



BSI Standards Publication

Particular requirements for load-shedding equipment (LSE)

National foreword

This British Standard is the UK implementation of EN IEC 62962:2019. It is identical to IEC 62962:2019.

The UK participation in its preparation was entrusted to Technical Committee PEL/23, Electrical accessories.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2019

Published by BSI Standards Limited 2019

ISBN 978 0 580 89383 4

ICS 27.015; 29.020

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2019.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

English Version

Particular requirements for load-shedding equipment (LSE)
(IEC 62962:2019)

Exigences spécifiques pour les délesteurs (LSE)
(IEC 62962:2019)

Besondere Anforderungen für Lastabwurfseinrichtungen
(LSE)
(IEC 62962:2019)

This European Standard was approved by CENELEC on 2019-10-18. 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.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 23K/47/FDIS, future edition 1 of IEC 62962, prepared by SC 23K "Electrical Energy Efficiency products" of IEC/TC 23 "Electrical accessories" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62962:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-07-18
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-10-18

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 62962:2019 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60038	NOTE	Harmonized as EN 60038
IEC 60112	NOTE	Harmonized as EN 60112
IEC 60364-4-41	NOTE	Harmonized as HD 60364-4-41
IEC 60364-5-51:2005	NOTE	Harmonized as HD 60364-5-51:2009
IEC 60364-8-1:2019	NOTE	Harmonized as HD 60364-8-1:2019 (not modified)
IEC 60529	NOTE	Harmonized as EN 60529
IEC 60669-1:2017	NOTE	Harmonized as EN 60669-1:2018
IEC 60721-3-3	NOTE	Harmonized as EN IEC 60721-3-3
IEC 60947-1:2007	NOTE	Harmonized as EN 60947-1:2007 (not modified)
IEC 60998-2-2:2002	NOTE	Harmonized as EN 60998-2-2:2004
IEC 61000-3-2	NOTE	Harmonized as EN IEC 61000-3-2
IEC 61008-1:2010	NOTE	Harmonized as EN 61008-1:2012
IEC 61008-1:2010/A1:2012	NOTE	Harmonized as EN 61008-1:2012/A1:2014
IEC 61008-1:2010/A2:2013	NOTE	Harmonized as EN 61008-1:2012/A2:2014
IEC 61009-1:2010	NOTE	Harmonized as EN 61009-1:2012
IEC 61009-1:2010/A1:2012	NOTE	Harmonized as EN 61009-1:2012/A1:2014
IEC 61009-1:2010/A2:2013	NOTE	Harmonized as EN 61009-1:2012/A2:2014
IEC 61140	NOTE	Harmonized as EN 61140
ISO 2039-2:1987	NOTE	Harmonized as EN ISO 2039-2:1999 (not modified)

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60065	2001	Audio, video and similar electronic apparatus - Safety requirements	-	-
IEC 60085	-	Electrical insulation - Thermal evaluation and designation	EN 60085	-
IEC 60127	series	Miniature fuses	EN 60127	series
IEC 60212	-	Standard conditions for use prior to and during the testing of solid electrical insulating materials	EN 60212	-
IEC 60317-0-1	1997	Specifications for particular types of winding wires -- Part 0-1: General requirements - Enamelled round copper wire	-	-
IEC 60364	series	Low-voltage electrical installations	HD 60364	series
IEC 60384-14	1993	Fixed capacitors for use in electronic equipment -- Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains	-	-
IEC 60417	-	Graphical symbols for use on equipment. Index, survey and compilation of the single sheets.	-	-
IEC 60664-1	2007	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests	EN 60664-1	2007
IEC 60695-2-10	2000	Fire hazard testing -- Part 2-10: Glowing/hot-wire based test methods - Glow-wire apparatus and common test procedure	-	-
IEC 60695-2-11	2000	Fire hazard testing -- Part 2-11: Glowing/hot-wire based test methods - Glow-wire flammability test method for end-products	-	-

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60730	series	Automatic electrical controls	EN 60730	series
IEC 61000-2-2	-	Electromagnetic compatibility (EMC) - Part 2-2: Environment - Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems	EN 61000-2-2	-
IEC 61000-4-2	-	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	EN 61000-4-2	-
IEC 61000-4-3	-	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	-	-
IEC 61000-4-4	-	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	EN 61000-4-4	-
IEC 61000-4-5	-	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	EN 61000-4-5	-
IEC 61000-4-6	-	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	EN 61000-4-6	-
IEC 61000-4-8	-	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	EN 61000-4-8	-
IEC 61000-4-11	-	Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests	EN 61000-4-11	-
IEC 61032	1997	Protection of persons and equipment by enclosures - Probes for verification	EN 61032	1998
IEC 61558-2-6	-	Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V - Part 2-6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers	EN 61558-2-6	-
ISO 306	-	Plastics - Thermoplastic materials - Determination of Vicat softening temperature (VST)	EN ISO 306	-
CISPR 15	-	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment	EN IEC 55015	-

