause 12.1 or 12.2)

napajano navitje; supply winding	U_0 [kV] NN;LV phase - phase	U_{test} [kV] NN;LV phase - phase	U_{test} [kV] VN;HV phase - phase	f [Hz]	t [s]	
NN	6.3	12.6	220	300	20	

4.1.2 Transformator z znižano izolacijo VN navitja
Transformer with non-uniformly insulated HV winding - IEC 60076-3 (clause 12.3)

napajano; supply	U_0 [kV] NN;LV phase - earth	U_{test} [kV] NN;LV phase - earth	U_{test} [kV] VN;HV phase - earth	U_{test} [kV] N N - earth	f [Hz]	t [s]

--

Merilna oprema; Measuring equipment:
- širokopasovni močnostni analizator Norma, tip D6000, točnosti ± 0.05 %
- wide band power analyzer Norma, type D6000, accuracy ± 0.05 %
- merilni tokovni in napetostni transformatorji CdC, točnosti ± 0.2 %
- measuring current and voltage transformer CdC, accuracy ± 0.2 %

4.3 PREIZKUS Z IZMENIČNO NAPETOSTJO IZ TUJEGA VIRA
SEPARATE SOURCE AC WITHSTAND VOLTAGE TEST - IEC 60076-3 (clause 11)

med; between	U [$kV_{peak/\sqrt{2}}$]	f [Hz]	t [s]	
VN - NN + M	230	50	60	
NN - VN + M	28	50	60	

Merilna oprema; Measuring equipment:
- voltmeter temenske vrednosti Haefely, tip 51, točnosti ± 0.5 %
- AC peak voltmeter Haefely, type 51, accuracy ± 0.5 %

OPOMBA; NOTE:
M - ozemljeni deli
M - ground

4.4 MERITEV IZOLACIJSKE UPORNOSTI
MEASUREMENTS OF ISULATION RESISTANCE

med; between	$R_{ISO\ (60\ sek.)}$ [MΩ]	R_d ($R_{50\ sek}/R_{30\ sek.}$)	U [kV_{DC}]	t [°C]	
VN - NN (M)	18 000	1.19	2.5	26	
VN - NN + M	11 800	1.10	2.5	26	
NN - VN + M	7 200	1.28	2.5	26	

Merilna oprema; Measuring equipment:
- merilnik izolacijske upornosti Norma ISO 5kV, točnosti ± 3 %
- isulation resistance meter Norma ISO 5kV, accuracy ± 3 %

OPOMBA; NOTE:
M - ozemljeni deli
M - ground

4

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4.2 MERITEV DELNIH PRAZNJENJ / PARTIAL DISCHARGE MEASUREMENT

- IEC 60076-3 (clause 12.4)
- IEC 60270

Položaj reg. stikala; Tap changer pos.:	8	Napajano navitje; Supply winding	NN	Tip preizkusa; Test type:	ACLD

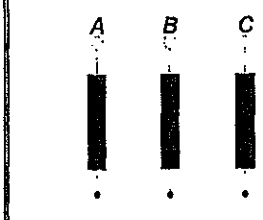
LI/AC	550/230	[kV]	- stopnja izolacije VN nav.; insulation level HV wind.
U_m(HV)	123	[$kV_{r.m.s.}$]	- najvišja nap. opreme; highest voltage for equipment
U_1(HV)	123	[$kV_{r.m.s.}$]	- preizkusna napetost; test voltage ($U \leq 2 \times U_{n\,ph}$)
U_2(HV)	106	[$kV_{r.m.s.}$]	$\Rightarrow q_{max} \leq 500$ pCat ACLD, ≤ 300 pCat ACSD
U_3(HV)	78	[$kV_{r.m.s.}$]	$\Rightarrow q_{max} \leq 100$ pC
f_{Um}	300	[Hz]	- napajalna frekvenca; supply frequency
$q_{o\,(calib.)}$	100	[pC]	- kalibracijska vrednost; calibration value
f_m	100 - 400	[kHz]	- merilna frekvenca; measuring frequency
Filter:	wide band		

$$U_1 = \frac{\sqrt{3} * U_m}{\sqrt{3}} \quad (phase-to-earth)$$

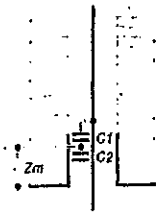
$$U_2 = 1.5 * \frac{Um}{\sqrt{3}} \quad (phase-to-earth)$$

$$U_1 = 1.1 * \frac{U_m}{\sqrt{3}} \quad (phase-to-earth)$$

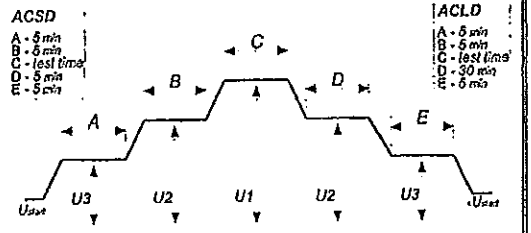
Časovni interval; Time sequence ↓		U_{ph} VN - HV [kV]	U_{ph} NN - LV [kV]	Priključki; Terminals A [pC]	B [pC]	C [pC]	[pC]	[pC]	[pC]	OPOMBE NOTES
	Osnovne motnje: Background noise:	0	0	13	12	11				
A ↓	1 min	78	7.73	20	21	12				
	5 min			25	50	21				
B ↓	1 min	106	10.51	29	228	64				
	5 min			31	234	47				
C	20 sec	123	12.20	35	236	51				
D ↓	1 min	106	10.51	28	230	41				
	5 min			30	231	41				
	10 min			27	231	34				
	15 min			28	208	31				
	20 min			26	207	31				
	25 min			26	180	28				
	30 min			27	177	28				
E ↓	1 min	78	7.73	23	75	24				
	5 min			24	83	22				
	Osnovne motnje: Background noise:	0	0	16	13	12				



Simetrični tri fazni priklop.
Simetrical three-phase connection.



Merjenje na kapacitivnem skoz.
Circuit for measure. on conden. bushing.



Časovni intervali preizkusne napetosti.
Time sequence for application of test voltage.

Merilna oprema; Measuring equipment:

- Širokopasovni močnostni analizator Norma, tip D6000, točnosti ± 0.05 %
- wide band power analyzer Norma, type D6000, accuracy ± 0.05 %
- merilni tokovni in napetostni transformatorji CdC, točnosti ± 0.2 %
- measuring current and voltage transformer CdC, accuracy ± 0.2 %
- merilnik delnih praznjen Lemke, tip LDS-6
- partial discharge instrument Lemke, tip LDS-6

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4.5 MERITEV PREBOJNE TRDNOSTI IZOLACIJSKEGA OLJA / MEASUREMENTS OF DIELECTRIC STRENGTH OF ISULATING OIL

Tip izolacijskega olja : Type of isolation oil : *Nynas Natro 10X*

mesto odvzema: test sample taken from:	1 [kV]	2 [kV]	3 [kV]	4 [kV]	5 [kV]	6 [kV]	M [kV/cm]	S
sredina transformatorskega kotla	54.7	61.3	56.5	57.8	60.5	58.7	232	2.5

Razmak med iskriščem preskusne naprave je 2.5 mm. Distance between geps of oil tester is 2.5 mm.

Merilna oprema; Measuring equipment:
- merilna naprava Bauer, tip DTA 75
- measuring device Bauer, type DTA 75

5.0 PREIZKUS REGULACIJSKEGA STIKALA / TESTS ON ON-LOAD TAP-CHANGER

- IEC 60076-1 (clause 10.8)

1.	8 kompletnih ciklov operacij z nevzbujenim transformatorjem 8 complete operating cycles with the transformer not energized	☑
2.	1 kompleten cikel operacij z vzbujenim transformatorjem v praznem teku pri nazivni frekvenci in nazivni napetosti 1 complete operating cycle with transformer at rated voltage and frequency, at no-load	☑
3.	10 delovanj regulacijskega stikala s ± 2 stopnjama regulacije z vsake strani glavnega odcepa, pri čim bližjem nazivnem toku transformatorja, z enim kratko vezanim navitjem 10 tap-change operations with ±2 steps on either side of the principal tapping with as far as possible the rated current of the transformer, with one winding short-circuited	☑

☑ preizkus opravljen
test O.K.

6.0 MERITEV NIČNE IMPEDANCE / MEASUREMENT OF ZERO-SEQUENCE IMPEDANCE

- IEC 60076-1 (clause 10.7)

Temperatura - Temperature : *26 °C* Frekvenca - Frequency : *50 Hz*

Napajano : Supply :			*1U+1V+1W - 1N*		
Pozicija stikala - Tap position:			*8*		
Tok - Current	I	[A]	*188.08*		
Napetost - Voltage	U	[V]	*3 607*		
Nazivni tok - Rated current	I_n	[A]	*105.0*		
Nazivna napetost - Rated voltage	U_n	[V]	*63 507*		
Impedanca - Impedance	Z_o	[Ω/f]	*57.53*		
	Z_o	[%]	*9.51*		

Merilna oprema; Measuring equipment:
- *širokopasovni močnostni analizator Norma, tip D6000, točnosti ± 0.05 %*
- *wide band power analyzer Norma, type D6000, accuracy ± 0.05 %*
- *merilni tokovni in napetostni transformatorji CdC, točnosti ± 0.2 %*
- *measuring current and voltage transformer CdC, accuracy ± 0.2 %*

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7.0 MERITEV IZGUB HLADILNEGA SISTEMA / MEASUREMENTS OF LOSS OF COOLING SYSTEM

Hladilni sistem ima: Cooling system includes:	2	ventilatorja; fans:	*Schorman - SH 800-12 (0.41 kW, 400V, 1.1A)*
	/	črpalk; oil pumps:	/

	U [V]	I [A]	P [W]	f [Hz]	
1. - ventilator; fan	*3 x 400*	*1.30*	*376*	*50*	
2. - ventilator; fan	*3 x 400*	*1.31*	*398*	*50*	
Σ	*3 x 400*	*2.61*	*774*	*50*	

Merilna oprema; Measuring equipment:

- *širokopasovni močnostni analizator Norma, tip D6000, točnosti ± 0.05 %*
- *wide band power analyzer Norma, type D6000, accuracy ± 0.05 %*

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11.0 MERITEV KAPACITIVNOSTI IN tg δ
MEASUREMENTS OF CAPACITY AND DISSIPATION FACTOR tg δ

		vezava connection	U [kV]	pos. (I - II)	N [Ω]	R₃ [Ω]	R₄ [kΩ]	C₄ [μF]		Cx [pF]	tg δ [%]
1	pred napetostnimi preizkusi	VN - NN (M)	10	II	∞	6.34	1/K	0.1485		5 021	0.148
2											
3		VN - NN + M	10	II	∞	4.06	1/K	0.1735		7 840	0.173
4											
5		NN - M (VN)	10	II	∞	3.12	1/K	0.2615		10 203	0.261
6											
7		NN - VN + M	10	II	∞	2.09	1/K	0.2165		15 231	0.216
8											
9	po napetostnih preizkusih	VN - NN (M)	10	II	∞	6.34	1/K	0.1455		5 021	0.145
10											
11		VN - NN + M	10	II	∞	4.06	1/K	0.1755		7 840	0.175
12											
13		NN - M (VN)	10	II	∞	3.12	1/K	0.2566		10 203	0.256
14											
15		NN - VN + M	10	II	∞	2.09	1/K	0.2585		15 231	0.258

Testni pogoji; Test condition:

C_N: 100.01 pF | t: 26 / °C | p: kPa

Merilna oprema; Measuring equipment:
- Schering most tip 2801 po vezavi 1a
- Schering Bridge type 2801- Arrangement 1a

12.0 MERITEV STRESANE INDUKTIVNOSTI
MEASUREMENTS OF LEAKAGE INDUCTANCE

	vezava connection	I [A]	pos. (I - II)	R₂ [Ω]	R₃ [Ω]	R₃ ext [Ω]	R₄ [kΩ]	C₄ [μF]	Lx [mH]
1	1U - 1N (2U+2V+2W)	1.0	I	100 000	2.0	-	57.752	1.0073	201.46
2									
3	1V - 1N (2U+2V+2W)	1.0	I	100 000	2.0	-	60.507	0.9962	199.24
4									
5	1W - 1N (2U+2V+2W)	1.0	I	100 000	2.0	-	61.340	1.0104	202.08
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

Testni pogoji; Test condition:

poz. stikala; tap range: 8 | (..) navitje kratko sklenjeno; winding short circuit

Merilna oprema; Measuring equipment:
- Schering most tip 2801 po vezavi 2c
- Schering Bridge type 2801- Arrangement 2c

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13.0 MERITEV NIVOJA HRUPA / MEASUREMENT OF SOUND LEVEL

- IEC 60076-10

ONAN (U_n = 100 %) razdalja 0.3 m
ONAN (U_n = 100 %) distance 0.3 m

	okolica amb.	transformator transformer 1/2 h			okolica amb.	transformator transformer 1/2 h			frekvenčna analiza (1/1 oktave) frequency analysis (1/1 octave)					
									amb.	4	8	-	-	-
	[dBA]	[dBA]	[dBA]		[dBA]	[dBA]	[dBA]		[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
1	35	53.4		19				A						
2	35	51.3		20				C						
3	35	55.4		21				L						
4	35	59.1		22				31.5 Hz						
5	35	62.2		23				63 Hz						
6	35	60.4		24				125 Hz						
7	35	56.1		25				250 Hz						
8	35	56.5		26				500 Hz						
9	35	56.4		27				1 kHz						
10	35	53.1		28				2 kHz						
11	35	51.6		29				4 kHz						
12	35	52.4		30				8 kHz						
13	35	50.5		31										
14	35	56.2		32										
15	35	52.5		33										
16	35	52.7		34										
17				35										
18				36										
povprečna kvadratna vrednost quadratic mean sound level					35	56.39								

		ONAN - 0.3 m			
Povprečna izmerjena kvadratna vrednost Quadratic mean sound level	[$L_{p(A)}$]	56.4		dBA	
Popravek zaradi okolice Environmental correction	[K]	0		dBA	
Korigirana izmerjena kvadratna vrednost **Corection quadratic mean sound level**	[$L_{p(A)}$]	56.4		dBA	
Garantirana kvadratna vrednost **Guaranteed quadratic mean sound level**	[$L_{p(A)}$]			dBA	
Dolžina merilne linije Length of the prescribed contour	[l_m]	16.5		m	
Višina transformatorskega kotla Height of the transformer tank	[h]	2.6		m	
Ekvivalentna površina Area of the effective surface	[S]	53.6		m^2	
Nivo A moči zvočnega vira **A - weighted sound power level**	[$L_{W(A)}$]	73.7		dBA	

Formule za izračun; Formulas for equation:

