IEC 61800-9-1

Edition 1.0 2017-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Adjustable speed electrical power drive systems – Part 9-1: Ecodesign for power drive systems, motor starters, power electronics and their driven applications – General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA) and semi analytic model (SAM)

Entraînements électriques de puissance à vitesse variable – Partie 9-1: Écoconception des entraînements électriques de puissance, des démarreurs de moteurs, de l'électronique de puissance et de leurs applications entraînées – Exigences générales pour définir les normes d'efficacité énergétique d'un équipement entraîné via l'approche produit étendu (EPA) et le modèle semi-analytique (SAM)

IEC 61800-9-1:2017-03 (en-fr)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 9-1: Ecodesign for power drive systems, motor starters, power electronics and their driven applications – General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA) and semi analytic model (SAM)

FOREWORD

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The text of this standard is based on the following documents:

FDIS	Report on voting
22G/348/FDIS	22G/351/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61800 series, published under the general title *Adjustable speed electrical power drive systems*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

IEC SC 22G includes the standardization task force for dealing with energy efficiency of motor systems. It has close collaboration with several other technical committees (for example, IEC TC 2, IEC SC 121A).

IEC SC 22G maintains responsibility for all relevant aspects in the field of energy efficiency and ecodesign requirements for power electronics, switchgear, control gear and power drive systems and their industrial applications.

The core requirements of energy efficiency standardization are illustrated in Figure 1. The work has been agreed to provide the reasonable target as a best compromise.

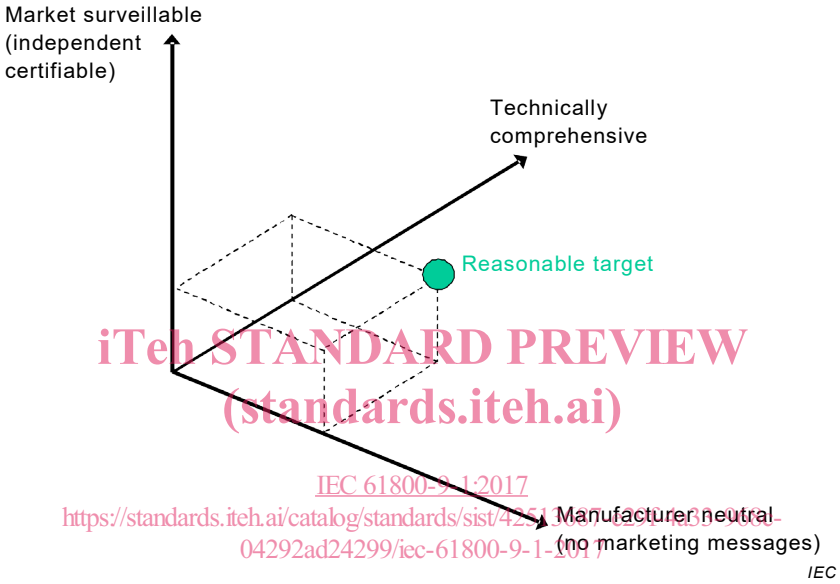


Figure 1 – Illustration of core requirements of energy efficiency standardization

IEC 61800 (all parts) does not deal with mechanical engineering components.

NOTE Geared motors (motors with directly adapted gearboxes) are treated like power drive systems (converter plus motor). See IEC 60034-30-1 for classification of the losses of a geared motor. The efficiency classes of gearboxes as individual components are under consideration.

IEC 61800-9-1 is a subpart of the IEC 61800 series, which has the following structure:

– *Part 1: General requirements – Rating specifications for low voltage adjustable speed d.c. power drive systems*
– *Part 2: General requirements – Rating specifications for low voltage adjustable speed a.c. power drive systems*
– *Part 3: EMC requirements and specific test methods*
– *Part 4: General requirements – Rating specifications for a.c. power drive systems above 1 000 V a.c. and not exceeding 35 kV*
– *Part 5: Safety requirements*
– *Part 6: Guide for determination of types of load duty and corresponding current ratings*
– *Part 7: Generic interface and use of profiles for power drive systems*
– *Part 8: Specification of voltage on the power interface*
– *Part 9: Ecodesign for power drive systems, motor starters, power electronics and their driven applications*

Each part is further subdivided into several subparts, published either as International Standards or as Technical Specifications or Technical Reports, some of which have already been published. Other will be published with the part number followed by a dash and a second number identifying the subdivision (for example, IEC 61800-9-2).

