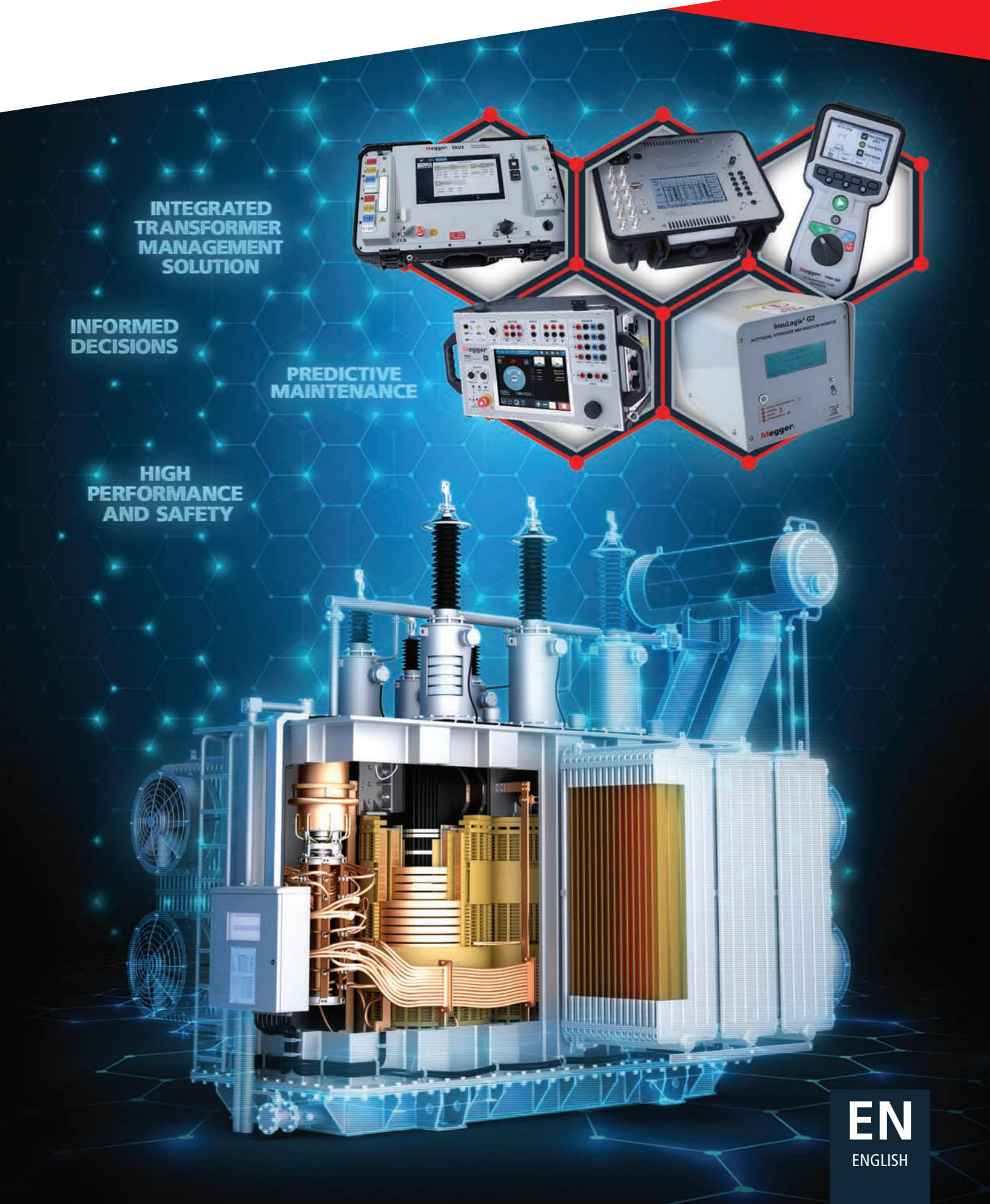
Power and distribution transformer overall diagnostics and condition assessment

Megger



EN
ENGLISH

Customer's challenges and solutions

When we address the topic of electrification, there is a strong social and economic commitment to supply high quality energy and build a strong and reliable power grid to help all humanity. In reality, almost 700 million people do not have access to electricity today and about the same number are expected to remain in darkness by the year 2030 (IEA). In this progressive challenge towards a more economical, dependable, and environmentally-friendly energy supply, transformers play a fundamental role.

The invention of the transformer was the key to unlocking energy transmission and distribution at high and low voltages, providing voltage regulation and economic energy flow from the source to the end user whether they are industrial, commercial, or domestic.

Utilities

Major utilities are responsible for the continuous supply of electricity. However, they face an unstoppable aging process of the electrical infrastructure. Aging infrastructure needs to be properly monitored, operated, and, when it reaches end-of-life, should be properly decommissioned.

At the generation point, transformers work at a very stable condition but also at almost full load. The design of step-up transformers, used at generation sites considers the challenges of taking an enormous amount of energy at voltages between 13.8 and 24 kV (typically) and stepping up to high voltages used for transmission networks.

At the utility site, asset managers deal daily with the challenges of managing the aging process of transformers and better understanding/preventing the causes of failure. As with any other asset manager, utilities look for preventive measurements and predictive methods based on off-line and on-line testing to assess the condition of a transformer, and to prevent the sudden and dangerous termination of a transformer. Utilities use their own highly-qualified maintenance staff, to test power transformers following the international standards to prevent failure, provide safety, and protect human, technical and financial resources.

Service contractors

The progressive load demand makes utilities expand and build new power stations or substations. When construction of new facilities is at hand, utilities rely on expert service providers to install and commission new equipment.

Service contractors work in many different places and mobilise equipment at different locations. The portability, accuracy, and reliability of testing equipment is crucial. Because the work is divided into different fronts and areas, service contractors tend to prefer the use of single-function testing equipment with a single software to collect, administer, and report the testing conducted on transformer bushings, windings, core, tank, and tap changers.

Nevertheless, when a dedicated task is taken on one only transformer, a multi-function test set provides a simple, reliable, and economic solution to the important task of deciding if a transformer is capable to manage the operating condition specified by design.

Industrials

Downstream from the transmission, we reach the distribution network where the load becomes more variable, and stability of the system is paramount. Voltage regulation is imperative to manage the load and work efficiently.

However, distribution networks are quite busy and the process of isolating a transformer may not be as easy as many would think. Oil sampling is always a safe and practical decision to estimate the most important condition of the insulation system inside the transformer without the need of disconnecting it from service. Oil testing can be performed on transformers at any level and samples can be locally analysed with dedicated portable equipment or taken to specialised laboratories.

We have reached the border line where critical loads are even more diverse. Industrial consumers rely on continuous operation of their devices. Testing may be conducted by a third-party service contractor or by dedicated maintenance and testing crews. In an industrial environment, voltage levels may range from 69 kV down to 120 V.

A practical approach for this end-user is the use of multi-function test sets where one instrument conducts a complete protocol of tests to ensure safe and reliable operation. But we cannot stay away from other critical loads such as hospitals, government entities, data centres, emergency response units, etc. These critical loads use qualified contractors to ensure safe and efficient operation at minimum risk of failure. Portable single-function equipment is typically used. It is low-weight and provides maximum accessibility to industrial complex installations.

OEMs

It is impossible to list all the different areas of application of transformers. Independent of the application, power and distribution transformers are susceptible to damage, degradation and aging, therefore a well-developed testing plan is fundamental to manage the service life cycle of transformers and minimising their risk of failure.

From power generation down to the smallest pole-mounted transformer in the distribution network, utilities, government, and society in general, rely on power and distribution transformer manufacturers to supply high quality products according to strict engineering specifications and a continuous variable and growing demand. Manufacturers (OEMs) follow strict quality control and quality assurance protocols and procedures to certify compliance with engineering design and expected operating conditions.

Factory Acceptance Testing (FAT) is conducted using integrated testing consoles where test results are collected and consolidated into one single report that represents a benchmark for future analysis, reference, and trending throughout the service life of power and distribution transformers.

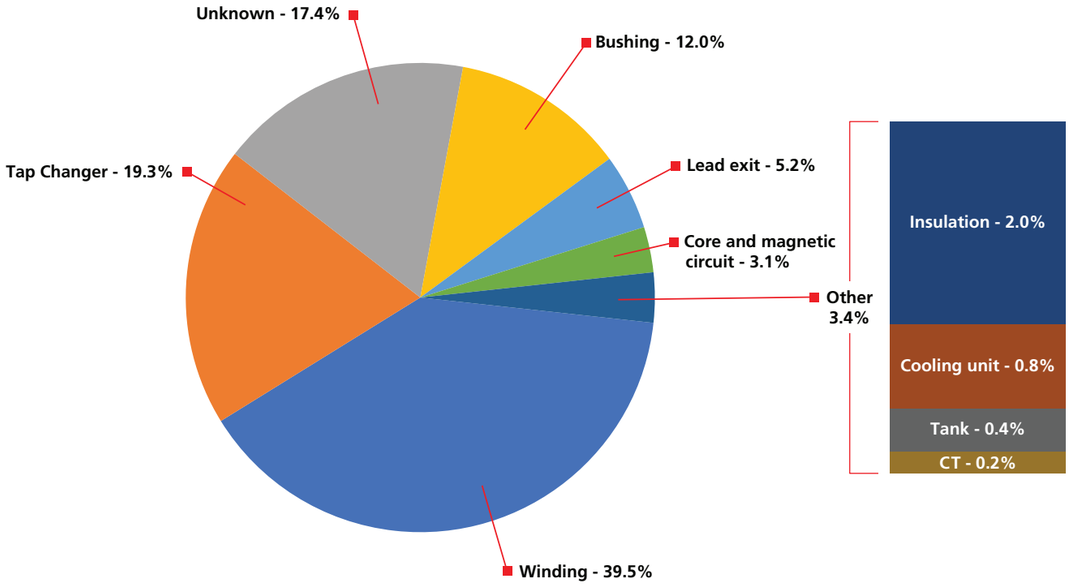
Transformer failure – A possibility, but not on your shift!

Transformer manufacturers around the world aim to provide the most suitable designs for field applications. It is a continuous quality control procedure that starts with the engineering design, extends through to the material acquisition, control, and parts assembly, and ends with a full set of standardised tests to fulfil factory acceptance testing criteria.

In the field, reliable operation of a transformer is expected. It should perform its specified function under normal and transient conditions, according to the engineering design, for 30 or more years.