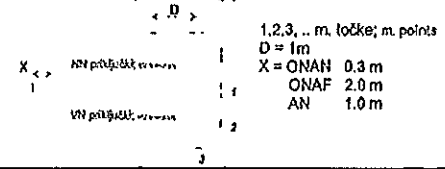
$$L_{pAU} = 10\log_{10}\frac{1}{N}\left[\sum_{i=1}^{N} 10^{0.1 L_{pAi}}\right] - K$$

$$L_{WA} = \overline{L}_{p(A)} + 10 * \log_{10} S$$

$$S = 1.25 \times h \times l_m \rightarrow 0.3m$$

$$S = (h+1) \times l_m \rightarrow 1m \qquad S = (h+2) \times l_m \rightarrow 2m$$

Merilne točke; Measuring points:



1,2,3, .. m. točke; m. points
D = 1m
X = ONAN 0.3 m
ONAF 2.0 m
AN 1.0 m

Merilna oprema; Measuring equipment:

- merilnik šuma B&K, tip 2236, tov. št. 1914395, na področju F SPL
- kalibrator B&K, tip 4231, tov. št. 1914631, *točnosti ± 0.20 dB*
- measuring instrument B&K, type 2236, ser. No. 1914395, on position F SPL
- calibrator B&K, type 4231, ser. No. 1914631, *accuracy ± 0.20 dB*

ETRA 33 ENERGETSKI TRANSFORMATORJI d.d. Ljubljana - SLOVENIJA	**MERILNI LIST TRANSFORMATORJA** TRANSFORMER TEST REPORT

Transformator: / Transformer:	RT 20000-110	Tov. št.: / Ser. No.:	74273

13.0 MERITEV NIVOJA HRUPA / MEASUREMENT OF SOUND LEVEL

- IEC 60076-10

ONAF (U_n = 100 %) razdalja 2 m
ONAF (U_n = 100 %) distance 2 m

	okolica amb.	transformator transformer 1/2 h			okolica amb.	transformator transformer 1/2 h			frekvenčna analiza (1/1 oktave) frequency analysis (1/1 octave) amb.	4	8	-	-	-
	[dBA]	[dBA]	[dBA]		[dBA]	[dBA]	[dBA]		[dB]	[dB]	[dB]	[dB]	[dB]	[dB]
1	38	60.8		19	38	61.3		A						
2	38	60.5		20	38	60.7		C						
3	38	57.8		21	38	61.0		L						
4	38	56.5		22	38	61.5		31.5 Hz						
5	38	56.4		23	38	61.9		63 Hz						
6	38	57.5		24	38	62.1		125 Hz						
7	38	56.6		25	38	61.8		250 Hz						
8	38	56.9		26	38	62.0		500 Hz						
9	38	55.7		27	38	61.1		1 kHz						
10	38	55.4		28				2 kHz						
11	38	56.1		29				4 kHz						
12	38	57.7		30				8 kHz						
13	38	59.5		31										
14	38	60.1		32										
15	38	61.7		33										
16	38	62.1		34										
17	38	60.6		35										
18	38	60.6		36										
povprečna kvadratna vrednost quadratic mean sound level					38	60.01								

		ONAF - 2 m			
Povprečna izmerjena kvadratna vrednost Quadratic mean sound level	$[L_{p(A)}]$	60.0		dBA	
Popravek zaradi okolice Environmental correction	[K]	0		dBA	
Korigirana izmerjena kvadratna vrednost Corection quadratic mean sound level	$[L_{p(A)}]$	60		dBA	
Garantirana kvadratna vrednost Guaranteed quadratic mean sound level	$[L_{p(A)}]$	65		dBA	
Dolžina merilne linije Length of the prescribed contour	$[l_m]$	28		m	
Višina transformatorskega kotla Height of the transformer tank	[h]	2.6		m	
Ekvivalentna površina Area of the effective surface	[S]	128.8		m^2	
Nivo A moči zvočnega vira A - weighted sound power level	$[L_{W(A)}]$	81.1		dBA	

Formule za izračun; Formulas for equation:

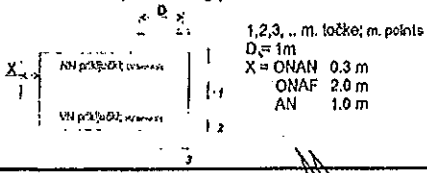
$$L_{p(A)} = 10\log_{10}\frac{1}{N}\left[\sum_{i=1}^{i=N} 10^{0.1L_{p(A)i}}\right] - K$$

$$L_{W(A)} = \overline{L}_{p(A)} + 10 * \log_{10} S$$

$$S = 1.25 \times h \times l_m \rightarrow 0.3m$$

$$S = (h+1) \times l_m \rightarrow 1m \qquad S = (h+2) \times l_m \rightarrow 2m$$

Merilne točke; Measuring points:



Merilna oprema; Measuring equipment:

- merilnik šuma B&K, tip 2236, tov. št. 1914395, na področju F SPL
- kalibrator B&K, tip 4231, tov. št. 1914631, *točnosti ± 0.20 dB*
- measuring instrument B&K, type 2236, ser. No. 1914395, on position F SPL
- calibrator B&K, type 4231, ser. No. 1914631, *accuracy ± 0.20 dB*

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ETRA 33 ENERGETSKI TRANSFORMATORJI d.d. Ljubljana - SLOVENIJA	**MERILNI LIST TRANSFORMATORJA** *TRANSFORMER TEST REPORT*

Transformator: Transformer:	RT 20000-110	Tov. št.: Ser. No.:	74273

15.0 SPISEK ELEMENTOV NA TRANSFORMATORJU / LIST OF ELEMENTS ON TRANSFORMER

		Oznaka Label	Tip Type	Tov. št. Ser. No.	Opombe Notes	
1	Skoznik Bushing	faza A	ABB - GOB 550	296 587		
2	Skoznik Bushing	faza B	ABB - GOB 550	296 586		
3	Skoznik Bushing	faza C	ABB - GOB 550	296 588		
4	Skoznik Bushing	faza N	ABB - GOB 550	296 589		
5	Komandna omarica Control cubicle	B00	Rittal - AE 1016			
6	Plinski rele Gas relay	B01	Comem - BR 80	C02871		
7	Zaščitni rele reg. stikala Pressure relief valve O.L.T.C.	B02	MR - RS 2001			
8	Kazalo olja za transformator Oil level indicator for transformer	B03	Comem - LB 22			
9	Kazalo olja za reg. stikalo Oil level indicator for O.L.T.C.	B04	Comem - LA 22			
10	Termična slika Winding temperature indicator	B05	Kihlströms - AKM 35	34884-2	75/0/110/115°C	25 K/1.6 Ω
11	Kontaktni termometer Contact thermometer	B06	Kihlströms - AKM 34	364703-1	50/0/95/100°C	
12	Varnostni ventil Pressure relief valve	B07	Comem - 125T			
13	Tokovni transformator Current transformer	B08	FTM - 150-2	04090848	Cl 3, 10VA	v 1V
14						
15						
16						
17						
18						
19						
20						
21						

16.0 FUNKCIONALNI PREIZKUS KOMANDNE OMARICE / FUNCTIONAL TEST OF CONTROL CUBICLE

☑ *Delovanje omarice je preizkušeno na osnovi načrta (na vratih omarice).*
The functional test has been performed according to the drawing (on cubicle door).

☑ preizkus opravljen
test O.K.

17.0 FUNKCIONALNI PREIZKUS ELEMENTOV NA TRANSFOR. / FUNCTIONAL TEST OF ELEMENTS ON TRANSFORMER

☑ *Elementi so preizkušeni na osnovi načrta (na vratih omarice).*
The functional test has been performed according to the drawing (on cubicle door).

☑ preizkus opravljen
test O.K.

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ETRA 33
ENERGETSKI TRANSFORMATORJI d.d.
Ljubljana - SLOVENIJA

MERILNI LIST TRANSFORMATORJA
TRANSFORMER TEST REPORT

Transformator: Transformer:	RT 20000-110	Tov. št.: Ser. No.:	74273

18.0 MERITEV VIŠJEHARMONSKIH TOKOV PRAZNEGA TEKA
MEASUREMENTS OF THE HARMONICS OF THE NO-LOAD CURRENT

Napajano navitje; Supply winding: NN / LV	90 % Un

Vrednosti; Variables: *Napetost; Voltage*

spectrum 0..19 — f11 50.011 Hz — average over 1 periods

order	U1 3.426E+3VH01 U [%H01]	φ01 [°]	U2 3.158E+3VH01 U [%H01]	φ01 [°]	U3 3.206E+3VH01 U [%H01]	φ01 [°]
0	0.000		0.000		0.000	
1	100.000	0.00	100.000	0.00	100.000	0.00
2	0.020	--,--	0.032	.--	0.003	--,--
3	1.450	177.20	1.459	171.11	1.505	-173.70
4	0.004	.	0.007	--,--	0.005	-,--
5	0.534	-6.54	0.515	19.64	0.805	5.03
6	0.015	--,--	0.005	.	0.007	--,--
7	1.395	15.00	1.432	-20.19	1.422	4.42
8	0.006	.	0.007	--,--	0.006	--,--
9	0.047	--,--	0.072	--,--	0.075	.
10	0.003	--,--	0.004	.	0.002	--,--
11	0.036	.--	0.041	--,--	0.045	--,--
12	0.002	- .	0.000	--,--	0.001	. -

scroll with cursor keys or enter a number — HOLD

functions: harmonics | spectrum | LOCKED

variable | bargraph | blockout | length | average | absolut

Vrednosti; Variables: *Tok; Current*

spectrum 0..19 — f11 50.010 Hz — average over 1 periods

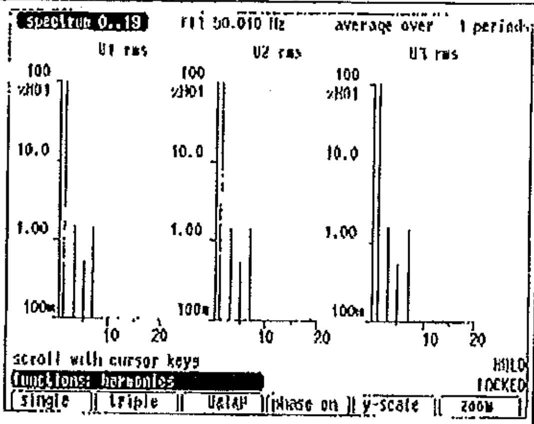
order	I1 8.618E-1AH01 I [%H01]	φ01 [°]	I2 7.494E-1AH01 I [%H01]	φ01 [°]	I3 1.202E+0AH01 I [%H01]	φ01 [°]
0	0.000		0.000		0.000	
1	100.000	0.00	100.000	0.00	100.000	0.00
2	1.656	-46.15	1.539	31.53	1.390	171.62
3	16.047	-177.15	18.181	-107.53	5.491	1.27
4	1.103	61.61	0.951	-179.22	0.657	76.12
5	12.898	-38.13	12.647	151.77	12.758	-167.30
6	0.852	-132.93	0.020	.	0.681	-02.74
7	2.969	14.26	2.967	139.52	1.048	123.96
8	0.302	.-	0.271	--,--	0.247	--,--
9	1.057	-81.05	0.914	-176.51	0.370	-65.65
10	0.143	--,--	0.161	.	0.110	--,--
11	0.815	39.72	1.158	52.75	1.018	140.14
12	0.101	.	0.033	--,--	0.068	--,--

scroll with cursor keys or enter a number — HOLD

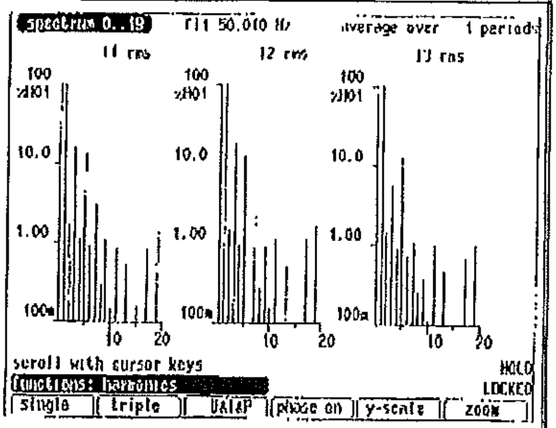
functions: harmonics | spectrum | LOCKED

variable | bargraph | blockout | length | average | absolut

Grafikon; Graph: *Napetost; Voltage*



Grafikon; Graph: *Tok; Current*



Merilna oprema; Measuring equipment:

- širokopasovni močnostni analizator Norma, tip D6000, točnosti ± 0.05 %
- *wide band power analyzer Norma, type D6000, accuracy ± 0.05 %*
- merilni tokovni in napetostni transformatorji CdC, točnosti ± 0.2 %
- *measuring current and voltage transformer CdC, accuracy ± 0.2 %*

EIMV
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Hajdrihova 2, 1000 Ljubljana, Slovenija

ETRA 33
ENERGETSKI TRANSFORMATORJI d.d.
Ljubljana - SLOVENIJA

MERILNI LIST TRANSFORMATORJA
TRANSFORMER TEST REPORT

Transformator: Transformer:	RT 20000-110	Tov. št.: Ser. No.:	74273

18.0 MERITEV VIŠJEHARMONSKIH TOKOV PRAZNEGA TEKA
MEASUREMENTS OF THE HARMONICS OF THE NO-LOAD CURRENT

Napajano navitje; Supply winding: NN / LV — 100 % Un

Vrednosti; Variables: Napetost; Voltage

spectrum 0..19 f11 50.010 Hz average over 1 periods

	U1 3.795E+3V/H01		U2 3.500E+3V/H01		U3 3.559E+3V/H01	
order	U [%H01]	fi01[°]	U [%H01]	fi01[°]	U [%H01]	fi01[°]
0	0.000		0.000		0.000	
1	100.000	0.00	100.000	0.00	100.000	0.00
2	0.014	--,--	0.011	--,--	0.023	--,--
3	1.491	-176.60	1.430	168.28	1.514	-175.79
4	0.003	--,--	0.016	--,--	0.013	--,--
5	0.723	-7.60	0.675	-23.69	0.833	2.69
6	0.023	--,--	0.005	--,--	0.020	--,--
7	1.255	-14.16	1.303	-28.45	1.255	3.63
8	0.008	--,--	0.011	--,--	0.015	--,--
9	0.040	--,--	0.098	--,--	0.075	--,--
10	0.004	--,--	0.008	--,--	0.005	--,--
11	0.078	--,--	0.094	--,--	0.115	--,--
12	0.008	--,--	0.001	--,--	0.008	--,--