This subpart of IEC 61800-9 is an International Standard for characterizing the energy efficiency of motor systems when supplied by a motor starter or by a variable voltage/frequency converter. The goal of this part of IEC 61800-9 is to establish a clear and simple system for the comparison of the energy performance of motor systems that can help manufacturers to improve their products, to give users the necessary transparency and information and to provide a robust reference base for regulators and minimum energy performance standards.

The IEC 61800-9 series (Ecodesign for power drive systems, motor starters, power electronics and their driven applications) will consist of the following subparts:

– *Part 9-1: General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA) and semi analytic model (SAM)*
– *Part 9-2: Energy efficiency indicators for power drive systems and motor starters*

ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 9-1: Ecodesign of power drive systems, motor starters, power electronics and their driven applications – General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA) and semi analytic model (SAM)

1 Scope

This part of IEC 61800 specifies the general methodology to energy efficiency standardization for any extended product by using the guidance of the extended product approach (EPA).

It enables product committees for driven equipment connected to motor systems (so called extended products) to interface with the relative power losses of the connected motor system (e.g. power drive system) in order to calculate the system energy efficiency for the whole application.

This is based on specified calculation models for speed/load profiles, the duty profiles and relative power losses of appropriate torque versus speed operating points.

This document specifies the methodology of determination of losses of the extended product and its sub-parts.

This document is applicable to motor systems operated by a motor starter or by a converter (power drive systems).

This document does not specify requirements for environmental impact declarations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-161, *International Electrotechnical Vocabulary – Part 161: Electromagnetic compatibility*

IEC 60034-2-1:2014, *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 induction motors*

IEC 61800-9-2:2016, *Adjustable speed electrical power drive systems – Part 9-2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications – Energy efficiency indicators for power drive systems and motor starters*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
duty profile
load-time profile

3.1.2
energy efficiency index
EEI
value describing the energy efficiency of an application, resulting from the extended product approach (EPA)

3.1.3
extended product
EP
driven equipment together with its connected motor system (e.g a PDS)

Note 1 to entry: See Figure 2.

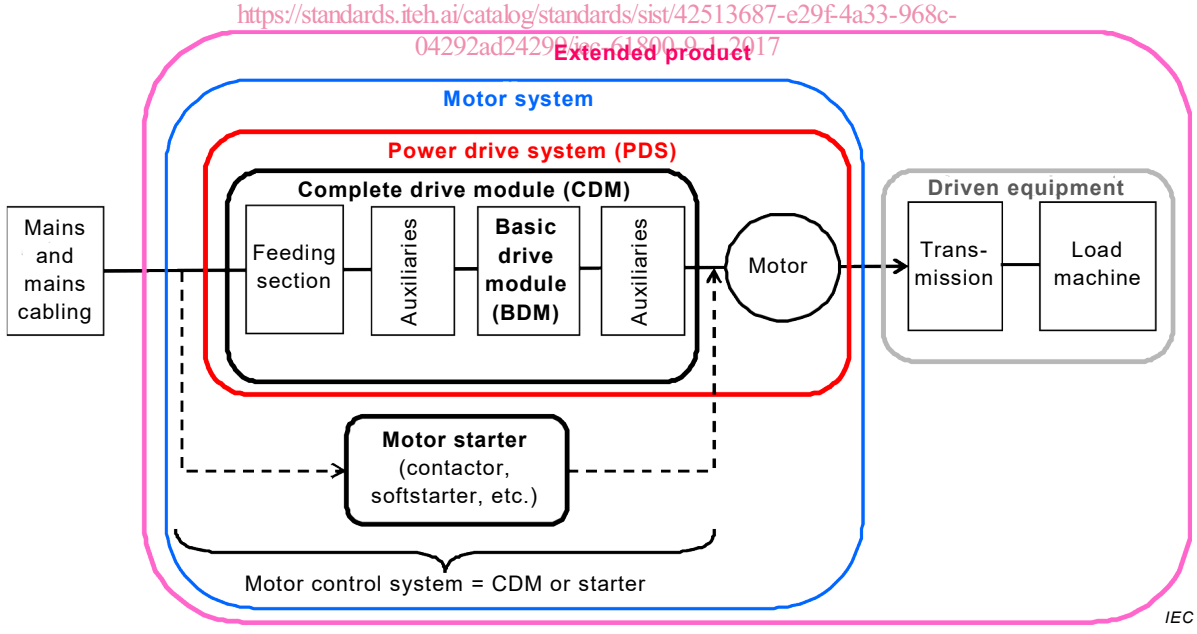


Figure 2 – Illustration of the extended product with embedded motor system

3.1.4
extended product approach
EPA
methodology to determine the energy eficiency index (EEI) of the extended product (EP) using the speed torque profiles of the driven equipment, the relative power losses of the motor system and the duty profile of the application

3.1.5
load-time profile
fraction of time spent at each operating point during the total operating time or a complete cycle of operation of the extended product

Note 1 to entry: Typically this profile is represented by a histogram.