As reported in CIGRE TB 642, "*dielectric mode failures featured as major contributors in most of the surveyed studies, irrespective of manufacturing period and transformer application*". As such, we know windings, tap -changers, and bushing-related failures are the major contributors to transformer failure.

Failure location analysis



Reference:

CIGRE TB 642 - Transformer Reliability Survey, 2015. Table 30 - Failure Location analysis dependent on Voltage Class (including "unknown")

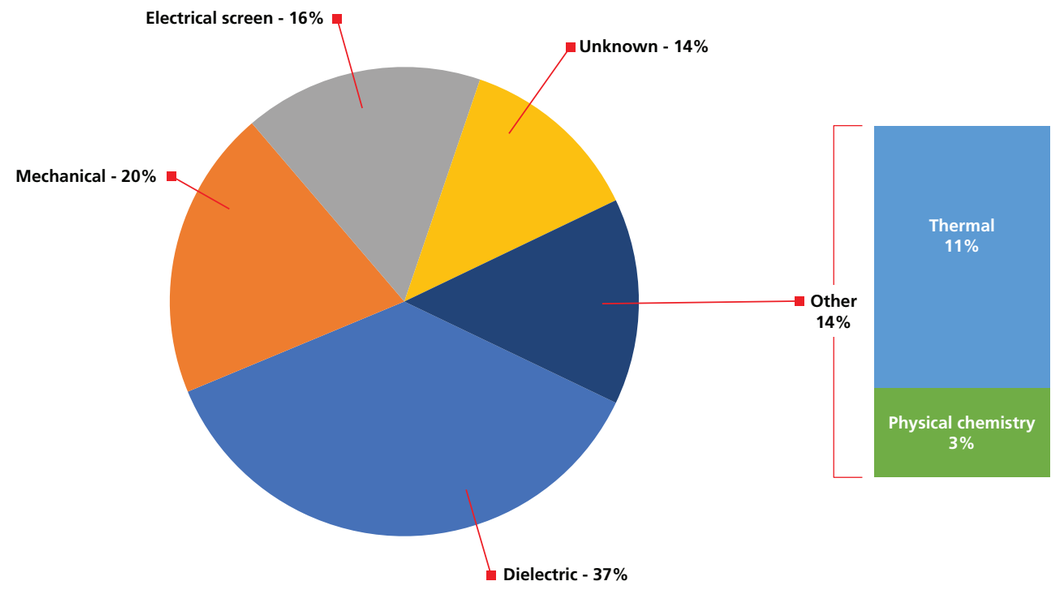
Having a good understanding of potential failure locations and failure modes means that it is expected that necessary preventative and proactive maintenance practices will be taken to minimise the risk of power and distribution transformer failures.

Transformer asset managers base their decisions on accurate information obtained from off-line testing and on-line monitoring devices. Good assessment and decision making is a result of reliable instruments gathering accurate test data that can later evaluate the electro mechanical and dielectric condition of a transformer during its service life.

As stated in CIGRE TB 761, "*The essence of condition assessment is to identify the indications that can be used to determine (and quantify where possible) the extent of the degradation of the components and sub-components of the transformer*".

This is where Megger becomes your best business partner. Megger supplies state-of-the-art instruments that have been trusted for over 130 years to end users all over the world. Megger's wide range of products include off-line diagnostics, on-line monitoring, and laboratory services. Megger's technical support, service, and training centres are located across the globe and are available to help you understand the condition of power, distribution, and instrument transformers in a proactive way minimising the risk of failure during your shift.

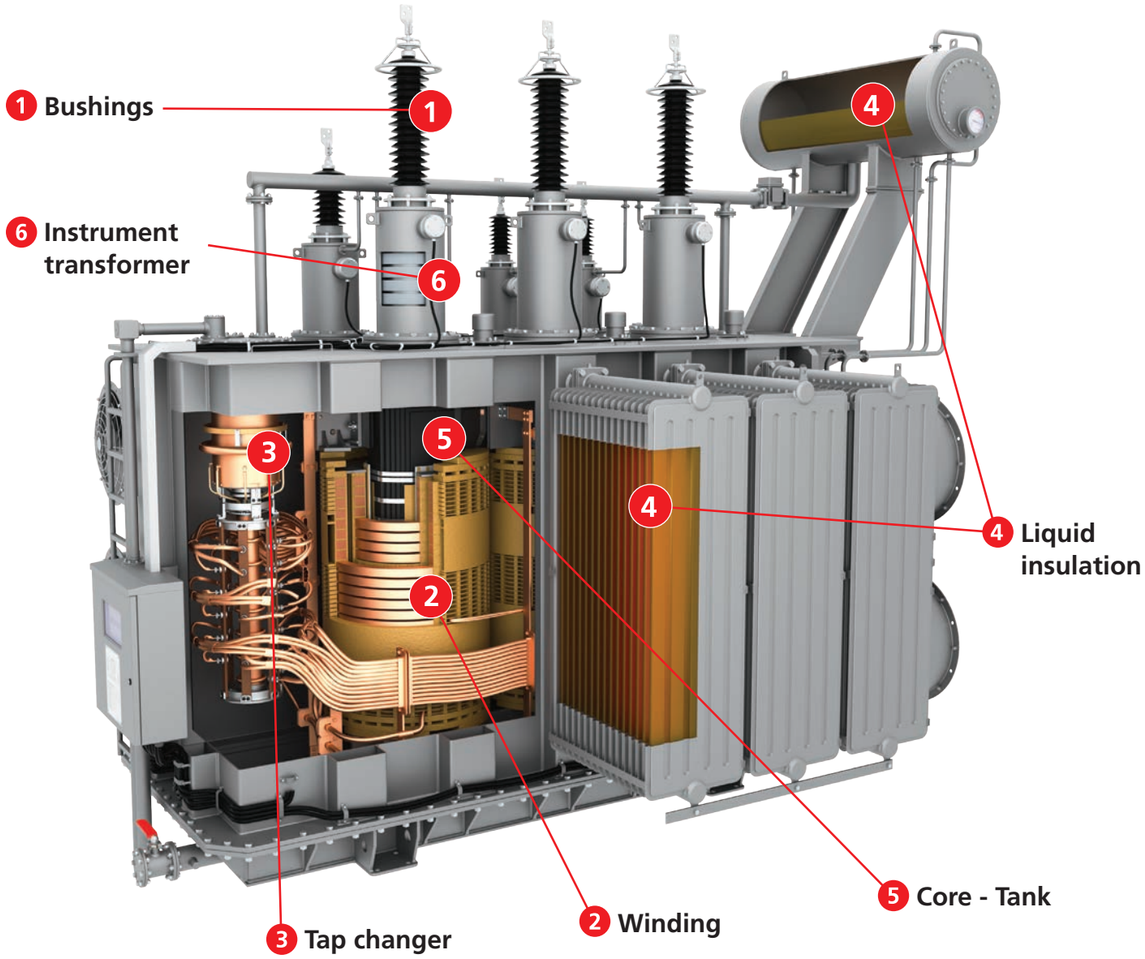
Failure mode analysis

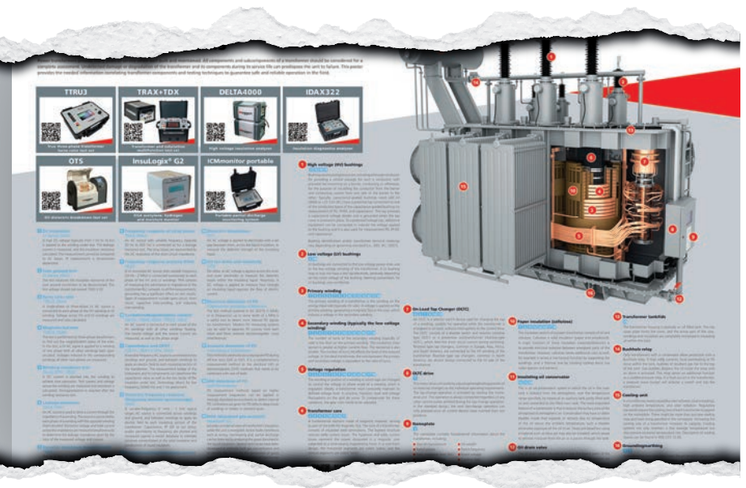


Reference:

CIGRE TB 642 - Transformer Reliability Survey, 2015. Table 32 - Failure Mode analysis dependent on Voltage Class (including "unknown")

Transformer testing components





Component importance

1 Bushings

Bringing electric energy into the transformer is achieved by using bushings. They are able to conduct electric energy and isolate the energy from exposed areas. The insulation of high voltage bushings (RBP, OIP, RIP, or RIS) is divided in to different insulation media (oil-to-air, oil-to-gas, and oil-to-oil). This enabled them to be used outdoors or indoors, depending on the application.

2 Winding

Transformer winding design and assembly is one of the most significant steps in transformer construction and future reliable operation. The number of turns in the winding defines the ratio of voltage and current conversion, and the winding connection between phases defines the vector diagram of the transformer. Winding design is directly related to the efficiency of the transformer as it defines the path for current to flow and its distance will influence in the mutual inductance and leakage reactance.

3 Tap changer

Tap changers (de-energised DETC or on-load OLTC) are a critical component in the power transformer. The DETC can only be operated off-line but the automatic OLTC benefits the operation of a transformer maintaining a stable voltage in the system. The OLTC adjusts the transformer turns ratio automatically under load to compensate any load variation and thus voltage variations.

4 Liquid insulation

Liquid insulation provides one of the greatest benefits to the transformer and the transformer operators. It is an information carrier. Mineral oil and vegetable oil provide unique insulation protection as well as internal flow by convection. The flow of oil inside the transformer is fundamental for cooling purposes. Oil samples can be taken from the transformer during operation and be analysed in laboratories for quality or dissolved gases in oil. It can be also connected to an on-line monitoring system for partial or full Dissolved Gas Analysis (DGA).

5 Core - Tank

The transformer core is the main structure supporting the entire active part of the transformer. The transformer core is made of a magnetic material with high magnetic permeability used to provide a path for magnetic field lines. No load losses (hysteresis and eddy current losses) are characteristic of the core. Its proper design and construction allows the transformer to be one of the most efficient machines in the electric grid.

6 Instrument transformer

The importance of instrument transformers is twofold. First, they transform the primary high current, or high voltage, into a low energy measurement signal (current, voltage) which can be easily used in protection or metrology systems and provides a true image of the primary signal. Second, they take this measurement signal from the high voltage of the line or the busbar to almost earth potential.

