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New EU requirements for transformers

Ecodesign Directive from the European Commission

The Ecodesign Directive from the European Commission takes effect for transformers in July 2015. The new regulations will apply throughout Europe starting from July 2015; an additional stage with stricter minimum standards is planned for 2021.

General information

Name of the directive:
No. 548/2014 from the commission for implementing the Ecodesign Guideline 2009/125/EG

Scope of application: Distribution and 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 CO_2 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:

- Instrument transformers for supplying measurement devices, meters, relays and similar devices
- Transformers with low voltage windings for use with rectifiers to deliver direct current
- Furnace transformers
- Offshore transformers
- Transformers for emergency operation
- (Energy-saving) transformers for supplying trains with power
- Grounding transformers
- Transformers mounted on rail vehicles
- Start-up transformers for switching on three-phase current motors to prevent drops in voltage
- Test transformers for generating a certain voltage or amperage for testing electrical equipment
- Welding transformers for arc welding equipment or resistance welding equipment
- Transformers for deep water applications
- Transformers for explosion-protected applications in underground mining
- Medium Voltage (MV) to Medium Voltage interface transformers of up to 5 MVA
- Large power transformers, if proven that technically achievable alternatives are not available for a certain application, to fulfill the minimum energy efficiency requirements mandated by the directive.
- Large power transformers which serve as an equivalent replacement for existing large power transformers at the same physical location/in the same system, if the replacement is not possible without unreasonable costs in conjunction with the transport and/or installation.

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

1. Requirements for distributor transformers (three-phase, ≤ 3,150 kVA)

a. Liquid-filled distributor transformers

Maximum load and no-load losses for liquid-filled distributor transformers with one U_m ≤ 24 kV winding and one U_m ≤ 1.1 kV winding

	Tier 1 (from July 1, 2015)		Tier 2 (from July 1, 2021)	
Rated Power (kVA)	Max. load losses P_K (W)*	Max. no-load losses P_0 (W)*	Max. load losses P_K (W)*	Max. no-load losses P_0 (W)*
≤ 25	C_k (900)	A_o (70)	A_k (600)	A_o –10 % (63)
50	C_k (1,100)	A_o (90)	A_k (750)	A_o –10 % (81)
100	C_k (1,750)	A_o (145)	A_k (1,250)	A_o –10 % (130)
160	C_k (2,350)	A_o (210)	A_k (1,750)	A_o –10 % (189)
250	C_k (3,250)	A_o (300)	A_k (2,350)	A_o –10 % (270)
315	C_k (3,900)	A_o (360)	A_k (2,800)	A_o –10 % (324)
400	C_k (4,600)	A_o (430)	A_k (3,250)	A_o –10 % (387)
500	C_k (5,500)	A_o (510)	A_k (3,900)	A_o –10 % (459)
630	C_k (6,500)	A_o (600)	A_k (4,600)	A_o –10 % (540)
800	C_k (8,400)	A_o (650)	A_k (6,000)	A_o –10 % (585)
1,000	C_k (10,500)	A_o (770)	A_k (7,600)	A_o –10 % (693)
1,250	B_k (11,000)	A_o (950)	A_k (9,500)	A_o –10 % (855)
1,600	B_k (14,000)	A_o (1,200)	A_k (12,000)	A_o –10 % (1,080)
2,000	B_k (18,000)	A_o (1,450)	A_k (15,000)	A_o –10 % (1,305)
2,500	B_k (22,000)	A_o (1,750)	A_k (18,500)	A_o –10 % (1,575)
3,150	B_k (27,500)	A_o (2,200)	A_k (23,000)	A_o –10 % (1,980)

b. Requirements for mast-mounted transformers from 25 to 315 kVA

	Tier 1 (July 1, 2015)		Tier 2 (July 1, 2021)	
Rated Power (kVA)	Max. load losses P_K (W)*	Max. no-load losses P_0 (W)*	Max. load losses P_K (W)*	Max. no-load losses P_0 (W)*
25	C_k (900)	A_o (70)	B_k (725)	A_o (70)
50	C_k (1,100)	A_o (90)	B_k (875)	A_o (90)
100	C_k (1,750)	A_o (145)	B_k (1,475)	A_o (145)
160	C_k +32 % (3,102)	C_o (300)	C_k +32 % (3,102)	C_o –10 % (270)
200	C_k (2,750)	C_o (356)	B_k (2,333)	B_o (310)
250	C_k (3,250)	C_o (425)	B_k (2,750)	B_o (360)
315	C_k (3,900)	C_o (520)	B_k (3,250)	B_o (440)

c. Casting resin distributor transformers (≤ 3,150 kVA)

Maximum load and no-load losses for casting resin transformers with one winding ≤ 24 kV and one ≤ 1.1 kV.

