

INTERNATIONAL STANDARD



**Low-voltage electrical installations –
Part 8-1: Functional aspects – Energy efficiency**





THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2019 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

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

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

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.



IEC 60364-8-1

Edition 2.0 2019-02

INTERNATIONAL STANDARD



**Low-voltage electrical installations –
Part 8-1: Functional aspects – Energy efficiency**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 13.020.01; 27.015; 91.140.50

ISBN 978-2-8322-6510-9

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

| | |
|---|----|
| FOREWORD..... | 6 |
| INTRODUCTION..... | 8 |
| 1 Scope..... | 9 |
| 2 Normative references | 9 |
| 3 Terms, definitions and abbreviated terms | 10 |
| 3.1 General..... | 10 |
| 3.2 Electrical energy management | 11 |
| 3.3 Energy measurement..... | 12 |
| 3.4 Sectors of activities..... | 13 |
| 3.5 Abbreviated terms..... | 13 |
| 4 General | 14 |
| 4.1 Fundamental principles | 14 |
| 4.1.1 Safety of the electrical installation | 14 |
| 4.1.2 Availability of electrical energy and user decision | 14 |
| 4.1.3 Design principles | 14 |
| 4.2 Energy efficiency assessment for electrical installations | 15 |
| 4.2.1 General | 15 |
| 4.2.2 Action plan following an assessment according to Annex B | 15 |
| 5 Sectors of activities | 15 |
| 6 Design requirements and recommendations | 15 |
| 6.1 General..... | 15 |
| 6.2 Determination of load energy profile..... | 16 |
| 6.3 Determination of the transformer and switchboard location with the barycentre method | 16 |
| 6.4 HV/LV substation | 16 |
| 6.4.1 General | 16 |
| 6.4.2 Optimum number and location of HV/LV substations..... | 16 |
| 6.4.3 Working point of the transformer..... | 17 |
| 6.4.4 Efficiency of the transformer | 17 |
| 6.5 Efficiency of local production and local storage..... | 17 |
| 6.6 Losses in the wiring | 17 |
| 6.6.1 Voltage drop..... | 17 |
| 6.6.2 Cross-sectional areas of conductors | 17 |
| 6.6.3 Power factor correction..... | 18 |
| 6.6.4 Reduction of the effects of harmonic currents | 18 |
| 7 Determination of the zones, usages and meshes | 18 |
| 7.1 Determining the zones | 18 |
| 7.2 Determining the usages within the identified zones | 19 |
| 7.3 Demand response..... | 19 |
| 7.4 Determining the meshes | 19 |
| 7.4.1 General | 19 |
| 7.4.2 Meshes..... | 20 |
| 7.4.3 Criteria for considering meshes | 20 |
| 7.5 Driving parameters..... | 21 |
| 7.5.1 General | 21 |
| 7.5.2 Occupancy | 22 |

| | | |
|---|--|----|
| 7.5.3 | Operating time | 22 |
| 7.5.4 | Environmental conditions | 22 |
| 7.5.5 | Cost of electricity | 22 |
| 7.6 | Impacts on the design of an electrical installation | 22 |
| 8 | Energy efficiency and load management system | 22 |
| 8.1 | General | 22 |
| 8.2 | User specification | 23 |
| 8.2.1 | General | 23 |
| 8.2.2 | Requirements on the loads | 23 |
| 8.2.3 | Requirements on the supplies | 23 |
| 8.3 | Inputs from loads, sensors and forecasts | 24 |
| 8.3.1 | General | 24 |
| 8.3.2 | Communication | 28 |
| 8.3.3 | Data logging | 29 |
| 8.3.4 | Loads | 29 |
| 8.3.5 | Forecasts | 31 |
| 8.4 | Inputs from the supplies: energy availability and pricing | 31 |
| 8.5 | Monitoring the performance of the electrical installation | 31 |
| 8.6 | Management of loads through meshes | 31 |
| 8.6.1 | General | 31 |
| 8.6.2 | Electrical energy management system (EEMS) | 31 |
| 8.7 | Multi-supply source management: grid, local electricity production and storage | 32 |
| 9 | Maintenance and enhancement of the performance of the installation | 32 |
| 9.1 | Methodology | 32 |
| 9.2 | Installation life cycle methodology | 34 |
| 9.3 | Energy efficiency life cycle | 34 |
| 9.3.1 | General | 34 |
| 9.3.2 | Performance maintenance programme | 34 |
| 9.3.3 | Verification | 35 |
| 9.4 | Data management | 35 |
| 9.5 | Maintenance | 35 |
| 10 | Parameters for implementation of efficiency measures | 35 |
| 10.1 | General | 35 |
| 10.2 | Efficiency measures | 35 |
| 10.2.1 | Current-using-equipment | 35 |
| 10.2.2 | Electrical installation | 37 |
| 10.2.3 | Implementation of management systems | 38 |
| 10.2.4 | Local power supply | 40 |
| 11 | Energy efficiency actions | 41 |
| Annex A (informative) Determination of transformer and switchboard location using the barycentre method | | 42 |
| A.1 | Barycentre method | 42 |
| A.2 | Total load barycentre | 45 |
| A.2.1 | General | 45 |
| A.2.2 | Sub-distribution board locations | 46 |
| A.2.3 | Iterative process | 46 |
| A.3 | Method of average route length | 46 |