Product and standards reference matrix

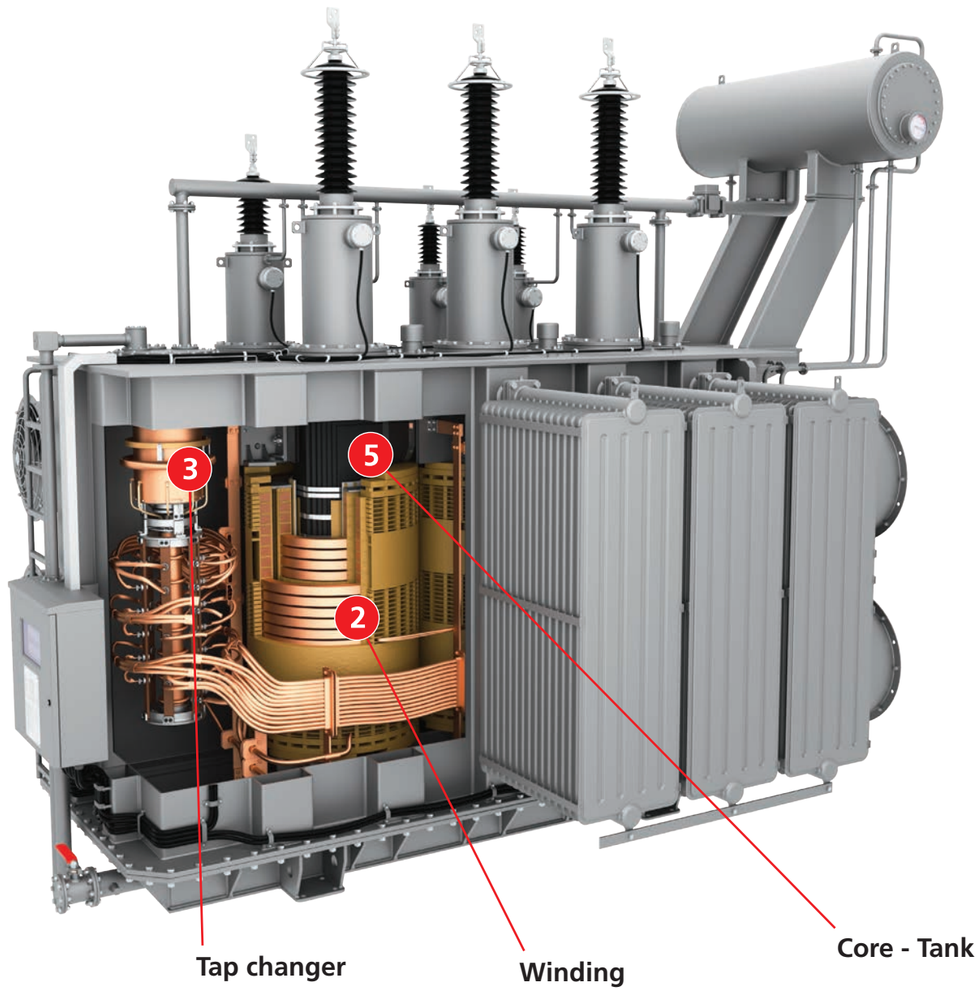
TEST TYPES		MEGGER TEST SET										MEGGER TEST SET								TECHNICAL REFERENCES		
		SINGLE FUNCTION				MULTI-FUNCTION			OVERALL INSULATION			CONDITION ASSESSMENT		LIQUID INSULATION				INST. TRANSFORMER				
COMPONENT	TEST	TTRU1	TTRU3	MTO	FRAX	TRAX	TAU3	TTV	S1/MIT	CDAX	DELTA	IDAX	ICM	OTS	OTD	KF	G2	MRCT	MVCT	IEEE	CIGRE TB	IEC
 1 Bushings	Capacitance					■		■	■	■	■	■								C57.19.100	755	60137
	Power factor/tan delta					■		■		■	■	■										
	Narrowband dielectric response					■		■			■	■								C57.12.200		-
	Dielectric frequency response							■				■										-
	Partial discharges												■							C57.19.01, C57.160		60270, 60137
 2 Windings	Winding resistance			■		■	■	■												C57.12.00, C57.12.01, C57.152	445	60076-1, 60076-16
	Ratio/polarity/phase	■	■			■	■	■		■	■											
	Excitation current	■	■			■	■	■			■	■										
	Short-circuit impedance	■				■	■	■														
	Sweep frequency response analysis (SFRA)				■			■												C57.149	342, 445, 812	60076-18
	Frequency response of stray losses (FRSL)				■	■	■	■													445	
	Magnetic balance		■			■	■	■														
	Insulation resistance							■	■			■								C57.12.00, C57.12.01, C57.152	445	60076-1, 60076-16
	Capacitance					■		■	■	■	■	■										
	Power factor/tan delta					■		■		■	■	■										
	Narrowband dielectric response					■		■			■	■								C57.161	414	
	Dielectric frequency response							■				■									414, 445	
	Moisture in paper							■				■									349	
	Partial discharges												■							C57.12.00, C57.12.01, C57.113, C57.12.90, C57.12.91	676, 445	60270, 60076-3, 60076-11, 62478, 60076-16
 3 On-load Tap changer (OLTC)	Resistance			■		■	■	■												C57.131	445	60214
	Ratio/polarity	■	■			■	■	■														
	Excitation current	■	■			■	■	■			■	■								C57.152		
	Contact timing/dynamic resistance					■		■														
	Continuity (make before break)			■		■	■	■														
	Partial discharges												■							C57.131		60270, 60214-1, 60214-2
	Dissolved Gas Analysis (DGA)																■			C57.139	409; 443; 771; 738	60599
	De-energised Tap changer (DETC) Resistance			■		■	■	■												C57.152	445	60214-2
	Ratio/Polarity	■	■			■	■	■														
	Excitation current	■	■			■	■	■			■	■										
	Partial discharges												■							C57.131	676; 445	60270, 60214-1, 60214-2
 4 Liquid insulation	Moisture in oil															■	■			C57.152, C57.106	445	60422
	Dielectric breakdown voltage							■						■						C57.152, C57.106, C57.637		60296, 60422, 60475, 60156
	Power factor/tan delta					■		■			■				■					-		-
	Temperature controlled tan delta, resistivity and relative permittivity							■							■					C57.152, C57.106, C57.637		60296, 60422, 60475, 60247, 61620
	Conductivity							■				■								-		-
	Dissolved Gas Analysis (DGA)																■			C57.104 C57.155 C57.146	409; 443; 771; 738	60599
 5 Core - Tank	Core insulation							■	■			■								C57.152	445	60076-1
	Excitation current	■	■			■	■	■			■	■										
	Power factor/tan delta					■		■			■	■										
	Magnetic balance		■			■	■	■														
	Sweep frequency response analysis (SFRA)				■			■												C57.149	342, 812	60076-18
	Contact resistance					■		■													445	
 6 Instrument transformers	Current transformers	■	■			■		■										■	■	C57.13	394	61869-1, 61869-2
	Voltage transformers	■	■			■		■										■	■			61869-1, 61869-3
	Capacitive voltage transformers					■		■			■							■		C57.13.9		61869-1, 61869-5
	PAGE NUMBER	11	11	11	11	13	15	15	17	17	17	19	21	25	25	25	27	29	29			

Single-function testing equipment

Electrical acceptance testing, according to national and/or international standards, ensures the safety, quality, and reliability of electrical equipment throughout the entire power grid from power generation to commercial and residential distribution. Electrical testing professionals assure the operational conditions of electrical equipment using single-function testing instruments.

Acceptance testing and commissioning services are often needed on construction projects where several pieces of electrical equipment are assessed simultaneously to expedite the process. The use of single-function testing instruments is an efficient way to keep several working fronts testing and gathering critical data to set benchmarks and assess the condition of multiple assets, including power and distribution transformers.

Portability and high accuracy make single-function instruments ideal for service contractors and maintenance crews responsible for the operation of power and distribution transformers.



VIEW PRODUCT PAGE

TTRU1 - Handheld transformer turns ratiometer

In addition to turns ratio measurements, the TTRU1 provides transformer polarity, excitation current, go/no go, and short circuit impedance verification for single and three-phase distribution, power, and instrument transformers.

- **On-screen vectors and connection diagrams with the ability to save common transformer configurations increase confidence in test setup and results evaluation**
- **Results automatically saved with pass/fail ratio evaluation, USB drive export, and PowerDB Import (coming soon)**
- **Models available: TTRU1^{BAS}; TTRU1^{ADV}; TTRU1^{PRO}; TTRU1^{EXP}**

VIEW PRODUCT PAGE

TTRU3 - True three-phase transformer turns ratio tester

A true three-phase transformer turns ratio tester capable of accurately testing in step-down or step-up (pending patent) modes. Ideal for high voltage (HV) autotransformers with tertiary winding where ratio testing experiences a voltage dependence effect. The step-up function eliminates the need for HV ratio testing.

- **One-touch OLTC test simplifies old cumbersome procedures and reduces field testing time**
- **The intuitive interface is ideal for rapid interactive test plan setup and report formulation**
- **Models available: TTRU3^{BAS}; TTRU3^{ADV}; TTRU3^{PRO}; TTRU3^{EXP}**

VIEW PRODUCT PAGE

MTO series - Winding resistance testers

The MTO series of instruments offer accurate and fast winding resistance tests. Single-phase and three-phase connections provide flexibility and easy access to transformer terminals.