HOLD
functions: harmonics | spectrum length | LOCKED
up | down

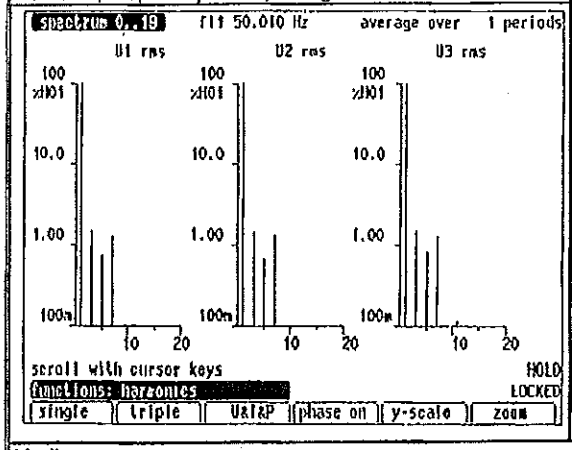
Vrednosti; Variables: Tok; Current

spectrum 0..19 f11 50.010 Hz average over 1 periods

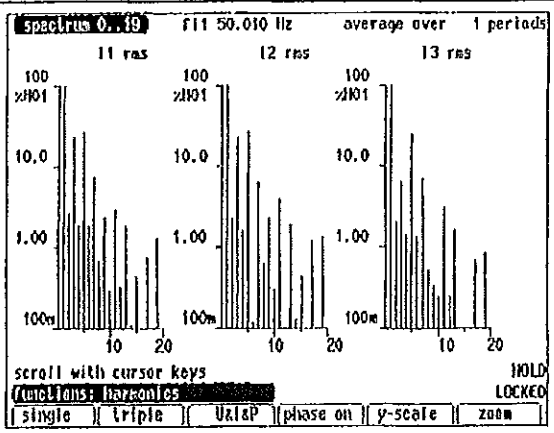
	I1 1.122E+0A/H01		I2 9.623E-1A/H01		I3 1.492E+0A/H01	
order	I [%H01]	fi01[°]	I [%H01]	fi01[°]	I [%H01]	fi01[°]
0	0.000		0.000		0.000	
1	100.000	0.00	100.000	0.00	100.000	0.00
2	2.591	-80.99	2.255	9.76	2.017	158.64
3	23.038	143.38	22.376	-150.37	8.160	-43.01
4	1.662	9.79	1.562	117.54	1.378	33.07
5	26.465	-108.97	26.592	72.25	24.450	135.44
6	1.808	149.33	0.116	--,--	1.314	-147.33
7	7.148	27.70	6.270	-157.95	6.958	-87.53
8	0.652	-61.05	0.643	173.04	0.495	20.69
9	2.323	168.04	2.203	61.32	0.338	178.13
10	0.294	--,--	0.309	--,--	0.238	-76.05
11	2.863	-101.68	3.873	-108.00	3.053	33.22
12	0.310	168.60	0.054	--,--	0.243	118.41

scroll with cursor keys or enter a number HOLD
functions: harmonics | spectrum | LOCKED
variable | bargraph | blackout | length | average | absolut

Grafikon; Graph: Napetost; Voltage



Grafikon; Graph: Tok; Current



Merilna oprema; Measuring equipment:

- širokopasovni močnostni analizator Norma, tip D6000, točnosti ± 0.05 %
- wide band power analyzer Norma, type D6000, accuracy ± 0.05 %
- merilni tokovni in napetostni transformatorji CdC, točnosti ± 0.2 %
- measuring current and voltage transformer CdC, accuracy ± 0.2 %

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ETRA 33 ENERGETSKI TRANSFORMATORJI *d.d.* *Ljubljana - SLOVENIJA*	**MERILNI LIST TRANSFORMATORJA** *TRANSFORMER TEST REPORT*

Transformator: Transformer:	*RT 20000-110*	Tov. št.: Ser. No.:	*74273*

18.0 MERITEV VIŠJEHARMONSKIH TOKOV PRAZNEGA TEKA
MEASUREMENTS OF THE HARMONICS OF THE NO-LOAD CURRENT

Napajano navitje; Supply winding: ***NN / LV*** | ***110 % Un***

Vrednosti; Variables: ***Napetost; Voltage***

Spektrum 0..19 f11 50.005 Hz average over 1 periods

	U1 4.210E+3VH01		U2 3.886E+3VH01		U3 3.854E+3VH01	
order	U [VH01]	Fi01[°]	U [VH01]	Fi01[°]	U [VH01]	Fi01[°]
0	0.000		0.000		0.000	
1	100.000	0.00	100.000	0.00	100.000	0.00
2	0.026	.	0.021	--,--	0.024	--,--
3	1.547	-171.67	1.480	128.37	1.511	-170.80
4	0.010	--,--	0.025	--,-	0.014	.--
5	1.453	-5.26	1.447	25.60	1.780	9.03
6	0.027	.	0.003	--,--	0.030	--,--
7	0.832	-14.02	0.754	-42.42	0.523	-14.05
8	0.014	--,--	0.010	--,--	0.014	.
9	0.105	-100.63	0.214	97.62	0.044	--,--
10	0.011	.	0.012	--,--	0.011	--,--
11	0.313	2.61	0.363	-24.71	0.413	42.77
12	0.011	--,--	0.001	--,-	0.012	--,--

scroll with cursor keys or enter a number HOLD
functions: harmonics | spectrum | LOCKED
variable | bargraph | blockout | length | average | absolut

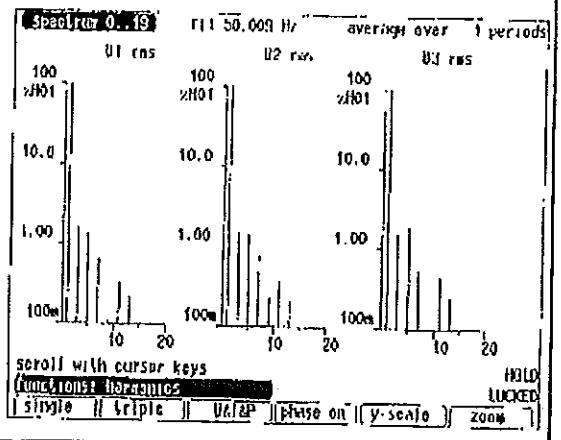
Vrednosti; Variables: ***Tok; Current***

Spektrum 0..19 f11 50.000 Hz average over 1 periods

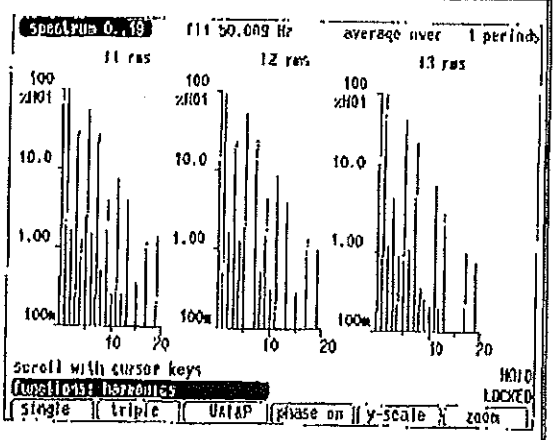
	I1 2.017E+0AH01		I2 2.025E+0AH01		I3 2.775E+0AH01	
order	I [AH01]	Fi01[°]	I [AH01]	Fi01[°]	I [AH01]	Fi01[°]
0	0.000		0.000		0.000	
1	100.000	0.00	100.000	0.00	100.000	0.00
2	1.603	-117.56	1.601	-45.16	1.139	97.50
3	30.542	44.22	25.143	135.05	4.763	142.06
4	1.199	137.74	1.212	-9.07	0.885	-72.30
5	52.726	72.20	50.747	-69.81	47.070	-4.16
6	1.433	-62.27	0.044	--,--	1.029	38.89
7	26.332	159.61	24.222	-10.41	23.510	70.46
8	0.509	18.52	0.512	81.30	0.341	. -
9	4.055	153.72	4.340	145.13	0.297	--,--
10	0.750	--,--	0.287	--,--	0.197	--,--
11	7.415	-138.41	8.330	-87.79	8.782	73.45
12	0.249	.	0.012	--,--	0.189	--,--

scroll with cursor keys or enter a number HOLD
functions: harmonics | spectrum | LOCKED
variable | bargraph | blockout | length | average | absolut

Grafikon; Graph: ***Napetost; Voltage***



Grafikon; Graph: ***Tok; Current***



Merilna oprema; Measuring equipment:

- *širokopasovni močnostni analizator Norma, tip D6000, točnosti ± 0.05 %*
- *wide band power analyzer Norma, type D6000, accuracy ± 0.05 %*
- *merilni tokovni in napetostni transformatorji CdC, točnosti ± 0.2 %*
- *measuring current and voltage transformer CdC, accuracy ± 0.2 %*

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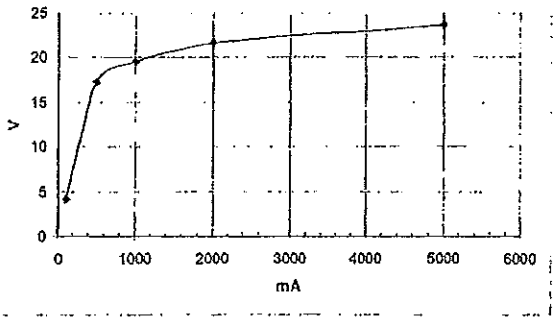
ETRA	ETRA 33 ENERGETSKI TRANSFORMATORJI d.d. Ljubljana - SLOVENIJA	**MERILNI LIST TRANSFORMATORJA** *TRANSFORMER TEST REPORT*	
Transformator: Transformer:	**RT 20000-110**	Tov. št.: Ser. No.:	**74273**

19.0 MERITVE NA VGRAJENIH TOKOVNIH TRANSFORMATORJIH
MEASUREMENT ON BUILT-IN CURRENT TRANSFORMERS

19.1 Podatki; Ratings:

Tip; Type:	AOS
Tov. številka; Ser. No.:	04090848
Proizvajalec; Manufacturer:	F.T.M. Srl . Italy
Razmerje; Ratio:	150/2 A
Moč; Power:	10 VA
Klasa; Class:	3
Fs	5
Int. oznaka; Int. designation:	B08
Sponke; Terminals:	P1-P2 / 1S1-1S2
Montiran v; Mounted in:	1V
	termična slika
Meritve in preizkusi: Measurements and tests:	
$R_{(20°C)}$:	0.329 Ω
Polariteta; Polarity:	O.K.

Magnetilna krivulja; Excitation curve:



Vse meritve in preizkusi so opravljeni na sponkah v komandni omarici!
All measurements and tests are carried out at terminals in the terminal cubicle.

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Hajdrihova 2, 1000 Ljubljana, Slovenija

SLOVENSKA AKREDITACIJA

LP-063

akreditacijska listina
accreditation certificate

Elektroinštitut Milan Vidmar

Hajdrihova ulica 2, 1000 Ljubljana
Laboratorij OVENO, Laboratorij OOK, Laboratorij LVN

Organizacija je akreditirana pri Slovenski akreditaciji (SA), kot preskuševalni laboratorij. S to listino se priznava izpolnjevanje zahtev standarda

SIST EN ISO/IEC 17025:2005

za dejavnosti, ki so opisane v prilogi te listine, označeni z isto številko.

Datum podelitve akreditacije: 30. maj 2005

Akreditacija je veljavna, če akreditirani organ v celoti izpolnjuje zahteve za akreditacijo, kar SA ugotavlja s postopki nadzora. Veljavnost akreditacije je mogoče preveriti na spletni strani SA, www.sa.gov.si.

Slovenska akreditacija je podpisnica sporazumov o medsebojnem priznavanju akreditacij na področju kalibracijskih in preskuševalnih laboratorijev pri Evropskem združenju za akreditacijo (EA) in pri Mednarodnem združenju za akreditiranje laboratorijev (ILAC).

The above entity has been accredited by Slovenian Accreditation (SA) as a testing laboratory. This is to signify compliance with the requirements of the SIST EN ISO/IEC 17025:2005 for the approved scope of accreditation as described in the Annex hereto marked with the same number.

Initial accreditation date: 30 May 2005

This accreditation shall remain in force provided that the accredited body fully complies with the accreditation requirements, which is determined by SA through surveillance. Information on current accreditation status is available at the SA website, www.sa.gov.si.

Slovenian Accreditation (SA) is a signatory of the Multilateral Agreements of the European Co-operation for Accreditation (EA) and International Laboratory Accreditation Co-operation (ILAC) for calibration and testing.

Ljubljana, 24. september 2008

SLOVENSKA AKREDITACIJA

Reg. št. / *Ref. No.*: 3150-0138/10-0007

Datum izdaje / *Issued on*: 30. maj 2016

Zamenjuje izdajo z dne / *Replaces Annex dated*: 1. julij 2015

Veljavnost akreditacije je mogoče preveriti na spletni strani SA, www.slo-akreditacija.si.
Information on current accreditation status is available at the SA website, www.slo-akreditacija.si.

