## Indications:

the following technical information are a guideline for the correct use of transformers in various voltage fields. The differences in the construction of the transformers are determined by the installation and equipment requirements. We summarize here the main definitions set down in EN 61558.1 and part 2 standard. Other standards which we refer to are: CEI 14-5, 14-8, EN 60076-1 (power transformers), UL 5085-1-2-3.

## Transformers

**Isolating transformer:** suitable for limiting risks caused by contact between the earth and the live parts that can give an electric shock if the isolation is broken or damaged.
**Primary voltage:** 1000V max - Secondary voltage: max 500V no-load - Frequency: 500Hz max –Rated power: 25kVA if single-phase, max. 40kVA if three-phase. Type of isolating: double or reinforced.
**Safety transformer:** isolating transformer suitable for feed circuits of low safety voltage. Primary voltage: 1000V max - Secondary voltage: 50V max. no-load - frequency 500Hz – Rated power: 10kVA if single-phase , max. 16kVA if three-phase. Type of isolating: double or reinforced.

## Rated Ambient Temperature:

this is the temperature surrounding the transformer. If not otherwise specified, the rated ambient temperature is 40°C. Particular care should be taken when the temperature is higher. It should not exceed the values laid down in the table below. The core power must be adapted to approximately the values given below:

| Rated Ambient Temperature | Rated power x factor |
|---|---|
| 40 ° C | 1 |
| 50 ° C | 0.92 |
| 60 ° C | 0.84 |
| 70 ° C | 0.75 |

**Over-temperature:** this is the temperature which is verified in the transformer when it is working normally. In particular, in the windings, depending on the type of isolating materials and the rated ambient temperature, the following values must not be exceeded:
Maximum excessive temperatures for winding with ta=40°C
A=60 °C - E=75 °C - B=80 °C - F=100 °C - H=125 ° C

**Rated Input Voltage:** network voltage feed of the transformer. Unless otherwise agreed, the maximum limit displayed is a value of 1.1 times the rated input voltage, as long as it does not cause damage to the continuous running of the transformer.

**No-load Current:** this is the input current of the no-load transformer with rated input voltage and frequency. The value of the no-load current is mainly effected by the properties of the used magnetic core laminations and can oscillate, even between transformers from the same production due to practical effects. An oscillation of - 10%/+20% with respect to the rated value is acceptable.

## Protection Class:

the equipment has built-in safety to protect against dangerous electrical currents.
**Class I:** all the metallic parts accessible from the transformer are insulated from the voltage parts by basic insulation and added safety measures consisting of a safety conductor within the electrical system of the installation.
**Class II:** all the metallic parts accessible from the transformers are separated from the voltage parts with double or reinforced isolating. The transformer must not be connected to the earth.

## Insulation Class:

| Max insulation system temperature | Max temperature on winding with Ta=40°C |
|---|---|
| A (105 ° C) | 60°C |
| E (120 °C) | 75°C |
| B (130 °C) | 80°C |
| F (155 °C) | 100°C |
| H (180 °C) | 125°C |

**Input Winding (Primary):** particular attention should be paid if, rather than only one input voltage, additional voltage inputs are required. In this case an increase of the core power is necessary. For example:

| Input voltage | Rated power x factor= scaling of the core power | |
|---|---|---|
| | 1 section | 2 sections |
| 230 | 1 | 1 |
| 230+400 | 1.23 | 1.52 |
| 230+500 | 1.26 | 1.49 |
| 400+440 | 1.06 | 1.12 |
| 400+440+500 | 1.12 | 1.25 |

**Rated Output Voltage:** this is the output voltage of the transformer at rated frequency, rated input voltage, with a rated output current at a rated power factor (=1). This is obtained when the transformer is running in continuous service conditions with a rated ambient temperature. If not otherwise agreed, a tolerance of ±5% is acceptable. For short-circuit proof transformers it is ±10% for construction.

## No-load Voltage:
this is the secondary voltage of the transformer in no-load conditions, at primary voltage and rated frequency. This formula can be found starting from:

$$\text{voltage drop \%} = \left| \frac{\text{No-load voltage} - \text{rated secondary voltage}}{\text{No-load voltage}} \right| \times 100$$

EN 61558.1 standard gives the following values for isolation and safety of transformers:

| Nominal % differences between secondary no-load and loaded voltage: | | |
|---|---|---|
| up to 10 VA | 100 | |
| from 10VA to 25 VA | 50 | Note: for insulating transformers up to 63VA:20% |
| over 25 VA to 63 VA | 20 | |
| over 63 VA to 250 VA | 15 | For control transformers in accordance with EN 61558.1 part CEI 96-3 standard the max. difference is 10% |
| over 250 VA to 630 VA | 10 | |
| over 630 VA | 5 | |

## Output Winding:
it means that in case of derivation output, the current is calculated in reference to the highest voltage, if not differently specified. In case of more windings, due to the quantity of isolation, it could be necessary to increase the core power.

## Rated Power:
this is the product of the rated secondary voltage for the rated secondary current. For three-phase transformers it is 3 times the product of the rated secondary voltage for the rated secondary current. For more secondary windings it is the sum of the product of rated secondary voltage for the rated secondary current of the circuits charged simultaneously.

## Autotransformer:
this is a transformer with common input and output windings, without galvanic isolation between the windings. The relative power is given by the formula:

$$P_{app} = P_{nom} \left(1- \frac{V_1}{V_2}\right)$$

where $P_{app}$= power (VA)
$P_{nom}$= rated power (VA)
V1= lower voltage (V)
$V_2$= higher voltage(V)

## Short Circuit Resistance:
here is the classification that the standard EN 61558.1 applies to short circuit proof transformers:

**a) Transformer not inerenthly short-circuit proof:** this is a transformer in which has been designed to resist extreme temperatures using a external protective device not supplied with the transformer (e.g. external fuses).