- **Fast and safe simultaneous winding measurements as well as demagnetisation process**
- **Fast and safe discharge function implemented to avoid human or equipment damage**
- **Models available: MTO106; MTO210; MTO250; MTO 300**

VIEW PRODUCT PAGE

FRAX – Sweep Frequency Response Analyser

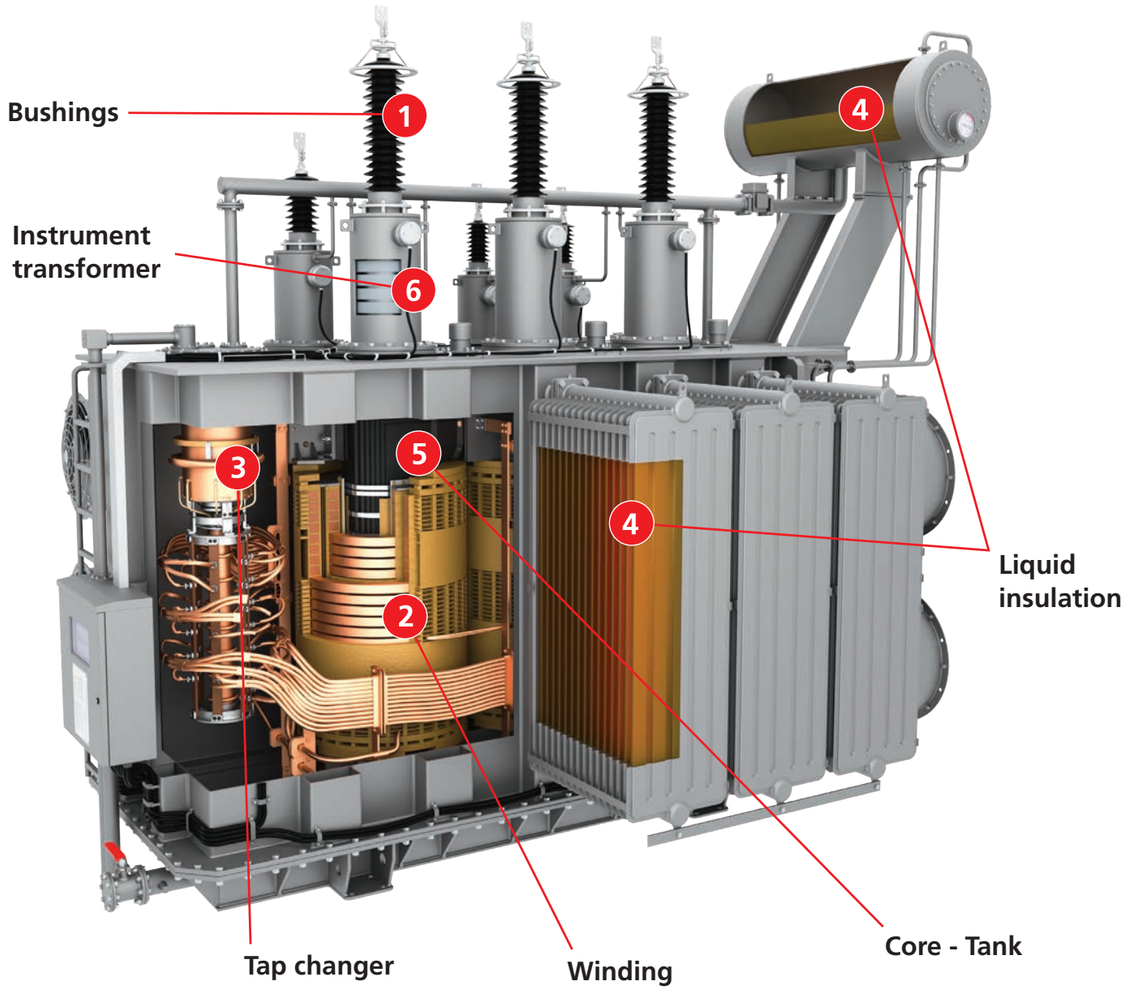
The FRAX series complies with all international SFRA testing standards for electromechanical transformer assessment.

- **Smallest and most rugged sweep frequency analyser on the market**
- **Advanced analysis and decision support built-in into the software**
- **Ground loop detection feature to verify test ground setup (FRAX101 and FRAX150)**
- **Extensive file import-export capabilities including CIGRE and XML formats**
- **Models available: FRAX99; FRAX101; FRAX150**

Multi-function testing equipment

Field testing electrical equipment aims to enhance substation performance and increase the efficiency and reliability of the entire power system.

One single multi-functional device can be used to cover a wide range of testing procedures, all controlled from a central computer and using the same software for testing, reporting, and diagnostics. It is the perfect tool for utilities and maintenance crews who have isolated only one line to conduct a sequence of testing procedures including transformers, instrument transformers, circuit breakers, and others.



VIEW PRODUCT PAGE

TRAX – Multi-function transformer and substation test system

Specially designed to maximize asset condition awareness, the TRAX is a decisively balanced multi-functional instrument that provides desirable outputs/sources while avoiding excessive weight and preserves easy usability while providing ample versatility.

- **Replaces the need for multiple test sets with one powerful, portable, and compact system**
- **Designed to test transformers, instrument transformers, circuit breakers, and many more substation equipment from one only test set**
- **Ideal troubleshooting device with manual control of inputs and outputs**
- **Models available: TRAX 219; TRAX 220; TRAX 279; TRAX 280**

TDX120 – Capacitance and dissipation factor (PF or tan delta) high voltage accessory

In conjunction with the TDX120, the TRAX provides the most accurate and reliable insulation diagnostics on the market.

- **Allows automatic and manual operation during insulation diagnostics and excitation current testing**
- **Provides advanced assessment in a wide frequency range (1-505 Hz) for DFR measurements including 'Megger's' 1 Hz assessment**
- **Eliminates the need for temperature correction tables using a patented built-in Individual Temperature Correction (ITC) algorithm**

TSX – Switch box accessory

Accessory to be used with transformers with up to three windings and eight terminals.

- **Provides simple and safe connection to all transformer terminals**
- **Reduces testing time and minimises measurement error**
- **Models available: TSX300 (manual); TSX303 (automatic)**

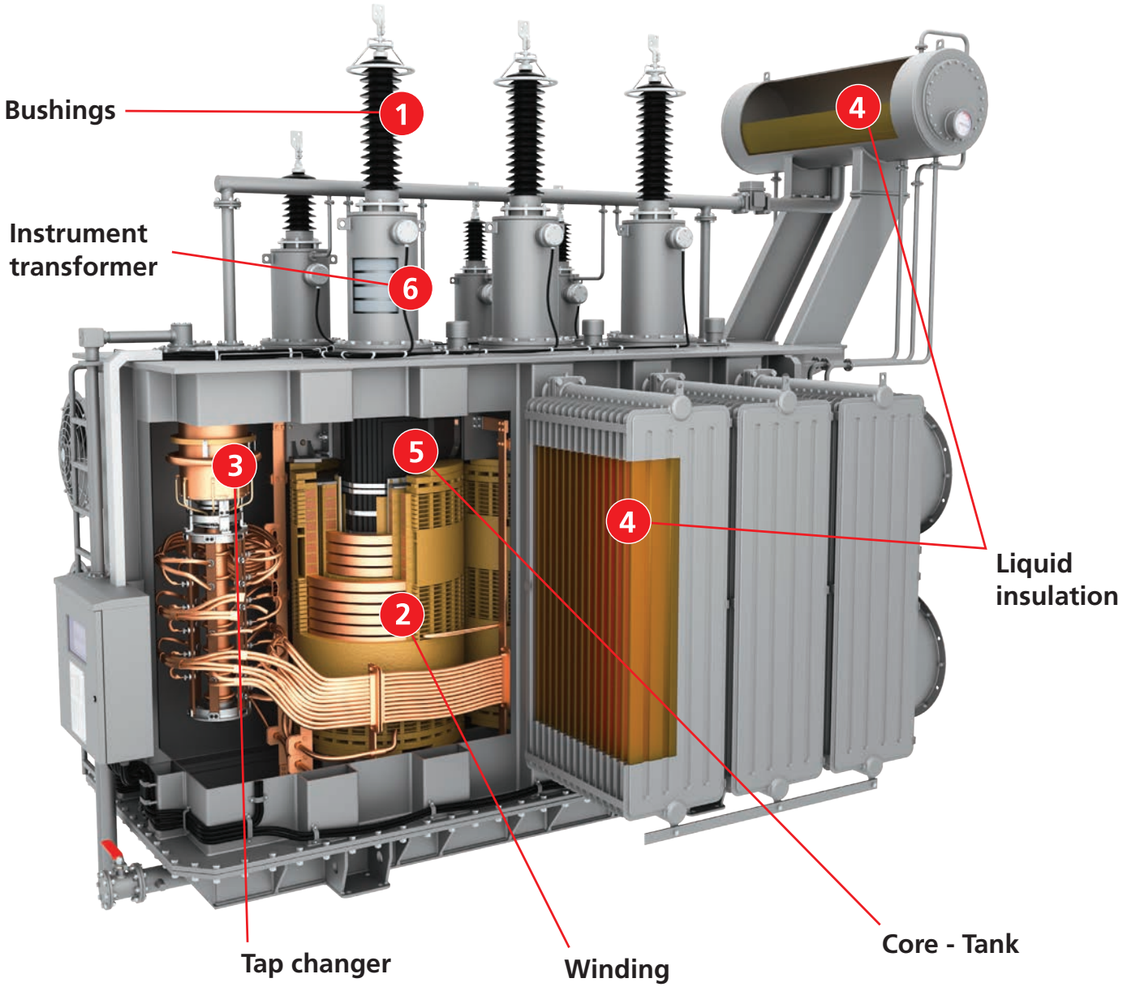
TCX200 - High current output accessory

Accessory to be used to boost current output up to 2000 A.

- **Its compact design allows operation in close proximity with the test object**
- **A low-weight unit designed for parallel or serial configuration**

Multi-function testing equipment

Multi-functional test sets are ideal to troubleshoot transformer and switchgear equipment. Incorporated diagnostic tools make them a powerful electrical testing laboratory and not just a test set. One software, one report but many applications to evaluate transformers, and other critical equipment in the substation.



TAU3 – True three-phase transformer winding analyser

A unique test set that provides a full range of electromechanical tests to analyse transformer windings in a comprehensive, fast, and confident way. Three-phase AC and DC outputs offer numerous benefits for today's demanding testing schedules.

- **True three-phase simultaneous AC or DC excitation for fast and repeatable testing**
- **Easy interface for a complete electromechanical test plan**
- **Ideal for special applications, such as phase-shifting transformers**
- **Models available: TAU3^{ADV}; TAU3^{PRO}; TAU3^{EXP}**

TTV – Power transformer test vehicle

The TTV is equipped with instruments selected by the end-user. The TTV arrives on site and is ready to start testing.

