Global Transformer Capabilities

Schneider Electric has a large network of transformer manufacturing plants around the world, producing medium power transformers, distribution and dry-type transformers, amorphous core and specialty transformers. Located in France and Turkey are two R&D centers of excellence that are able to provide a wealth of engineering expertise.

**Poland**
- Dry-type up to 4MVA, 36kV
- Liquid filled up to 2.5MVA, 36kV

**France**
- Dry-type up to 15MVA, 36kV
- Liquid filled up to 60MVA, 110kV

**Turkey**
- Dry-type up to 25MVA, 52kV
- Liquid filled up to 80MVA, 170kV

**India**
- Dry-type up to 5MVA, 33kV
- Liquid filled up to 100MVA, 170kV

**China**
- Dry-type up to 15MVA, 36kV
- Liquid filled up to 80MVA, 110kV

**Greece**
- Liquid filled up to 2.5MVA, 36kV

**Indonesia - Jakarta**
- Liquid filled up to 45MVA, 72.5kV

**Australia - Benalla**
Industry leading Australian manufacturing plant for oil filled distribution transformers and kiosks. Over 35 years experience designing and building kiosks for Australian utilities and various other market sectors. Innovations include internal arc rated kiosks, automated kiosks and cyclone rated kiosks.

**Turkey - Cayirova**
World-class manufacturing plant for oil distribution transformers, medium power transformers, cast resin transformers and special transformers.

**France - Fontenay le Comte**
Specialised manufacturing plant for impregnated and cast resin transformers, impregnated and cast resin reactors and special winding transformers (earthing transformers, motor starting transformers, rectifier transformers).

**France - Metz**
Centre of Excellence for Schneider Electric. Spread over three sites manufacturing a broad range of oil and dry type transformers.

**Indonesia - Jakarta**
An expanding manufacturing plant that offers oil distribution transformers, medium power transformers and special transformers (Zone 2 Hazardous transformers, autotransformers and phase shifting transformers).
Brazil
Dry-type up to 25MVA, 36kV
Liquid filled up to 2.5MVA, 36kV

India - Vadodara
There are two manufacturing sites in India with over 50+ years of experience in total. The plants manufacture generator, furnace, isolation, earthing, converter duty/rectifier duty, auto and reactor transformers.

China - Suzhou
The plant in Suzhou has over 20 years experience in cast resin dry-type technology and produce the Trihal range of transformers. The transformers have a fire proof resin filter and the core is made with grain oriented silicon steel, which minimises loss and noise levels.

Poland
Specialised manufacturing factory with almost 70 years of experiences in the design and production of oil-immersed and cast resin transformers. The factory also specialises in production of epoxy resin/fibreglass dry type transformers ideal for industrial applications.

Greece
An industrial site with 40 years of experience capable of manufacturing oil immersed (mineral or vegetable oil), natural cooling, wound-core and distribution transformers. The plant specialises in the manufacture of amorphous core, photo voltaic and wind farm transformers.

Brazil
The Brazilian manufacturing plant was originally established in 1976, Blumenau, Santa Catatrina. The plant offers dry epoxy resin encapsulated transformers as well as inductance, control, measurement and power transformers.
We are proud to present to you Schneider Electric’s complete transformer product portfolio. These products showcase both the local and the global expertise of the company and represent a long history of engineering development and expertise.

Schneider Electric’s offer has been built around its long time core brands of Merlin Gerin, a leader in electrical switching technologies that was formally brought into the group in 1986; Telemecanique, a leading specialist in industrial control and automation that joined the business in 1988 and Square D, a major North American supplier of electrical distribution and industrial control equipment, which was acquired in 1991.

These three brands were well established in Australia and joined by Australian Standard Electrical Transformers (ASET), a Victorian distribution transformer and kiosk manufacturer; Nu-Lec Industries, a Queensland manufacturer of pole-mounted reclosers and sectionalisers and Clipsal, a manufacturer of low voltage wiring accessories.

More recently, Schneider Electric’s growth has continued with the acquisition of TAC, a global leader in building automation; CiTect, a global provider of software for industrial automation; Pelco, a manufacturer of hi-tech security cameras; SCADA group, an Australian-based leading provider of telemetry products and solutions; and APC, a world leader in critical power and cooling services that now includes Gutor, MGE and Unifair.

Transformer Solutions

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2010 and 2011 saw the company embark on two of its largest acquisitions, Areva T&D and Telvent. The acquisition of Areva enables Schneider Electric to provide a comprehensive offer in medium voltage switchgear, network automation and transportable substations, while Telvent provides access to market leading software for management of pipelines, tank farms, distribution terminals and networks for liquids and gases.

Schneider Electric’s Transformer Solutions manufacturing plant is located in Benalla, Victoria and was formally known as Australian Standard Electrical Transformers (ASET). ASET originally manufactured and refurbished transformers and featured an extensive oil farm which included 4 x 5000 litre tanks maintained under vacuum to improve oil quality. The first ASET transformer was produced in Benalla in 1975 and the company official became a part of Schneider Electric in 1994.

In 2003, the Merlin Gerin switchgear adaptation business moved into the Benalla plant, and in 2007 a major upgrade was completed with the welding and paint facilities doubling in size. Today, the expert engineering and design team focus on the manufacture of kiosks, which comprise of medium voltage ring main units, transformers and low voltage feeder switchboards. The Benalla Transformer Solution plant continues to pride itself in the manufacture of oil filled distribution transformers complying with Australian Minimum Efficiency Performance Standards (MEPS). They are hermetically sealed and are designed in accordance to AS 9001 Standards.
# Transformer Selection Table

## Power Transformers

### Minera EX

<table>
<thead>
<tr>
<th>Max. rated voltage (kV)</th>
<th>36</th>
<th>170</th>
<th>Various</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. rated power (MVA)</td>
<td>60</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Switching medium</td>
<td>Liquid insulation</td>
<td>Liquid insulation</td>
<td>Liquid insulation</td>
</tr>
<tr>
<td>Indoor/outdoor</td>
<td>Indoor and outdoor</td>
<td>Indoor and outdoor</td>
<td>Indoor and outdoor</td>
</tr>
<tr>
<td>Features and applications</td>
<td>Zone 1 and Zone 2 explosion proof transformer for mines and the oil and gas industries. Hazardous zones (Atex Transformer range).</td>
<td>Hermetically sealed or breathing with conservator. Low flammability dielectric liquids (Vegeta ranges).</td>
<td>Rectifier transformer for railways, metals and renewables. Rectifier feeder (Rectifier Transformer range).</td>
</tr>
</tbody>
</table>

