

EU requirements for transformers

Ecodesign Directive from the European
Commission
Tier 2 - July 1st, 2021

[siemens.com/energy/transformers](https://www.siemens.com/energy/transformers)

The Ecodesign Directive from the European Commission takes effect for transformers Tier 2 in July 2021. The regulations started throughout Europe from July 2015 with Tier 1.

1. General information

Name of the directive:

Commission Regulation (EU) 2019/1783 of October 1st, 2019 amending Regulation (EU) 548/2014 of May 21st, 2014 on implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to small, medium and large power transformers

Scope of application:

small, medium and large power transformers

Contents:

The Ecodesign Guideline defines a framework for the requirements for the environmentally friendly design of energy consumption-relevant products. The objectives include improved energy efficiency and a general environmental compatibility and thus the reduction of CO₂ emissions.

Batch E2 addresses the transformers product group. Based on a preparatory study, specific ecodesign standards for transformers were defined by the European Commission which have now been introduced in the new implementation directive. In principle, the new directive should affect an increase in the degree of effectiveness by 20 %.

Exceptions:

The directive does not apply to transformers solely designed and implemented for the following purposes:

- a.) instrument transformers, specifically designed to transmit an information signal to measuring instruments, meters and protective or control devices or similar apparatus;
- b.) transformers specifically designed and intended to provide a DC power supply to electronic or rectifier loads. This exemption does not include transformers that are intended to provide an AC supply from DC sources such as transformers for wind turbine and photovoltaic applications or transformers designed for DC transmission and distribution applications;
- c.) transformers specifically designed to be directly connected to a furnace;
- d.) transformers specifically designed to be installed on fixed or floating offshore platforms, offshore wind turbines or on-board ships and all kinds of vessels;
- e.) transformers specifically designed to provide for a situation limited in time when the normal power supply is interrupted due to either an unplanned occurrence (such as a power failure) or a station refurbishment, but not to permanently upgrade an existing substation;
- f.) transformers (with separate or auto-connected windings) connected to an AC or DC contact line, directly or through a converter, used in fixed installations for railway applications;
- g.) earthing or grounding transformers specifically designed to be connected in a power system to provide a neutral connection for earthing either directly or via an impedance;
- h.) traction transformers specifically designed to be mounted on rolling stock, connected to an AC or DC contact line, directly or through a converter, for specific use in fixed installations for railway applications;
- i.) starting transformers, specifically designed for starting three-phase induction motors to eliminate supply voltage dips and that remain de-energised during normal operation;
- j.) testing transformers, specifically designed to be used in a circuit to produce a specific voltage or current for the purpose of testing electrical equipment;
- k.) welding transformers, specifically designed for use in arc-welding equipment or resistance-welding equipment;
- l.) transformers specifically designed for explosion-proof applications in accordance with Directive 94/9/EC of the European Parliament and of the Council and underground mining applications;
- m.) transformers specifically designed for deep water (submerged) applications;
- n.) medium Voltage (MV) to Medium Voltage (MV) interface transformers up to 5 MVA used as interface transformers used in a network voltage conversion program and placed at the junction between two voltage levels of two medium voltage networks and that need to be able to cope with emergency overloads;
- o.) medium and large power transformers specifically designed to contribute to the safety of nuclear installations, as defined in Article 3 of Council Directive 2009/71/Euratom;
- p.) three-phase medium power transformers with a power rating below 5 kVA,

This does not pertain to the requirements for product information and technical documents (see p. 3)

2. Important change with review of regulation October 1st, 2019

Note:

Definitions indicated in this chapter refer to definitions originally made in EU regulation review October 1st, 2019.

This document shows only the important topics of the regulation, please read full text of regulation and review for further details

Medium and large power transformers, regardless of when they were first placed on the market or put into service, shall be reassessed for conformity and comply with this Regulation, if they are subject to all of the following operations:

- a) replacement of the core or part thereof;
- b) replacement of one or more of the complete windings. This is without prejudice to the legal obligations under other Union's harmonization legislation that these products could be subject to.

