
Ekološko snovanje (ecodesign) motornih pogonskih sistemov, motornih zaganjalnikov, močnostne elektronike in njihove aplikacije, ki jih ti poganjajo - 2. del: Energijska učinkovitost indikatorjev motorno gnanih sistemov in motornih zaganjalnikov

Ecodesign for power drive systems, motor starters, power electronics & their driven applications - Part 2: Energy efficiency indicators for power drive systems and motor starters

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Ökodesign für Antriebssysteme, Motorstarter, Leistungselektronik und deren angetriebene Einrichtungen -- Teil 2: Indikatoren für die Energieeffizienz von Antriebssystemen und Motorstartern

Ecoconception des entraînements électriques de puissance, des démarreurs de moteur, de l'électronique de puissance et de leurs applications entraînées -- Partie 2: Indicateurs d'efficacité énergétique pour les entraînements électriques de puissance et les démarreurs de moteur

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Part 2: Energy efficiency indicators for power drive systems and motor starters**

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Teil 2: Indikatoren für die Energieeffizienz von Antriebssystemen und Motorstartern

This draft European Standard is submitted to CENELEC members for CENELEC enquiry.
Deadline for CENELEC: 2014-02-21.

It has been drawn up by CLC/TC 22X.

If this draft becomes a European Standard, CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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European Committee for Electrotechnical Standardization
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prEN 50598-2:2013 (E)**Foreword**

This document [prEN 50598-2:2013] has been prepared by CLC/TC 22X "Power electronics".

This document is currently submitted to the Enquiry.

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

The TC22X Working Group 6 as being the standardization Task Force for dealing with the Mandate M/476 from European Commission for standardization in the field of variable speed drives and/or Power Drive System products has been set a close collaboration with several other technical committees (i.e. CLC/TC2; CLC/TC17B; CEN TC 197) in order to provide a comprehensive standard for energy efficiency and eco design requirements.

Key points:

- Clear requirements how to achieve an energy efficient driven equipment using a power drive system
- Requirements and limits for IE-classes for power electronic converters
- Requirements and limits for IES-classes for Power Drive Systems (PDS)
- Loss determination of the PDS and requirements for the link to the driven equipment in order to determine the energy efficiency classification/evaluation of the extended product
- Requirements how to achieve the environmental conscious design and environmental declaration of PDS

It is the intention of the working group that this document, once finalised as European standard, will be further processed to an international consensus in IEC according to the UAP procedure agreement between CENELEC and IEC.

Introduction

The CENELEC TC22X Technical Committee has circulated on last 2010-03-31 for a short period of time the CLC/TC22X/Sec0100/DC document including the Mandate M/476 from European Commission for standardization in the field of variable speed drives and/or Power Drive System products.

As the PDS contains converter driven motors, the additional requirements for measuring of the energy efficiency of those motors with non-sinusoidal supply and the labelling for the whole PDS are also included. This covers the requirements coming from the Mandate M/470.

The document is based on the CENELEC Technical board document referenced BT137/DG8058/INF also reproducing this EC-Mandate.

The TC22X Working Group 6 as being the standardization Task Force for dealing with this Mandate has anticipated that a close collaboration with several other technical committees (i.e. CLC/TC2; CLC/TC17B) should be set.

Therefore CLC TC22X Committee has taken its responsibility this field and has started a standardization work to clarify all aspects in field of Energy efficiency and Eco-design requirements for Power electronics, Switchgear, Control gear, and Power drive systems and their industrial applications.

The sometimes controversial requirements in the field of these tasks are illustrated in Figure 1. The work has been agreed to provide the reasonable target as a best compromise in this field.