	Tier 1 (from July 1, 2015)		Tier 2 (from July 1, 2021)	
Rated Power (kVA)	Max. load losses P_K (W)*	Max. no-load losses P_0 (W)*	Max. load losses P_K (W)*	Max. no-load losses P_0 (W)*
≤ 50	B_k (1,700)	A_o (200)	A_k (1,500)	A_o –10 % (180)
100	B_k (2,050)	A_o (280)	A_k (1,800)	A_o –10 % (252)
160	B_k (2,900)	A_o (400)	A_k (2,600)	A_o –10 % (360)
250	B_k (3,800)	A_o (520)	A_k (3,400)	A_o –10 % (468)
400	B_k (5,500)	A_o (750)	A_k (4,500)	A_o –10 % (675)
630	B_k (7,600)	A_o (1,100)	A_k (7,100)	A_o –10 % (990)
800	A_k (8,000)	A_o (1,300)	A_k (8,000)	A_o –10 % (1,170)
1,000	A_k (9,000)	A_o (1,550)	A_k (9,000)	A_o –10 % (1,395)
1,250	A_k (11,000)	A_o (1,800)	A_k (11,000)	A_o –10 % (1,620)
1,600	A_k (13,000)	A_o (2,200)	A_k (13,000)	A_o –10 % (1,980)
2,000	A_k (16,000)	A_o (2,600)	A_k (16,000)	A_o –10 % (2,340)
2,500	A_k (19,000)	A_o (3,100)	A_k (19,000)	A_o –10 % (2,790)
3,150	A_k (22,000)	A_o (3,800)	A_k (22,000)	A_o –10 % (3,420)

d. Correction for load and no-load losses for other voltages

One winding with U_m ≤ 24 kV and one winding U_m > 1.1 kV	Maximum losses in tables 1a and 1c must be increased by 10 % each
One winding with U_m = 36 kV and one winding U_m ≤ 1.1 kV	Maximum losses in tables 1a and 1c must be increased by 15 % (no-load losses) and 10 % (load losses)
One winding with U_m = 36 kV and one winding U_m > 1.1 kV	Maximum losses in tables 1a and 1c must be increased by 20 % (no-load losses) and 15 % (load losses)
Dual-voltage on one winding	For transformers with a high-voltage winding and two voltages from one tapped low-voltage winding, the losses are calculated based on the higher voltage of the lower-voltage; they must correspond with the highest permissible losses in tables 1a and 1c. For such transformers, the highest available power at the lower voltage on the low-voltage winding is limited to 0.85 times the nominal power assigned to the low-voltage winding at its higher voltage.
	For transformers with a low-voltage winding with two voltages from a tapped high-voltage winding, the losses are calculated based on the higher voltage; they must correspond with highest permissible losses in tables 1a and 1c. For such transformers, the highest available power at the lower voltage of the high-voltage winding is limited to 0.85 times the nominal power assigned to the high voltage winding at its higher voltage.
	If the full nominal power is available independent upon the combination of the voltages, the losses in tables 1a and 1c can be increased by 15 % of the no-load losses and 10 % for the load losses.
Dual-voltage on both windings	For transformers with dual-voltage on both windings, the highest permissible losses in tables 1a and 1c can be increased by 20 % each for the no-load and load losses. The losses pertain to the highest possible nominal voltage and is based on the assumption that the nominal power remains constant regardless of the combination of the voltages.

e. Requirements for distributor transformers ≤ 3,150 kVA with step switches (incl. distributor transformers with voltage regulation)

The maximum losses in tier 1 must be exceeded by 20 % in no-load losses and 5 % in load losses; furthermore, tier 2 no-load losses must be exceeded by 10 %.

* Highest losses for rated powers in kVA between those in the table are determined using linear interpolation.