CONTENTS

FOREWORD.....	9
INTRODUCTION.....	11
1 Scope.....	12
2 Normative references	13
3 Terms and definitions	14
4 General requirements	22
4.1 General.....	22
4.2 Architecture	23
4.3 Standard conditions for operation in service.....	24
5 General remarks on tests	25
5.1 Environmental conditions	25
5.1.1 General	25
5.1.2 Ambient temperature range in normal use.....	25
5.1.3 Relative humidity	25
5.1.4 Altitude	25
5.2 General testing procedure and samples	26
6 Ratings.....	27
6.1 Rated values.....	27
6.1.1 Rated operational voltages	27
6.1.2 Rated insulation voltage	27
6.1.3 Rated impulse voltage	27
6.1.4 Maximum value of rated current.....	27
6.1.5 Preferred rated current values (I_n).....	27
6.1.6 Minimum value of rated making and breaking capacity (I_{RMS})	28
6.1.7 Rated frequency	28
6.1.8 Rated conditional short-circuit current.....	28
6.1.9 Preferred rated load-shedding current (power) values (I_nL_S , P_nL_S).....	28
6.2 Time-current characteristic for LSEs monitoring the current	28
6.2.1 LSE operating principle.....	28
6.2.2 Current limits (I_nL_S).....	30
6.2.3 Minimum switch OFF-time	30
6.2.4 Reclosing conditions.....	31
6.3 Time-power characteristic	32
6.4 LSE shedding sequence	32
7 Classification.....	33
7.1 General.....	33
7.2 According to the LSE functional category	33
7.3 According to the switching means	34
7.4 According to the possibility of adjusting the rated load-shedding current(s) (or power)	34
7.5 According to the shedding sequence.....	34
7.6 According to the design	34
7.6.1 Stand-alone LSE with internal or external sensors or measuring units	34
7.6.2 LSE with external sensor	34
7.6.3 Combined LSE (or assembled LSE).....	34
7.7 According to the method of mounting	34

7.8	According to the type of terminals	34
7.9	According to the contact openings	34
7.10	According to the protection against external influences	35
7.11	According to the number of poles	35
7.12	According to the type of monitored parameters	35
8	Markings and information	35
8.1	General	35
8.2	Test of markings	36
9	Protection against electric shock	36
9.1	General	36
9.2	Test for protection against electric shock	37
10	Terminals for external copper conductors	40
10.1	General	40
10.2	Terminals with screw clamping for external copper conductors	40
10.2.1	General	40
10.2.2	Conductor fitting	46
10.2.3	Mechanical strength of terminals	46
10.2.4	Resistance to corrosion of terminals	46
10.2.5	Clamping effects on conductors	46
10.2.6	Clamping reliability of terminals	47
10.2.7	Clamping length of terminals	48
10.2.8	Reliability of terminals	49
10.2.9	Accidental loosening of earthing terminals	49
10.2.10	Resistance to corrosion of earthing terminals	49
10.2.11	Additional requirements for the design of pillar terminals	50
10.2.12	Additional requirements for the design of lug terminals	50
10.2.13	Additional requirements for terminals for the connection of external conductors	50
10.3	Screwless terminals for external copper conductors	50
10.3.1	General	50
10.3.2	Conductor fittings	50
10.3.3	Connection of conductors	51
10.3.4	Type of material	51
10.3.5	Conductors clamping	51
10.3.6	Operation of terminals	51
10.3.7	Multi conductor terminals	52
10.3.8	Introduction of conductors	52
10.3.9	Fixing of terminals	52
10.3.10	Mechanical strength	52
10.3.11	Electrical and thermal stress resistance	54
10.3.12	Mechanical reliability	56
11	Constructional requirements	59
11.1	General	59
11.2	Mechanical requirements for insulating means	59
11.3	Installation requirements	59
11.4	Fixing of covers, cover plates and actuating members	62
11.4.1	General	62
11.4.2	Fixings based on screws or rivets	63

11.4.3	Fixings which may be removed by applying a force perpendicular to the surfaces	63
11.4.4	Fixings which may be removed using a tool	63
11.5	Attachment of knobs	64
11.6	Mounting means	64
11.7	Accessories	64
12	Mechanism and operating means	64
12.1	General.....	64
12.2	Indication of the position	65
12.3	Rest position.....	65
12.4	Making and breaking.....	65
12.5	Action of the mechanism without cover or cover plate	65
12.6	Fixings and removal of operating means	65
12.7	Locking.....	66
12.8	Status indicators	66
13	Resistance to ageing and humidity	66
13.1	Resistance to ageing	66
13.2	Resistance to humidity.....	67
14	Insulation resistance and dielectric strength	67
14.1	General.....	67
14.2	Insulation resistance of the main circuit	67
14.3	Dielectric strength of main circuits	68
14.4	Insulation resistance and dielectric strength of other circuits.....	70
14.5	Verification of impulse withstand voltages (across clearances and through solid insulations).....	71
14.5.1	General testing procedure	71
14.5.2	Verification of clearances with the impulse withstand voltage tests	72
15	Temperature rise	72
15.1	General.....	72
15.2	Test setup.....	73
15.3	Test procedure.....	74
16	Making and breaking capacity.....	76
17	Normal operation	76
17.1	Functional tests: disconnection and reclosing	76
17.1.1	General	76
17.1.2	Disconnection tests	77
17.1.3	Reclosing tests	78
17.1.4	Load-shedding sequence(s) tests	79
17.1.5	Remotely controlled LSE and LSE with connection to other external equipment.....	79
17.2	Endurance test.....	79
18	Mechanical strength	80
18.1	General.....	80
18.2	Pendulum hammer test	81
18.3	Covers, cover plates or actuating members – Accessibility to live parts	89
18.3.1	General	89
18.3.2	Verification of the non-removal of covers, cover plates or actuating members	89
18.3.3	Verification of the removal of covers, cover plates or actuating members.....	89