### Minera MPT

<table>
<thead>
<tr>
<th>Max. rated voltage (kV)</th>
<th>36</th>
<th>170</th>
<th>Various</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. rated power (MVA)</td>
<td>60</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Switching medium</td>
<td>Liquid insulation</td>
<td>Liquid insulation</td>
<td>Liquid insulation</td>
</tr>
<tr>
<td>Indoor/outdoor</td>
<td>Indoor and outdoor</td>
<td>Indoor and outdoor</td>
<td>Indoor and outdoor</td>
</tr>
<tr>
<td>Features and applications</td>
<td>Pole-mounted oil immersed transformer.</td>
<td>High efficiency transformer with amorphous core technology available.</td>
<td>Internal arc rated full transformer oil containment (optional). Square or elongated footprints, modular, upgradable in the field. Remote monitoring and control with the Easergy range. Used for wind farms, electrical utilities, defence and industrial solutions.</td>
</tr>
</tbody>
</table>

### Minera R

### Distribution Transformers

<table>
<thead>
<tr>
<th>Max. rated voltage (kV)</th>
<th>36</th>
<th>36</th>
<th>36</th>
<th>22</th>
<th>36</th>
<th>52</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. rated power (MVA)</td>
<td>0.5</td>
<td>1.6</td>
<td>2.5</td>
<td>2.5</td>
<td>3.15</td>
<td>30</td>
</tr>
<tr>
<td>Switching medium</td>
<td>Liquid insulation</td>
<td>Liquid insulation</td>
<td>Liquid insulation</td>
<td>Liquid insulation</td>
<td>Liquid insulation</td>
<td>Solid insulation</td>
</tr>
<tr>
<td>Indoor/outdoor</td>
<td>Outdoor</td>
<td>Indoor and Outdoor</td>
<td>Indoor and Outdoor</td>
<td>Indoor and Outdoor</td>
<td>Outdoor</td>
<td>Indoor and Outdoor</td>
</tr>
</tbody>
</table>

### Catalogue Page No.

- Transformer Selection Table: Page 6, Page 5, Page 7
- Distribution Transformers: Page 10, Page 11, Page 12, Page 9, Page 8, Page 13
### Transformer Selection Table

#### Special Transformers

<table>
<thead>
<tr>
<th>Auto- transformers</th>
<th>LV/LV Tx</th>
<th>Minera SGrid</th>
<th>Minera PV</th>
<th>Minera LowRad</th>
<th>R-Cool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. rated voltage (kV)</td>
<td>231/400V or 400/231</td>
<td>400/400</td>
<td>24</td>
<td>36</td>
<td>52</td>
</tr>
<tr>
<td>Max. rated power (MVA)</td>
<td>0.4</td>
<td>0.4</td>
<td>0.8</td>
<td>1.6</td>
<td>3.15</td>
</tr>
<tr>
<td>Switching medium</td>
<td>Liquid insulation</td>
<td>Liquid insulation</td>
<td>Liquid insulation</td>
<td>Liquid insulation</td>
<td>Liquid insulation</td>
</tr>
<tr>
<td>Indoor/outdoor</td>
<td>Indoor and Outdoor</td>
<td>Indoor and Outdoor</td>
<td>Indoor and Outdoor</td>
<td>Indoor and Outdoor</td>
<td>Indoor and Outdoor</td>
</tr>
<tr>
<td>Features and applications</td>
<td>The BCV range of autotransformers are available in ratings up to 400kVA. Applications include stepping voltage up or down without isolating the secondary or primary.</td>
<td>The BCV range of 400V/400V transformers are available in ratings up to 400kVA. Applications include where the earthing system needs to be changed or as an isolation transformer.</td>
<td>Transformer for residential photovoltaic (PV) generation. It features an on-load tap changer.</td>
<td>Transformer for residential photovoltaic (PV) generation.</td>
<td>Compliant to NISV standards for the protection of people from non-ionising radiation.</td>
</tr>
</tbody>
</table>

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Any oil filled transformer can be filled with environmentally friendly biodegradable vegetable oil and be known as a Minera Vegeta.
Overview
The Minera oil-immersed medium voltage power transformer is dedicated to all applications up to 170kV and 80MVA. Schneider Electric's R&D team has created a variety of Minera transformers to meet both utility and industrial requirements. The superior reliability of the transformer means that it is highly suitable for the oil and gas market.

Technical Characteristics
Rated power: from 2.5 up to 80MVA.
Rated voltage: up to 170kV.
Phases: one or three-phase unit.
Rated frequency: 50Hz or 60Hz.
Type of cooling: ONAN, (ONAF, ODAF, OFAF, OFWF or ODWF on request).
Other (optional): breathing or sealed type, off-circuit tap changer (OCTC) or on load tap changer (OLTC), a wide variety of accessories.
Manufacturing Standard: AS 60076

Applications
- Utilities: transmission and distribution network, automatic voltage regulator.
- Power generation: hydro, nuclear, thermal, photovoltaic.
- Small industries: textile, automotive, pharmaceutics, food.
- Renewable energies: solar, wind onshore and offshore, biomass.
- Mining: ground-mounted, under ground-mounted, heavy polluted area.
- Metal: furnace, cycloconverter load, rectifier load.
- Oil and gas: onshore, offshore, FPSO and hazardous area.

Magnetic Core
The transformer’s magnetic core is manufactured from a high grade, cold-rolled, grain-oriented silicon steel. The lamination stacking is either butt-lap or step-lap-type. The magnetic core is generally a multi-layer circular cross section and the slitting and cutting of the magnetic core is made by automated machines.

In order to reduce transformer sound level to a minimum, the magnetic core and its framework are carefully sized to minimise the vibrations and, in particular, magnetostriction effects, which constitute the main sources of sound in medium power transformers.
Medium Power Transformers
Minera Ex

Explosion Proof Transformers up to 36kV/60MVA

Overview
Oil-immersed transformers can be installed in explosive atmospheres, particularly around hydrocarbon fluids. In this case, explosion proof transformers in accordance with the relevant standards can be supplied. Based on decades of field-tested experience in electrical generation and distribution for both offshore and onshore installations, Schneider Electric has adapted transformers to provide safety solutions for Zone 1 and Zone 2 applications in accordance with the latest ATEX and IEC-EX standards.