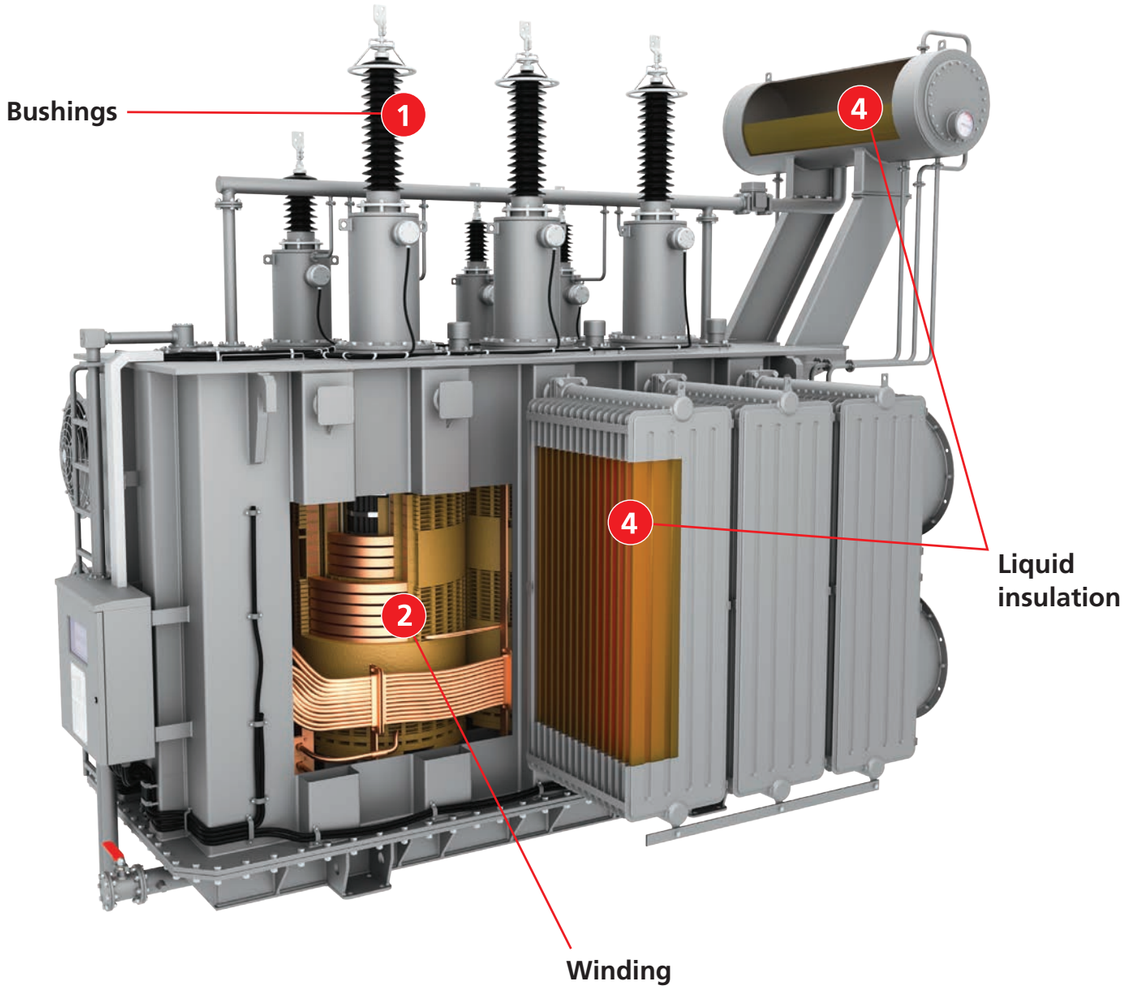
- **Integration of multiple testing devices in one single control module**
- **Ideal for mobilising testing equipment; always ready to start testing**
- **TTV provides an effective safety system with an easy-to-coil-out/coil-in test lead arrangement**

VIEW PRODUCT PAGE

Insulation condition assessment

The condition of the insulation reflects the overall condition of the electrical equipment. Transformers, cables, instrument transformers, bushings, motors, generators, and other major equipment in the substation or industrial facility need proper and accurate insulation condition assessment.

In power transformers, paper, and mineral oil are mainly used as insulation materials. Paper and oil are of organic origin and therefore prone to age, contamination, and degradation. The effect of moisture, heat, and oxygen accelerates the aging process, and at a certain point, the transformer needs to be removed from service as its insulation reaches its end-of-life.



S1/MIT – Diagnostic insulation testing

A complete and extensive set of insulation resistance test sets for factory and field applications even under high noise environments.

- **S1 family of test sets provide high noise immunity**
- **Always ready to test with battery or AC power supply**
- **Portable and quick verification of insulation status on any type of electrical asset**

VIEW PRODUCT PAGE

CDAX – Capacitance and dissipation factor instrument

High precision capacitance and dissipation factor measuring instrument designed to be used with an external generator.

- **Test at almost any voltage level**
- **CDAX accuracy level allows for laboratory, factory and field testing**
- **Enables testing of two specimens simultaneously**

VIEW PRODUCT PAGE

DELTA4000 – Capacitance and dissipation factor test set

Automatic 12 kV insulation dissipation factor (power factor or tan delta) test set to assess the condition of electrical insulation.

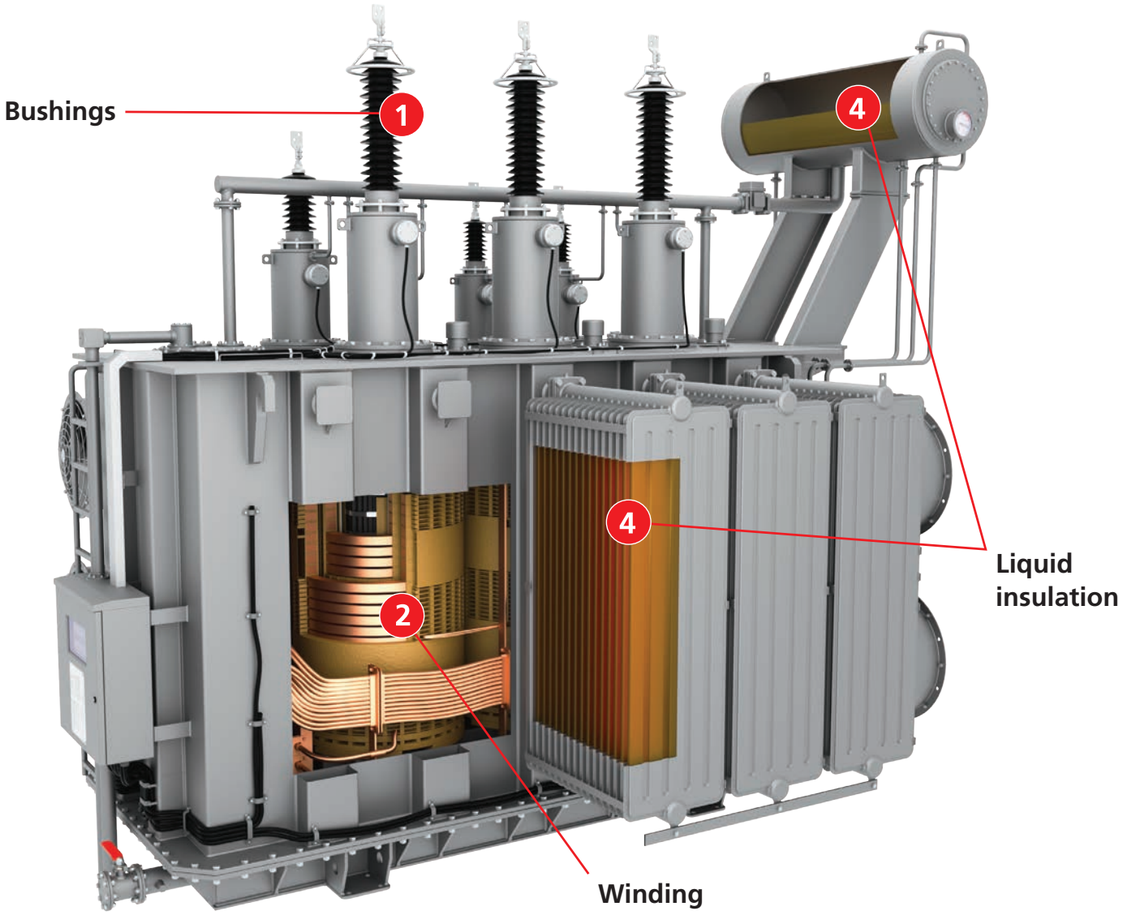
- **First industry insulation test set providing high confidence results with a 1 – 505 Hz test frequency range**
- **Patented built-in ITC algorithm**
- **High accuracy measurements even under high noise environments**
- **Models available: DELTA 4110 and DELTA 4310**

VIEW PRODUCT PAGE

Insulation condition assessment

Service contractors, maintenance crews, OEMs, and utilities worldwide use insulation testing starting from factory acceptance testing (FAT) to commissioning, routine, and specialised testing.

Time domain and frequency domain techniques allow for basic and advanced insulation diagnostics. Newly developed diagnostics tools, such as 1 Hz validation and Individual Temperature Correction (ITC) algorithms, make a significant difference in the correct interpretation of results.



VIEW PRODUCT PAGE

IDAX300 – Insulation diagnostics analyser

High precision capacitance and dissipation factor measuring instrument designed to be used with an external generator.

- **State-of-the-art measurement of moisture content in transformer's solid insulation and conductivity of the liquid insulation**
- **Low-voltage measurement of the dielectric response time and frequency domains**
- **Megger's unique approach to evaluate HV bushings and instrument transformers using 1 Hz dissipation factor limits and automated ITC algorithms**
- **Fastest dielectric response measurement system on the market**
- **Models available: IDAX 300; IDAX 300S; IDAX 350**

VIEW PRODUCT PAGE

VAX020 – 2 kV high voltage amplifier

The VAX020 expands the IDAX300 series instrument test voltage range from 200 V to 2 kV.