PRILOGA K AKREDITACIJSKI LISTINI
Annex to the accreditation certificate

LP-063

1 AKREDITIRANI ORGAN / *Accredited body*

Elektroinštitut Milan Vidmar
Hajdrihova ulica 2, 1000 Ljubljana

2 STANDARD

SIST EN ISO/IEC 17025:2005

3 OBSEG AKREDITACIJE / *Scope of accreditation*

V okviru te akreditacijske listine Slovenska akreditacija priznava akreditiranemu organu usposobljenost za opravljanje naslednjih dejavnosti: / *SA hereby acknowledges the accredited body as being competent for performing the following activities:*

3.1 Skrajšan opis obsega akreditacije / *A short description of the scope*

Področja preskušanja glede na vrsto preskušanja / *Testing fields with reference to the type of test:*

- neionizirajoča sevanja (elektromagnetno sevanje, elektromagnetna združljivost / *non-ionising radiation (electromagnetic radiation, electromagnetic compatibility)*
- akustika, hrup, vibracije (hrup) / *acoustics, noise, vibrations (noise)*
- vzorčenje / *sampling*
- kemija / *chemistry*
- fizikalno preskušanje / *physical testing*

Področja preskušanja glede na vrsto preskušanca / *Testing fields with reference to the type of test item:*

- okolje in vzorci iz okolja (viri elektromagnetnih sevanj, okolje, viri emisij snovi, zrak) / *environment and samples from the environment (electromagnetic radiation sources, environment, sources of emissions of substances, air)*
- električni proizvodi in oprema (elektromehanske naprave) / *electrical products and equipment (electromechanical devices)*

3.2 Podroben opis obsega akreditacija / *Detailed scope of accreditation*

3.2.1 Laboratorij OVENO, Hajdrihova ulica 2, 1000 Ljubljana

Tabela / *Table* 1

Tip obsega: **fiksni** / *Type of scope: **fixed***
Mesto izvajanja: **na terenu** / *Site: **fieldwork***
Področja preskušanja glede na vrsto preskušanja: **neionizirajoča sevanja (elektromagnetno sevanje)** / *Testing fields with reference to the type of test: **non-ionising radiation (electromagnetic radiation)***
Področja preskušanja glede na vrsto preskušanca: **Okolje in vzorci iz okolja (viri elektromagnetnih sevanj)** / *Testing fields with reference to the type of test item: **environment and samples from the environment (electromagnetic radiation sources)***

Št. / *No.*	Oznaka standarda ali nestandardne preskusne metode / *Reference to standard or non-standard testing method*	Naslov standarda ali nestandardne preskusne metode in morebitne navezave na druge standarde ali metode / *Title of standard or non-standard testing method and eventual relations to other standards or methods*	Območje preskušanja; Negotovost rezultata preskušanja (kjer je to pomembno) / *Range of testing; Uncertainty of the result of testing (where relevant)*	Materiali; proizvodi / *Materials; products*
1.	SIST ENV 50166-1:1995 razveljavljen *withdrawn* brez poglavja 4 *without chapter 4*	Izpostavljenost človeka elektromagnetnim poljem, Nizke frekvence (0 Hz do 10 kHz) *Human exposure to electromagnetic fields Low frequency (0 HZ to 10 kHz)*	5 Hz – 10 kHz	visokonapetostni daljnovodi, transformatorske postaje, elektrarne, transformatorji in električna oprema *HV power lines, power substations, power plants, transformers and electric equipment*
2.	IEEE Std 644-1987 brez točk 4.3, 6.3 *without points 4.3, 6.3*	Standardni postopki IEEE za meritev izmeničnih električnih in magnetnih polj energetskih vodov *IEEE standard procedures for measurement of power frequency electric and magnetic fields from AC power lines*	5 Hz – 30 kHz	visokonapetostni daljnovodi, transformatorske postaje, elektrarne, transformatorji in električna oprema *HV power lines, power substations, power plants, transformers and electric equipment*
3.	IEEE Std 644-1994 brez točk 4.3, 6.3 *without points 4.3, 6.3*	Standardni postopki IEEE za meritev izmeničnih električnih in magnetnih polj energetskih vodov *IEEE standard procedures for measurement of power frequency electric and magnetic fields from AC power lines*	5 Hz – 30 kHz	visokonapetostni daljnovodi, transformatorske postaje, elektrarne, transformatorji in električna oprema *HV power lines, power substations, power plants, transformers and electric equipment*

Tip obsega: **fiksni** / *Type of scope: **fixed***
Mesto izvajanja: **na terenu** / *Site: **fieldwork***
Področja preskušanja glede na vrsto preskušanja: **neionizirajoča sevanja (elektromagnetno sevanje)** / *Testing fields with reference to the type of test: **non-ionising radiation (electromagnetic radiation)***
Področja preskušanja glede na vrsto preskušanca: **Okolje in vzorci iz okolja (viri elektromagnetnih sevanj)** / *Testing fields with reference to the type of test item: **environment and samples from the environment (electromagnetic radiation sources)***

Št. / *No.*	Oznaka standarda ali nestandardne preskusne metode / *Reference to standard or non-standard testing method*	Naslov standarda ali nestandardne preskusne metode in morebitne navezave na druge standarde ali metode / *Title of standard or non-standard testing method and eventual relations to other standards or methods*	Območje preskušanja; Negotovost rezultata preskušanja (kjer je to pomembno) / *Range of testing; Uncertainty of the result of testing (where relevant)*	Materiali; proizvodi / *Materials; products*
4.	SIST IEC 61786: 2005 brez točk 5.2, 6.2 *without points 5.2, 6.2*	Merjenje nizkofrekvenčnih elektromagnetnih polj z vidika izpostavljenosti ljudi – Posebne zahteve za instrumente in napotki za merjenje *Measurement of low-frequency magnetic and electric fields with regard to exposure of human beings – Special requirements for instruments and guidance for measurements*	frekvenčno območje: 15 Hz – 9 kHz *frequency range:* *15 Hz – 9 kHz*	visokonapetostni daljnovodi, transformatorske postaje, elektarne, trasformatorji in električna oprema *HV power lines, power substations, power plants, transformers, and electric equipment*

Tabela / *Table* 2

Tip obsega: **fiksni** / *Type of scope: **fixed***
Mesto izvajanja: **na terenu** / *Site: **fieldwork***
Področja preskušanja glede na vrsto preskušanja: **neionizirajoča sevanja (elektromagnetna združljivost)** / *Testing fields with reference to the type of test: **non-ionising radiation (electromagnetic compatibility)***
Področja preskušanja glede na vrsto preskušanca: **električni proizvodi in oprema (elektromehanske naprave)** / *Testing fields with reference to the type of test item: **electrical products and equipment (electromechanical devices)***

Št. / *No.*	Oznaka standarda ali nestandardne preskusne metode / *Reference to standard or non-standard testing method*	Naslov standarda ali nestandardne preskusne metode in morebitne navezave na druge standarde ali metode / *Title of standard or non-standard testing method and eventual relations to other standards or methods*	Območje preskušanja; Negotovost rezultata preskušanja (kjer je to pomembno) / *Range of testing; Uncertainty of the result of testing (where relevant)*	Materiali; proizvodi / *Materials; products*
5.	SIST EN 61000-4-4:2013 poglavje 7.4, samo asimetrične prenapetosti *clause 7.4, asymmetrical overvoltages only* modificirana *modified*	Elektromagnetna združljivost (EMC) - 4-4. del: Preskusne in merilne tehnike - Preskus odpornosti proti hitrim električnim prehodnim pojavom/razpoku (IEC 61000-4-4:2012) *Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test* OPA.6.EMC Merjenje prehodnih prenapetosti *Measurement of transient overvoltages*	frekvenčno območje: (0 – 100) MHz napetostno območje: (0-2500) Veff *frequency range:* (0 – 100) MHz *voltage range:* (0-2500) Veff	sekundarna oprema v visokonape-tostnih, srednjena-petostnih in nizkonape-tostnih transforma-torskih postajah, elektrarnah *secondary equipment in HV, MV and LV power substations, power plants*

Tip obsega: **fiksni** / *Type of scope: fixed*
Mesto izvajanja: **na terenu** / *Site: fieldwork*
Področja preskušanja glede na vrsto preskušanja: **neionizirajoča sevanja (elektromagnetna združljivost)** / *Testing fields with reference to the type of test: non-ionising radiation (electromagnetic compatibility)*
Področja preskušanja glede na vrsto preskušanca: **električni proizvodi in oprema (elektromehanske naprave)** / *Testing fields with reference to the type of test item: electrical products and equipment (electromechanical devices)*

Št. / *No.*	Oznaka standarda ali nestandardne preskusne metode / *Reference to standard or non-standard testing method*	Naslov standarda ali nestandardne preskusne metode in morebitne navezave na druge standarde ali metode / *Title of standard or non-standard testing method and eventual relations to other standards or methods*	Območje preskušanja; Negotovost rezultata preskušanja (kjer je to pomembno) / *Range of testing; Uncertainty of the result of testing (where relevant)*	Materiali; proizvodi / *Materials; products*
6.	SIST EN 50522:2011 paragraf L.2.2c), L.4 a, L.4 b / *paragraph L.2.2c),* L.4 a, L.4 b	Ozemljitve močnostnih inštalacij, ki presegajo 1 kV izmenične napetosti / *Earthing of power installations exceeding 1 kV a.c.*		razdelilne transformatorske postaje, razdelilne postaje, transformatorske postaje, elektrarne / *power stations, power substations, power plants*
7.	SIST EN 50522:2011 paragraf L.2.2c) / *paragraph L.2.2c)* modificirana / *modified*	OPA.6.OZ Meritev ozemljitvene impedance z visokotokovno metodo / *Measurement of impedance to earth using heavy current injection method*		razdelilne transformatorske postaje, razdelilne postaje, transformatorske postaje, elektrarne / *power stations, power substations, power plants*

Tabela / *Table* 3

Tip obsega: **fiksni** / *Type of scope: fixed*
Mesto izvajanja: **na terenu** / *Site: fieldwork*
Področja preskušanja glede na vrsto preskušanja: **akustika, hrup, vibracije (hrup)** / *Testing fields with reference to the type of test: acoustics, noise, vibrations (noise)*
Področja preskušanja glede na vrsto preskušanca: **okolje in vzorci iz okolja (okolje)** / *Testing fields with reference to the type of test item: environment and samples from the environment (environment)*

Št. / *No.*	Oznaka standarda ali nestandardne preskusne metode / *Reference to standard or non-standard testing method*	Naslov standarda ali nestandardne preskusne metode in morebitne navezave na druge standarde ali metode / *Title of standard or non-standard testing method and eventual relations to other standards or methods*	Območje preskušanja; Negotovost rezultata preskušanja (kjer je to pomembno) / *Range of testing; Uncertainty of the result of testing (where relevant)*	Materiali; proizvodi / *Materials; products*
8.	SIST ISO 1996-2:2007	Akustika – Opis, merjenje in ocena hrupa v okolju – 2. del: Določanje ravni hrupa v okolju / *Acoustics- Description, masurement ansd assessment of environmental noise – Part 2: Determination of environmental noise levels* v povezavi s SIST ISO 1996-1:2006	območje merjenja: (34 – 108) dBA frekvenčno območje: (20 – 20.000) Hz *range of measurement: (34 – 108) dBA frequency range: (20 – 20.000) Hz*	hrup v okolju / *environmental noise*

Tip obsega: **fiksni** / *Type of scope: **fixed***
Mesto izvajanja: **na terenu** / *Site: **fieldwork***
Področja preskušanja glede na vrsto preskušanja: **akustika, hrup, vibracije (hrup)** / *Testing fields with reference to the type of test: **acoustics, noise, vibrations (noise)***
Področja preskušanja glede na vrsto preskušanca: **okolje in vzorci iz okolja (okolje)** / *Testing fields with reference to the type of test item: **environment and samples from the environment (environment)***

Št. / *No.*	Oznaka standarda ali nestandardne preskusne metode / *Reference to standard or non-standard testing method*	Naslov standarda ali nestandardne preskusne metode in morebitne navezave na druge standarde ali metode / *Title of standard or non-standard testing method and eventual relations to other standards or methods*	Območje preskušanja; Negotovost rezultata preskušanja (kjer je to pomembno) / *Range of testing; Uncertainty of the result of testing (where relevant)*	Materiali; proizvodi / *Materials; products*
9.	SIST ISO 9613-2:1997	Akustika – Slabljenje zvoka pri širjenju na prostem – Splošna metoda za računanje Izračun na osnovi meritev izvedenih po standardu SIST ISO 1996-2 *Acoustics – Attenuation of sound during propagation outdoors - General method of calculation* *The calculation on the basis of measurements carried out according to standard SIST ISO 1996-2*	območje izračuna: (34 – 108) dBA frekvenčno območje: (100 – 8000) Hz *range of measurement:* *(34 – 108) dBA* *frequency range:* *(100 – 8000) Hz*	hrup v okolju *environmental noise*
10.	IEEE Std 656-1992	IEEE standard za merjenje akustičnega hrupa daljnovodov *IEEE Standard for the Measurment of Audible Noise From Overhad Transmission lines*	Območje merjenja: (34 – 108) dBA Frekvenčno območje: (20 – 20.000) Hz *range of measurement:* *(34 – 108) dBA* *frequency range:* *(20 – 20.000) Hz*	hrup daljnovodov v okolju *noise from overhad transmission lines*

3.2.2 Laboratorij OOK, Hajdrihova ulica 2, 1000 Ljubljana

Tabela / *Table* 4

Tip obsega: **fiksni** / *Type of scope: **fixed***
Mesto izvajanja: **na terenu** / *Site: **fieldwork***
Področja preskušanja glede na vrsto preskušanja: **vzorčenje; kemija; fizikalno preskušanje** / *Testing fields with reference to the type of test: **sampling; chemistry; physical testing***
Področja preskušanja glede na vrsto preskušanca: **okolje in vzorci iz okolja (viri emisij snovi, zrak)** / *Testing fields with reference to the type of test item: **environment and samples from the environment (sources of emissions of substances, air)***

Št. / *No.*	Oznaka standarda ali nestandardne preskusne metode / *Reference to standard or non-standard testing method*	Naslov standarda ali nestandardne preskusne metode in morebitne navezave na druge standarde ali metode / *Title of standard or non-standard testing method and eventual relations to other standards or methods*	Območje preskušanja; Negotovost rezultata preskušanja (kjer je to pomembno) / *Range of testing; Uncertainty of the result of testing (where relevant)*	Materiali; proizvodi / *Materials; products*
11.	SIST ISO 7935:1996	Emisije nepremičnih virov - Ugotavljanje masne koncentracije žveplovega dioksida - Delovne karakteristike avtomatskih merilnih metod *Stationary source emissions - Determination of the mass concentration of sulfur dioxide - Performance characteristics of automated measuring methods*	SO_2: (1 – 2000) mg/m^3	odpadni plini *waste gases*

Tip obsega: **fiksni** / *Type of scope: fixed*
Mesto izvajanja: **na terenu** / *Site: fieldwork*
Področja preskušanja glede na vrsto preskušanja: **vzorčenje; kemija; fizikalno preskušanje** / *Testing fields with reference to the type of test: sampling; chemistry; physical testing*
Področja preskušanja glede na vrsto preskušanca: **okolje in vzorci iz okolja (viri emisij snovi, zrak** / *Testing fields with reference to the type of test item: environment and samples from the environment (sources of emissions of substances, air)*