Note 2 to entry: The standby mode can be included in the load time profile.

3.1.6
motor control equipment
either a CDM or a motor starter

3.1.7
motor system
motor control equipment and a motor

3.1.8
semi analytic model
SAM
determination model for the losses of a motor system or a driven equipment

Note 1 to entry: SAMs include physical and mathematical parameters and calculation algorithm of the subparts of an EP. SAMs are necessary to determine the typical relative power losses of the subparts of an EP in order to determine its overall losses.

3.1.9
transmission
any component (coupling, Gear box, etc.) which connects the motor shaft to the load machine (e.g. pump): coupling, gearbox

3.2 Symbols

3.2.1
$E_{\text{Electrical}}$
electrical energy consumption of an application during a certain runtime period

3.2.2
k_{P}
ratio of the weighted average electrical power consumption $P_{\text{Electrical}}$ of an application to the reference power consumption $P_{\text{Reference}}$

3.2.3
$P_{\text{Electrical}}$
power consumption [kW] of an application over time

3.2.4
$P_{\text{Electrical Max}}$
power consumption [kW] at 100 % speed and 100 % load

3.2.5
P_i
power consumption [kW] at operating point i

3.2.6
$P_{\text{L,control}}$
power losses of the control

3.2.7
P_n
nominal power of an equipment which is typical for its population of the same rating (see IEC 60034-1 for motors)

3.2.8
$P_{out,CDM}$
output power of CDM from the power loss measurement

3.2.9
$P_{out,PDS}$
output power of PDS from the power loss measurement

3.2.10
P_r
rated power of equipment which is assigned by its manufacturer

3.2.11
$P_{Reference}$
power consumption used for reference, defined by the extended product committee

3.2.12
P_L
electrical power losses

Note 1 to entry: In $P_{L,CDM}$, $P_{L,Mot}$ and $P_{L,Aux}$, the index CDM refers to the complete drive module, Mot refers to the motor, Aux refers to the auxiliary devices like cables, transformers or filters. The relative power losses are the per unit losses relative to the nominal power of the device.

3.2.13
$P_{L,CDM}$
power losses of a CDM

3.2.14
$P_{L,CDM,determined}$
power losses of CDM from the power loss determination method

3.2.15
$P_{L,CDM,relative}$
power losses of the CDM, with reference to its rated apparent power

3.2.16
$P_{L,inverter}$
power losses in the inverter section of a CDM

3.2.17
$P_{L,PDS,determined}$
power losses of PDS from the power loss determination method

3.2.18
$P_{L,Mot}$
total losses of a motor according to IEC 60034-2-1:2014, method 2-1-1B, when supplied by a converter (non sinusoidal power supply)

3.2.19
t_W
working time of an equipment

3.2.20
T_i
torque [Nm] at operating point i

3.2.21
TF_i
percentage of time (time fraction) an extended product is operated at one specific operating point i

4 Requirements for the development of energy efficiency standards for extended products

4.1 General

This document specifies a methodology to determine the energy efficiency index of an application, based on the concept of semi analytic models (SAM). The methodology shall be referred to as the extended product approach (EPA).