18.4	Covers, cover plates or actuating members – Accessibility to non-earthed metal parts separated from live parts	90
18.5	Covers, cover plates or actuating members – Accessibility to insulating parts, earthed metal parts, the live parts of SELV ≤ 25 V AC or metal parts separated from live parts	90
18.6	Covers, cover plates or actuating members – Application of gauges	90
18.7	Grooves, holes and reverse tapers	92
18.8	Rail mounted LSEs	93
19	Resistance to heat	94
19.1	General	94
19.2	Basic heating test	94
19.3	Ball-pressure test on parts of insulating material necessary to retain current-carrying parts and parts of the earthing circuit in position	95
19.4	Ball-pressure test on parts of insulating material not necessary to retain current-carrying parts and parts of the earthing circuit in position	95
20	Screws, current carrying capacity and connections	95
20.1	General	95
20.2	Correct insertion of screws	96
20.3	Contact pressure of electrical connections	97
20.4	Screws and rivets used both as electrical and mechanical connections	97
20.5	Material of current-carrying parts	97
20.6	Thread-forming and thread-cutting screws	98
21	Creepage distances, clearances and distances through sealing compound	98
21.1	General	98
21.2	Measurements	98
21.3	Insulating compound	99
22	Resistance of insulating material to abnormal heat and fire	101
22.1	General	101
22.2	Glow-wire test	101
23	Resistance to rusting	103
24	EMC requirements	104
24.1	General	104
24.2	Immunity	104
24.2.1	General	104
24.2.2	Voltage dips and short interruptions	105
24.2.3	Surge immunity test for 1,2/50 wave impulses	105
24.2.4	Electrical fast transient/burst test	106
24.2.5	Electrostatic discharge test	106
24.2.6	Radiated electromagnetic field test	107
24.2.7	Radio-frequency voltage test	107
24.2.8	Power-frequency magnetic field test	108
24.3	Emission	108
24.3.1	General	108
24.3.2	Low-frequency emission	108
24.3.3	Radio-frequency emission	108
25	Coordination with short-circuit devices	108
25.1	General requirements for coordination	108
25.2	Testing conditions	108
25.2.1	Test circuit	108

25.2.2	Tolerances on test quantities	112
25.2.3	Power factor of the test circuit	112
25.2.4	Power frequency recovery voltage	113
25.2.5	Calibration of the test circuit	113
25.2.6	Sequence of operations	113
25.3	Tests of coordination between the LSE and the SCPD	113
25.3.1	General	113
25.3.2	Verification of the coordination at the rated conditional short-circuit current (I_{nc}).....	114
25.3.3	Verification at the instantaneous tripping of the SCPD	114
25.3.4	Condition of the LSE during and after tests	114
26	Tests under abnormal conditions	114
26.1	General.....	114
26.2	Tests under fault conditions	115
26.3	Overload tests	116
27	Components	116
27.1	Fuses.....	117
27.2	Capacitors	117
27.3	Resistors	118
27.4	Automatic protective devices (other than fuses)	118
27.4.1	General	118
27.4.2	Cut-outs	118
27.4.3	Automatic protective devices	120
27.5	Transformers	120
Annex A (normative)	Test sequences and number of specimens	121
Annex B (informative)	Correspondence between ISO and AWG copper conductors	123
Annex C (normative)	Determination of clearances and creepage distances	124
C.1	General.....	124
C.2	Orientation and location of a creepage distance.....	124
C.3	Creepage distances where more than one material is used	124
C.4	Creepage distances split by floating conductive part	124
C.5	Measurement of creepage distances and clearances	124
Annex D (normative)	Arrangement for the detection of the emission of ionized gases during short-circuit tests	128
Bibliography		131
Figure 1	– Energy efficiency management system.....	11
Figure 2	– LSE general architecture.....	24
Figure 3	– Time-current characteristic of a Class A LSE	29
Figure 4	– Joined test finger (test probe B according to IEC 61032:1997)	38
Figure 5	– Test pin for checking the protection against electric shock	40
Figure 6	– Terminals with stirrup.....	41
Figure 7	– Pillar terminals	41
Figure 8	– Screw terminals and stud terminals	43
Figure 9	– Saddle terminals	44
Figure 10	– Lug terminals	45
Figure 11	– Test apparatus for checking damage to conductors	