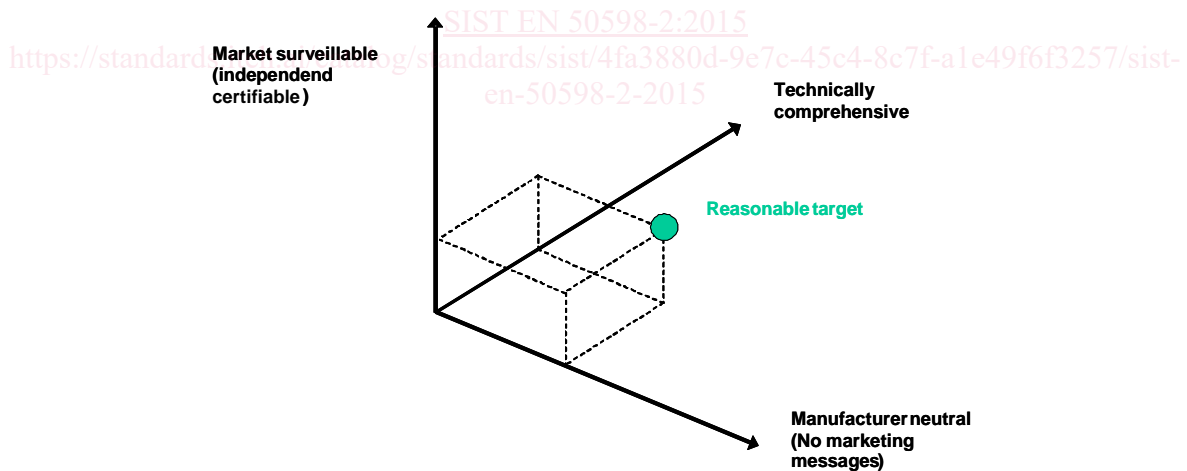


Figure 1 - Illustration of controversial requirements for the Energy related product (ErP) Standardization

EN 50598 is developed under the CENELEC projects number 24602 to 24604 for compliance with requirements from the horizontal mandate M/495. EN 50598 "Ecodesign for power drive systems, motor starters, power electronics & their driven applications" will consist of the following parts:

Part 1: General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA), and semi analytic model (SAM);

Part 2: Energy efficiency indicators for power drive systems and motor starters;

Part 3: Quantitative eco design approach through life cycle assessment including product category rules and the content of environmental declarations.

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212 The parts together will provide the appropriate set of standards also covering the individual mandates
 213 M/470, M/476, M/498, M/500 already in reference within the mandate M/495 and the upcoming
 214 mandates for standardization of other power driven applications.

215 **Table 1 - Mandates of the European Commission given to CEN, CENELEC and ETSI**
 216 **and how they are solved by the individual parts of the standardization of CLC/TC 22X WG 6**

Mandates	Part 1	Part 2	Part 3
M/470 Motors		✓	✓
M/476 PDS		✓	✓
M/495 Horizontal all future Applications	✓	✓	✓
M/488 HVAC comfort fans	✓	✓	(✓)
M/498 Pumps	✓	✓	(✓)
M/500 Compressors	✓	✓	(✓)

217
 218 NOTE Geared motors (motor plus gearbox) shall be treated for efficiency classes like a Power Drive system (converter plus
 219 motor). See IEC 60034-30-1 for determination of the losses of a geared motor. The efficiency class of a gearbox itself is under
 220 consideration.

1 Scope

This part of EN 50598 specifies the Energy Efficiency indicators for power drive systems, motor starters, power electronics (e.g. Complete Drive Modules, CDM) used in motor driven applications in the power range of 0,12 kW up to 1000 kW.

This part of EN 50598 specifies the methodology for determination of losses of the complete motor system, the power drive system (PDS) and the CDM. It defines IE and IES-classes, their limit values and provides test procedures for the classification and the overall losses of the motor system.

Furthermore, this part of EN 50598 proposes a methodology for characterization of the best energy efficiency solution to be implemented, depending on the motor driven system architecture, the speed/load profile and the duty profiles of the application.

The structure of EN 50598 contains the following:

- the losses of a standardized reference PDS (RPDS) and the mathematical model of their calculation are given;
- requirements for determining the losses of a real PDS are given, and be classified in comparison to the RPDS;
- requirements for the type testing and the content of user documentation;
- some illustrations of losses in an overall system as an example are given in Annexes;
- information about system and drive topologies are given in Annexes.

Specific data on losses and IE/IES-classes are given for low voltage (100 V up and equal to 1 000 V) single axis AC/AC power drive systems with three phase induction motors. Geared motors shall be treated as standard motors.

This part of EN 50598 does not specify the methodology for eco-design for environmental impact. This is defined in Part 3 of EN 50598.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE As it is intended by the working group to process this document, once finalised, as IEC Standard, some normative references are given even in case if no European harmonized document exists.