Št. / *No*	Oznaka standarda ali nestandardne preskusne metode / *Reference to standard or non-standard testing method*	Naslov standarda ali nestandardne preskusne metode in morebitne navezave na druge standarde ali metode / *Title of standard or non-standard testing method and eventual relations to other standards or methods*	Območje preskušanja; Negotovost rezultata preskušanja (kjer je to pomembno) / *Range of testing; Uncertainty of the result of testing (where relevant)*	Materiali; proizvodi / *Materials; products*
12.	ASTM D 2156-94:2003	Standardna preskusna metoda za določanje dimnega števila v odpadnih plinih pri izgorevanju destiliranih goriv *Standard Test Method for Smoke Density in Flue Gases from Burning Distillate Fuels*	dimno število: 0 - 9	odpadni plini *waste gases*
13.	SIST ISO 10780:1996	Emisije nepremičnih virov: Meritev hitrosti in volumskega pretoka plinskih tokov v odvodnikih *Stationary source emissions - Measurement of velocity and volume flowrate of gas streams in ducts*	v: (2 – 48) m/s	odpadni plini *waste gases*
14.	SIST EN 14385:2004 samo vzorčenje *sampling of only*	Emisije nepremičnih virov – Določevanje celotne emisije As, Cd, Cr, Co, Cu, Mn, Ni, Pb, Sb, Tl in V *Stationary source emissions - Determination of the total emission of As, Cd, Cr, Co, Cu, Mn, Ni, Pb, Sb, Tl and V*		odpadni plini *waste gases*
15.	SIST EN 13211:2002 samo vzorčenje *sampling only*	Kakovost zraka – Emisije nepremičnih virov – Ročna metoda za določevanje celotnega živega srebra *Air quality - Stationary source emissions - Manual method of determination of the concentration of total mercury*		odpadni plini *waste gases*
16.	SIST EN 15058:2006	Emisije nepremičnih virov – Določevanje masne koncentracije ogljikovega monoksida (CO) – Referenčna metoda: nedisperzivna infrardeča spektrometrija *Stationary source emissions - Determination of the mass concentration of carbon monoxide (CO) - Reference method: Non-dispersive infrared spectrometry*	CO: (0,5 – 1250) mg/m^3	odpadni plini *waste gases*
17.	SIST EN 14792:2006	Emisije nepremičnih virov – Določevanje masne koncentracije dušikovih oksidov (NO_X) – Referenčna metoda: kemiluminiscenca *Stationary source emissions - Determination of mass concentration of nitrogen oxides (NOx) - Reference method: Chemiluminescence*	NO_X: (0,5 – 2000) mg/m^3	odpadni plini *waste gases*
18.	SIST EN 14789:2005	Emisije nepremičnih virov – Določevanje volumske koncentracije kisika (O2) – Referenčna metoda: paramagnetizem *Stationary source emissions - Determination of volume concentration of oxygen (O2) - Reference method – Paramagnetism*	O_2: (0,1-25) % vol.	odpadni plini *waste gases*

Tip obsega: **fiksni** / *Type of scope: fixed*
Mesto izvajanja: **na terenu** / *Site: fieldwork*
Področja preskušanja glede na vrsto preskušanja: **vzorčenje; kemija; fizikalno preskušanje** / *Testing fields with reference to the type of test: sampling; chemistry; physical testing*
Področja preskušanja glede na vrsto preskušanca: **okolje in vzorci iz okolja (viri emisij snovi, zrak** / *Testing fields with reference to the type of test item: environment and samples from the environment (sources of emissions of substances, air)*

Št. / *No.*	Oznaka standarda ali nestandardne preskusne metode / *Reference to standard or non-standard testing method*	Naslov standarda ali nestandardne preskusne metode in morebitne navezave na druge standarde ali metode / *Title of standard or non-standard testing method and eventual relations to other standards or methods*	Območje preskušanja; Negotovost rezultata preskušanja (kjer je to pomembno) / *Range of testing; Uncertainty of the result of testing (where relevant)*	Materiali, proizvodi / *Materials; products*
19.	SIST EN 12619:2013	Emisije nepremičnih virov - Določevanje masnih koncentracij celotnega organskega ogljika v plinasti fazi - Kontinuirana metoda plamenske ionizacijske detekcije *Stationary source emissions - Determination of the mass concentration of total gaseous organic carbon - Continuous flame ionisation detector method*	(0,1 – 200) mg/m^3	odpadni plini *waste gases*
20.	SIST EN ISO 16911-1:2014	Emisije nepremičnih virov - Ročno in avtomatsko določevanje hitrosti in volumenskega pretoka v odvodnikih - 1. del: Ročna referenčna metoda *Stationary source emissions - Manual and automatic determination of velocity and volume flow rate in ducts - Part 1: Manual reference method*	v: (2 – 30) m/s	odpadni plini *waste gases*
21.	SIST EN 14211:2012 brez poglavja 8 in 11.1 *without chapter 8 and 11.1*	Kakovost zunanjega zraka – Standardna metoda za določanje koncentracije dušikovega dioksida in dušikovega monoksida s kemiluminiscenco *Ambient air quality – Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence*	NO: (2-1200) µg/m^3 NO_2: (2-500) µg/m^3	zrak *air*
22.	SIST EN 14212:2012 brez poglavja 8 in 11.1 *without chapter 8 and 11.1*	Kakovost zunanjega zraka – Standardna metoda za določanje koncentracije žveplovega dioksida z ultravijolično fluorescenco *Ambient air quality – Standard method for the measurement of the concentration of sulphur dioxide by ultraviolet fluorescence*	SO_2: (1-1000) µg/m^3	zrak *air*

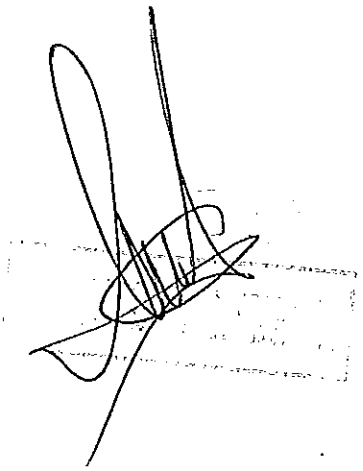


Tabela / *Table* 5

Tip obsega: **fiksni** / *Type of scope: fixed*
Mesto izvajanja: **na terenu in v laboratoriju** / *Site: fieldwork* **and in the laboratory**
Področja preskušanja glede na vrsto preskušanja: **vzorčenje; kemija; fizikalno preskušanje** / *Testing fields with reference to the type of test: sampling; chemistry; physical testing*
Področja preskušanja glede na vrsto preskušanca: **okolje in vzorci iz okolja (viri emisij snovi, zrak** / *Testing fields with reference to the type of test item: environment and samples from the environment (sources of emissions of substances, air)*

Št. *No.*	Oznaka standarda ali nestandardne preskusne metode *Reference to standard or non-standard testing method*	Naslov standarda ali nestandardne preskusne metode in morebitne navezave na druge standarde ali metode *Title of standard or non-standard testing method and eventual relations to other standards or methods*	Območje preskušanja; Negotovost rezultata preskušanja (kjer je to pomembno) *Range of testing; Uncertainty of the result of testing (where relevant)*	Materiali; proizvodi *Materials; products*
23.	SIST ISO 9096:2003	Emisije nepremičnih virov - Ročno določanje masne koncentracije trdnih delcev *Stationary source emissions – Manual determination of mass concentration of particulate matter*	celotni prah: (20 – 475) mg/m^3	odpadni plini *waste gases*
24.	SIST EN 13284-1:2002	Emisije nepremičnih virov – Določevanje majhnih masnih koncentracij prahu – 1. del: Ročna gravimetrijska metoda *Stationary source emissions – Determination of low range mass concentration of dust – Part 1: Manual gravimetric method*	celotni prah: (0,5 – 50) mg/m^3	odpadni plini *waste gases*
25.	VDI 2066 Part 10:2004	Meritev emisij PM_{10} in $PM_{2,5}$ na nepremičnih virih onesnaževanja z impaktorjem *Messung der Emissionen von PM_{10} und $PM_{2,5}$ an geführten Quellen nach dem Impaktionsverfahren*	$PM_{2,5}$: (1 – 50) mg/m^3 PM_{10}: (2 – 50) mg/m^3	odpadni plini *waste gases*
26.	SIST EN 12341:2014	Zunanji zrak - Standardna gravimetrijska metoda za določevanje masne koncentracije frakcije lebdečih delcev PM10 ali PM2,5 *Ambient air - Standard gravimetric measurement method for the determination of the PM10 or PM2,5 mass concentration of suspended particulate matter*	$r > 2$ µg/m^3	zrak *air*
27.	SIST EN ISO 1911:2011	Emisije nepremičnih virov - Določevanje masne koncentracije plinskih kloridov, izražene kot HCl – Standardna referenčna metoda – Analiza vzorca se izvaja po metodi B *Stationary source emissions - Determination of mass concentration of gaseous chlorides expressed as HCl - Standard reference method – Sample analysis according to Method B*	HCl: (1,5 – 5000) mg/m^3	odpadni plini *waste gases*
28.	SIST EN 14791:2005	Emisije nepremičnih virov – Določevanje masne koncentracije žveplovega dioksida – Referenčna metoda *Stationary source emissions - Determination of mass concentration of sulphur dioxide - Reference method*	SO_2: (20 – 500) mg/m^3	odpadni plini *waste gases*
29.	SIST ISO 15713:2009	Emisije nepremičnih virov – Vzorčenje in določevanje plinastega fluorida *Stationary source emissions - Sampling and determination of gaseous fluoride content*	HF: (0,5-200) mg/m^3	odpadni plini *waste gases*
30.	SIST EN 14790:2005	Emisije nepremičnih virov – Določevanje vodne pare v odvodnikih Stationary source emissions - Determination of the water vapour in ducts	vlaga: (58-250) g/m^3	odpadni plini waste gases

3.2.3 Laboratorij za visoke napetosti (LVN), Jamova 20, 1000 Ljubljana

Tabela / *Table* 6

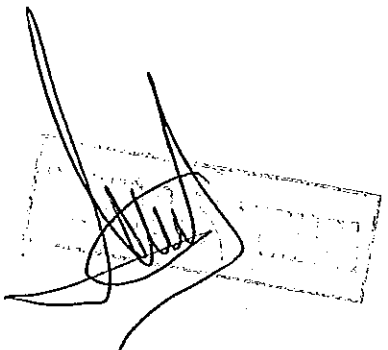
Tip obsega: **fiksni** / *Type of scope: **fixed***
Mesto izvajanja: **v laboratoriju** / *Site: **in the laboratory***
Področja preskušanja glede na vrsto preskušanja: **fizikalno preskušanje** / *Testing fields with reference to the type of test: **physical testing***
Področja preskušanja glede na vrsto preskušanca: **električni proizvodi in oprema (elektromehanske naprave)** / *Testing fields with reference to the type of test item: **electrical products and equipment (electromechanical devices)***

Št. / *No.*	Oznaka standarda ali nestandardne preskusne metode / *Reference to standard or non-standard testing method*	Naslov standarda ali nestandardne preskusne metode in morebitne navezave na druge standarde ali metode / *Title of standard or non-standard testing method and eventual relations to other standards or methods*	Območje preskušanja; Negotovost rezultata preskušanja (kjer je to pomembno) / *Range of testing; Uncertainty of the result of testing (where relevant)*	Materiali; proizvodi / *Materials; products*
31.	IEC 60060-1:2010 razen točke 4.5 *except point 4.5*	Visokonapetostni preizkusi električnih naprav *High voltage tests.*	Izmenična napetost: do 500 kV Enosmerna napetost: do 600 kV Udarna napetost: LI do 1800 kV SI do 1100 kV	visokonapetostne naprave *high-voltage equipment*
32.	IEC 61284:1997 točka 14 *point 14*	Meritev korone in radiointerferenčne napetosti (RIV) *Corona and radio interference voltage (RIV) tests*	do 500 kV	visokonapetostne naprave *high-voltage equipment*

Opombe / *Notes:*

- V vseh točkah podrobnega obsega akreditacije, pri katerih v rubriki "**Območje** preskušanja; **Negotovost** rezultata preskušanja" ni navedenih podatkov, veljajo določila posameznih standardov oziroma nestandardnih preskusnih metod, ki se na to nanašajo.
  *In all columns of the scope of accreditation where the cells under "**Range** of measurement, testing; **Uncertainty** of the result of testing" are empty, the provisions of the relevant standards or non-standard testing methods should apply.*
- V točkah podrobnega obsega akreditacije, pri katerih sta v rubriki "**Oznaka** standarda" navedeni dve ali več oznak standardov, se sklic nanaša na v celoti identične standarde.
  *In those columns of the scope of accreditation where the cells under "**Reference**" specify two or more codes of standards, the complete citation to identical standards should apply.*

Direktor / *Director*
dr. Boštjan Godec



на бланка на СЛОВЕНСКА АКРЕДИТАЦИЯ

ЛП-063

СЕРТИФИКАТ ЗА АКРЕДИТАЦИЯ

ЕЛЕКТРОИНСТИТУТ МИЛАН ВИДМАР

ул. Хайдрихова 2, 1000 Любляна, Словения

Лаборатории ОВЕНО, Лаборатории ООК, Лаборатории ЛВН

Горната организация е акредитирана от Словенската Акредитация (СА), като изпитвателна лаборатория. Този документ удостоверява съответствие с изискванията на стандарта СИСТ ЕН ИСО/ИЕЦ 17025:2005 (SIST EN ISO/IEC 17025:2005) за одобрения обхват за акредитация, както е описано в анекса, отбелязан със същия номер.

Първоначална дата за акредитация: 30 май 2005г.

Тази акредитация остава в сила при условие, че акредитираната организация напълно отговаря и съответства с изискванията за акредитиране, които са определени от СА чрез наблюдение. Информация за настоящия статут на акредитиране може да бъде намерена на интернет страницата на СА: www.sa.gov.si.

Словенската Акредитация (СА) подписваща страна на многостранно споразумение за Европейско сътрудничество за Акредитация (ЕА) и Международно Сътрудничество за Акредитация на Лаборатории (МСАЛ) за калибриране и изпитване.

Любляна, 24 септември 2008г.

Преводът на български език е извършен от Стефан Минчев

Реф. No.: 3150-0138/10-0007
Издаден на: 30 май 2016
Заменя Анекс издаден на: 1 юли 2015
Информация за настоящия акредитационен статус е налична на интернет страницата на СА: www.slo-akreditacija.si.