Figure 12 – Information for deflection test	57
Figure 13 – Determination of the direction of the forces to be applied	61
Figure 14 – Direction for the conductor pull of 30 N for 1 min	62
Figure 15 – Pendulum impact test apparatus	82
Figure 16 – Pendulum impact test apparatus (striking element)	83
Figure 17 – Mounting support of specimens	84
Figure 18 – Mounting block for a flush type LSE	85
Figure 19 – Example of mounting support of a panel board type LSE	86
Figure 20 – Example of mounting support for a rear fixed LSE	87
Figure 21 – Gauge (thickness: about 2 mm) for the verification of the outline of covers, cover-plates or actuating members	90
Figure 22 – Example of application of the gauge of Figure 21 on covers fixed without screws on a mounting surface or supporting surface	91
Figure 23 – Examples of applications of the gauge of Figure 21	92
Figure 24 – Gauge for verification of grooves, holes and reverse tapers	93
Figure 25 – Sketch showing the direction of application of the gauge of Figure 24	93
Figure 26 – Application of forces on a rail-mounted LSE	94
Figure 27 – Ball-pressure test apparatus	95
Figure 28 – Thread-cutting screw	96
Figure 29 – Thread-forming screw	96
Figure 30 – Diagrammatic representation	102
Figure 31 – Typical diagram for all coordination tests	110
Figure 32 – Detail of impedances Z and Z_1	110
Figure C.1 – Example 1	125
Figure C.2 – Example 2	125
Figure C.3 – Example 3	125
Figure C.4 – Example 4	126
Figure C.5 – Example 5	126
Figure C.6 – Example 6	126
Figure C.7 – Example 7	127
Figure D.1 – Test arrangement	129
Figure D.2 – Grid	130
Figure D.3 – Grid circuit	130
Table 1 – Cross-sectional areas (S) of test copper conductors corresponding to the rated currents	26
Table 2 – Rated impulse voltage as a function of the nominal voltage of the installation	27
Table 3 – Load-shedding classes	30
Table 4 – Disconnecting time	31
Table 5 – Load-shedding classes	32
Table 6 – Disconnecting time	32
Table 7 – Load-shedding functional categories	33
Table 8 – Marking and position of marking	35

Table 9 – Relationship between rated currents and connectable cross-sectional areas of copper conductors	39
Table 10 – Dimensions and tightening torque of pillar terminals	42
Table 11 – Dimensions and tightening torque for screw and stud terminals	44
Table 12 – Dimensions and tightening torque for saddle terminals	45
Table 13 – Dimensions and tightening torque for lug terminals	45
Table 14 – Tightening torque for the verification of the mechanical strength of screw-type terminals	47
Table 15 – Test values for pulling out test	48
Table 16 – Relationship between rated currents and connectable cross-sectional areas of copper conductors for screwless terminals	51
Table 17 – Test values for flexion and pull out for copper conductors	53
Table 18 – Test current for the verification of electrical and thermal stresses in normal use of screwless terminals	55
Table 19 – Cross-sectional areas of rigid copper conductors for deflection test of screwless terminals	58
Table 20 – Deflection test forces	58
Table 21 – Forces to be applied to covers, cover-plates or actuating members whose fixing is not dependent on screws	63
Table 22 – Test voltage, points of application and minimum values of insulating resistance for the verification of dielectric strength	69
Table 23 – Test voltages of auxiliary circuits	71
Table 24 – Test voltage for verification of impulse withstand voltage	72
Table 25 – Temperature-rise test currents and cross-sectional areas of copper conductors	73
Table 26 – Permissible temperature rise values (based on Table 3 of IEC 60065:2001)	75
Table 27 – Number of operations for normal operation test	80
Table 28 – Height of fall for impact test	88
Table 29 – Minimum clearances and creepage distances	100
Table 30 – Immunity tests (overview)	104
Table 31 – Voltage dip and short-interruption test values	105
Table 32 – Surge immunity test voltages	106
Table 33 – Fast transient test values	106
Table 34 – Minimum values of I^2t and I_p	111
Table 35 – Power factors for short-circuit tests	112
Table 36 – Capacitors	118
Table A.1 – Specimen for tests	122
Table B.1 – Correspondence between ISO and AWG copper conductors	123

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PARTICULAR REQUIREMENTS FOR
LOAD-SHEDDING EQUIPMENT (LSE)**

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 62962 has been prepared by subcommittee 23K: Electrical energy efficiency products, of IEC technical committee 23: Electrical accessories.

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

FDIS	Report on voting
23K/47/FDIS	23K/48/RVD

Full information on the voting for the approval of this document 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.

In this document, the following print types are used:

- *conformity statements: in italic type.*

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

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

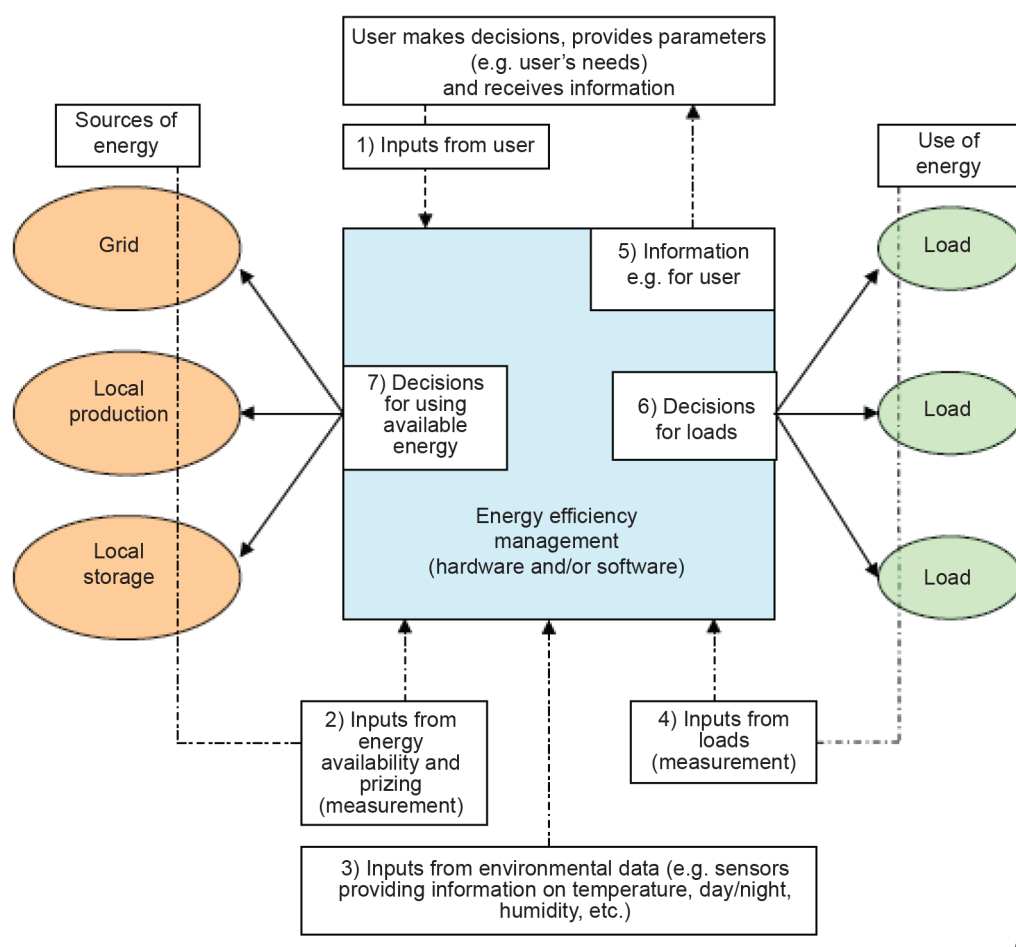
IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 to establish the best use of electrical energy.

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, as described in Figure 1 according to IEC 60364-8-1:2019.



IEC

Figure 1 – Energy efficiency management system

This document applies to load-shedding equipment (LSE), for household and similar uses.

The LSE is an equipment able to respond to the monitored current or power, or alternative monitored parameters to switch ON and OFF selected loads when certain conditions are met.

The load-shedding function is used in energy management systems to optimize the overall use of electrical energy including production and storage, and can be used for example for energy efficiency purposes as per IEC 60364-8-1:2019.

PARTICULAR REQUIREMENTS FOR LOAD-SHEDDING EQUIPMENT (LSE)

1 Scope

The purpose of this document is to provide requirements for equipment to be used in energy efficiency systems. This document covers load-shedding equipment (LSE).

Guidelines relating to safety for LSE as given in IEC Guide 110 have been followed.

This document applies to load-shedding equipment for household and similar uses. The load-shedding function is used in energy management systems to optimize the overall use of electrical energy including production and storage. Load-shedding can be used for example for energy efficiency purposes as per IEC 60364-8-1:2019.

This document applies to LSE for operation under normal conditions:

- AC circuits with a rated frequency of 50 Hz, 60 Hz or both, with a rated voltage not exceeding 440 V (between phases), a rated current not exceeding 125 A and a rated short-circuit capacity not exceeding 25 000 A; or
- DC circuits¹.

LSEs are intended to control the energy supplied to one or more load, circuit or mesh when:

- defined conditions of time and current are reached;
- a command or information from an external system is received.

An LSE is intended to serve as:

- a single equipment having all the necessary means able to control the loads (e.g. the electrical energy management function is embedded in such an equipment); or
- a unit integrated into a more complex equipment or an independent equipment being part of an electrical energy management system (EEMS); or
- an assembly of independent equipment forming an LSE (e.g. an LSE with external current sensors); or
- as a combination of the above points.

LSE can have a wireless interface.

LSE is part of the fixed installation.

NOTE 1 This document covers load shedding equipment in the fixed installations including portable appliances connected thereto.

LSE are intended for use in circuits with protection against electrical shock and over-current according to IEC 60364 (all parts).

NOTE 2 For example, fault protection (indirect contact protection) can be covered as follows:

- in TT systems, by an upstream RCBOs or RCCBs according to IEC 61008-1 and IEC 61009-1;

¹ LSE for DC circuits are under consideration.

– in a TN system, by an upstream over-current protective device.

LSEs do not, by their nature, provide an isolation function nor the over-current protection.

LSEs are normally installed by instructed persons (IEC 60050-195:1998, 195-04-02) or skilled persons (IEC 60050-195:1998, 195-04-01) and normally used by ordinary persons (IEC 60050-195:1998, 195-04-03).

This document contains all requirements necessary to ensure compliance with the operational characteristics required by type tests for LSEs based on single equipment or based on an assembly of independent equipment.