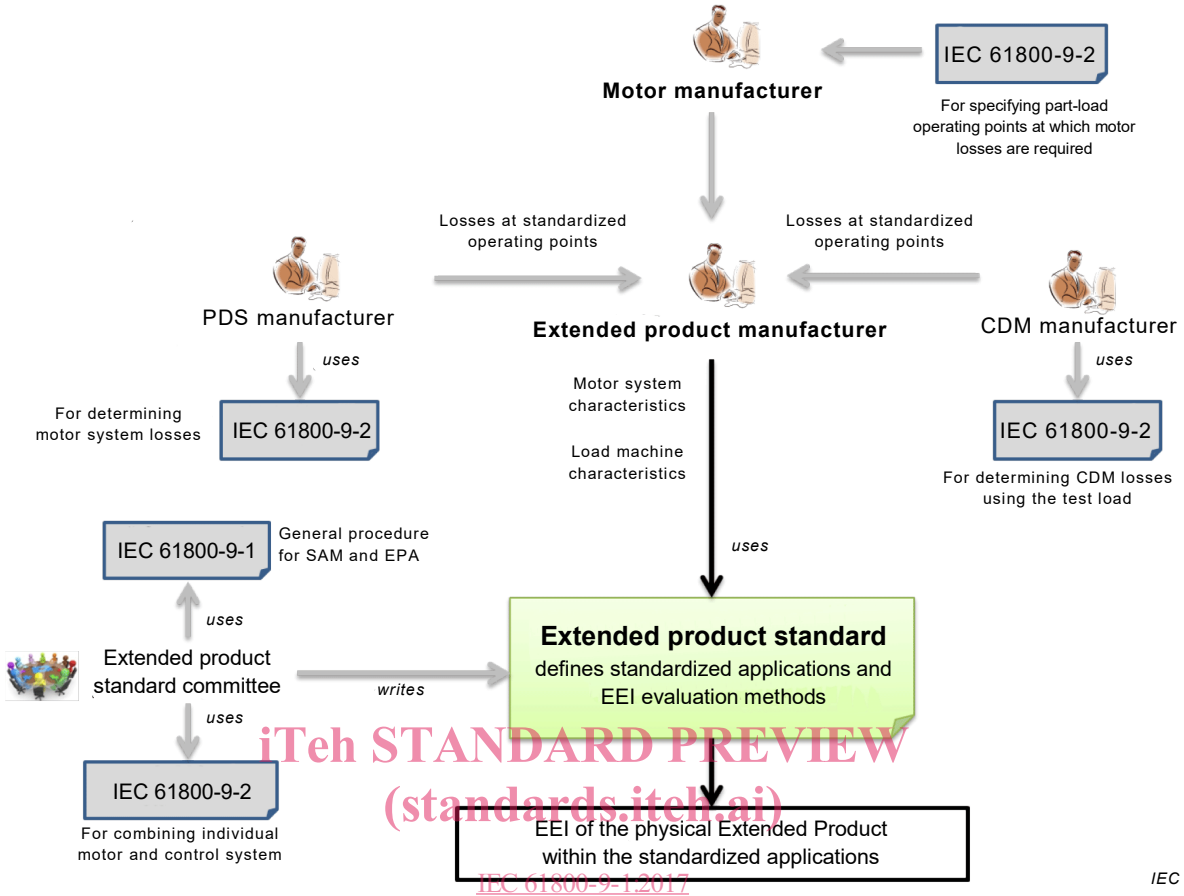
The responsibilities and tasks of the different stakeholders creating or using these extended products standards, as well as the data flows in-between, are required.

a) Specific information about the equipment shall be considered:
   - The torque versus speed profile of the driven load as specified by the load manufacturer or other pertinent entity (e.g. regulatory authority, other specified organization).
   - The losses of the Motor System or its constituents (motor, CDM or starter) at reference part-load operating points. These shall be provided by the different manufacturers as specified in IEC 61800-9-2.

b) Information about the driven equipment shall be considered:
   - The duty profile of the driven equipment. Pertinent entities can for example define typical applications of their extended products, each associated with a typical duty profile.

c) Extended product approach shall be used to determine an energy efficiency indicator (losses, efficiency, energy consumption, etc.):
   - IEC 61800-9-2 specifies the methods for the determination of losses of the motor system using measurement and/or calculations.
   - Other pertinent entity(ies) (e.g. regulatory authority, other specified organization) shall define how to combine the losses of the motor system and the losses of the load, to obtain an overall energy efficiency index for the extended product within the defined application.

The interactions between the different stakeholders are shown in Figure 3.



NOTE 1 Motor and CDM manufacturers can provide data directly to the motor system manufacturer.

NOTE 2 If the motor system is based on a starter, then only the motor losses are needed as input to the EPA.

Figure 3 – Stakeholders and responsibilities for determination of the energy efficiency indicator for an extended product

4.2 Responsibility of the extended product standard or technical committee

Based on the general principles described in this document, it shall be the responsibility of the entity(ies) dealing with a type of extended product (e.g. regulatory authority, other specified organization) to specify the semi analytic model of the driven load and of the extended product for the product-specific application(s).

Other pertinent entity(ies) (e.g. regulatory authority, other specified organization) shall specify and standardize

– one or more torque versus speed profiles (load profiles) as described in Annex C considering typical loads,
– one or more duty profiles as described in Annex C considering typical service conditions,
– an appropriate method for determining the losses at intermediate operating points based on the data from the motor, CDM and PDS (see 7.3),
– a Semi analytic model for the Extended Product considering the extended product approach (EPA) as described in Clause 7, using the part-load operating points of the motor system as determined according to IEC 61800-9-2: 2016, Annex E, and
– a method for determining an energy efficiency indicator for the extended product under their responsibility (see Annex B for example).