Product definition per regulation:

- 'Medium power transformer' means a power transformer with all windings having rated power lower than or

equal to 3 150 kVA, and highest voltage for equipment greater than 1,1 kV and lower than or equal to 36 kV

- 'Large power transformer' means a power transformer with at least one winding having either rated power greater than 3 150 kVA or highest voltage for equipment greater than 36 kV
- 'Medium power pole-mounted transformer' means a power transformer with a rated power of up to 400 kVA suitable for outdoor service and specifically designed to be mounted on the support structures of overhead power line
- 'Declared value(s)' mean the values given in the technical documentation pursuant to point 2 of Annex IV to Directive 2009/125/EC, and where applicable, the values used to calculate these values
- The Commission shall review this Regulation in the light of technological progress and shall present the results of the assessment, including, if appropriate, a draft revision proposal, to the Consultation Forum no later than July 1st, 2023.

3. New standards are needed to implement the review of the Regulation

Existing standards:

- EN 50588 was related to MPT ≤ 3150 kVA and ≤ 36 kV
- EN 50629 was related to LPT > 3150 kVA and > 36 kV

The new standard EN50708 will be split in 3 mains parts and subparts:

| Power transformers-Additional European requirements | | | | | | |
|---|-----|---|-----|---|-----|---|
| | 1 | Common part | 2 | Medium Power transformers | 3 | Large Power transformers |
| General requirements | 1-1 | Power transformers-Additional European requirements: Part 1-1 Common Part-General requirements | 2-1 | Power transformers-Additional European requirements: Part 2-1 Medium power transformers-General requirements | 3-1 | Power transformers-Additional European requirements: Part 3-1 Large power transformers-General requirements |
| Assessment of energy performance | 1-2 | Power transformers-Additional European requirements: Part 1-1 Common Part- Assessment of energy performance | 2-2 | | 3-2 | |
| Accessories | 1-3 | | 2-3 | Power transformers-Additional European requirements: Part 2-1 Medium power transformers-Accessories | 3-3 | |
| Special tests | 1-4 | | 2-4 | Power transformers-Additional European requirements: Part 2-1 Medium power transformers-Special tests | 3-4 | Power transformers-Additional European requirements: Part 3-1 Large power transformers-Special tests |
| Single phase | 1-5 | | 2-5 | Power transformers-Additional European requirements: Part 2-1 Medium power transformers-Single phase | 3-5 | |
| Non-conventional technologies | 1-6 | | 2-6 | Power transformers-Additional European requirements: Part 2-1 Medium power transformers-Non-conventional technologies | 3-6 | |

4. Requirements for medium power transformers (three-phase, $\leq 3,150$ kVA)

a) Liquid filled medium power transformers

Maximum load and no-load losses (in W) for three-phase liquid-immersed medium power transformers with one winding with $U_m \leq 24$ kV and the other one with $U_m \leq 1.1$ kV

| Rated Power (kVA) | Tier 1 (July 1st, 2015) | | Tier 2 (July 1st, 2021) | |
|-------------------|---------------------------------|------------------------------------|---------------------------------|------------------------------------|
| | Maximum load losses P_k (W) * | Maximum no-load losses P_o (W) * | Maximum load losses P_k (W) * | Maximum no-load losses P_o (W) * |
| ≤ 25 | C_k (900) | A_o (70) | A_k (600) | A_o -10% (63) |
| 50 | C_k (1100) | A_o (90) | A_k (750) | A_o -10% (81) |
| 100 | C_k (1750) | A_o (145) | A_k (1250) | A_o -10% (130) |
| 160 | C_k (2350) | A_o (210) | A_k (1750) | A_o -10% (189) |
| 250 | C_k (3250) | A_o (300) | A_k (2350) | A_o -10% (270) |
| 315 | C_k (3900) | A_o (360) | A_k (2800) | A_o -10% (324) |
| 400 | C_k (4600) | A_o (430) | A_k (3250) | A_o -10% (387) |
| 500 | C_k (5500) | A_o (510) | A_k (3900) | A_o -10% (459) |
| 630 | C_k (6500) | A_o (600) | A_k (4600) | A_o -10% (540) |
| 800 | C_k (8400) | A_o (650) | A_k (6000) | A_o -10% (585) |
| 1000 | C_k (10500) | A_o (770) | A_k (7600) | A_o -10% (693) |
| 1250 | B_k (11000) | A_o (950) | A_k (9500) | A_o -10% (855) |
| 1600 | B_k (14000) | A_o (1200) | A_k (12000) | A_o -10% (1080) |
| 2000 | B_k (18000) | A_o (1450) | A_k (15000) | A_o -10% (1305) |
| 2500 | B_k (22000) | A_o (1750) | A_k (18500) | A_o -10% (1575) |
| 3150 | B_k (27500) | A_o (2200) | A_k (23000) | A_o -10% (1980) |