These requirements apply for standard conditions of temperature and environment as given in 5.1. They are applicable to LSEs with a degree of protection of IP 20 intended for use in an environment with pollution degree 2. For LSE having a degree of protection higher than IP 20 according to IEC 60529, for use in locations where arduous environmental conditions prevail (e.g. excessive humidity, heat or cold or deposition of dust) and in hazardous locations (e.g. where explosions are liable to occur), special construction can be required.

If other functions are included in LSE, these functions are covered by the relevant standards.

This document does not address communication aspects such as protocols, interoperability, data security and any other related aspects.

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 60065:2001, *Audio, video and similar electronic apparatus – Safety requirements*²

IEC 60085, *Electrical insulation – Thermal evaluation and designation*

IEC 60127 (all parts), *Miniature fuses*

IEC 60212, *Standard conditions for use prior to and during the testing of solid electrical insulating materials*

IEC 60317-0-1:1997, *Specifications for particular types of winding wires – Part 0: General requirements – Section 1: Enamelled round copper wire*²

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60384-14:1993, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*²

IEC 60417, *Graphical symbols for use on equipment* (available at <http://www.graphical-symbols.info/equipment>)

² A more recent edition exists for this standard.

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60695-2-10:2000, *Fire hazard testing – Part 2-10: Glowing/hot-wire based test methods – Glow-wire apparatus and common test procedure*²

IEC 60695-2-11:2000, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*²

IEC 60730 (all parts), *Automatic electrical controls*

IEC 61000-2-2, *Electromagnetic compatibility (EMC) – Part 2-2: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61032:1997, *Protection of persons and equipment by enclosures – Probes for verification*

IEC 61558-2-6, *Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V – Part 2-6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers*

CISPR 15, *Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment*

ISO 306, *Plastics – Thermoplastic materials – Determination of Vicat softening temperature (VST)*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1

electrical energy efficiency

system approach to optimize the efficiency of electrical energy use

3.2

electrical energy management system

EEMS

system operating and controlling energy resources and loads of the installations

Note 1 to entry: This note applies to the French language only.

3.3

load

any equipment connected to LSE output

Note 1 to entry: A load may include combinations of equipment, meshes or circuits.

3.4

rated load-shedding current value

$I_n L_s$

nominal value of the load-shedding current assigned to the LSE

Note 1 to entry: The load-shedding function has a specific time-current (power) characteristic as shown in 6.2 and 6.3.

Note 2 to entry: The corresponding nominal value assigned to the LSE for the rated load-shedding power is represented by $P_n L_s$.

3.5

operating cycle

minimum period of time allowed between two allowed switch OFF operation

3.6

shedding sequence

number of operating cycles as declared by the manufacturer, optionally extended to a number of lockout periods, which may or may not terminate into a permanent lockout

Note 1 to entry: A sequence is defined, for example, in terms of number of operations/lockout duration, etc.

3.7

lockout period

minimum time duration during which the LSE shall not reclose the loads after a previous attempt

3.8

load-shedding equipment

LSE

equipment able to respond to the monitored current or power, or alternative monitored parameters in order to switch ON and OFF selected loads when certain conditions are met

Note 1 to entry: An LSE may be defined with different rated values for $I_n L_s$ ($P_n L_s$).

Note 2 to entry: An LSE may be a single equipment or a combination of several units.

Note 3 to entry: An LSE able to monitor alternative parameters are under consideration.

Note 4 to entry: These conditions may include, but are not limited to:

- total load current (power) above a specified value;
- price and/or availability of energy;

- user priorities;
- climatic conditions.

Note 5 to entry: This note applies to the French language only.

3.9

mesh

group of electrical equipment powered from one or several circuits of the electrical installation for one or several zones including one or several services for the purpose of electrical energy efficiency

EXAMPLE

- one or several circuits for one service of one or several zones, for example circuits dedicated to light the kitchen, the hotel reception or lobby, the swimming pool etc.;
- one or several circuits for one or several services within one zone only, for example circuits for heating and lighting the hotel reception;
- one or several circuits dedicated to one service in one zone only, for example circuits for pumps in the north part of the water purification system.

3.10

rated conditional short-circuit current

I_{nc}

prospective current that an LSE, protected by a specified short-circuit protective device (SCPD), can satisfactorily withstand for the operating time of that device under specified conditions of use and behavior

Note 1 to entry: The text has been referred to LSE assuming that the I_{nc} definition referred to the upstream SCPD complies with IEC 60898-1:2015, 3.5.14.9.

Note 2 to entry: See also IEC 60898-1.

3.11

rated current

I_n

value of current, assigned to the LSE by the manufacturer, which the device can carry in uninterrupted duty

3.12

measured current

I_m

current measured by the load-shedding equipment at any time

Note 1 to entry: An equipment having several rated load-shedding currents (power) may measure several current (power) values at a time.

Note 2 to entry: The measured power is represented by P_m .

3.13

rated frequency

<of an LSE> value of power frequency assigned by the manufacturer for which the LSE is designed

Note 1 to entry: The same device may be assigned a number of rated frequencies.