| | |
|--|----|
| Annex B (normative) Method to assess the energy efficiency of an electrical installation | 49 |
| B.1 General..... | 49 |
| B.2 Electrical installation efficiency classes..... | 49 |
| B.3 Determination of the electrical installation efficiency class | 49 |
| B.3.1 General | 49 |
| B.3.2 Industrial, commercial buildings and infrastructures..... | 50 |
| B.3.3 Residential | 64 |
| Annex C (informative) List of notes concerning certain countries | 70 |
| Bibliography..... | 71 |
| | |
| Figure 1 – Energy efficiency and load management system overview | 23 |
| Figure 2 – Electrical distribution scheme..... | 26 |
| Figure 3 – Example of measurement equipment selection in an installation | 28 |
| Figure 4 – Iterative process for electrical energy efficiency management | 33 |
| Figure A.1 – Example 1: floor plan of production plant with the planned loads and calculated barycentre..... | 44 |
| Figure A.2 – Example 2: barycentre calculated | 45 |
| Figure A.3 – Example of location of the barycentre in an industrial building | 46 |
| Figure A.4 – Example of location of the barycentre using the average route length method | 48 |
| Figure B.1 – Level of efficiency of the electrical installation efficiency classes | 49 |
| | |
| Table 1 – Measurement applications..... | 25 |
| Table 2 – Overview of the needs for power metering and monitoring..... | 26 |
| Table 3 – Process for electrical energy efficiency management and responsibilities..... | 33 |
| Table A.1 – Cable length for supply of DB..... | 47 |
| Table B.1 – Electrical installation efficiency classes..... | 50 |
| Table B.2 – Energy efficiency measures | 51 |
| Table B.3 – Determination of energy consumption: coverage | 52 |
| Table B.4 – Main substation: consumption | 52 |
| Table B.5 – Main substation: location..... | 53 |
| Table B.6 – Voltage drop | 53 |
| Table B.7 – Efficiency of transformer | 54 |
| Table B.8 – Efficiency of fixed installed current using equipment | 55 |
| Table B.9 – Zones | 55 |
| Table B.10 – Usages | 56 |
| Table B.11 – Demand response: coverage..... | 56 |
| Table B.12 – Demand response: duration | 56 |
| Table B.13 – Meshes | 57 |
| Table B.14 – Measurement by usages | 58 |
| Table B.15 – Occupancy coverage..... | 58 |
| Table B.16 – Occupancy measurement..... | 58 |
| Table B.17 – Energy management system (EEMS) | 59 |
| Table B.18 – HVAC control | 59 |

| | |
|---|----|
| Table B.19 – Lighting control | 60 |
| Table B.20 – Performance maintenance process | 60 |
| Table B.21 – Frequency of the performance verification process..... | 60 |
| Table B.22 – Data management..... | 61 |
| Table B.23 – Working point of transformer | 61 |
| Table B.24 – Presence of continuous monitoring for large energy using systems | 62 |
| Table B.25 – Power factor..... | 62 |
| Table B.26 – THD_U | 63 |
| Table B.27 – THD_I | 63 |
| Table B.28 – Renewable energy | 64 |
| Table B.29 – Electrical energy storage..... | 64 |
| Table B.30 – Energy efficiency measures parameters | 65 |
| Table B.31 – Determination of energy consumption | 65 |
| Table B.32 – Zones..... | 66 |
| Table B.33 – Demand response coverage..... | 66 |
| Table B.34 – Meshes | 67 |
| Table B.35 – HVAC control | 67 |
| Table B.36 – Lighting control | 68 |
| Table B.37 – Measurement by usage | 68 |
| Table B.38 – Renewable energy | 69 |
| Table B.39 – Electrical energy storage..... | 69 |
| Table C.1 – Notes concerning certain countries | 70 |

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE ELECTRICAL INSTALLATIONS –

Part 8-1: Functional aspects – Energy efficiency

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60364-8-1 has been prepared by IEC technical committee 64: Electrical installations and protection against electric shock.

This second edition cancels and replaces the first edition published in 2014. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) revision of Annex B;
- b) revision of 4.2: Energy efficiency assessment for electrical installations;
- c) update of 8.3: Input from loads, sensors and forecasts;
- d) introduction of new definitions.