2. Power transformers

a. Requirements for medium power transformers (three-phase, > 3,150 kVA)

For power transformers > 3,150 kVA, a so-called "Minimum Peak Efficiency Index" was set and is indicated in percent. This is also implemented in two stages.

Rated Power (kVA)	Tier 1 (July 1, 2015)	Tier 2 (July 1, 2021)
	Minimum Peak Efficiency Index (%)	
3,150 < S_r ≤ 4,000	99.465	99.532
5,000	99.483	99.548
6,300	99.510	99.571
8,000	99.535	99.593
10,000	99.560	99.615
12,500	99.588	99.640
16,000	99.615	99.663
20,000	99.639	99.684
25,000	99.657	99.700
31,500	99.671	99.712
40,000	99.684	99.724

b. Requirements for dry transformers (medium rated power) (three-phase, > 3,150 kVA)

Rated Power (kVA)	Tier 1 (July 1, 2015)	Tier 2 (July 1, 2021)
	Minimum Peak Efficiency Index (%)	
3,150 < S_r ≤ 4,000	99.348	99.382
5,000	99.354	99.387
6,300	99.356	99.389
8,000	99.357	99.390
≥ 10,000	99.357	99.390

c. Requirements for large power transformers

Rated Power (MVA)	Tier 1 (July 1, 2015)	Tier 2 (July 1, 2021)
	Minimum Peak Efficiency Index (%)	
≤ 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

3. Requirements for product information

Rated power, load and no-load losses and electrical power of the cooling system in idle must be indicated in all product documentation and on the rating plate.

Where applicable, for power transformers, the value of the peak efficiency index and the power at which it is reached must be indicated in the documentation.

Information about the weight of all main components of the transformer must be provided in all product information.

4. Measurement and calculation methods

Measurements must be performed using an approved, accurate and reproducible process. This includes the generally acknowledged measuring methods.
The calculation of the peak efficiency index for power transformers is based on the ration of the transferred power minus the electrical losses to the transferred power of the transformer.

$$PEI = 1 - \frac{2(P_0 + P_{c0})}{S_r\sqrt{\frac{P_0 + P_{c0}}{P_k}}}$$

P_0 = no-load losses at rated voltage and rated frequency at the measured tap

P_{c0} = electrical output of the cooling system in idle

P_k = measured losses at rated current and frequency at the measured tap corrected by the reference temperature in accordance with EN 60076-2

S_r = rated power of the transformers, on which P_k is based

Frequently asked questions

Which legal obligations result?
From July 2015, transformers put into circulation within the European Economic Area (EEA) must comply with the ecodesign requirements in the new directive if they fall within its scope of applicability. Since the directive is a measure for implementing the Ecodesign Guideline 2009/125/EG, the CE marking is used as proof of compliance and a corresponding EU conformity certificate is issued.

The aforementioned guideline does not apply for to products manufactured for export to other countries outside the EEA. Products already in circulation and in operation may continue to be operated.

Who is responsible for compliance?
The party seeking to introduce the product to the European Economic Area (EEA) is responsible. This is either the manufacturer, its representative or the product importer.

What is decisive is the introduction of the transformer or, if the transformer is not going to be put into circulation (e.g. internal use by the manufacturer), its commissioning.

According to its definition, putting into circulation means the "initial provision of an energy consumption-related product to the Community market for distribution or use in the Community.

Can Siemens fulfill the requirements?
In the past years, Siemens has designed and produced transformers that already comply with the first and parts of the second stage of the new Ecodesign Directive. By using new materials such as amorphous laminations in distributor transformers, even more energy-efficient transformers can be created.

In particular, for large power transformers, our experience is that the degree of efficiency can even be higher than required using already known methods. The method of loss evaluation used for many years for defining individual, economically ideal solutions has proven itself in this context. It should, therefore, still apply.

What effects does the guideline have on the transformer design?
Potential effects can include increasing material consumption and the use of high-quality electrical sheets; larger dimensions and weights and thus resulting increased investment costs.

It is, however, important that all legal requirements from the 1st stage (from 2015) can be implemented now with the design concepts and materials available in the industry.

Questions about the Ecodesign Guideline?
If you have questions regarding the Ecodesign Guideline or its implementation and fulfillment, please contact your contact partner at Siemens.

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