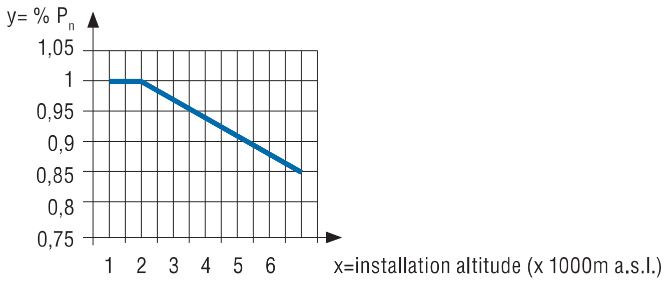
**b) Short-circuit proof Transformer**: this is a transformer in which the over- temperature can not exceed the limits specified when the transformer is short circuited, and can function normally after the removal of the short circuit.

- **Transformer short-circuit proof with specific construction:** this is a transformer which comes with a protective device inside which opens the primary or secondary circuit or reduces the current in case of short circuit (e.g. PTC, bi-metal).
- **Transformer short-circuit proof not with specific construction:** this is a transformer which, in the absence of protective devices, in case of short circuit, does not exceed the temperature limits (e.g. small transformer with high internal resistance).
- **Fail-safe transformer:** this is a transformer which after abnormal use, stops working without placing the user at risk (e.g. transformer with thermo-fuse included).

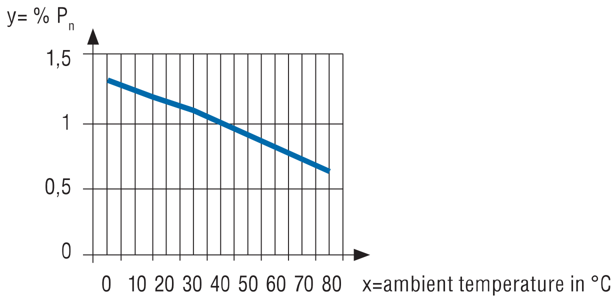
De-rating Tables: the working conditions of rated power (Pn) are referred to the following parameters:
- Continuos service
- Frequency: 50Hz…60Hz
- Protection degree: IP00
- Installation up to 1000m a.s.l.
- Ambient temperature: ta=40°C

Other conditions are allowed according to the following tables:

## ALTITUDE:




## AMBIENT TEMPERATURE:




Note: tables are in general. Upon request can be provided tables for the various types of transformers.

**Intermittent Service:** the required power could be calculated for different intermettent services starting from the following parameters:

- rated power (Pn)
- working time (Ton)
- resting time (Toff)

Intermittent rated power $P_{int}$

$$P_{int} = P_n \times \sqrt{\frac{T_{on}}{T_{on} + T_{off}}} \times 1{,}1$$

For example: rated load = 500VA
Ton = 10’
Toff = 20’

$$P_{int} = 500 \times \sqrt{\frac{10}{10+20}} \times 1{,}1$$

350VA transformer is enough.

**Protection Devices:** as general rule the transformer should be protected against short-circuits on the primary, against over-loads on the secondary. In both cases with delaying fuses (T) or with magneto-thermal switches with delayed tripping curve. Secondary protection calculation (against over-load) has not problems: EN 61558-1 standards provide a tolerance of ±10%on the rated secondary current and in any case on the external label it is indicated the fuse dimension. The primary protection calculation (against the short-circuit) is more difficult. It should be noted that a current peak (Ie) is generated at insertion moment which is 20-30 times In for about 10ms without protection that will occur in case of short-circuit.

It is necessary to know the short-circuit current, considering also the farthest point of the line transformer-user.

**Known data:**

**V2=** transformer output voltage
**Vcc=** short-circuit voltage in % (see catalogue)
**Pn=** transformer rated power
**L=** line length in meters
**S=** section of the conductor in m2

$$I_{2cc} = \frac{V_2}{\frac{V_2^2}{P_n} \times \frac{V_{cc}(\%)}{100} + \frac{0{,}036 \times l\,(m)}{S\,(mm^2)}}$$

In general it is enough to consider a protection calculated as 1,5-2,5xIn prim.

The table below is for single-phase transformers from 50VA to 1000VA with voltages 230-400/24V or 115V

Single-phase transformers - Protections with delaying fuses “T” serie

## Protection against short-circuit

| Pn | Input voltage | | Output voltage | |
|---|---|---|---|---|
| VA | 230V | 400V | 24V | 115V |
| 50 | 0,50 | 0,315 | 2 | 0,40 |
| 75 | 0,80 | 0,40 | 3,15 | 0,63 |
| 100 | 1 | 0,63 | 4 | 1 |
| 150 | 1,50 | 0,80/1 | 6,3 | 1,25 |
| 200 | 2 | 1,25 | 8 | 1,6 |
| 250 | 2,50 | 1,6 | 10 | 2 |
| 300 | 3 | 1,6 | 12 | 2,5 |
| 400 | 3,15 | 2,5 | 15 | 3,15/4 |
| 500 | 4 | 3 | 25 | 4/5 |
| 630 | 5 | 4 | - | 5/6,3 |
| 800 | 6 | 5 | - | 8 |
| 1000 | 8 | 6,30 | - | 8/10 |