АНЕКС към Сертификат за Акредитация Номер ЛП-063/LP-063

1. Акредитирана организация:
ЕЛЕКТРОИНСТИТУТ МИЛАН ВИДМАР
ул. Хайдрихова 2, 1000 Любляна, Словения

2 СТАНДАРТ
СИСТ ЕН ИСО/ИЕЦ 17025:2005 (SIST EN ISO/IEC 17025:2005)

3 ОБХВАТ НА АКРЕДИТАЦИЯТА
СА с настоящото потвърждава, че акредитираната организация притежава компетенция/компетентност за извършването на следните дейности:

3.1 Кратко описание на обхвата
Тестване по отношение на вида на изпитването:
- *не-йонизиращо лъчение (електромагнитна радиация, електромагнитна съвместимост)*
- *акустика, шум, вибрации (шум)*
- *вземане на проби*
- *химия*
- *физически тестове*

Тестване във връзка с вида на изпитвания обект:
- *околната среда и проби от околната среда (електромагнитни лъчения, околната среда, източници на емисии на вещества, въздух)*
- *електрически продукти и оборудване (електромеханични устройства)*

3.2 Подробен обхват на акредитирането
3.2.1. ЛАБОРАТОРИИ ЛАВЕНО, ул. Хайдрихова 2, 1000 Любляна, Словения
Таблица 1

Тип на обхвата: ***фиксиран***
Място: ***на обекта/на полето***
Изпитване по отношение на типа на изпитване: не-йонизиращо лъчение (електромагнитна радиация, електромагнитна съвместимост)
Тестване във връзка с вида на изпитвания обект: околната среда и проби от околната среда (електромагнитни лъчения, околната среда, източници на емисии на вещества, въздух)

Номер	*Референция към стандарт или не-стандартен метод за изпитване*	*Заглавие на стандарт или нестандартен метод за изпитване и евентуални препратки към други стандарти или методи*	*Обхват на изпитването; Несигурност на резултата от изпитването (където е приложимо)*	*Материали; продукти*
1.	SIST ENV 50166-1:1995 *изтеглен без глава 4*	*Излагане на човешкия организъм на въздействието на електромагничтни полета с ниска честота(0 HZ до 10 kHz)*	5 Hz – 10 kHz	*Силови линии Високо Напрежение (ВН), подстанции, централи, трансформатори и електрооборудване*
2.	IEEE Std 644-1987 *Без точки 4.3, 6.3*	*IEEE стандартни процедури за измерване на електрически и магнитни полета с промишлена честота от АС силови линии*	5 Hz – 30 kHz	*Силови линии Високо Напрежение (ВН), подстанции, централи, трансформатори и електрооборудване*

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3.	IEEE Std 644-1994 *Без точки 4.3, 6.3*	*IEEE стандартни процедури за измерване на електрически и магнитни полета с промишлена честота от АС силови линии*	5 Hz – 30 kHz	*Силови линии Високо Напрежение (ВН), подстанции, централи, трансформатори и електрооборудване*

Тип на обхвата: ***фиксиран*** Място: ***на обекта/на полето*** *Изпитване по отношение на типа на изпитване:* ***не-йонизиращо лъчение (електромагнитна радиация, електромагнитна съвместимост)*** *Тестване във връзка с вида на изпитвания обект:* ***околната среда и проби от околната среда (електромагнитни лъчения, околната среда, източници на емисии на вещества, въздух)***				
Номер	*Референция към стандарт или не-стандартен метод за изпитване*	*Заглавие на стандарт или нестандартен метод за изпитване и евентуални препратки към други стандарти или методи*	*Обхват на изпитването; Несигурност на резултата от изпитването (където е приложимо)*	*Материали; продукти*
4.	SIST IEC 61786: 2005 без точки 5.2, 6.2	*Измерване на нискочестотни магнитни и електрически полета по отношение на излагането на човешкото тяло – Специални изисквания за измервателните прибори и ръководство за измервания*	*Честотен обхват: 15 Hz – 9 kHz*	*Силови линии, подстанции, централи, трансформатори и електрооборудване*

Таблица 2

Тип на обхвата: **фиксиран** Място: **на обекта/на полето** Изпитване по отношение на типа на изпитване: **не-йонизиращо лъчение (електромагнитна радиация, електромагнитна съвместимост)** Тестване във връзка с вида на изпитвания обект: **електрически продукти и оборудване (електромеханични устройства)**				
Номер	*Референция към стандарт или не-стандартен метод за изпитване*	*Заглавие на стандарт или нестандартен метод за изпитване и евентуални препратки към други стандарти или методи*	*Обхват на изпитването; Несигурност на резултата от изпитването (където е приложимо)*	*Материали; продукти*
5.	SIST EN 61000-4-4:2013 *клауза 7.4, асиметрични пренапрежения само* *променено*	*Електромагнитна съвместимост (ЕМС) - Част 4-4: Тестване и техники за измерване Електрически бърз преходен процес/тест за пробив* Измерване на преходни пренапрежения	Честотен обхват: (0 – 100) MHz *Обхват по напрежение:* (0-2500) Veff	*Силови подстанции и електрически централи с Високо Напрежение (ВН), Средно НАпрежение (СрН) и Ниско Напрежение (НН)*

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Тип на обхвата: **фиксиран** Място: **на обекта/на полето** Изпитване по отношение на типа на изпитване: **не-йонизиращо лъчение (електромагнитна радиация, електромагнитна съвместимост)** Тестване във връзка с вида на изпитвания обект: **електрически продукти и оборудване (електромеханични устройства)**				
Номер	*Референция към стандарт или не-стандартен метод за изпитване*	*Заглавие на стандарт или нестандартен метод за изпитване и евентуални препратки към други стандарти или методи*	*Обхват на изпитването; Несигурност на резултата от изпитването (където е приложимо)*	*Материали; продукти*
6.	SIST EN 50522:2011 *параграф L.2.2c),* L.4 a, L.4 b	Заземяване на силови инсталации над *1 kV a.c.*		*Силови станции, подстанции и електрически централи*
7.	SIST EN 50522:2011 *параграф L.2.2c)* Променен	*Измерване на импеданс към земя с използване на метод с голям инжектиран ток*		*Силови станции, подстанции и електрически централи*

Таблица 3

Тип на обхвата: **фиксиран** Място: **на обекта/на полето** Изпитване по отношение на типа на изпитване: **акустика, шум, вибрации (шум)** Тестване във връзка с вида на изпитвания обект: **околната среда и проби от околната среда (околната среда)**				
Номер	*Референция към стандарт или не-стандартен метод за изпитване*	*Заглавие на стандарт или нестандартен метод за изпитване и евентуални препратки към други стандарти или методи*	*Обхват на изпитването; Несигурност на резултата от изпитването (където е приложимо)*	*Материали; продукти*
8.	SIST ISO 1996-2:2007	*Акустика- Описание, измерване и оценка на шума в околната среда - Част 2: Определяне на нивата на шум в околната средav* Съответствие с/във връзка с SIST ISO 1996-1:2006	*Обхват на измерване:* (34 – 108) dBA *Честотен обхват:* *(20 – 20.000) Hz*	Шум в околната среда

Тип на обхвата: **фиксиран** Място: **на обекта/на полето** Изпитване по отношение на типа на изпитване: **акустика, шум, вибрации (шум)** Тестване във връзка с вида на изпитвания обект: **околната среда и проби от околната среда (околната среда)**				
Номер	*Референция към стандарт или не-стандартен метод за изпитване*	*Заглавие на стандарт или нестандартен метод за изпитване и евентуални препратки към други стандарти или методи*	*Обхват на изпитването; Несигурност на резултата от изпитването (където е приложимо)*	*Материали; продукти*
9.	SIST ISO 9613-2:1997	*Акустика - Затихване на звука по време на разпространението му на открито - Общ метод за изчисляване Изчисляването на базата на измерванията, извършени в съответствие със стандарт SIST ISO 1996-2*	*Обхват на измерванията:* (34 – 108) dBA *Честотен обхват:* *(100 – 8000) Hz*	*Шум в околната среда*
10.	IEEE Std 656-1992	*IEEE Стандарт за измерване на Звуков шум от преносни въздушни електропроводи*	*Обхват на измерванията:* (34 – 108) dBA *Честотен обхват:* *(20 – 20.000) Hz*	Шум от преносни въздушни електропроводи

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3.2.1. ЛАБОРАТОРИИ ООК, ул. Хайдрихова 2, 1000 Любляна, Словения

Таблица 4

Тип на обхвата: ***фиксиран*** Място: ***на обекта/на полето*** *Изпитване по отношение на типа на изпитване:* ***вземане на проби, химия, физически тестове*** *Тестване във връзка с вида на изпитвания обект:* ***околната среда и проби от околната среда (източници на емисии на вещества, въздух)***				
Номер	*Референция към стандарт или не-стандартен метод за изпитване*	*Заглавие на стандарт или нестандартен метод за изпитване и евентуални препратки към други стандарти или методи*	*Обхват на изпитването; Несигурност на резултата от изпитването (където е приложимо)*	*Материали; продукти*
11.	SIST ISO 7935:1996	*Емисии от неподвижни източници - Определяне на масовата концентрация на серен диоксид - Работни характеристики на автоматизирани методи за измерване*	SO_2: (1 – 2000) mg/m3	Отпадни газове

Тип на обхвата: ***фиксиран*** Място: ***на обекта/на полето*** *Изпитване по отношение на типа на изпитване:* ***вземане на проби, химия, физически тестове*** *Тестване във връзка с вида на изпитвания обект:* ***околната среда и проби от околната среда (източници на емисии на вещества, въздух)***				
Номер	*Референция към стандарт или не-стандартен метод за изпитване*	*Заглавие на стандарт или нестандартен метод за изпитване и евентуални препратки към други стандарти или методи*	*Обхват на изпитването; Несигурност на резултата от изпитването (където е приложимо)*	*Материали; продукти*
12.	ASTM D 2156-94:2003	*Стандартен метод за изпитване Smoke Плътност в димните газове от изгарянето на дестилатни горива*	Чувствителност за дим: 0 - 9	Отпадни газове
13.	SIST ISO 10780:1996	*Неподвижни източници на емисии - измерване на скоростта на скорост и дебит на газовите потоци в проводите*	v: (2 – 48) m/s	Отпадни газове
14.	SIST EN 14385:2004 Само проби	*Емисии от неподвижни източници - Определяне на общото количество на емисиите на As, Cd, Cr, Co, Cu, Mn, Ni, Pb, Sb, Tl and V*		Отпадни газове
15.	SIST EN 13211:2002 само проби	*Качество на въздуха - Неподвижни източници на емисии - Manual метод за определяне на концентрацията на общия живак*		Отпадни газове
16.	SIST EN 15058:2006	*Неподвижни източници на емисии - Определяне на концентрацията на масата на въглероден окис (CO) - Референтен метод: Не-дисперсионни инфрачервена спектрометрия*	CO: (0,5 – 1250) mg/m3	Отпадни газове

Преводът на български език е извършен от Стефан Минчев

17.	SIST EN 14792:2006	*Неподвижни източници на емисии - Определяне на масова концентрация на азотни оксиди (NOx) - Референтен метод: хемилуминесценция*	NOx: (0,5 – 2000) mg/m3	Отпадни газове
18.	SIST EN 14789:2005	*Неподвижни източници на емисии - Определяне на концентрация обем на кислород (O2) - Референтен метод - парамагнетизъм*	O2: (0,1-25) % vol.	Отпадни газове

Тип на обхвата: ***фиксиран*** Място: ***на обекта/на полето*** *Изпитване по отношение на типа на изпитване:* ***вземане на проби, химия, физически тестове*** *Тестване във връзка с вида на изпитвания обект:* ***околната среда и проби от околната среда (източници на емисии на вещества, въздух)***				
Номер	*Референция към стандарт или не-стандартен метод за изпитване*	*Заглавие на стандарт или нестандартен метод за изпитване и евентуални препратки към други стандарти или методи*	*Обхват на изпитването; Несигурност на резултата от изпитването (където е приложимо)*	*Материали; продукти*
19.	SIST EN 12619:2013	*Неподвижни източници на емисии - Определяне на концентрацията на масата на общия газообразен органичен въглерод - Непрекъснато пламък метод йонизационен детектор*	(0,1– 200) mg/m3	Отпадни газове
20.	SIST EN ISO 16911-1:2014	*Стационарни източници на емисии - Ръчно и автоматично определяне на скоростта и дебит в канали - Част 1: Ръчно референтен метод*	v: (2 – 30) m/s	Отпадни газове
21.	SIST EN 14211:2012 *Без глава 8 и 11.1*	*Качество на атмосферния въздух - стандартен метод за измерване на концентрацията на азотен диоксид и азотен монооксид чрез хемилуминесценция*	NO: (2-1200) □g/m3 NO2: (2-500) □g/m3	въздух
22.	SIST EN 14212:2012 *Без глава 8 и 11.1*	*Качество на атмосферния въздух - стандартен метод за измерване на концентрацията на серен диоксид от ултравиолетова флуоресценция*	SO2: (1-1000) □g/m3	въздух

Преводът на български език е извършен от Стефан Минчев

Таблица 5

Тип на обхвата: ***фиксиран***
Място: ***на обекта/на полето и в лаборатория***
Изпитване по отношение на типа на изпитване: ***вземане на проби, химия, физически тестове***
Тестване във връзка с вида на изпитвания обект: ***околната среда и проби от околната среда (източници на емисии на вещества, въздух)***

Номер	*Референция към стандарт или не-стандартен метод за изпитване*	*Заглавие на стандарт или нестандартен метод за изпитване и евентуални препратки към други стандарти или методи*	*Обхват на изпитването; Несигурност на резултата от изпитването (където е приложимо)*	*Материали; продукти*
23.	SIST ISO 9096:2003	*Неподвижни източници на емисии - Ръчно определяне на масова концентрация на частици*	Съдържание на прах: (20 – 475) mg/m3	Отпадни газове
24.	SIST EN 13284-1:2002	*Неподвижни източници на емисии - Определяне на малък обхват масова концентрация на прах - Част 1: Ръчно гравиметричен метод*	Съдържание на прах: (0,5 – 50) mg/m3	Отпадни газове
25.	VDI 2066 Part 10:2004	*Измерване на емисиите на ФПЧ10 и ФПЧ2,5 на източници*	$PM_{2,5}$: (1 – 50) mg/m3 PM_{10}: (2 – 50) mg/m3	Отпадни газове
26.	SIST EN 12341:2014	*Атмосферния въздух - стандартен метод за гравиметрично измерване за определяне на PM10 или ПЧ2,5 маса концентрация на суспендирани частици*	r >2 □g/m3	въздух
27.	SIST EN ISO 1911:2011	*Неподвижни източници на емисии - Определяне на масова концентрация на газообразни хлориди, изразени като HCl - стандартен референтен метод - анализ на проба съгласно Метод B*	HCl: (1,5 – 5000) mg/m3	Отпадни газове
28.	SIST EN 14791:2005	*Неподвижни източници на емисии - Определяне на масова концентрация на серен диоксид - Референтен метод*	SO_2: (20 – 500) mg/m3	Отпадни газове
29.	SIST ISO 15713:2009	*Стационарни източници на емисии - вземане на проби и определяне на газообразни съдържание на флуор,*	HF: (0,5-200) mg/m3	Отпадни газове
30.	SIST EN 14790:2005	Емисии от неподвижни източници - Определяне на водната пара в каналите	влага: (58-250) g/m3	Отпадни газове

Преводът на български език е извършен от Стефан Минчев

3.2.3. Лаборатория за високи напрежения (ЛВН), ул. Ямова 20, 1000 Любляна, Словения
Таблица 6

Тип на обхвата: ***фиксиран*** Място: ***в лаборатория*** *Изпитване по отношение на типа на изпитване:* ***физически тестове*** *Тестване във връзка с вида на изпитвания обект:* **електрически продукти и оборудване (електромеханични устройства)**				
Номер	*Референция към стандарт или не-стандартен метод за изпитване*	*Заглавие на стандарт или нестандартен метод за изпитване и евентуални препратки към други стандарти или методи*	*Обхват на изпитването; Несигурност на резултата от изпитването (където е приложимо)*	*Материали; продукти*
31.	IEC 60060-1:2010 *Без точка 4.5*	Изпитания с високо напрежение.	Синусоидално напрежение до 500 kV Постоянно напрежение до 600 kV Ударно напрежение: LI до 1800 kV SI до 1100 kV	Оборудване за високо напрежение
32.	IEC 61284:1997 *точка 14*	*Изпитания за Корона и радиочестотно смущение (RIV)*	до 500 kV	Оборудване за високо напрежение

Бележки:

- Във всички колони от обхвата на акредитация, където клетките под "Обхват на тестване: неопределеност на резултат от изследване" са празни, следва да се прилагат разпоредбите на съответните стандарти или нестандартни методи за изпитване.
- В колоните на обхвата на акредитация където клетките под "Референтен" определят два или повече кодове на стандарти, позоваването се отнася до напълно идентични стандарти.