- **Separate high voltage amplifier enables capacitance and dissipation factor measurements at 2 kV test voltage**
- **Designed to work with IDAX300 series covering a wide spectrum of frequencies**

VIEW PRODUCT PAGE

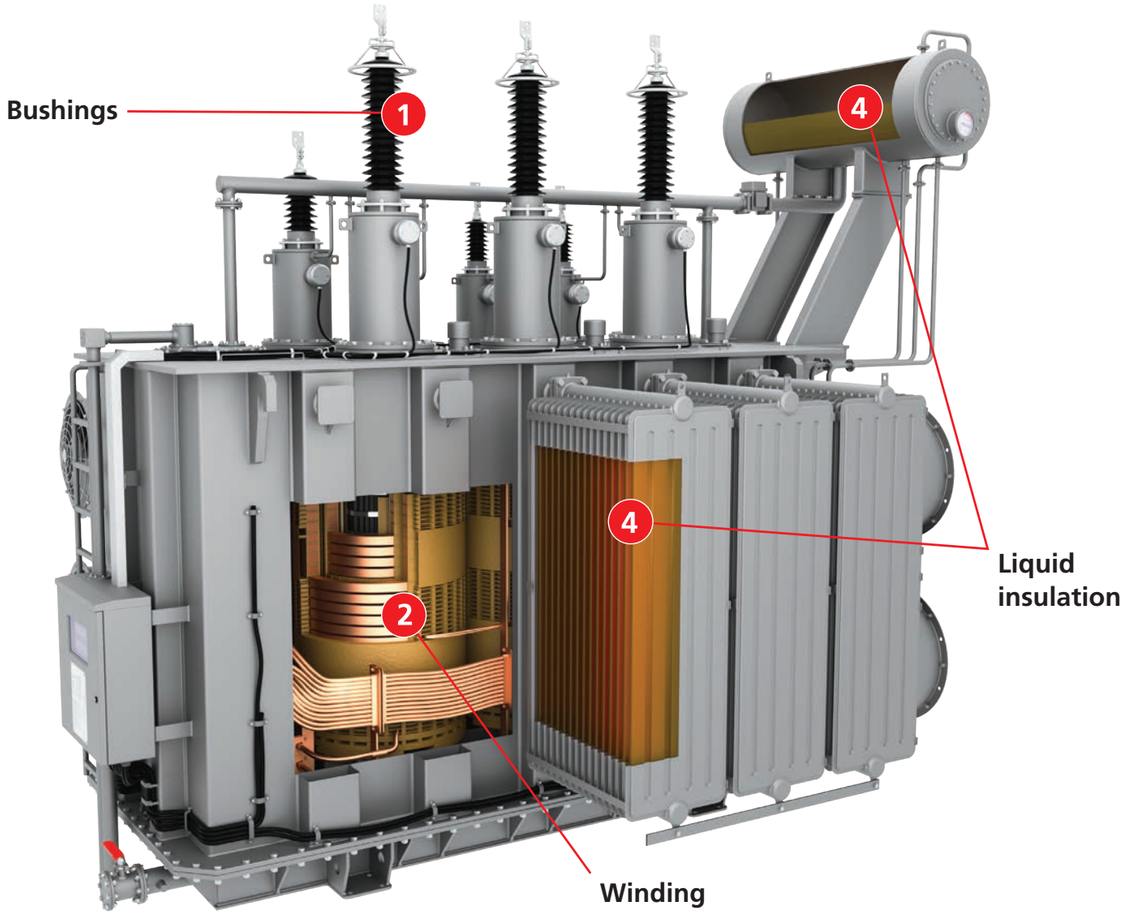
IDAX322 – High voltage insulation diagnostics analyser

High precision capacitance and dissipation factor measuring instrument designed to be used with an external generator.

- **State-of-the-art, high voltage DFR instrument tailored for field testing transformers, HV bushings, instrument transformers, cables and more**
- **Easy-to-use sotfware with integrated assessment guidance aligned with standards and informed by 25+ years of field experience with DFR technology**

PD localisation and monitoring

Transformer insulation is a complex design. Fluid-filled transformers are comprised of solid and liquid insulation that is not accessible from outside, and dry-type transformers are built with an exposed active part (coil-core assembly) that is not accessible during operation. Partial discharges, as per [Ref. IEC 60270], primarily result from local electrical stress concentrations in insulation or on its surface. Discharges in solid insulation are typically ignited in gas-filled cavities like voids and cracks, while in liquid insulation, partial discharges may occur in gas bubbles due to thermal and electrical phenomena. Additionally, water vapor can be generated in high field regions, leading to discharges. In transformers, partial discharge activity is the most prominent indicator of insulation degradation. Early detection and localisation are vital for effective transformer condition assessment and predictive maintenance planning.



VIEW PRODUCT PAGE

ICM*monitor* portable – Partial discharge monitoring device (temporary)

A compact stand-alone instrument for evaluating the condition of medium and high voltage insulation, mainly used for temporary on-line monitoring of power transformers.

- **Demonstrated versatility with a broad range of standard and customised accessories**
- **Configurable alarm setting to monitor changes in PD activity**
- **The portable instrument features several noise handling techniques**

VIEW PRODUCT PAGE

ICM*monitor* – Partial discharge monitoring device (permanently installed)

The ICM*monitor* continuously monitors the condition of a transformer's insulation system, minimising the risk of disruptions to your daily operations.

- **Provides consistent and real-time updates on your transformer's condition through the monitoring web server option**
- **Enhances your capabilities with a wide array of adaptable features and accessory options, allowing for seamless adjustment to different transformer and site conditions (e.g., pre-existing sensors, retrofitting requirements, noise factors at the site)**
- **Harnesses the power of collected trending data to identify defects early on, preventing potentially expensive outages**

VIEW PRODUCT PAGE

ICMsystem Generation 5 – Advanced partial discharge detector

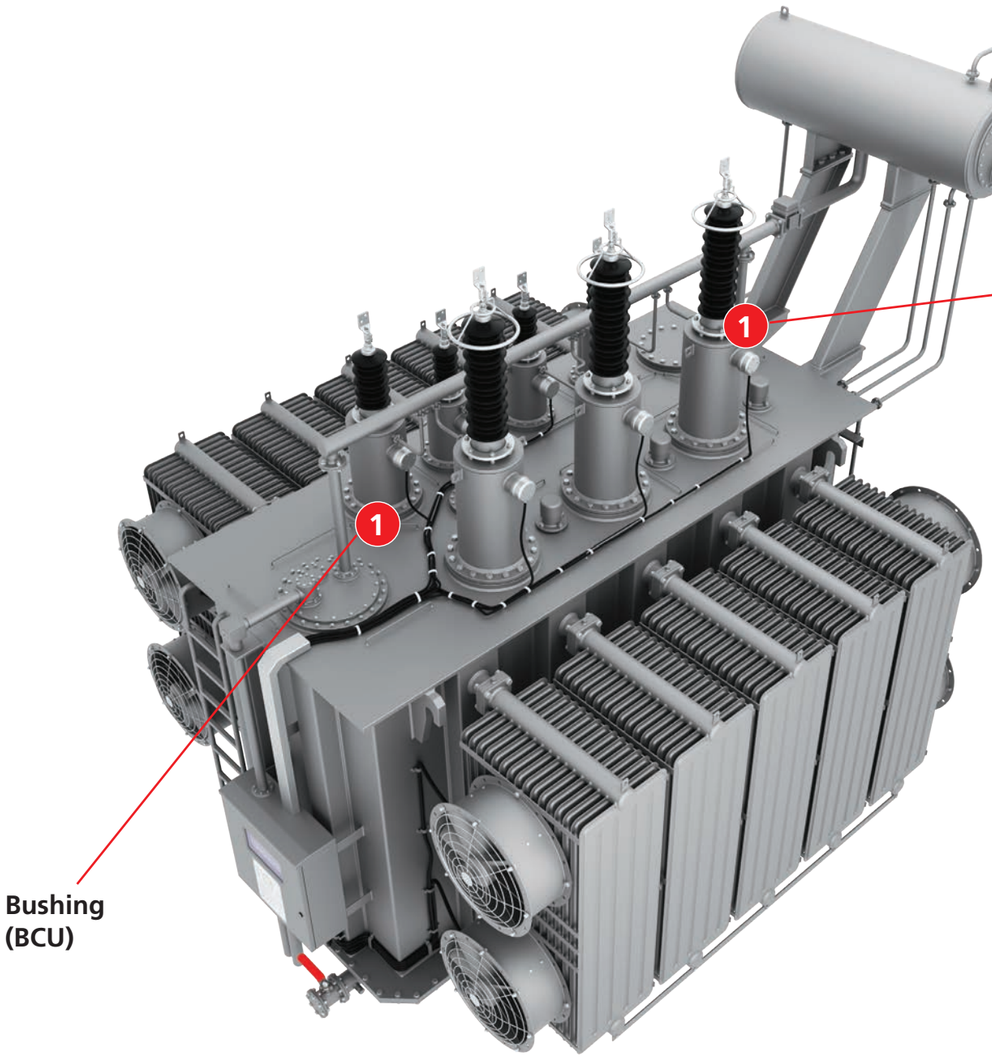
The ICM*system* provides high-resolution digital PD patterns for classification of defects in high voltage insulation systems.

- **A powerful, versatile instrument for evaluating the condition of medium and high voltage insulation and usable over a range of frequencies of applied voltage, including power system frequency (50/60 Hz) and VLF (0.1 Hz)**
- **Complete access to detailed control parameters and the ability to download and analyse PD patterns on a PC**
- **Convenient 3-D PD pinpointing using acoustic sensors and ICMacoustic software**

PD monitoring accessories

Monitoring the partial discharge activity continuously on-line on a power transformer unveils deterioration of the insulation system in an early stage. Continuous on-line monitoring of the partial discharge activity helps maintain the reliability of power transformers.

Coupling to the partial discharge signals is conveniently achieved by using the capacitive taps of the condenser bushing. Since a huge variety of capacitive taps designs exists, Power Diagnostix offers various versions of tap adapter units.



BA – Bushing Adapters

These adapters have been made to fit to many different models of bushings test taps. To manufacture a custom-made bushing adapter, customers need only specify the dimensions of the bushing's test tap. Our standard offering of bushing adapters covers most common existing bushing designs. Every adapter has two built-in surge arresters (spark gaps) as overvoltage protection. Each adapter is also available in a stainless-steel housing without colours, or in a housing made of anodised aluminium (ca. RAL 9006).

- **Signals are taken from the capacitive tap of the transformer bushing by bushing adapter (BA) and bushing coupling unit (BCU)**
- **UHF sensors are available for the oil drain valve (TVS2) and for spare flanges (TFS1)**
- **Gating signal from optional disturbance antenna (DA1) or high frequency current transformer (CT)**

BCU - Bushing Coupling Unit

The coupling unit is equipped with circuits for both the measurement of voltage and of partial discharge. For the PD measurement, both a high frequency current transformer and a standard quadrupole are built in.