IEC EN 60038:, *IEC standard voltages*

IEC 60050, *International Electrotechnical Vocabulary (IEV)*

IEC EN 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

IEC EN 60034-2-1, *Rotating electrical machines – Part 2-1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)*

IEC/TS 60034-2-3, *Rotating electrical machines – Part 2-3: Specific test methods for determining losses and efficiency of converter-fed AC motors*

IEC EN 60034-30-1, *Rotating electrical machines – Part 30-1: Efficiency classes of single-speed, three-phase, cage-induction motors (IE Code)*

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- 259 IEC/TS 60034-31, *Rotating electrical machines – Part 31: Guide for the selection and application of*
 260 *energy-efficient motors including variable speed applications*
- 261 IEC EN 60072-1, *Dimensions and output series for rotating electrical machines – Part 1: Frame*
 262 *numbers 56 to 400 and flange numbers 55 to 1080*
- 263 IEC EN 60146-1-1, *Semiconductor converters - General requirements and line commutated*
 264 *converters - Part 1-1: Specification of basic requirements*
- 265 IEC EN 60947-4-1, *Low voltage switchgear and Controlgear – Part 4-1: Contactors and motor starters*
- 266 IEC EN 60947-4-2, *Low voltage switchgear and Controlgear – Part 4-2: Contactors and motor starters*
 267 *- AC semiconductor motor controllers and starters*
- 268 IEC EN 61800-2, *Adjustable speed electrical power drive systems – Part 2: Rating specifications for*
 269 *low voltage adjustable frequency a.c. power drive systems*
- 270 IEC EN 61800-3, *Adjustable speed electrical power drive systems – Part 3: EMC requirements and*
 271 *specific test methods*
- 272 IEC/TS 62578, *Power electronics systems and equipment - Operations and characteristics of active*
 273 *infeed converter applications*

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274 **3 Terms and definitions**

275 For the purposes of this document, the terms and definitions given in IEC 60050(161) and the
 276 following apply.

277 **3.1** [https://standards.iteh.ai/catalog/standards/sist/4fa3880d-9e7c-45c4-8c7f-a1e49f6f3257/sist-](https://standards.iteh.ai/catalog/standards/sist/4fa3880d-9e7c-45c4-8c7f-a1e49f6f3257/sist-en-50598-2-2015)
 278 **Active infeed converter**
 279 **AIC**
 280 [en-50598-2-2015](https://standards.iteh.ai/catalog/standards/sist/4fa3880d-9e7c-45c4-8c7f-a1e49f6f3257/sist-en-50598-2-2015)

280 Self-commutated electronic power converters of all technologies, topologies, voltages and sizes which
 281 are connected between the a.c. power supply system (lines) and a stiff d.c.-side (current source or
 282 voltage source) and which can convert electric power in both directions (generative or regenerative)
 283 and which can control the reactive power or the power factor (see IEC/TS 62578)

284 Note 1 to entry: In IECV these terms (VSC and CSC) are defined as voltage stiff a.c./d.c. converter [551-12-03] and current stiff
 285 a.c./d.c. converter [551-12-04]. Most of the AICs are bi-directional converters and have sources on the d.c. side. So, they are
 286 known as voltage source converters and current source converters.

287 **3.2**

288 **c_{liquid}**

289 Specific heat capacity of liquid

290 **3.3**

291 **CDM**

292 Complete Drive Module according to IEC 61800-2. Means the AC/AC frequency converter which feeds
 293 the motor. Some countries use the term "Drive" instead of CDM.