Това е копие от приложението към сертификата за акредитация, предназначено за публикуване на сайта. Подписаният документ – оригинали са на разположение за проверка в централата на СА.

Директор
Д-р. Бостиан Годец

Превода̀т на български език е извършен от Стефан Минчев

Zavod za gradbeništvo Slovenije
Slovenian National Building and Civil Engineering Institute
Dimičeva ulica 12, 1000 Ljubljana, Slovenija
http://www.zag.si, e-mail: info@zag.si

Na podlagi poročila Št. **P – 1338/11-520-1** izdaja

IZKAZ O ZRAKOTESNOSTI OBJEKTA

Objekt: **Kolektor ETRA – Zrakotesna hala**

Naslov: Šlandrova 10, 1231 Ljubljana

Neto prostornina: $V_e = 47138\ m^3$

Rezultati: Na podlagi meritev zrakotesnosti objekta znaša vrednost urne izmenjave zraka po standardu SIST EN 13829 – Metoda A (objekt v obratovalnem stanju)

$$n_{15} = 0,03\ h^{-1}$$

pri tlačni razliki $\Delta p = 15\ Pa$ glede na okolico in pri standardnih pogojih zraka $T_0 = 20\ °C$ in $p_0 = 1{,}01325\ bar$.

Datum preizkusa: 29.11.2011

V Ljubljani, dne 22.12.2011

Vodja Laboratorija za toplotno zaščito
Friderik Knez, univ. dipl. fiz.

Direktor Zavoda za gradbeništvo Slovenije
izr. prof. dr. Andraž Legat, univ. dipl. fiz.

ZAVOD ZA GRADBENIŠTVO SLOVENIJE LJUBLJANA

BREMO C OPRAVIČILOM

ZAG Ljubljana

Slovenian National Building and Civil Engineering Institute

Dimičeva ulica 12, 1000 Ljubljana

http://www.zag.si, e-mail: info@zag.si

Based on the Report No. P-1338/11-520-1, we hereby grant

CERTIFICATE ON AIRTIGHTNESS OF BUILDING

Building:	Kolektor ETRA – Airtight Hall
Location:	Šlandrova 10, 12311 Ljubljana
Net volume:	$V_e = 47138\ m^3$
Results:	Based on the measurement of airtightness of the Building the value of hourly exchange of air according to the SIST EN 13829 Standard – A Method (Building in the state of operation) is

$$n_{15} = 0.013\ h^{-1}$$

at pressure difference $\Delta p = 15\ Pa$ in respect to the environment at

standard condition of the air $T_0 = 20\ ^oC$ and $p_o = 1.01325\ bars$.

Date of test: 29 November 2011

In Ljubljana on 22 December 2011

Head of Laboratory for Thermal Protection	Director of Slovenian National Building and Civil Engineering Institute
Friderik Knez, B.Sc. in Physics	Assoc. Prof. dr. Andraž Legat, B.Sc. in Physics
(signed)	(signed)

Official round seal:

Slovenian National Building and Civil Engineering Institute

Ljubljana

Podpisana Marjeta Sekirnik, prof. z odločbo Ministrstva za pravosodje Republike Slovenije štev. 756-93/93, z dne 13. junija 1994 imenovana za stalnega sodnega tolmača za angleški jezik izjavljam, da se ta prevod povsem ujema z izvirnikom v slovenskem jeziku.

I, the undersigned Marjeta Sekirnik, BA, certified permanent court interpreter for English language, appointed under the Decree No.756-93/93, issued on 13 June 1994 by the Minister of Justice of the Republic of Slovenia, hereby declare and certify that this is a true translation of the original document written in Slovene attached hereinbefore.

Ljubljana, April 14, 2017

SODNA TOLMAČKA ZA ANGLEŠKI JEZIK
MARJETA
SEKIRNIK
Bohoričeva 58
LJUBLJANA


SODNA TOLMAČKA ZA ANGLEŠKI JEZIK
MARJETA
ŠEKIRNIK
Bohoričeva 5B
LJUBLJANA

ЗАГ Любляна

Словенски Национален Сграден и
Строително инженерингов Институт

Димичева Улица 12, 1000 Любляна

http://www.zag.si, e-mail: info@zag.si

Въз основа на Доклад № P-1338/11-520-1, с настоящото ние гарантираме

СЕРТИФИКАТ ЗА ХЕРМЕТИЧНОСТ НА СГРАДАТА

Сграда: Колектор ETPA – Херметична сграда

Локация: Сландрова 10, 12311 Любляна

Общ обем: $V_e = 47138\ m^3$

Резултат: на основание на измерване на херметичността на сградата стойността на часовата подмяна на въздуха съгласно стандарт SIST EN 13829 – A Метод (сграда в състояние на експлоатация) е

$$n_{15} = 0.013\ h^{-1}$$

при разлика в налягането $\Delta p = 15$ Pa по отношение на околната среда, при стандартни условия на въздуха T_0=20°C и p_0=1.01325 бара.

Дата на теста: 29 Ноември 2011

В Любляна на 22 Декември 2011

Ръководител на Лабораторията по термична защита

Фредерик Кнез
(Подписано)

Директор Словенски Национален Сграден и Строително инженерингов Институт
Проф. Др. Андраз Легат
(Подписано)

Официален кръгъл печат:

Словенски Национален Сграден и Строително инженерингов Институт

Любляна

Превод на български език: Деян Маринов .....

ZRMK INSTITUT
Gradbeni inštitut ZRMK
Building and Civil Engineering Institute

POROČILO O OPRAVLJENIH MERITVAH TEMPERATURE IN RELATIVNE VLAŽNOSTI NOTRANJEGA ZRAKA ZA PROSTOR »KONČNA MONTAŽA«

Objekt: Proizvodni obrat Kolektor Etra d.o.o., Šlandrova ulica 10, Ljubljana

Delovni nalog: DN 2005457

Čas izvajanja meritev: Začetek 10.2.2015 ob 8:00, zaključek 11.2.2015 ob 8:00

Merilna oprema: Registratorji temperature in relativne vlažnosti zraka, tip Tinytag Ultra 2, TGU-4500 (oznake registratorjev: 609969, TT1*, 609964, TT2**)

Kalibracija opreme: Preizkušeno pri Laboratoriju za metrologijo in kakovost, Fakulteta za elektrotehniko, Univerza v Ljubljani
* oznaka certifikata LMK0115I090, z dne 27.1.2015, in LMK0115H094, z dne 30.1.2015
** oznaka certifikata LMK0115I091, z dne 27.1.2015, in LMK0115H095, z dne 30.1.2015

Protokol meritev: Meritve so potekale skladno s postopki opisanimi v standardu SIST EN ISO 7726:2002

Izmerjene vrednosti:

Merilno mesto	Temperatura	Relativna vlažnost
Končna montaža h=1,8m	25,0°C	9,8%
Končna montaža h=5,2m	25,0°C	8,7%

VODJA CENTRA ZA BIVALNO OKOLJE, GRADBENO FIZIKO IN ENERGIJO

dr. Marjana ŠIJANEC-ZAVRL, univ.dipl.inž.grad.

TEHNIČNI DIREKTOR

dr. Blaž DOLINŠEK, univ.dipl.inž.grad.

GRADBENI INŠTITUT ZRMK d.o.o. Ljubljana, Dimičeva 12

BARVNO C OPTIMIRANA

ZRMK INSTITUTE

Building and Civil Engineering Institute

REPORT ON COMPLETED MEASUREMENTS OF TEMPERATURE AND RELATIVE HUMIDITY OF INDOORL AIR IN THE »FINAL ASSEMBLY« HALL

Building: Kolektor Etra d.o.o. Production Plant
Šlandrova ulica 10, Ljubljana

Order: DN 2005457

Time of performed measurement: Beginning on 10 February 2015 at 8:00; conclusion on 11 February 2015 at 8:00

Measuring equipment: Temperature registrars and relative humidity of air, Type Tinytag Ultra 2, TGU-5400 (registrars designation: 609969, TT1*, 609964, TT2**

Calibration equipment: Tested in the Laboratory for Metrology and Quality, Faculty of Electrical Engineering
*- Certificate LMK0115I090 dated 27 January 2015 and LMK0115H094 dated 30 January 2015
**- Certificate LMK0115I091 dated 27 January 2015 and LMK0115H095 dated 30 January 2015

Measurement protocol: Measurements were performed according to the procedures in compliance with the described standard SIST EN ISO 7726:2002

Measured values:

Location	Temperature	Relative humidity
Final Assembly h= 1.8 m	25.0 ^{0} C	9.8%
Final Assembly h= 5.2 m	25.0 ^{0} C	8.7%

Manager of Living Environment Centre,
Civil Engineering Physics and Energy

(signed)

Dr. Marjan ŠIJANEC ZAVRL, B.Sc. in Civil Eng.

Manager of Technical Department

(signed)

Dr. Blaž DOLINŠEK, B.Sc. in Civil Eng.

Rectangular seal:

Building and Civil Engineering Institute

Podpisana Marjeta Sekirnik, prof. z odločbo Ministrstva za pravosodje Republike Slovenije štev. 756-93/93, z dne 13. junija 1994 imenovana za stalnega sodnega tolmača za angleški jezik izjavljam, da se ta prevod povsem ujema z izvirnikom v slovenskem jeziku.

I, the undersigned Marjeta Sekirnik, BA, certified permanent court interpreter for English language, appointed under the Decree No.756-93/93, issued on 13 June 1994 by the Minister of Justice of the Republic of Slovenia, hereby declare and certify that this is a true translation of the original document written in Slovene attached hereinbefore.

Ljubljana, April 14, 2017

SODNA TOLMAČKA ZA ANGLEŠKI JEZIK
MARJETA SEKIRNIK
Bohoričeva 5B
LJUBLJANA

BREZPLAČNA KOPIJA

SODNA TOLMAČKA ZA ANGLEŠKI JEZIK
MARJETA SEKIRNIK
Bohoričeva 58
LJUBLJANA

ЗРМК Институт

Сграден и Строително инженерингов Институт

ПРОТОКОЛ ЗА ЗАВЪРШЕНИ ИЗМЕРВАНИЯ НА ТЕМПЕРАТУРАТА И ОТНОСИТЕЛНАТА ВЛАЖНОСТ НА ВЪЗДУХА В ЗАЛА „ФИНАЛНО СГЛОБЯВАНЕ"

Сграда:	Колектор ETPA д.о.о. Фабрика Сландрова улица 10, Любляна
Поръчка:	DN2005457
Време за изпълнение на измерванията:	Започване на 10 Февруари 2015 в 8:00; Завършване на 11 Февруари 2015 в 8:00
Измервателно оборудване:	Регистратори на температура и относителна влажност на въздуха, Тип Tinytag Ultra 2, TGU-5400 (обозначение на регистраторите: 609969 TT1*, 609964 TT2**)
Калибрационно оборудване:	Тествано в Лабораторията за метрология и качество, Факултет по Електроинженеринг *- сертификат LMK0115I090 от 27 Януари 2015 и LMK0115H094 от 30 Януари 2015 **- сертификат LMK0115I091 от 27 Януари 2015 и LMK0115H095 от 30 Януари 2015
Протокол от измервания	Измерванията бяха изпълнени в съответствие с процедурите по описания стандарт SIST EN ISO 7726: 2002

Измерени величини

Локация	Температура	Относителна влажност
Финално сглобяване h = 1.8m	25°C	9.8%
Финално сглобяване h = 5.2m	25°C	8.7%

Мениджър Център за жилищна околна среда
Строителен инженеринг Физика и Енергия

Др. Мариян Суанец Заврл
(Подписано)

Мениджър Техническа Дирекция

Др. Блаз Долинсек
(Подписано)

Официален кръгъл печат:

Словенски Национален Сграден и Строително инженерингов Институт

Превод на български език: Деян Маринов .....

IVD
Institut za varstvo pri delu
d.o.o. Valvasorjeva cesta 73 Maribor p.o.

IVD Maribor p.o.
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T: +386 (0)2 421 60 10
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E: info@ivd.si
W: www.ivd.si

Contractor:
IVD MARIBOR p.o.
Valvasorjeva 73
2000 MARIBOR

Requested by
KOLEKTOR ETRA d.o.o.
Šlandrova 10
1231 Ljubljana-Črnuče

REPORT ON AIR DUST PARTICLES TEST RESULTS

Building:	Production Plant of Kolektor Etra d.o.o., Šlandrova 10, Ljubljana
Order No.:	CEVO-409/2015
Date of test measurement:	20 October 2015
Measuring equipment:	Laser measuring equipment for counting of particles - GRIMM 1.108 product
Method of measurement:	in compliance with the EN ISO 14644-1 Standard
Purpose:	The purpose of this measurement test is to establish the quantity of present particles in the working area and the purity class in the working area - Assembly HALL 1 and Assembly Hall 2 and compliance with the EN ISO 14644-1 Standard.

Measuring Station	Measured number of particles		
	(0.5 µm/m^3)	(0.1 µm/m^3)	(0.5 µm/m^3)
HALL 1 - normal conditions of operation	16,124	3,325	30
HALL 2 - normal conditions of operation	19,065	2,050	17
HALL 2 - dry conditions of operation	20,050	5,568	31
Marginal value as per ISO 14644-1 for Class 8	3,520,000	832,000	29,300
Marginal value as per ISO 14644-1 for Class 7	352,000	83,200	2,930

Conclusion: Based on the performed measurements, we estimate, that production halls used for the assembly of magnetic circle, production of coiling, assembly of coiling, active part and final assembly, do comply with the purity criteria CLASS 8 and CLASS 7 in line with the SIST EN ISO 14664-1:2000 Standard, which applies to the operation phase.