Technical Characteristics
Rated power: up to 60MVA.
Rated voltage: up to 36kV.
Phases: three-phase units (single-phase available on request).
Rated frequency: 50Hz or 60Hz.
Type of cooling: ONAN, (ONAF on request).
Manufacturing standards: AS 60076 / EN 50464-1, IEC 60079-6 / EN 50015, ATEX.
Other (optional): hermetically sealed or conservator; ground-mounted with normal, low noise or very low noise levels.

Applications
- Mining Zone 1 and Zone 2 sites.
- Oil and gas - onshore or offshore Zone 1 and Zone 2 sites.

How Do Explosions Occur?
An explosion is any uncontrolled combustion wave. Many manufacturing and processing industries generate potentially explosive atmospheres using substances ranging from solvents to baking flour. An explosion can be produced due to the combination of fuel, an oxidiser (such as the oxygen in the air) and a source of ignition energy. To avoid ignition, the following actions can be taken:
- use special terminal boxes
- avoid non-essential accessories
- use ex-type cable boxes and glands
- use intrinsically safe relays.
Medium Power Transformers
Minera R- Rectifier Transformers

Medium Power Transformers up to 80MVA

Overview

The electrical and mechanical design of the Schneider Electric rectifier transformer is based on decades of experience in transformer design for both medium and high voltage ranges, expert calculation and CAD programming. They are oil-type transformers filled with mineral, silicone or vegetable oil. They operate at the fundamental frequency of an alternating current system and are designed to have one or more output windings connected to the rectifier. It is possible to make major changes in the output current and voltage by using the transformer with a different rectifier configuration.

Rectifier transformers that are designed for treating high harmonics will dramatically increase load losses (DC and eddy currents) but have very little effect on no-load losses. Various types of transformer connections are available on request including polygon or double-zigzag connections. High or low value coupling coefficient and phase shifting options are also available.

Technical Characteristics

Rated power: up to 80MVA.
Rated voltage: various - please consult us.
Phases: three-phase unit.
Rated frequency: 50Hz or 60Hz.
Type of cooling: ONAN (ONAF on request).
Manufacturing standards: AS 60076 / EN 50464-1, IEC 60079-6 / EN 50015, ATEX.

Applications

• Railways
• Metal
• Renewables

How to Avoid Harmonic Effects on the Transformer

What are the negative effects on the transformer due to harmonics? Harmonic distortion will result in an increase of transformer stray/eddy current losses in the windings and steel parts due to harmonic current components. The net effect of harmonic distortion is an increase in the operational temperature and a consequential reduction in service life. Taking into account the power needs of the equipment fed by the transformer and especially the harmonics generated by the rectifier or the speed drive, our experts will dimension the transformer to the exact size using CAD programming. These programs have been created based on our long term experience and are constantly evolving and being improved. As a result, you can:

• improve your power quality
• improve the transformer’s and surrounding equipment’s life expectancy
• minimise space requirements.
Distribution Transformers
Minera GMX Ground Mounted Transformers

Distribution Transformers up to 36kV/3150kVA

Overview
The GMX range is an outdoor range of ground-mounted oil-filled transformers with bushings wall-mounted to suit cables from above or below. Rated from 315kVA to 3.15MVA or higher at 11kV and 22kV, GMX transformers are fully compliant with the Minimum Energy Performance Standard (MEPS).

Schneider Electric has a long history of transformer manufacturing in Australia. Our Transformer Solutions factory is located in Benalla, Victoria. A wide range of oil-immersed transformers and transformer solutions are designed to meet different specifications and applications.

Technical Characteristics
- Rated power: up to 3150kVA.
- Rated voltage: up to 36kV
- Phases: three-phase unit.
- Rated frequency: 50Hz.
- Type of cooling: ONAN.
- Manufacturing standards: AS 60076
- Other (optional): oil temperature indicator, integrated safety detector, pressure relief device, winding temperature indicator, marshalling box and wheels.

Applications
- Industrial
- Commercial
- Mining
- Infrastructure

Minimum Energy Performance Requirement (MEPS)
In accordance with the requirements of AS 2374.1.2 all Schneider Electric distribution transformers are fully compliant with MEPS. The scope of AS 2374.1.2 covers oil immersed and dry-type distribution transformers, with power ratings from 10kVA to 2500kVA intended to be used on 11kV and 22kV networks. Compliance to MEPS is a legally enforceable requirement on all manufacturers since the 1st October, 2004.
Distribution Transformers
Minera TESA Ground Mounted Transformers

Distribution Transformers up to 22kV/2500kVA

Overview
The TESA range is an outdoor range of ground-mounted oil-filled transformers with bushings cover-mounted to suit cable from above (cables from below is also possible). Rated from 315kVA to 2500kVA or higher at 11kV and 22kV, TESA transformers are fully compliant with Minimum Energy Performance Standard (MEPS).

Schneider Electric has a long history of transformer manufacturing in Australia. Our transformer solutions factory is located in Benalla, Victoria. A wide range of oil-immersed transformers and transformer solutions are designed to meet different specifications and applications.

Technical Characteristics
Rated power: up to 2500kVA
Rated voltage: up to 22kV.
Phases: three-phase unit.
Rated frequency: 50Hz.
Type of cooling: ONAN.
Manufacturing standards: AS 60076
Other (optional): oil temperature indicator, integrated safety detector, pressure relief device, winding temperature indicator, marshalling box and wheels.

Applications
• Industrial
• Commercial
• Mining
• Infrastructure

Minimum Energy Performance Requirement (MEPS)
In accordance with the requirements of AS 2374.1.2 all Schneider Electric distribution transformers are fully compliant with MEPS. The scope of AS 2374.1.2 covers oil-immersed and dry-type distribution transformers with power ratings from 10kVA to 2500kVA intended to be used on 11kV and 22kV networks. Compliance to MEPS is a legally enforceable requirement on all manufacturers since the 1st October, 2004.
Distribution Transformers
Minera Pole-Mounted Transformers

Pole-Mounted Transformers up to 36kV/500kVA

Overview
The Minera pole-mounted range is an outdoor range of pole-top oil-filled transformers. Rated from 10kVA to 500kVA, single or three-phase at 11kV, 22kV and 36kV; Minera Pole-Mounted transformers are fully compliant with Minimum Energy Performance Standard (MEPS). A wide range of oil-immersed transformers and transformer solutions are designed to meet different specifications and applications. In accordance with the requirements of AS 2374.1.2, all Schneider Electric distribution transformers are fully compliant with MEPS.