b) Medium power pole-mounted transformers 25 up to 400 kVA

| Rated Power (kVA) | Tier 1 (July 1st, 2015) | | Tier 2 (July 1st, 2021) | |
|-------------------|------------------------------|---------------------------------|------------------------------|---------------------------------|
| | Maximum load losses (in W) * | Maximum no-load losses (in W) * | Maximum load losses (in W) * | Maximum no-load losses (in W) * |
| 25 | C_k (900) | A_o (70) | B_k (725) | A_o (70) |
| 50 | C_k (1100) | A_o (90) | B_k (875) | A_o (90) |
| 100 | C_k (1750) | A_o (145) | B_k (1475) | A_o (145) |
| 160 | $C_k+32\%$ (3102) | C_o (300) | $C_k+32\%$ (3102) | C_o -10% (270) |
| 200 | C_k (2750) | C_o (356) | B_k (2333) | B_o (310) |
| 250 | C_k (3250) | C_o (425) | B_k (2750) | B_o (360) |
| 315 | C_k (3900) | C_o (520) | B_k (3250) | B_o (440) |

c) Medium power dry type transformers

| Rated Power (kVA) | Tier 1 (July 1st, 2015) | | Tier 2 (July 1st, 2021) | |
|-------------------|---------------------------------|------------------------------------|---------------------------------|------------------------------------|
| | Maximum load losses P_k (W) * | Maximum no-load losses P_o (W) * | Maximum load losses P_k (W) * | Maximum no-load losses P_o (W) * |
| ≤ 50 | B_k (1700) | A_o (200) | A_k (1500) | A_o -10% (180) |
| 100 | B_k (2050) | A_o (280) | A_k (1800) | A_o -10% (252) |
| 160 | B_k (2900) | A_o (400) | A_k (2600) | A_o -10% (360) |
| 250 | B_k (3800) | A_o (520) | A_k (3400) | A_o -10% (468) |
| 400 | B_k (5500) | A_o (750) | A_k (4500) | A_o -10% (675) |
| 630 | B_k (7600) | A_o (1100) | A_k (7100) | A_o -10% (990) |
| 800 | A_k (8000) | A_o (1300) | A_k (8000) | A_o -10% (1170) |
| 1000 | A_k (9000) | A_o (1550) | A_k (9000) | A_o -10% (1395) |
| 1250 | A_k (11000) | A_o (1800) | A_k (11000) | A_o -10% (1620) |
| 1600 | A_k (13000) | A_o (2200) | A_k (13000) | A_o -10% (1980) |
| 2000 | A_k (16000) | A_o (2600) | A_k (16000) | A_o -10% (2340) |
| 2500 | A_k (19000) | A_o (3100) | A_k (19000) | A_o -10% (2790) |
| 3150 | A_k (22000) | A_o (3800) | A_k (22000) | A_o -10% (3420) |

d) Correction factors to be applied to the load and no load losses indicated in Tables 4 a-c for medium power transformers with special combinations of winding voltages (for rated power ≤ 3150 kVA)