3.14

rated making and breaking capacity

I_{RMS}

RMS value of the AC component of prospective current, assigned by the manufacturer, which an LSE can make, carry or break under specified conditions

3.15**rated impulse voltage** U_{imp}

impulse withstand voltage value assigned by the manufacturer to the equipment or to a part of it, characterizing the specified withstand capability of its insulation against transient overvoltages

[SOURCE: IEC 60664-1:2007, 3.9.2, modified – The symbol U_{imp} has been added.]

3.16**rated insulation voltage** U_i

value of voltage, assigned by the manufacturer, to which dielectric test voltages and creepage distances are referred

3.17**rated voltage**

value of voltage assigned by the manufacturer to which its performance is referred

Note 1 to entry: The same LSE may have different rated voltages.

3.18**rated operational voltage** U_e

value of voltage assigned by the manufacturer to which its performance (in particular the short-circuit performance) is referred

3.19**terminal**

conductive part of a device, provided for re-usable electrical connection to external circuits

[SOURCE: IEC 60898-1:2015, 3.3.12]

3.20**screw-type terminal**

terminal for the connection and subsequent disconnection of a conductor or the interconnection of two or more conductors, capable of being dismantled, the connection being made, directly or indirectly, by means of screws or nuts of any kind

[SOURCE: IEC 60898-1:2015, 3.3.12.1]

3.21**clamping unit**

part or parts of a terminal necessary for the mechanical clamping and the electrical connection of the conductor(s)

[SOURCE: IEC 60669-1:2017, 3.4]

3.22**terminal with screw clamping**

terminal intended for the connection, by clamping only, of (an) external rigid or flexible conductor(s)

[SOURCE: IEC 60669-1:2017, 3.5 modified – The term "screw-type terminal" has been replaced by "terminal with screw clamping".]

3.23

pillar terminal

screw-type terminal in which the conductor is inserted into a hole or cavity, where it is clamped under the shank of the screw(s)

Note 1 to entry: The clamping pressure can be applied directly by the shank of the screw or through an intermediate clamping element to which pressure is applied by the shank of the screw.

Note 2 to entry: Examples of pillar terminals are shown in Figure 7.

[SOURCE: IEC 60050-442:1998, 442-06-22, modified – In Note 1 to entry, the words "intermediate clamping element" replace "intermediate part", and Note 2 to entry has been added.]

3.24

screw terminal

terminal in which the conductor is clamped under the head of one or more screws and where the clamping pressure can be applied directly by the head of the screw or through an intermediate part, such as a washer, a clamping plate or an anti-spread device

Note 1 to entry: Examples of screw terminals are shown in Figure 8.

[SOURCE: IEC 60050-442:1998, 442-06-08, modified – Note 1 to entry has been added.]

3.25

stud terminal

screw-type terminal in which the conductor is clamped under a nut

Note 1 to entry: The clamping pressure can be applied directly by a suitably shaped nut or through an intermediate part, such as a washer, a clamping plate or an anti-spread device.

Note 2 to entry: Examples of stud terminals are shown in Figure 8.

[SOURCE: IEC 60050-442:1998, 442-06-23, modified – Note 2 to entry has been added.]

3.26

saddle terminal

screw-type terminal in which the conductor is clamped under a saddle by means of two or more screws or nuts

Note 1 to entry: Examples of saddle terminals are shown in Figure 9.

[SOURCE: IEC 60050-442:1998, 442-06-09, modified – The word "screw-type" has been added to the definition, and Note 1 to entry has been added.]

3.27

lug terminal

screw terminal or stud terminal, designed for clamping a cable lug or a bar directly or indirectly by means of a screw or nut

Note 1 to entry: Examples of lug terminals are shown in Figure 10.

[SOURCE: IEC 60050-442:1998, 442-06-16, modified – The words "screw-type terminal" have been replaced by "screw terminal or stud terminal" in the definition, and Note 2 to entry has been added.]

3.28

screwless terminal

connecting device for the connection and subsequent disconnection of a rigid (solid or stranded) or flexible conductor or the interconnection of two conductors capable of being dismantled, the connection being made, directly or indirectly, by means of springs, parts of

angled, eccentric or conical form, etc., without special preparation of the conductor concerned, other than removal of insulation

[SOURCE: IEC 60669-1:2017, 3.6 modified – The word "screwless-type" has been replaced by "screwless" in the term, and the word "terminal" has been replaced by "connecting device" in the definition.]

3.29

screwless-type terminal

terminal for the connection and subsequent disconnection obtained directly or indirectly by means of springs, wedges or the like

[SOURCE: IEC 60898-1:2015, J.3.2, modified – Note 1 to entry has been deleted.]

3.30

tapping screw

screw manufactured from a material having a greater resistance to deformation when applied by rotary insertion to a hole in a material having a lesser resistance to deformation

Note 1 to entry: The screw is made with a tapered thread, the taper being applied to the core diameter of the thread at the end section of the screw.

Note 2 to entry: The thread produced by application of the screw is formed securely only after sufficient revolutions have been made to exceed the number of threads on the tapered section.

[SOURCE: IEC 60898-1:2015, 3.3.13]

3.31

thread-forming screw

screw having an uninterrupted thread which, by screwing in, forms a thread by displacing material

Note 1 to entry: It is not a function of this thread to remove material from the hole.