Technical Characteristics
Rated power: up to 500kVA.
Rated voltage: 11, 22 and 36kV.
Phases: three-phase and single-phase.
Rated frequency: 50Hz.
Type of cooling: ONAN.
Manufacturing standards: AS 60076.
Other (optional): oil temperature indicator.

Applications
- Utilities
- Commercial
- Mining
- Infrastructure
Distribution Transformers
Minera HE+ High Efficiency Transformers

Distribution Transformers up to 36kV/1600kVA

Overview
Transformer losses represent a cost to the energy retailer sending electricity through the transformer. In the aggregate, these losses are the highest in the distribution (<33kV) network. The losses can be broadly divided into two categories: load losses, which are proportional to the electric current; and no-load losses, which are caused by the magnetisation of the core steel and are constant - independent of the electrical load. These represent fixed costs to the energy retailer.

One way to reduce the no-load losses in the core is to take traditional core steel and scribe it with a laser; this will reduce the losses to a certain extent. Another way is to glassify the steel, which produces randomly oriented grains within the steel. The alternating magnetic field is able to switch direction more easily and losses are strongly reduced.

Schneider Electric provides a full range of energy-efficient solutions to suit your exact needs. In addition to the existing high efficiency Minera HE transformers, Schneider Electric offers a new technology product range; amorphous core transformers Minera HE+, which provide even greater energy savings. Minera HE+ is an ultra high efficiency amorphous transformer, which is more economical than “standard efficiency” transformers, as it consumes 70% to 80% less energy than conventional silicon steel transformers.

Technical Characteristics
Rated power: up to 1600kVA.
Rated voltage: up to 36kV.
Phases: three-phase (single-phase available upon request).
Rated frequency: 50Hz or 60Hz.
Type of cooling: ONAN, KNAN (other on request).
Manufacturing standards: AS 60076, EN 50464-1 (others on request).

Applications
• Industry
• Infrastructure
• Data Centres
• Buildings

What is Amorphous Core Technology?
Amorphous metal is a solid metallic material with high magnetic conductivity that provides energy saving performance. The metal atoms are disordered and arranged in a non-crystalline way. Amorphous metal is different from conventional steel because it’s easier to magnetise and de-magnetise. Amorphous metal sheet is 0.02mm thick, which is about 1/10 the thickness of conventional silicon steel.

Advantages of Amorphous Metal Magnetic Core
• Reduction of magnetising current.
• Lower temperature rise of core.
• Low-loss, especially no-load losses divided by three more than conventional steel.
• Lower greenhouse emissions.
Distribution Transformers

KPX Kiosks

Kiosks - up to 36kV/2500kVA

Overview

Prefabricated (kiosk) substations are defined as an enclosure containing transformers, low voltage and high voltage switchgear, connections and auxiliary equipment to supply low voltage energy from a high voltage system or vice versa. Kiosk designs may have different configurations depending on the requirements of the site “footprint” and access.

- KPX - elongated design with access from both ends.
- KPX² - square design with access from one side.

Applications

Wind farm solutions: the initial design of a wind farm can have profound implications for its future profitability. The fundamental aim is to maximise energy production, minimise capital and operational costs and stay within the constraints imposed by the site. The kiosk substation for wind farms have to take into account many variables such as the environment (oil containment), exposure to windy weather and connection to the grid.

Electrical utility solutions: for electrical utilities, long blackout periods and voltage fluctuations are unacceptable. Their primary needs include safety of supply and continuity of service, due to increasing pressures from the mandatory measurement of customer service and customer expectations.

Defence solutions: defence substations differ from those provided by electrical utilities, as typically they also form part of the emergency power distribution system and contain control and communications equipment needed to effectively distribute and control emergency power.

Industrial solutions: reliability of supply for industrial customers is critical. A power outage can potentially cost millions of dollars. Their primary needs include quality of supply, energy efficiency and continuity of service.

Defence-Style Cyclone Rated Kiosk

Schneider Electric has recently designed a defence-style kiosk for use in cyclone regions, which has been independently verified to meet cyclone criteria AS/NZ 1170.2.2011. Included in the certification are impact tests that prove compliance to the standard. Defence-style kiosks are suitable for Cyclonic Region D and Terrain Category 2, and have been tested for an ultimate wind speed of up to 88m/s. The construction of the upper and base frames consists of cross members made from hot dipped galvanised carbon steel and the enclosure panels are made using stainless steel.
Distribution Transformers
Trihal/Tricast - Cast Resin Transformers

Overview
Schneider Electric has two types of cast resin transformers: Trihal and Tricast. Although the methods of construction and E, C and F ratings differ, the basic technology is similar. However, the Tricast is also available with an on-load tap changer if requested. Both Tricast and Trihal are both self-extinguishing, providing an effective solution for use in industrial installations susceptible to fire hazards. In addition, they meet the needs of special applications, such as wind farms and are the perfect replacement for PCB transformers.

Trihal is available in two levels. The standard level C2 E2 F1 10pC suits the majority of situations. It is ideal in clean, dry rooms such as in hospitals, airports, high-rise buildings and the like. Trihal also has a range C3 E3 F1 5pC for extreme environments where high humidity over 95% and/or heavy pollution are encountered. This range is also specially tested to prove partial discharge ≤ 5pC. Trihal and Tricast are fully compliant with the Minimum Energy Performance Standards (MEPS) AS 2374.1.2.

Technical Characteristics
Rated power: Trihal (15MVA), Tricast (25-30)MVA.
Rated voltage: Trihal (40kV), Tricast (36-52)kV.
Phases: one or three-phase unit.
Rated frequency: 50Hz or 60Hz.
Type of cooling: AN (AF, ANAF available on request).
Manufacturing standards: AS 60076, EN 60726, NF EN 60076-11 and NF C 52-115, VDE 0532 part 6, DIN 42523, ANSI C57.12.01
Other: thermal protection system.

On request: enclosure, fans, anti-vibration pads, plug-in bushing, monobloc bushing, automatic voltage regulator panel, surge arrestors, etc.

Safety and Reliability
To ensure total compliance with relevant national and international standards, Trihal transformers have been put through the most stringent series of tests. Trihal is one of few transformers having successfully passed these tests and is characterised by the following features:

Standard offer
- C2 – Climate Test – Operation and Storage to -25°C.
- E2 – Environment Test – Frequent condensation or heavy pollution or both - Relative humidity up to 93%.
- ≤ 10pC – Routine Test for Partial Discharge.