The text of this International Standard is based on the following documents:

| | |
|--------------|------------------|
| FDIS | Report on voting |
| 64/2353/FDIS | 64/2360/RVD |

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

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

It has the status of a group energy efficiency publication in accordance with IEC Guide 118 and IEC Guide 119.

The reader's attention is drawn to the fact that Annex C lists all of the "in-some-country" clauses on differing practices of a less permanent nature relating to the subject of this document.

A list of all parts in the IEC 60364 series, published under the general title *Low-voltage electrical installations*, can be found on the IEC website.

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

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

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The optimization of electrical energy usage can be facilitated by appropriate design and installation considerations. An electrical installation can provide the required level of service and safety for the lowest electrical consumption. This is considered by designers as a general requirement of their design procedures in order to establish the best use of electrical energy. In addition to the many parameters taken into account in the design of electrical installations, more importance is nowadays focused on reducing losses within the system and its use. The design of the whole installation has therefore to take into account inputs from users, suppliers and utilities.

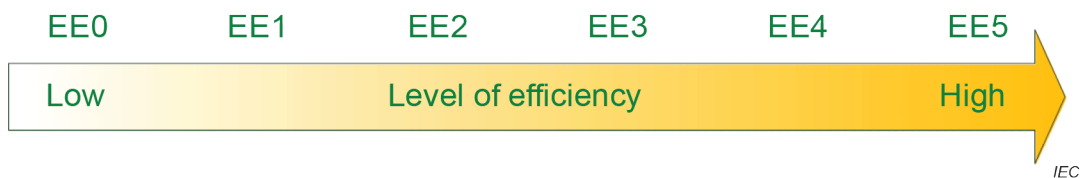
It is important that this document covers existing electrical installations in buildings, in addition to new installations. It is in the refurbishment of existing buildings that significant overall improvements in energy efficiency can be achieved.

The optimization of the use of electricity is based on energy efficiency management which is based on the price of electricity, electrical consumption and real-time adaptation. Efficiency is checked by measurement during the whole life of the electrical installation. This helps identify opportunities for any improvements and corrections. Improvements and corrections may be implemented by redesign or equipment replacement. The aim is to provide a design for an efficient electrical installation which allows an energy management process to suit the user's needs, and in accordance with an acceptable investment. This document first introduces the different measures to ensure an energy efficient installation based on kWh saving. It then provides guidance on giving priority to the measures depending on the return of investment; i.e. the saving of electrical energy and reducing of electrical power costs divided by the amount of investment.

This document is intended to provide requirements and recommendations for the electrical part of the energy management system addressed by ISO 50001.

It introduces requirements, recommendations and methods for the design and the energy efficiency assessment of an electrical installation within the framework of an energy efficiency management approach in order to get the best permanent functionally equivalent service for the lowest electrical energy consumption and the most acceptable energy availability and economic balance.

The assessment method described in Annex B based on the electrical energy efficiency of the installation allows a classification of energy efficiency installation according to the following levels:



NOTE Account can be taken, if appropriate, of induced works (civil works, compartmentalization) and the necessity to expect, or not, the modifiability of the installation.

This document introduces requirements and recommendations to design the adequate installation in order to give the ability to improve the management of the energy performance of the installation by the tenant/user or for example the energy manager.

All requirements and recommendations of this part of IEC 60364 enhance the requirements contained in Parts 1 to 7 of the IEC 60364 series.

LOW-VOLTAGE ELECTRICAL INSTALLATIONS –

Part 8-1: Functional aspects – Energy efficiency

1 Scope

This part of IEC 60364 provides additional requirements, measures and recommendations for the design, erection, operation and verification of all types of low voltage electrical installation including local production and storage of energy for optimizing the overall efficient use of electricity.

It introduces requirements, recommendations and methods for the design and the energy efficiency (EE) assessment of an electrical installation within the framework of an energy efficiency management approach in order to get the best permanent functionally equivalent service for the lowest electrical energy consumption and the most acceptable energy availability and economic balance.

These requirements, recommendations and methods apply, within the scope of IEC 60364 (all parts), for new installations and modification of existing installations.

This document is applicable to the electrical installation of a building or system and does not apply to products. The energy efficiency of products and their operational requirements are covered by the relevant product standards.

Where another standard provides specific requirements for a particular system or installation application (e.g. manufacturing system covered by ISO 20140 (all parts)), those requirements may supersede this document.

This document does not specifically address building automation systems.

This group energy efficiency publication is primarily intended to be used as an energy efficiency standard for the low voltage electrical installations mentioned in Clause 1, but is also intended to be used by technical committees in the preparation of standards, in accordance with the principles laid down in IEC Guide 119 and IEC Guide 118.

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 61557-12:2007, *Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 12: Performance measuring and monitoring devices (PMD)*

IEC 61869-2, *Instrument transformers – Part 2: Additional requirements for current transformers*

IEC 62053-21, *Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*