Maribor, 23 October 2015

Zoran Belić, B.Sc. in Mech.
Head of Technical Department

ЛОГО ИВД Марибор

Изпълнител:

ИВД Марибор п. о.
Валвасориева 73
2000 Марибор

Заявител
Колектор ETPA д.о.о.
Сландрова 10
1231 Любляна

ДОКЛАД ЗА ТЕСТВАНЕ ЗА НАЛИЧИЕ НА ПРАХОВИ ЧАСТИЦИ ВЪВ ВЪЗДУХА

Сграда: Производствен завод Колектор ETPA д.о.о., Сландрова 10, Любляна
Поръчка №: CEVO-409/2015
Дата на измерване: 20 Октомври 2015
Измервателно оборудване: Лазерно измервателно оборудване за преброяване на частици GRIMM 1.108 продукт
Метод на измерване: съгласно Стандарт EN ISO 14644-1
Цел: Целта на измерването е да бъде определено наличното количество частици в работната площ и класа на чистота на работната площ – Зала за сглобяване 1 и Зала за сглобяване 2 и съответствието със Стандарт EN ISO 14644-1

Измервателна станция	Измерено количество частици		
	(0.5 µm/m3)	(0.1 µm/m3)	(0.5 µm/m3)
Зала 1 – нормални условия на работа	16,124	3,325	30
Зала 2 – нормални условия на работа	19,065	2,050	17
Зала 2 – сухи условия на работа	20,050	5,568	31
Гранични стоности съгласно ISO 14644-1 за Клас 8	3,520,000	832,000	29,300
Гранични стоности съгласно ISO 14644-1 за Клас 7	352,000	83,200	2,930

Заключение На база извършените изревания ние преценяваме, че производствените зали използвани за сглобяване на магнитните кръгове, производство на намотки, сглобяване на намотки и активна част и финално сглобяване отговарят на критериите за чистота КЛАС 8 и КЛАС 7 във връзка със Стандарт SIST ISO 14664-1:2000, които отговаря за работни фази.

Марибор, 23 октомври 2015

Зоран Белич

Ръководител Техническа дирекция

(Подписано)

Превод на български език: Деян Маринов .....

ДЕКЛАРАЦИЯ

за отсъствие на полихлорирани бифинили (PCB) в изолационното масло

Долуподписаните

Екехарт Бернхард Нойрайтер, притежаващ лична карта (удостоверение за продължително пребиваване) №1801, издадена от МВР – гр. София, валидно до 18.07.2017г. адрес гр. София, бул. Христофор Колумб № 9, ет.3,

в качеството ми на Управител на АББ България ЕООД

и

Стефан Василев Минчев, притежаващ лична карта №641790843, издадена на 11.01.2011 от МВР – гр. София, адрес: гр. София, бул. Христофор Колумб № 9, ет.3,

в качеството ми на Управител на АББ България ЕООД,

участник в процедура за възлагане на обществена поръчка с предмет: „Доставка, демонтаж и монтаж на трифазни маслонапълнени понижаващи силови трансформатори 110kV/Средно напрежение (СрН) и цялото необходимо помощно оборудване", реф. № PPD 17-001",

ДЕКЛАРИРАМЕ, ЧЕ:

В предложените от нас трифазни маслонапълнени понижаващи силови трансформатори 110kV/Средно напрежение (СрН) се използва изолационно масло, което не съдържа полихлорирани бифинили (PCB).

Приложение:

Заверено становище от производителя Ергон Рефайнинг Инк.

Дата: 19.04.2017

Декларатор:

Екехарт Нойрайтер
Управител
АББ България ЕООД

Стефан Минчев
Управител
АББ България ЕООД

ABB Bulgaria EOOD
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BIC: INGBBGSF

Ergon Refining, Inc.
An ISO 9001 and 14001 Certified Company

July 23, 2014

Dear Valued Customer:

Reference: PCBs, chlorinated and halogenated compounds

This letter is generated in response to your recent inquiry concerning the polychlorinated biphenyl (PCB); polychlorinated terphenyl (PCT) and monomethyl-tetrachloro-diphenyl methane (PCBT) contents as well as the chlorinated and halogenated compounds contents of the Ergon naphthenic base, process and insulating oils.

PCBs are synthetically produced compounds added to oils to improve stability and/or flame retardation. Polychlorinated terphenyls (PCTs) and monomethyl-tetrachloro-diphenyl methanes (PCBTs) are addressed in EU Directive n. 96/59/EC of 16 September 1996 and included in the definition of PCBs. Ergon Refining oils are processed from naturally occurring raw materials with no additives or recycled oils that might introduce PCB contamination. Products are routinely tested to verify they are PCB-free.

In addition to being PCB-free, Ergon naphthenic base, process and insulating oils do not contain other chlorine or chlorinated compounds. They contain no halogen or organohalogen derivative products. These chemicals are not utilized in the manufacturing process, nor are they naturally occurring in the products produced.

Please give me a call if you have additional questions. I can be reached at 601-630-8314.

Best Regards,

Jennifer D. Hall
Manager, Product Services and Development

Ergon Refining, Inc. / P.O. Box 309 / Vicksburg, MS 39181-0309 / Phone – 601-630-8300 / Fax – 601-630-8425

Лого ЕРГОН Рафиниране

23 Юли 2014

Уважаеми Клиенти:

Референция: PCB, хлорирани и халогенирани съединения

Това писмо се е в отговор на Ваше запитване във връзка с полихлориден бифенол (PCB); полихлорирани терфенили (PCT) и монометил-тетрахлоро-дифенил метан (PCBT) съдържание както и за съдържание на хлорирани и халогенирани съединения в Ергон нафтенова основа, процес и изолиране на масла.

PCB са синтетично произведени съединения добавяни към маслото за подобряване стабилността и/или забавянето при изгаряне. Полихлорираните терфенили (PCT) и монометил-тетрахлоро-дифенил метан (PCBT) са посочени в Евро Директива n. 96/59/EC от 16 Септември 1996 и включени в дефиницията за PCB. Маслата на Ергон Рафиниране са от преработката на природни суровинни материали без добавки или рециклиране на масла което може да доведе до замърсяване с PCB. Продуктите са рутинно тествани за да се потвърди тяхната PCB – чистота.

В допълнение за PCB-чистота, Ергон нафтенова основа, процес и изолиране на масла не съдържат хлорин или други хлоринови съединения. Те съдържат нехалогенни или производни на органохалогенни продукти. Тези химикали не се използват в производствения процес, нито се срещат естествено в произвежданите продукти.

Моля обадете се ако имате други въпроси. Може да ме намерите на 601-630-8314.

С най-добри пожелания,

Дженифър Д. Халл

Маниджър, Продукти услуги и Развитие

Превод на български език: Деян Маринов .....

Приложение 3 - Декларация за конфиденциалност и извършен оглед на обекта

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IBAN: BG60INGB91451400027311 (EUR)
BIC: INGBBGSF

ДЕКЛАРАЦИЯ

за конфиденциалност и извършен оглед на обект по предмета на поръчката

Долуподписаните Екехарт Нойрайтер и Стефан Минчев в качеството ни на представляващи АББ България ЕООД, участник в процедура за възлагане на обществена поръчка с реф. № PPD 17-001 и предмет:

Доставка, демонтаж и монтаж на трифазни маслонапълнени понижаващи силови трансформатори 110kV/Средно напрежение (СрН) и цялото необходимо помощно оборудване,

ДЕКЛАРИРАМЕ, ЧЕ:

1/ Представител на участника, когото представлявам е извършил оглед на обект: п/ст Студентски град и съм запознат със съществуващото положение.

2/ Няма да разпространявам поверителна информация, във връзка с извършения оглед на обекта на Възложителя, като ми е известно, че за поверителна се счита всяка информация, относно пропускателния режим в обекта, организацията на работната сила и работния процес, наличното оборудване и техническите схеми на функционирането му, системите за защита и сигурност в обекта и всичко, което е свързано с наличното оборудване, съоръжения и тяхното функциониране в съответния обект.

3/ Прилагам документ за извършен оглед, съставен на място в подстанцията.

Приложение: Документ за извършен оглед, съставен на място в подстанцията

Дата: 19.04.2017

Участник:

Екехарт Нойрайтер
Управител
АББ България ЕООД

Стефан Минчев
Управител
АББ България ЕООД

ABB Bulgaria EOOD
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ДЕКЛАРАЦИЯ

за извършен оглед на ПС „Студенец" 110/Ср.Н

Долуподписаният/-ната/ Стефан Василев Митев,
в качеството ми на представляващ АББ България ЕООД,
кандидат за участие в процедура за възлагане на обществена поръчка с предмет: „Доставка, демонтаж и монтаж на трифазни маслонапълнени понижаващи силови трансформатори 110kV/Средно напрежение (СрН) и цялото необходимо помощно оборудване" и реф. № PPD 17-001

ДЕКЛАРИРАМ:

Извърших оглед на обекта, предмет на обществената поръчка и се запознах със съществуващото положение, включително с действащите електрически съоръжения и спецификата на ПС „Студенец" 110/Ср.Н.

Дата 11.04.2018 г.

Декларатор: _____
/име, подпис и печат/
Стефан Василев Митев

Служител на Възложителя допуснал до оглед кандидата:

Нинко Ангелов - р-л ЕО - _____
име и фамилия ***длъжност*** ***подпис***

Приложение 4 - Копие на сертификат по стандарт БДС EN ISO 9001 на производителя на предлагания трансформатор

ABB Bulgaria EOOD
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BIC: INGBBGSF

03.2017

BUREAU VERITAS
Certification

Certificate

Awarded to

KOLEKTOR ETRA d.o.o.

ŠLANDROVA ULICA 10, 1231 LJUBLJANA – ČRNUČE, SLOVENIA

Bureau Veritas Certification Holding SAS – UK Branch certify that the Management System of the above organization has been audited and found to be in accordance with the requirements of the management system standard detailed below

STANDARD

ISO 9001:2008

SCOPE OF CERTIFICATION

DESIGN, PRODUCTION, INSTALLATION AND DECOMMISSION OF POWER AND SPECIAL TRANSFORMERS AND REACTORS

Certification cycle start date: **31/10/2014**

Subject to the continued satisfactory operation of the organisation's Management System, this certificate expires on: **31/10/2017**

Original certification date: **30/06/1997**

Certificate number: **SL21076Q** *Version number:* **01** *Revision date:* **06/10/2015**

Signed on behalf of BVCH SAS UK Branch

Certification body address: 66 Prescot Street, London, E1 8HG, United Kingdom
Local office: Linhartova cesta 49a, 1000 Ljubljana, Slovenia

Further clarifications regarding the scope of this certificate and the applicability of the management system requirements may be obtained by consulting the organization.

To check this certificate validity please call: + 386 1 47 57 670.

UKAS MANAGEMENT SYSTEMS 008

На бланка на Бюро Веритас Сертифициране

СЕРТИФИКАТ

Присъден на

КОЛЕКСТОР ЕТРА д.о.о.
улица „Сландрова“ № 10, 1231 Любляна – Чрунче, Словения

БЮРО ВЕРИТАС СЕРТИФИКАЦИОНЕН ХОЛДИНГ САС – клон Великобритания
удостоверява, че СИСТЕМА ЗА УПРАВЛЕНИЕ на горната организация е одитирана и е установено, че тя е в съответствие с изискванията на стандартите на системата, описани подробно в:

Стандарт
ISO 9001:2008
обхват

Проектиране, производство, монтаж и демонтаж на силови и специални трансформатори и реактори.

Сертификационен цикъл с начална дата: **31.10.2014**

Подложен на непрекъсната задоволителна експлоатация на Системата за управление, този сертификат е валиден до: **31.10.2017.**

Дата на първоначално одобрение: **30.06.1997.**

Сертификат номер: **SL21076Q**

Версия **01**, Дата на ревизия: **06.10.2015**

Подписано от името на Бюро Веритас Сертификационен Холдинг САС клон Великобритания
/подписът не се чете/

Адрес на сертификационното тяло: ул. Прескот №66, гр. Лондон, E1 8XГ, Великобритания
Адрес на местен офис: Любартова цеста 49а, 1000 Любляна, Словения

Други подробности относно обхвата на този сертификат и приложимостта на изискванията на системата за управление могат да бъдат получени при връзка с организацията.

За проверка на този сертификат моля, обадете се на телефон: +38614757670

Преводът на български език е извършен от Стефан Минчев

Приложение 5 - Декларация за срока на валидност на офертата

ABB Bulgaria EOOD
Main Office
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BIC: INGBBGSF

03.2017

ДЕКЛАРАЦИЯ
за срока на валидност на офертата

Долуподписаните

Екехарт Бернхард Нойрайтер, притежаващ лична карта (удостоверение за продължително пребиваване) №1801, издадена от МВР – гр. София, валидно до 18.07.2017г. адрес гр. София, бул. Христофор Колумб № 9, ет.3,

в качеството ми на Управител на АББ България ЕООД

и

Стефан Василев Минчев, притежаващ лична карта №641790843, издадена на 11.01.2011 от МВР – гр. София, адрес: гр. София, бул. Христофор Колумб № 9, ет.3,

в качеството ми на Управител на АББ България ЕООД,

участник в процедура за възлагане на обществена поръчка с предмет: „Доставка, демонтаж и монтаж на трифазни маслонапълнени понижаващи силови трансформатори 110kV/Средно напрежение (СрН) и цялото необходимо помощно оборудване“, реф. № PPD 17-001”,

Обособена позиция 5 /ОП 5/ - Доставка, демонтаж и монтаж на трифазен маслонапълнен понижаващ силов трансформатор 110kV/СрН за подстанция /ПС/ „Студентски град“, както и доставка на цялото необходимо помощно оборудване

ДЕКЛАРИРАМЕ, ЧЕ:

С подаване на настоящата оферта, направените от нас предложения и поети ангажименти са валидни за срока, посочен в обявлението, считано от крайния срок за подаване на офертите.

Дата: 19.04.2017

Декларатор: .....

Екехарт Нойрайтер
Управител
АББ България ЕООД

.....

Стефан Минчев
Управител
АББ България ЕООД

ABB Bulgaria EOOD
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Приложение 6 - Декларация за приемане на условията в проекта на договор

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1592 Sofia, Bulgaria
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BIC: INGBBGSF

ДЕКЛАРАЦИЯ

за приемане на условията в проекта на договор

Долуподписаните Екехарт Нойрайтер и Стефан Минчев в качеството ни на представляващи АББ България ЕООД участник в обществена поръчка с предмет: „Доставка, демонтаж и монтаж на трифазни маслонапълнени понижаващи силови трансформатори 110kV/Средно напрежение (СрН) и цялото необходимо помощно оборудване“, реф.№ PPD 17-001, обособена позиция № Обособена позиция 5 /ОП 5/ - Доставка, демонтаж и монтаж на трифазен маслонапълнен понижаващ силов трансформатор 110kV/СрН за подстанция /ПС/ „Студентски град“, както и доставка на цялото необходимо помощно оборудване

Д Е К Л А Р И Р А М Е, ЧЕ:

Приемаме условията в проекта на договор, приложен в документацията за участие.

Дата: 19.04.2017

Декларатор: .....

Екехарт Нойрайтер
Управител
АББ България ЕООД

.....

Стефан Минчев
Управител
АББ България ЕООД

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