Premium offer
- C3 – Climate Test – Operation and Storage to -50°C.
- E3 – Environment Test – Nearly total condensation or heavy pollution or both - Abnormal level of humidity up to 95% to IEC 60076-16.
- ≤ 5pC – Special test for Partial Discharge.

Trihal/Tricast is your best solution for public safety. Whether for industrial plants susceptible to fire hazards or use in public buildings and high rise developments that are occupied or visited by thousands of people every day.

Applications
- Rail
- Water
- MMM
- Wind farms
- Buildings
- Oil and gas
Special Transformers
Minera SGrid Transformers

Distribution Transformers up to 24kV/800kVA

Overview
High penetration of residential photovoltaic (PV) generation in some areas can cause a rise in the low voltage level, beyond limits permitted by regulation. The particular difficulty with this voltage rise is that it is present during sunny days, when the PV cells are generating but absent at night when generation ceases. This means that permanent changes of off-load tap switches can be problematic. One solution is to mount a small on-load tap changer in a distribution transformer, which is why Schneider Electric developed the SGrid.

Technical Characteristics
Rated power: up to 800kVA.
Rated voltage: up to 24kV.
Phases: three-phase unit.
Rated frequency: 50Hz.
Type of cooling: ONAN.
Manufacturing standards: AS 60076, EN 50464-1, DIN EN 50464-1.

Applications
• Residential
• MV/LV distribution substations

On-Load Tap Changer
The Minera SGrid features an on-load tap changer that is used to adjust the desired tap winding under load. The on-load tap changer is based on the reactor switching principle and uses vacuum bottles to change the tap position under load. The arc is extinguished and insulated in a vacuum bottle, which avoids impurities affecting the transformer oil.
Special Transformers
R-Cool - Air Conditioned Special Dry-Type

Dry-Type Transformers up to 36kV/3150kVA

Overview
R-Cool dry-type transformer is an air conditioned special dry-type transformer, designed to achieve high IP ratings and efficient cooling, which can not be reached with conventional enclosures and cooling. It is now possible to utilise dry-type transformers in extreme temperatures and dust; indoor or outdoor or 100 per cent humidity without the need for filters or any other disposal materials. External air, water or other coolant is not required at site since R-Cool is a complete stand-alone solution; it simply needs to be powered up to operate.

Technical Characteristics
Rated power: up to 3150kVA (for higher ratings, please consult us).
Rated voltage: up to 36kV (for higher ratings, please consult us).
Phases: three-phase unit.
Rated frequency: 50Hz or 60Hz.
Type of cooling: two independent cooling flows.
Manufacturing standards: AS 60076, ISO 12944.
Other: the R-Cool dry-type transformer is equipped with a transformer enclosure and a cooling compartment. Due to the size of the transformer, cooling compartments can be single or dual. Enclosure and cooling compartments are manufactured with 2mm S235 sheet steel. Outdoor units are also zinc coated to achieve higher corrosion resistance.

Applications
• Mines and metals
• Chemical industries
• Transportation (tunnels)
• Power generation
• Marine
• Infrastructure with limited cooling
• Oil and gas

R-Cool Cooling System
The purpose of R-Cool systems is to transfer heat from the evaporator to the condenser by the refrigerant transfer. Basically, there are two independent flows in the system. Condenser fans use ambient air to cool down the condenser. This flow is completely separated from enclosure so the transformer is isolated from ambient conditions. R-Cool system does not only cool transformer coils like conventional cooling systems, but provides the desired environment by creating and controlling the ambient inside the transformer enclosure. The R-Cool system provides a homogenous and stable environment for the entire unit, while the conventionally cooled dry-type transformers only cools down the transformer coils.
Overview
The BCV range of 400V/400V transformers are available in ratings up to 400kVA. Applications include where the earthing system needs to be changed or as an isolation transformer.

Technical Characteristics
Rated power: up to 400kVA (for higher ratings, please consult us).
Rated voltage: 400/400V or 400/231 (for other voltages, please consult us).
Phases: three-phase.
Rated frequency: 50Hz or 60Hz.
Other: electrostatic shield between the primary and the secondary connected to the earth, completely separate windings; covers may be purchased later as accessories.

Applications
- Final distribution
- Isolated operation
- Bypass transformer
Special Transformers
BCV Autotransformer

Overview
The BCV range of auto transformers are available in ratings up to 400kVA. Applications include stepping voltage up or down without isolating the secondary or primary.

Technical Characteristics
Rated power: up to 400kVA (for higher ratings, please consult us).
Rated voltage: 231/400V or 400/231 (for other voltages, please consult us).
Phases: three-phase.
Rated frequency: 50Hz or 60Hz.
Other: star/star coupling with neutral; covers may be purchased later as accessories.

Applications
- Stepping voltage up/down in a small physical size.
- Stepping voltage up/down without reducing network impedance.
- Compensating for voltage drops over long cables (e.g. tunnels).
**Overview**

Some countries, such as Switzerland, have developed regulations for the protection of people from non-ionising radiation (the NISV standards). This limits the magnetic flux density at a distance from electrical plant to 1 micro-Tesla. The distance at which the measurement is taken needs to be specified by the end user, but it is typically between 1m and 3m. The NISV standard is met by using magnetic shields (or shunts) on the inside tank walls, special connections of the windings and a special design for the LV terminal box. Schneider Electric’s Minera LowRad transformer has been tested to emit only 1 micro Tesla (1µT) of magnetic flux density between 1 and 3 metres, depending on the rating and design of the transformer.

**Technical Characteristics**

- Rated power: 3150kVA.
- Rated voltage: 52kV.
- Phases: three-phase unit.
- Rated frequency: 50Hz or 60Hz.
- Type of cooling: ONAN.

**Applications**

- Utilities
- Medical industries

Tested NISV Curves for Schneider Transformer (630kVA)

Schneider Electric’s Minera LowRad transformer has been tested to emit only 1 micro Tesla (1µT) of magnetic flux density between 1 and 3 metres, depending on the rating and design of the transformer.
Overview
Recently Schneider Electric developed three-winding transformers specially designed for grid connected photovoltaic systems. These transformers are designed according to any single customer requirements regarding voltage, power, low losses, sound level, climate and more. Special attention to people and environmental safety issues is always considered. In large PV installations, multiple inverters paralleled to the PV arrays are directly connected to one or more medium-voltage utility transformers. Schneider Electric’s offer of three-winding transformers can reduce costs without compromising any of the transformer functions. The transformer’s primary voltage is at the low voltage side and the secondary is at the medium voltage side. The input voltages usually take values 270, 315 or 375V and the medium voltage varies according to the feeding network voltage (i.e. 11, 20, 30kV). Present solar inverter power requires a transformer rated power of 500kVA, 1000kVA or 1250kVA.