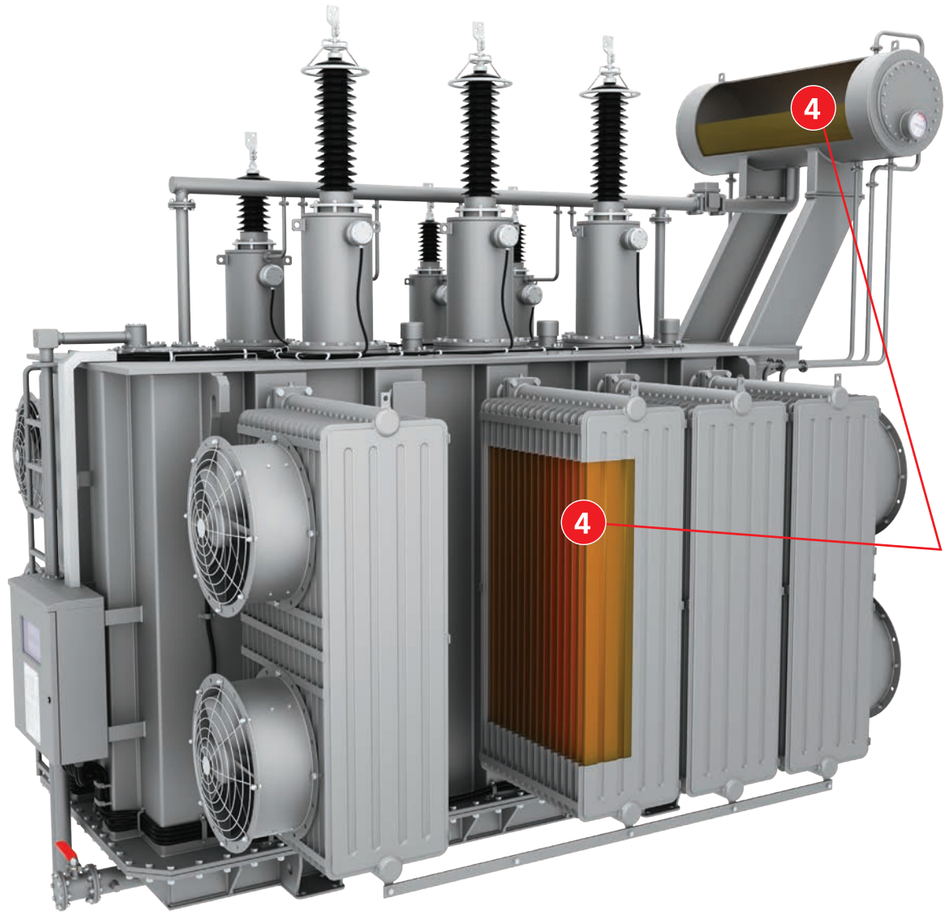
External disturbances can be detected by an antenna, e.g., DA1, or by a clamp-on high frequency current transformer (CT1, CT100, or similar). A stainless-steel box is also available for offshore applications.

Liquid insulation

Besides the fundamental function of being an insulating material, liquid insulation in power and distribution transformers cover an essential and decisive function – they carry information from inside the transformer without the need to shut down.

The information from the liquid insulation can be processed in the field by specialised personnel or it can be taken to a laboratory for physical and chemical analysis of more advanced diagnostics such as DGA (dissolved gas analysis) and others.

In the field, utilities rely on practical and precise analysis of liquid insulation samples. Time is usually a constraint when power equipment needs to be put back in service. Having the right equipment on-site allows for fast response and certainty in the decision made.



VIEW PRODUCT PAGE

OTS – Insulating oil test set

Fully automatic insulating oil dielectric breakdown test set used for mineral, ester, and silicone insulating liquids

- **Suitable for field and laboratory use**
- **Support all IEEE, IEC, and other international standards**
- **A safe locking mechanism eliminates electrode displacement**
- **Configurable alarm setting to monitor changes in PD activity**
- **A variety of models are available for laboratory and field tests from 60 kV up to 100 kV: OTS PB (60 and 80 kV); OTS AF (60, 80, and 100 kV)**

VIEW PRODUCT PAGE

OTD – Oil tan delta test set

The OTD is a laboratory instrument designed to measure the tan delta, resistivity, and relative permittivity of insulating liquids

- **Support all IEEE, IEC, and other international standards**
- **Integrated test cell heating and cooling systems**
- **IEC 60247 innovative test cell - easy to assemble and clean**

VIEW PRODUCT PAGE

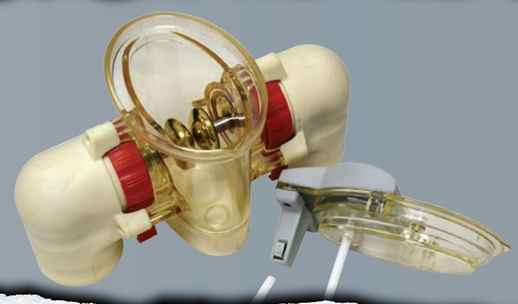
KF – Karl Fischer moisture in oil test sets

The Coulometric Karl Fisher titration instrument allows accurate estimation of moisture in oil test sets for field or laboratory use.

- **A portable and easy-to-use instrument**
- **KF875 – optimized for testing insulating oils with a specific gravity of 0.875 and KF-LAB MkII – allows titration of samples in a wide range of specific gravities from 0.6 to 1.40**

UNCOVER THE FACTS

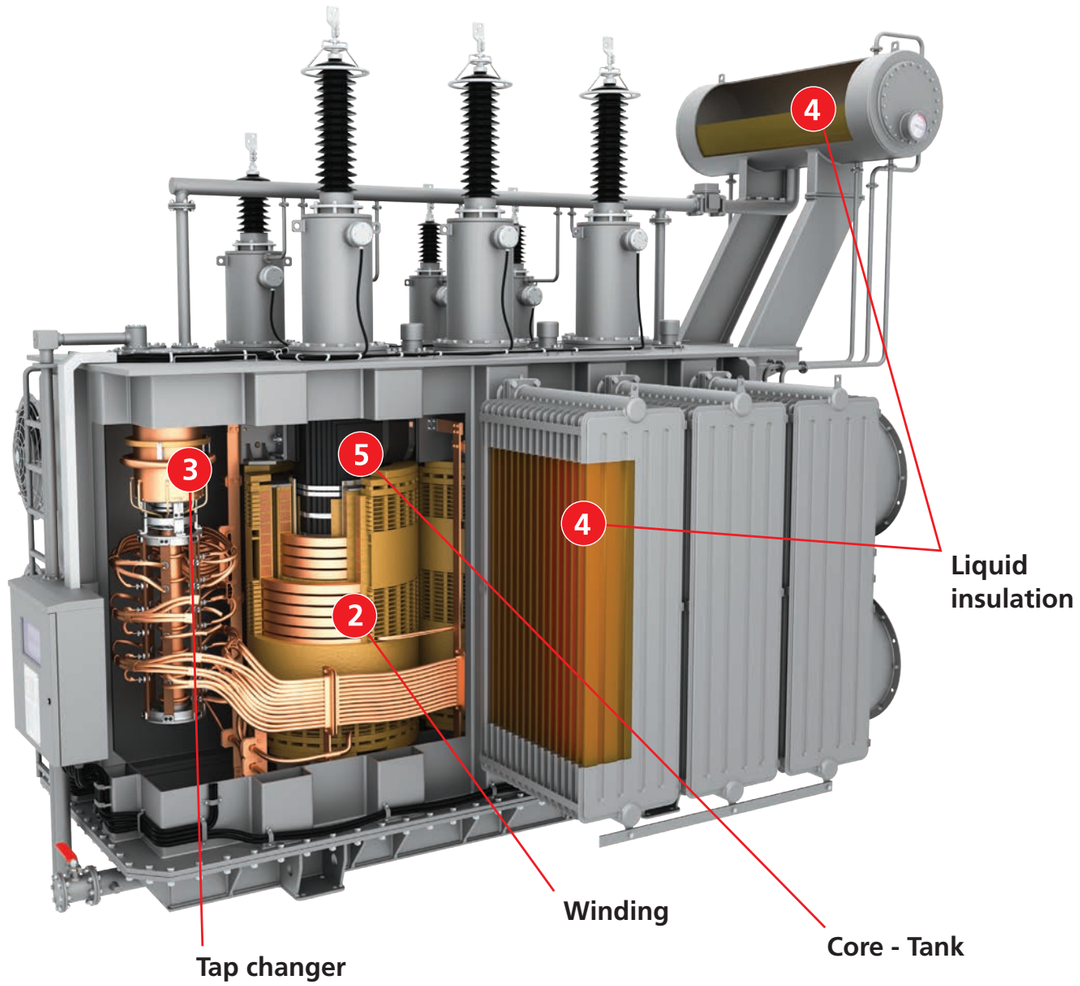
Download the technical guide for OTS vessel preparation



Dissolved Gas Analysis (DGA)

A fundamental strategy for the asset performance management of liquid-impregnated transformers is the analysis of gases dissolved in oil.

Transformers with windings immersed in oil, are prompt to continuous monitoring without the need of service interruption. An oil sample is taken for analysis to certified laboratories such as AVO Diagnostics Laboratories, while the transformer is under normal operation, The analysis of dissolved gases in oil can also be performed on-line when the technology provides a reliable method of gas extraction, quantification and data display. On-line DGA monitors may work as a 'watchdog' to trigger immediate alarm of potential fault conditions inside the transformer or to monitor progressive degradation and aging of the entire insulation system. DGA is a method recognised by international standards for the condition assessment and performance monitoring of power and distributions transformers.



VIEW PRODUCT PAGE

InsuLogix® G2 – DGA acetylene, hydrogen and moisture monitor

The InsuLogix® G2 accurately measures low levels of acetylene, providing reliable detection of arcing faults in their early stages. The InsuLogix® G2 empowers transformer owners to take necessary actions to mitigate life-ending damage to their transformers, preventing costly unplanned outages.

Monitoring acetylene, along with hydrogen and moisture, provides the essential, actionable information needed to help protect your power transformer.