294 Also the term "Drive Controller" is somehow used instead of CDM

295 **3.4**

296 **Driven equipment**

297 Apparatus mechanically connected to the shaft of a motor

3.5**EEI**

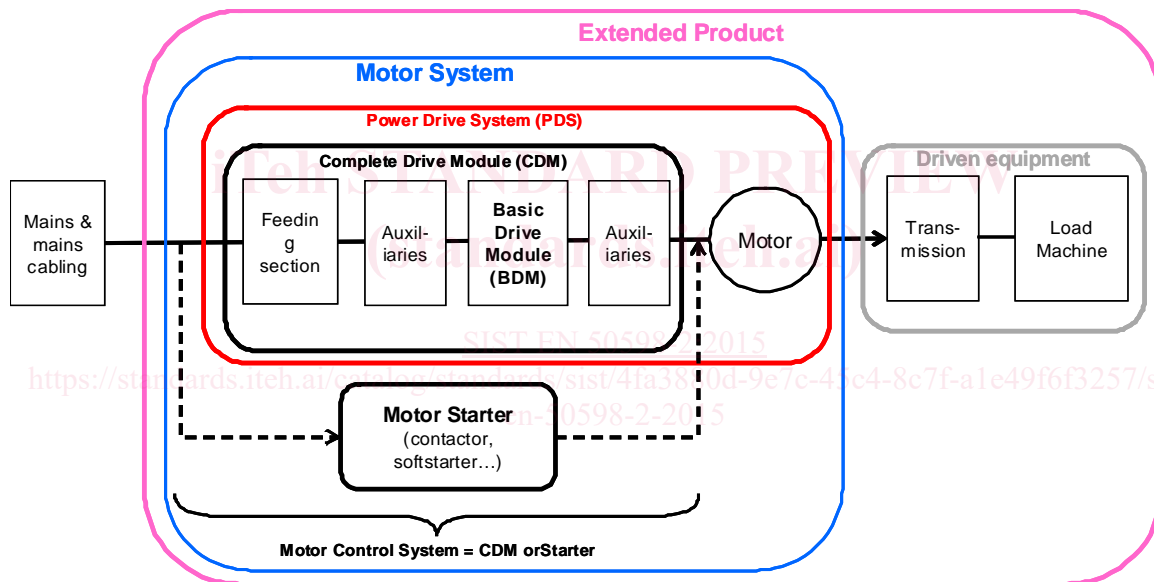
Energy Efficiency Index (EEI) of an extended product (e.g. a pump unit). The higher the EEI value, the higher the gap to the "best efficient pump unit". The smaller the EEI value, the lower the losses of a dedicated pump unit

3.6 **E_D**

Switching loss energy per volt and per ampere of a power diode

3.7 **E_T**

Switching loss energy per volt and per ampere of a power transistor

3.8**Extended product****EP****Figure 1 bis**

An extended product is the combination of a motor system and a driven equipment

3.9 **f_{sw}**

The switching frequency is the number of switching events of one semiconductor within one second. It determines, together with the selected pulse pattern and the converter topology, the lowest frequency of non-controllable harmonics or interharmonics at the IPC (in-plant point of coupling) or the motor

3.10 **G_{dose}**

Metering level (or operation level) of a driven application, its range of values is between zero and one (without overload considerations). Zero corresponds to a fully blocked flow (throttling valve is closed, friction brake is fully enabled), one to a situation where the working machine operates at rated load (flow, or completely open throttling valve, completely released friction brake).

G_{Dose} is the relation between the rated working point of a machine and the actual working point in a process

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329 **3.11**330 **H**

331 Pump head is the height/pressure to which a pump can transfer fluid at some flow

332 **3.12**333 **H_{BEP}**

334 The Pump head of the best efficiency (H_{BEP}) is the pump head at the point of best pump efficiency

335 **3.13**336 **IE class**

337 IE is an abbreviation for "International Efficiency" which stands for the efficiency classification of
 338 components of a Motor system. It shall not be mixed with the so called Energy Efficiency Index (EEI)
 339 see 3.5

340 **3.14**341 **IES class**

342 IES is an abbreviation for "International Efficiency of Systems" which stands for the efficiency
 343 classification of a motor system (e.g. PDS or a gear drive motor). It shall not be mixed with the so
 344 called IE class see 1.1 or with the EEI class see 3.5

345 **3.15**346 **$I_{\text{motor cable}}$**

347 Current in the motor cable of one power port (see IEC EN 61800-2) of the PDS, used for calculating
 348 switching losses. $I_{\text{motor cable}}$ represents a capacitive leakage current, which is normally for shielded
 349 motor cables

350 **3.16**351 **$I_{1,r \text{ CDM}}$**

352 Fundamental of the rated CDM or PDS input current waveform

353 **3.17**354 **I_r**

355 Rated CDM or PDS input current

356 **3.18**357 **I_{out}**

358 Output current

359 **3.19**360 **$I_{r,\text{out}}$**

361 Rated CDM output current

362 **3.20**363 **I_{rM}**

364 Rated motor current

365 **3.21**366 **$k1_{\text{DC-link}}$**

367 Load independent DC link losses per rated ampere and volt square of the CDM

368 **3.22**369 **$Z1_{\text{choke}}$**

370 Choke impedance, relative to the rated inverter impedance

371 **3.23**372 **$P2_{\text{DC-link}}$**

373 Load dependent DC link losses per ampere rated inverter current