Technical Characteristics
Rated power: up to 1600kVA.
Rated voltage: up to 36kV.
Phases: three-phase unit.
Rated frequency: 50Hz.
Type of cooling: ONAN.
Manufacturing standards: AS 60076, EN 50464-1.
Other: protection relays on the filing plug, liquid retention bund.

Applications
• Photovoltaic systems
• Solar

Photovoltaic Systems
Minera PV transformers are the ideal solution for photovoltaic systems. The technology used along with the appropriate sizing of the core, the framework and the high quality materials results in the most suitable product in terms of quality, reliability, efficiency and cost effectiveness. Three-winding transformer features include:
• galvanic isolation between the solar inverter and the feeding network
• voltage step-up from the inverter output to the MV feeding network
• wound magnetic core for:
  > standard or low losses
  > minimum sound levels and low inrush current.
Services

Transformer Repair and Refurbishment Services

Transformer Refurbishment

Schneider Electric offers a range of refurbishment and repair services to extend the life of transformers and kiosks. By partnering with Schneider Electric you can gain full life cycle support for your electrical distribution equipment and maximise the return on your investment. Benefit from our expertise gained through 40 years of transformer manufacturing in Australia.

Transformer Repair and Refurbishment Services

Level 1: on-site inspection and condition assessment
- Inspection of the transformer at your premises followed by a written report of our findings and recommendations.

Level 2: on-site repair - minor repairs to tank, radiator and gaskets (where practicable).

Level 3: intermediate repair - repair and refurbishment at our transformer manufacturing facility.

Level 4: major repair - removal of transformer core and coils for repairs and moisture removal.

Level 5: end-of-life disposal - the offer ensures safe and environmentally friendly disposal of the equipment. Hazardous materials are extracted and disposed of by specialist partners approved by Schneider Electric. Maximum recycling of materials is achieved.

Oil Testing Services

Test A: PCBs
- Test for polychlorinated biphenyls (PCBs) before disposal.

Test B: Dissolved Gas Analysis (DGA)
- Evaluates transformer condition by the presence of dissolved gasses.

Test C: Basic Condition Assessment
- Comprises Test B, plus a suite of oil tests to evaluate the condition of the transformer.

Test D: Full Condition Assessment
- An exhaustive suite of oil tests to provide information on the overall condition of the transformer.

Kiosk Refurbishment

We also specialise in the total repair and refurbishment of MV/LV kiosks. This extends the life of your assets and helps you make the most of your capital investment.

This offer typically comprises:
- door-to-door kiosk refurbishment service contracts
- condition assessment of the kiosk and equipment with a detailed report
- kiosk enclosure repairs and re-paint
- MV and LV switchgear inspection and repairs or replacement
- upgrade transformer power capacity
- upgrades to the MV or LV equipment
- full re-testing of complete kiosk
- end-of-life disposal.
Technical Information
Three-Phase Transformers - Line Currents and Minimum Energy Performance Standards

Line Current = kVA / (1.732 x kV)

Minimum Energy Performance Standards


Scope:
- Distribution transformers between 10kVA and 2500kVA connected to 11kV or 22kV networks (50Hz only);
- Single-phase, three-phase systems.
- Transformer impedance between 3% and 8%.
- Two winding transformers only.

Government Regulations:
- All distribution transformers sold in Australia must comply with the standard.
- State government regulators are responsible for enforcing the regulations.
- Website: www.energyrating.gov.au

Definition:
The transformer power efficiency at 50% load and unity power factor in percent is calculated in accordance with AS2374.1.2 - 2003 S 1.5.1 (c).

\[ \eta_{50\%} = \frac{0.5 \times S_r}{0.5 \times S_r + 0.25 \times P_o + P_{L0}} \times 100\% \]

\[ S_r = \text{Rated Power in } kVA \]
\[ P_{L0} = \text{No Load Loss in } kW \]
\[ P = \text{Load Loss in } kW \]
\[ \eta_{50\%} = \text{MEPS Required Power} \]
\[ \eta_{50\%} = \text{MEPS Level} \]

MEPS Table

<table>
<thead>
<tr>
<th>kVA</th>
<th>Power Level</th>
<th>MEPS KVA</th>
<th>MEPS %</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>98.76%</td>
<td>99.01%</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>98.82%</td>
<td>99.04%</td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>98.85%</td>
<td>99.06%</td>
<td></td>
</tr>
<tr>
<td>250</td>
<td>98.88%</td>
<td>99.08%</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td>98.90%</td>
<td>99.10%</td>
<td></td>
</tr>
<tr>
<td>350</td>
<td>98.92%</td>
<td>99.12%</td>
<td></td>
</tr>
<tr>
<td>400</td>
<td>98.94%</td>
<td>99.14%</td>
<td></td>
</tr>
<tr>
<td>450</td>
<td>98.96%</td>
<td>99.16%</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>98.98%</td>
<td>99.18%</td>
<td></td>
</tr>
</tbody>
</table>

Table contains values for kVA and corresponding MEPS percentages from 100 to 500 kVA.
## Technical Information

### Three-Phase Common Transformer

#### Vector Groups

<table>
<thead>
<tr>
<th>Phasor symbols</th>
<th>Terminal markings and phase displacement diagram of induced voltages</th>
<th>Winding connections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HV winding</td>
<td>LV winding</td>
</tr>
<tr>
<td>Dy1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of Dy1 vector group](image1)

- Phase displacement = **-30°**
- Clock-hour figure = **1**

<table>
<thead>
<tr>
<th>Yd1</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of Yd1 vector group](image2)

- Phase displacement = **30°**
- Clock-hour figure = **11**

<table>
<thead>
<tr>
<th>Dy11</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of Dy11 vector group](image3)

<table>
<thead>
<tr>
<th>Yd11</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Diagram of Yd11 vector group](image4)

- Phase displacement = **30°**
- Clock-hour figure = **11**
Technical Information
Transformer Calculations

Transformer Efficiency and Voltage Drop

Calculation of Transformer Efficiency

Let us assume that a three-phase transformer, 630 kVA, 20/0.4 kV, has 1200 W no-load losses and 9300 W load losses. Determine the transformer efficiency at full load (case 1) and at 75% load (case 2) for power factor 1.0 and 0.8.