- **Laser technology - detects down to 0.5 ppm acetylene in oil**
- **Easy to install - Proven installation in 1.5 hours**
- **Long life, low maintenance (10+ years)**

VIEW PRODUCT PAGE

Oil testing laboratories and services

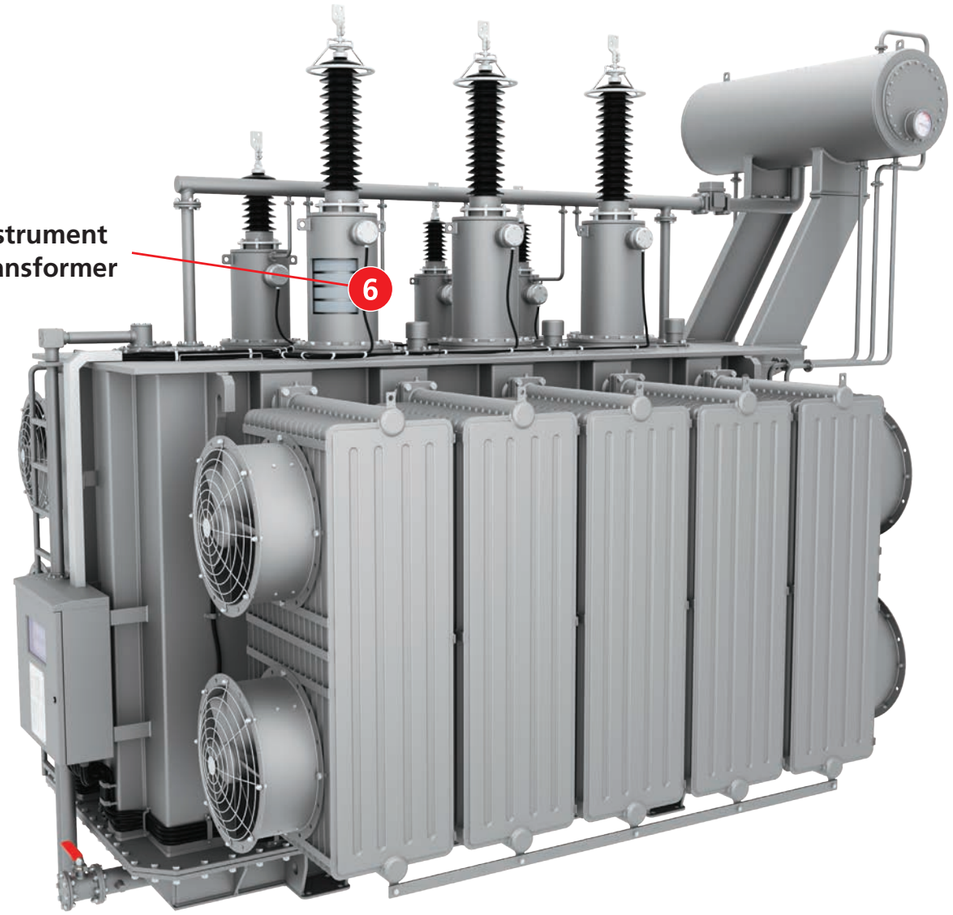
Transformer oil laboratories play a crucial role in ensuring the efficient and reliable operation of transformers in various industries.

- **Transformer oil analysis enables proactive maintenance to minimise the risk of unexpected failures and contributes to cost-effective maintenance strategies**
- **The service provided ensures compliance with the latest industry standards for continuous and safe operation**
- **Laboratories contribute to on-going research and development to improve transformer condition assessment**

Instrument transformers

Protection, control, and metering class instrument transformers are installed near every major piece of equipment in the substation. Failure in accuracy or insulation degradation may lead to failure of reliable operation of protection devices responsible for the secure and continuous operation of the power system.

Dedicated testing equipment is available to speed up the test of multi-tap CTs where a variety of types, accuracy classes, and designs are used in the field. Simplified algorithms and one-touch functions allow for fast and reliable testing of any instrument transformer device.



MRCT – Relay and instrument transformer testing

A dedicated test set to expedite testing on protection and metering instrument transformers.

- **Reduce testing time with multi-tap connections and automatic testing**
- **One unit tests all types of instrument transformers including CTs, VTs, and CCVTs**
- **Self-diagnostic mode confirms the reliability of the results**
- **Configurable to meet end-user's unique testing needs**

VIEW PRODUCT PAGE

MVCT – Voltage transformer (VT) and current transformer (CT) test set

A dedicated test set to expedite testing on protection and metering current and voltage transformers.

- **Automatic control to test single and multi-ratio Ts and VTs**
- **Friendly interface in a large TFT LCD touchscreen display**
- **Complete test plan for CTs, VTs, and burdens**

VIEW PRODUCT PAGE

Verification tools

Functionality verification is critical to ensure proper operation of an electrical test instrument. Whether you're performing laboratory calibration or on-site validation in the field, Megger has the tools to give you confidence in any transformer test set.

VIEW PRODUCT PAGE

TOS1 – Transformer ohmmeter standard

The transformer ohmmeter standard is designed for resistance verification of any ohmmeter. Four-terminal kelvin connections provide accurate winding resistance confirmation, ensuring that shorted turns, loose connections, and malfunctioning tap changers can be properly identified in a transformer.

- **High accuracy ±0.1 % ohmmeter standard**
- **Rugged design for field use**
- **Designed to be used with large test clips or banana jack inputs**

PFDF10 – PF/DF and capacitance reference

With multiple power factor settings, the PFDF10 can give you confidence in the assessment of your transformer insulation so you can be assured if any deterioration has occurred due to moisture and/or liquid contamination.

The PFDF10 as an accessory to the DELTA4000, IDAX, or TRAX, offers a comprehensive UST and GST capacitance and power factor/dissipation factor measurement system analysis.

- **Rugged and lightweight**
- **Three-electrode connection**
- **Multiple frequency verification**

VIEW PRODUCT PAGE

TRS1 – Transformer ratio standard

The transformer ratio standard is designed for use with any hand-cranked, handheld, or line-powered transformer turns ratiometer. The TRS1 provides step-up and step-down turns ratio verification, ensuring that problems with transformer windings, core, and tap changers can be properly identified.

- **High accuracy 0.01 %**
- **Rugged design for field use**
- **Versatile step-down and step-up ratio**

PowerDB software

It is of important to have a sophisticated data acquisition and data analysis software specially designed for all substation testing. Whether you test transformers, circuit breakers, instrument transformers, or any other substation equipment, PowerDB has a form to properly display the information and analyse the condition of critical equipment in the field.

For transformer testing, PowerDB can acquire the information directly from many Megger instruments and organise the fields in a dedicated database. New forms are being continuously developed and added to the software to satisfy industry needs.

VIEW PRODUCT PAGE

PowerDB Lite – Free version

A free version which contains a collection of test forms with built-in interfaces for Megger instruments.

- **Associates test results with historical results**
- **Completed results are stored in discrete files on your PC**
- **PowerDB Lite does not include interfaces for non-Megger test equipment**

VIEW PRODUCT PAGE

PowerDB Pro – Licensed version

Is a licensed software product which contains over 300 test forms and has the capability to customise existing forms or create new ones.

- **Test all assets with one software package**
- **Data is entered by remote users in 'field' databases and then merged into a central 'master' database for access by all users**
- **Assets are efficiently organised. Querying and trending data provides the user with analysis tools to help in evaluating equipment condition**
- **Inlcudes many options: integrates with other software, enables asset pre-loading, provides pre-association of test forms for assets and dashboard**

An integrated transformer management solution

Megger is a global provider of industry leading test, monitoring and data analytic solutions, that inform and validate decision-making of network grid operators. Built on a 130+ year history, our expertise helps enhance the performance and reliability of grid networks. The fast development of mathematical modelling, machine learning, artificial intelligence, and power electronics, combined with our vast experience in the field, allows us to provide you with advanced diagnostic techniques to ensure your equipment is running smoothly. It also enables us to offer measures and methods that can extend the service life of your transformer fleet, as well as services and support to enhance your network reliability.

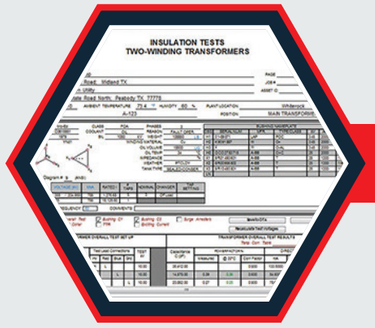
What does the integrated transformer management solution offer to our customers:

Off-line testing

- Widest range of products
- Laboratory quality and DGA analysis
- Single and multi-function test equipment
- Basic and advanced testing technologies

On-line monitoring

- PD localisation
- PD monitoring
- Dissolved Gas Analysis (DGA)



Software

- PowerDB
- AIM - Asset Information Management
- IPS

Training

- AVO Training institute
- On-site and on-line training
- Basic and advanced

Services

- Quality and DGA analysis
- Repair and calibration
- Technical support and field testing
- Rental of advanced technology

Expertise

- Guidance through complexity
- Results understanding
- Validation of transformer's health

Customer values

- Efficiency
- Profitability
- Safety
- Confidence

An integrated transformer performance management solution

Improved safety, reduced operating costs, extended service life, and enhanced network reliability are among the crucial benefits that modern techniques for transformer testing make possible. Megger equipment, which has been developed in close consultation with users to meet their real needs, provides the key to unlocking those benefits.

Megger has a comprehensive set of tools for off-line testing and on-line monitoring that deliver the dependable data needed to support technical and financial decisions. These tools have been designed to be easy to use and guide users through even the most complex testing challenges, thereby saving time, promoting safety for personnel and equipment, and providing accurate, reliable results.

But Megger does more than deliver the results. Our unrivalled experience and expertise mean we can also provide expert support in interpreting those results to give the most insightful and valuable evaluation of transformer health. We complement our support services with training to help our customers get the best return on their test equipment investment.

Megger provides an all-in-one solution for your transformer testing needs and challenges, which is firmly focused on delivering genuine and significant user benefits.

Customers benefits achieved with the integrated transformer management solution by Megger, your trusted partner:

Proactive maintenance savings

Avoid financial penalties

Minimise unplanned repairs

Lower maintenance costs

Ease pressure on CAPEX budgets

Early issue detection

Valuable electrical condition insights

Dependable condition assessment

Extended asset lifespan

Optimise transformer efficiency

Optimal decision making for assets

Protect operators and equipment

Minimise exposure to hazards

Enhanced safety

Peace-of-mind

Enhance network reliability

Comprehensive training to use tools effectively

Boost staff confidence and competence

Upgraded staff skills

Enhance operational efficiency and safety culture

Use of engineering resources more efficiently

Faster, easier testing

Efficient testing

Reduce troubleshooting time

CONTACT US

Request a demo or contact us directly to help you with the health of your transformers.

one test makes a big difference

1 Hz is the new trend
in transformer insulation testing

Learn more about 1 Hz testing:

Megger Limited
Archcliffe Road
Dover CT17 9EN
United Kingdom

www.megger.com

Megger

TransformerCatalogue_EN_V03