Correction factors to be applied as follows:
Maximum permissible losses to be increased by factors indicated in two tables below based on individual product type.

| Special combination of voltages in one winding | | Load losses (P _k) | No load losses (P ₀) |
|--|---|-------------------------------|----------------------------------|
| For both liquid immersed (Table 4 a) and dry type (Table 4 c) | | No correction | No correction |
| Primary highest voltage for equipment U _m ≤ 24kV | Secondary highest voltage for equipment U _m > 3,6kV | | |
| For liquid immersed (Table 4 a) | | 10% | 15% |
| Primary highest voltage for equipment U _m = 36kV | Secondary highest voltage for equipment U _m ≤ 3,6kV | | |
| Primary highest voltage for equipment U _m = 36kV | Secondary highest voltage for equipment U _m > 3,6kV | 10% | 15% |
| For dry type (Table 4 c) | | 10% | 15% |
| Primary highest voltage for equipment U _m = 36kV | Secondary highest voltage for equipment U _m ≤ 3,6kV | | |
| Primary highest voltage for equipment U _m = 36kV | Secondary highest voltage for equipment U _m > 3,6kV | 15% | 20% |

e) Correction factors to be applied to the load and no load losses indicated in Tables 4 a-c for medium power transformers with dual voltage in one

or both windings differing more than 10% and rated power ≤ 3150 kVA

| Type of dual voltage | Reference voltage for the application of correction factors | Load losses (P _k)(*)) | No load losses (P ₀)(*)) |
|--|---|-----------------------------------|--------------------------------------|
| Dual voltage on one winding with reduced power output on the lower low-voltage winding AND maximum available power on the lower voltage of the low-voltage winding limited to 0,85 of the rated power assigned to the low-voltage winding at its higher voltage | Losses shall be calculated based on the higher voltage of the low-voltage winding | No correction | No correction |
| Dual voltage on one winding with reduced power output on the lower high-voltage winding AND maximum available power on the lower voltage of the high-voltage winding limited to 0,85 of the rated power assigned to the high-voltage winding at its higher voltage | Losses shall be calculated based on the higher voltage of the high-voltage winding | No correction | No correction |
| Dual voltage on one winding AND full rated power available on both windings, i.e., the full nominal power is available regardless of the combination of voltages. | The losses shall be calculated based on the higher voltage of the dual voltage winding | 10% | 15% |
| Dual voltage on both windings AND rated power available on all combinations of windings, i.e., both voltages on one winding are fully rated in combination with one of the voltages on the other winding | The losses shall be calculated based on the higher voltages of both dual voltage windings | 20% | 20% |

5. Minimum energy efficiency requirements for large power transformers (three-phase, > 3,150 kVA)

a) Liquid immersed transformer

| Rated Power (MVA) | Tier 1 (July 1st, 2015) | Tier 2 (July 1st, 2021) |
|-------------------|-----------------------------------|-------------------------|
| | Minimum Peak Efficiency Index (%) | |
| ≤ 0.025 | 97.742 | 98.251 |
| 0.05 | 98.584 | 98.891 |
| 0.1 | 98.867 | 99.093 |
| 0.16 | 99.012 | 99.191 |
| 0.25 | 99.112 | 99.283 |
| 0.315 | 99.154 | 99.320 |
| 0.4 | 99.209 | 99.369 |
| 0.5 | 99.247 | 99.398 |
| 0.63 | 99.295 | 99.437 |
| 0.8 | 99.343 | 99.473 |
| 1 | 99.360 | 99.484 |
| 1.25 | 99.418 | 99.487 |
| 1.6 | 99.424 | 99.494 |
| 2 | 99.426 | 99.502 |
| 2.5 | 99.441 | 99.514 |
| 3.15 | 99.444 | 99.518 |
| 4 | 99.465 | 99.532 |
| 5 | 99.483 | 99.548 |
| 6.3 | 99.510 | 99.571 |
| 8 | 99.535 | 99.593 |
| 10 | 99.560 | 99.615 |
| 12.5 | 99.588 | 99.640 |
| 16 | 99.615 | 99.663 |
| 20 | 99.639 | 99.684 |
| 25 | 99.657 | 99.700 |
| 31.5 | 99.671 | 99.712 |
| 40 | 99.684 | 99.724 |
| 50 | 99.696 | 99.734 |
| 63 | 99.709 | 99.745 |
| 80 | 99.723 | 99.758 |
| 100 | 99.737 | 99.770 |
| 125 | 99.737 | 99.780 |
| 160 | 99.737 | 99.790 |
| ≥200 | 99.737 | 99.797 |