**Case 1: full load**

The efficiency at full load and for power factor equal to 1.0 \((\cos \varphi = 1.0)\) is calculated as follows:

\[
\eta_1 = \frac{S \cos \varphi}{S \cos \varphi + N_L + L_L \left(\frac{S}{S_n}\right)^2}
\]

\[
= \frac{630000 \cdot 1.0}{630000 \cdot 1.0 + 1200 + 9300 \cdot (1.0)^2} = 0.9836 = 98.36\%
\]

The efficiency at full load and \(\cos \varphi = 0.8\) is:

\[
\eta_2 = \frac{630000 \cdot 0.8}{630000 \cdot 0.8 + 1200 + 9300 \cdot (0.8)^2} = 97.96\%
\]

**Case 2: load 75%**

The efficiency at load 75% and \(\cos \varphi = 1.0\) is:

\[
\eta_1 = \frac{472500 \cdot 1.0}{472500 \cdot 1.0 + 1200 + 9300 \cdot (0.75)^2} = 98.66\%
\]

The efficiency at load 75% and \(\cos \varphi = 0.8\) is:

\[
\eta_2 = \frac{472500 \cdot 0.8}{472500 \cdot 0.8 + 1200 + 9300 \cdot (0.75)^2} = 98.33\%
\]

Calculation of Voltage Drop

Let us assume that a three-phase transformer, 630 kVA, 20/0.4 kV, has 9300 W load losses and 6% short-circuit impedance. Determine the voltage drop at full load (case 1) and at 75% load (case 2) for power factor 1.0 and 0.8.

The voltage drop is given by the following equation:

\[
U_{\text{drop}} = \frac{S}{S_n} \left( e_r \cos \varphi + e_s \sin \varphi \right) + \frac{1}{2} \left( \frac{S}{S_n} \right)^2 (e_r \sin \varphi - e_s \cos \varphi)^2, \text{ where}
\]

\[
e_r = \frac{L_L}{S_n} = \frac{9300}{63000} = 0.014762 = 1.4762\% \quad \text{and} \quad e_s = \sqrt{U_{\text{imp}}^2 - e_r^2} = \sqrt{0.06^2 - 0.014762^2} = 0.05816 = 5.816\%
\]

**Case 1: full load**

For \(\cos \varphi = 1, \sin \varphi = 0\).

\[
U_{\text{drop}} = \frac{S}{S_n} (e_r \cos \varphi + e_s \sin \varphi) + \\
+ \frac{1}{2} \left( \frac{S}{S_n} \right)^2 (e_r \sin \varphi - e_s \cos \varphi)^2 = \\
= 1.0 \cdot (1.4762 \cdot 1 + 5.816 \cdot 0) + \\
+ \frac{1}{2} \left( \frac{1}{100} \right)^2 (1.4762 \cdot 0 - 5.816 \cdot 1)^2 = 1.645\%
\]

For \(\cos \varphi = 0.8, \sin \varphi = \sqrt{1 - (\cos \varphi)^2} = 0.6\).

\[
U_{\text{drop}} = (1.0) \cdot (1.4762 \cdot 0.8 + 5.816 \cdot 0.6) + \\
+ \frac{1}{2} \left( \frac{1}{100} \right)^2 (1.4762 \cdot 0.6 - 5.816 \cdot 0.8)^2 = 4.741\%
\]

**Case 2: load 75%**

For \(\cos \varphi = 1\), the voltage drop is calculated as follows:

\[
U_{\text{drop}} = (0.75) \cdot (1.4762 \cdot 1 + 5.816 \cdot 0) + \\
+ \frac{1}{2} \left( \frac{1}{100} \right)^2 (1.4762 \cdot 0 - 5.816 \cdot 1)^2 = 1.202\%
\]

For \(\cos \varphi = 0.8, \) the voltage drop is:

\[
U_{\text{drop}} = (0.75) \cdot (1.4762 \cdot 0.8 + 5.816 \cdot 0.6) + \\
+ \frac{1}{2} \left( \frac{1}{100} \right)^2 (1.4762 \cdot 0.6 - 5.816 \cdot 0.8)^2 = 3.543\%
\]
Technical Information
Transformer Calculations

Parallel Operation and Transformer Selection

Parallel Operation of Transformers

Let us assume that three transformers operate in parallel. The first transformer has 800 kVA rated power and 4.4% short-circuit impedance. The rated power and the short-circuit impedance of the other two transformers is 500 kVA and 4.8%, and 315 kVA and 4.0%, respectively. Calculate the maximum total load of the three transformers.

Among the three transformers, the third transformer has the minimum short-circuit impedance, i.e. \( U_{\text{L,min}} = 4.0\% \).

The load of transformer 1 is:
\[
P_{\text{L,1}} = \frac{V_{\text{L,1}}}{U_{\text{L,min}}} = 800 \times \frac{4}{4.4} = 728\text{kVA}.
\]

The load of transformer 2 is:
\[
P_{\text{L,2}} = \frac{V_{\text{L,2}}}{U_{\text{L,min}}} = 500 \times \frac{4}{4.8} = 417\text{kVA}.
\]

The load of the transformer 3 is:
\[
P_{\text{L,3}} = \frac{V_{\text{L,3}}}{U_{\text{L,min}}} = 315 \times \frac{4}{4} = 315\text{kVA}.
\]

The maximum total load of the three transformers is:
\[
P_{\text{total}} = P_{\text{L,1}} + P_{\text{L,2}} + P_{\text{L,3}} = 728 + 417 + 315 = 1460\text{kVA}.
\]

Transformer Selection

Let us assume that an industrial user wants to buy a 630kVA transformer. The transformer will operate with 60% average loading, eight hours per day, 200 working days per year. Two transformer manufacturers submit different offers to the industrial user. The first manufacturer offers a transformer with 900W no-load losses and 6800W load losses at a sales price of $23,300. The second manufacturer offers a transformer with 780W no-load losses and 7045W load losses at a sales price of $24,000. Considering that the depreciation of the transformer purchase investment is going to be done in five years and the energy charge is $0.11/kWh, calculate the economical optimum offer.

The comparison of the two offers will be based on the annual total owning cost, which is the sum of the annual buying cost and the annual usage cost. An approximation of the annual buying cost can be found by dividing the sales price with the years of depreciation. An approximation of the annual usage cost can be calculated based on the annual charge due to the transformer operation (annual charge for load losses and no-load losses).

**Manufacturer A**

The annual buying cost in $ is:
\[
OC_1 = \frac{23300}{5} = 4660.00
\]

The annual charge in $ for no load losses is:
\[
\text{NLLC}_1 = 8760\text{h} \times 0.9\text{kW} \times 0.11 \text{ $/kWh} = 867.24
\]

The annual charge in $ for load losses is:
\[
\text{LLC}_1 = (200\times8)\text{h} \times 6.8\text{kW} \times 0.11 \text{ $/kWh} = 430.85
\]

The annual total owning cost in $ is:
\[
\text{TOC}_1 = OC_1 + \text{NLLC}_1 + \text{LLC}_1 = 5958.09
\]

**Manufacturer B**

The annual buying cost in $ is:
\[
OC_2 = \frac{24000}{5} = 4800.00
\]

The annual charge in $ for no load losses is:
\[
\text{NLLC}_2 = 8760\text{h} \times 0.78\text{kW} \times 0.11 \text{ $/kWh} = 751.61
\]

The annual charge in $ for load losses is:
\[
\text{LLC}_2 = (200\times8)\text{h} \times 5\text{kW} \times 0.11 \text{ $/kWh} = 316.80
\]

The annual total owning cost in $ is:
\[
\text{TOC}_2 = OC_2 + \text{NLLC}_2 + \text{LLC}_2 = 5888.41
\]

As a result, although the transformer sales price of the second manufacturer is 20% more expensive (i.e. $700.00 more expensive), the transformer of the second manufacturer is finally more economical, since its annual total owning cost is 1.5% less (i.e. $90.00 less). From the above, it is concluded that the cheapest transformer is not always the most economical. In particular, the difference at the annual total owning cost could be more than 1.5%. This will happen if we consider more years for the depreciation (instead of the current assumption of five years), or if we use the transformer more (instead of the current assumption of 60% average loading, eight hours per day, 200 working days per year).
Technical Information
Transformer Calculations
Air Resistance and Cross-Section Input and Output Openings

When the transformer is going to be installed inside an electrical room (indoor installation), particular attention should be paid to the calculation of the dimensions of the installation area as well as to the ventilation of the installation room. The ventilation of the electrical room influences the cooling, and consequently, the transformer’s life. The distance between the walls of the room and the transformer end points must be from 50 to 60 cm.

Calculation of air resistance

For the calculation of the dimensions of the openings for the input and output of air in the electrical room, the calculation of the air resistance is required. For the air resistance, the symbol W is used in the sequel. The value of the air resistance depends on the existence or not of lattices, meshes and venetian blinds.

If there are no lattices, meshes and venetian blinds in the input and output openings of the air, then the minimum air resistance is:

\[ W_{\text{min}} = 4. \]

For each lattice, the value \( W_L = 1 \) is added to the value of \( W_{\text{min}} \).

For each mesh, the value \( W_M = 1.5 \) is added to the value of \( W_{\text{min}} \).

For each adjustable venetian blind, the value of \( W_V = 3 \) is added to the value of \( W_{\text{min}} \).

For example, for a transformer installation room with two meshes (one in the input and one in the output of air), the minimum air resistance is:

\[ W = W_{\text{min}} + 2W_M = 4 + 2 \times 1.5 = 7. \]

The lowest possible temperature in the transformer electrical room is achieved with the following ways:

- the opening for the output of the hot air is placed in the highest possible location, and
- the opening for the input of the cold air is placed in the lowest possible location.

Calculation of cross-section area of the input and output openings

The cross-section area of the opening for the input of air, \( F_1 \) (m\(^2\)), is calculated by the following formula:

\[
F_1 = \frac{4.25}{100} \times \sqrt{\frac{10^4 W}{H \cdot t}}.
\]

where \( W \) is the total transformer losses (kW), \( W \) is the air resistance, \( H \) is the height (m) of the opening for the output of air from the horizontal symmetry axis of transformer (see diagram), and \( t \) is the temperature rise (°C) of the transformer room.

The cross-section area of the opening for the output of air, \( F_2 \) (m\(^2\)), should be 10% to 15% larger than the cross-section area of the opening for the input of air (\( F_1 \)).

Dimensions of transformer installation room.
Ambient Temperature

The rated power of the transformer is typically calculated for the following conditions:

- maximum ambient temperature of 40°C
- average daily ambient temperature of 30°C
- average annual ambient temperature of 20°C.

On request, transformers operating under different ambient temperature conditions can be produced.

Overloading

The rated overloading of transformer depends on the transformer’s previous load or the corresponding oil temperature at the beginning of the overloading. Examples of the permissible duration and the respective levels of the acceptable over-loadings are shown below.

For example, if the transformer is loaded with 50% of its rated power continuously, then the transformer can be overloaded to 150% of its rated power for 15 minutes or to 120% of its rated power for 90 minutes.

<table>
<thead>
<tr>
<th>Previous continuous loading (% of rated power)</th>
<th>Oil temperature (°C)</th>
<th>10% min.</th>
<th>20% min.</th>
<th>30% min.</th>
<th>40% min.</th>
<th>50% min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>55</td>
<td>180</td>
<td>90</td>
<td>60</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>75</td>
<td>68</td>
<td>120</td>
<td>60</td>
<td>30</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>90</td>
<td>78</td>
<td>60</td>
<td>30</td>
<td>15</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>

Permissible duration and level of acceptable overloading.

It should also be noted that the oil temperature is not a safe measure for the winding temperature, since the time constant of the oil is 2 to 4 hours, while the time constant of the winding is 2 to 6 minutes. Therefore, the determination of the permissible duration of the overloading must be done very carefully, since there is a danger of the winding temperature exceeding the critical temperature of 105°C, without being visible by the oil temperature.
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Western Australia
Perth ■ 10 Harris Road, Malaga, Western Australia, 6090

Northern Territory
Darwin ■ 16 Albatross Street, Winnellie, NT 0820

Manufacturing sites
Benalla Medium voltage switchgear and transformer manufacturing and development ■ Sydney Road, Benalla VIC 3672
Brisbane Medium voltage overhead distribution switchgear manufacturing and development ■ 80 Schneider Road, Eagle Farm, QLD 4009
Adelaide Wiring accessories and low voltage switchgear manufacturing ■ 33-37 Port Wakefield Road, Gepps Cross, SA 5094
Sumner Park Medium voltage switchgear and transportable substations ■ 15 Wolstone Road, Sumner Park, QLD 4074
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