Minimum PEI values for MVA ratings that fall in between the ratings given in this table shall be calculated by linear interpolation

b) Dry-type large power transformer with $U_m \leq 36$ kV

| Rated Power (MVA) | Tier 1 (July 1st, 2015) | Tier 2 (July 1st, 2021) |
|-------------------|-----------------------------------|-------------------------|
| | Minimum Peak Efficiency Index (%) | |
| 3.15 < S_r ≤ 4 | 99.348 | 99.382 |
| 5 | 99.354 | 99.387 |
| 6.3 | 99.356 | 99.389 |
| 8 | 99.357 | 99.390 |
| ≥10 | 99.357 | 99.390 |

Minimum PEI values for MVA ratings that fall in between the ratings given in this table shall be calculated by linear interpolation

c) Dry-type large power transformer with $U_m > 36$ kV

| Rated Power (MVA) | Tier 1 (July 1st, 2015) | Tier 2 (July 1st, 2021) |
|-------------------|-----------------------------------|-------------------------|
| | Minimum Peak Efficiency Index (%) | |
| ≤ 0.05 | 96.174 | 96.590 |
| 0.1 | 97.514 | 97.790 |
| 0.16 | 97.792 | 98.016 |
| 0.25 | 98.155 | 98.345 |
| 0.4 | 98.334 | 98.570 |
| 0.63 | 98.494 | 98.619 |
| 0.8 | 98.677 | 98.745 |
| 1 | 98.775 | 98.837 |
| 1.25 | 98.832 | 98.892 |
| 1.6 | 98.903 | 98.960 |
| 2 | 98.942 | 98.996 |
| 2.5 | 98.933 | 99.045 |
| 3.15 | 99.048 | 99.097 |
| 4 | 99.158 | 99.225 |
| 5 | 99.200 | 99.265 |
| 6.3 | 99.242 | 99.303 |
| 8 | 99.298 | 99.356 |
| 10 | 99.330 | 99.385 |
| 12.5 | 99.370 | 99.422 |
| 16 | 99.416 | 99.464 |
| 20 | 99.468 | 99.513 |
| 25 | 99.521 | 99.564 |
| 31.5 | 99.551 | 99.592 |
| 40 | 99.567 | 99.607 |
| 50 | 99.585 | 99.623 |
| ≥63 | 99.590 | 99.626 |

6. How to implement Tier 2 on July 1st, 2021, T&D EU statements

- In normal situation (no concession), that means after July 1st, 2021 Manufacturers and Importers will not have the right to deliver Transformers TIER 1 but only Transformers TIER 2 even if contract has been signed before.
- The blue guide on the implementation of the 2016 European Union product regulation clarifies when TIER 2 transformers are to be manufactured and delivered. There are only 2 stages:
 - **Placing on the market**
 - A product is placed on the market when it is made available for the first time on the Union market.
 - This phase is only for manufacturers or importers.
 - In normal situation (no concession), that means after July 1st, 2021 Manufacturers and Importers will not have the right to deliver Transformers TIER 1 but only Transformers TIER 2 even if contract has been signed before.
 - **Making available**
 - Products made available on the market must comply with the applicable Union harmonisation legislation at the moment of placing on the market.
 - This operation is only done by distributor to distributor or distributor to user.
 - That means after July 1st, 2021 distributor can deliver to user or other distributor and put in service transformers TIER 1 if these transformers has been placed on the market before July 1st, 2021