Note 2 to entry: An example of thread-forming screw is shown in Figure 29.

[SOURCE: IEC 60669-1:2017, 3.7, modified – The words "in the cavity" have been deleted from the definition, and Note 1 to entry has been replaced by two new notes.]

3.32

thread-cutting screw

screw having an interrupted thread which, by screwing in, forms a thread by removing material

Note 1 to entry: An example of thread-cutting screw is shown in Figure 28.

[SOURCE: IEC 60669-1:2017, 3.8, modified – The words "from the cavity" have been deleted from the definition, and Note 1 to entry has been replaced by two new notes.]

3.33

main circuit

<of an LSE> all the conductive parts of an LSE included in the circuit which it is designed to close and open

[SOURCE: IEC 60898-1:2015, 3.2.4, modified – The word "circuit-breaker" has been replaced by "LSE" in the entry.]

3.34

control circuit

<of an LSE> circuit (other than a path of the main circuit) intended for the closing operation or opening operation, or both, of the LSE

[SOURCE: IEC 60898-1:2015, 3.2.5, modified – The word "circuit-breaker" has been replaced by "LSE" in the entry.]

3.35

auxiliary circuit

<of an LSE> all the conductive parts of an LSE intended to be included in a circuit other than the main circuit and the control circuit of the LSE

[SOURCE: IEC 60898-1:2015, 3.2.6, modified – The word "circuit-breaker" has been replaced by "LSE" in the entry.]

3.36

LSE input

supply side of an LSE current circuit

3.37

LSE output

load circuits that may be switched OFF or ON to optimize the energy use under defined conditions of time and currents (power) or other predefined conditions or based upon information received from external systems or from the electrical energy provider

Note 1 to entry: An LSE may be equipped with more than one output and may have outputs with different priorities.

3.38

priority output

output which is not switched OFF or ON by the LSE for shedding purposes

3.39

non-priority output

output which is switched OFF or ON by the LSE for shedding purposes depending on time and levels of current (power) conditions, or based on information or commands received from other systems interacting with the LSE

3.40

pollution

addition of foreign matter, solid, liquid or gaseous that can result in a reduction of electric strength or surface resistivity of the insulation

[SOURCE: IEC 60664-1:2007, 3.11]

3.41

pollution degree

number characterizing the expected pollution of the micro-environment

Note 1 to entry: The pollution degree to which equipment is exposed may be different from that of the macro environment where the equipment is located because of protection offered by means such as an enclosure or internal heating to prevent absorption or condensation of moisture.

[SOURCE: IEC 60664-1:2007, 3.13, modified – The word "numeral" has been replaced by "number" in the definition, and the note has been replaced.]

3.42**minimum and maximum current values for load-shedding** $I_{nL_{smin}}$ and $I_{nL_{smax}}$

values of current in between which an LSE switches OFF one (or more) output(s)

Note 1 to entry: According to this document, the minimum current (power) value for load-shedding is defined as equal to the no-load-shedding current (power).

Note 2 to entry: The load-shedding function has a specific time-current (or time-power) characteristics as shown in 6.2 and 6.3.

Note 3 to entry: The minimum and maximum power values for load shedding are represented by ($P_{nL_{smin}}$) and $P_{nL_{smax}}$.

3.43**load reclosing current** I_{nL_r}

value of current under which an LSE may reclose (depending on pre-defined conditions) any outputs being in open mode state

Note 1 to entry: The load reclosing power is represented by P_{nL_r} .

3.44**maximum time for load-shedding** T_{smax}

maximum allowed time duration for an LSE:

- to reduce the measured current (power) to a value lower than its no-load-shedding current ($I_{nL_{smin}}$) or power ($P_{nL_{smin}}$) whenever predefined overload conditions of current (or power) are reached; or
- to react whenever shedding is supposed to happen based on information received from an external equipment, for example the EEMS or the electrical energy provider

3.45**minimum time for load-shedding** T_{smin}

minimum time duration during which an LSE does not react to any current or power overload (switching OFF no allowed)

3.46**minimum disconnection time** T_{dmin}

minimum time duration during which an LSE is not allowed to reclose any of its output(s)

3.47**switched neutral pole**

pole only intended to switch the neutral, and not intended to have a short-circuit capacity

[SOURCE: IEC 60898-1:2015, 3.2.7.3]

3.48**closed position**

position in which the predetermined continuity of the main circuit of the LSE is secured

[SOURCE: IEC 60898-1:2015, 3.2.8, modified – The words "circuit breaker" have been replaced by "LSE" in the definition.]

3.49

open position

position in which the predetermined clearance between open contacts in the main circuit of the LSE is secured

[SOURCE: IEC 60898-1:2015, 3.2.9, modified – The words "circuit breaker" have been replaced by "LSE" in the definition.]

3.50

isolation

isolating function

function intended to cut OFF the supply from all or a discrete section of the installation by separating the installation from every source of electrical energy for reasons of safety

[SOURCE: IEC 60947-1:2007, 2.1.19, modified – The words "or the section" have been deleted in the phrase "separating the installation or section".]

3.51

actuating member

part which is pulled, pushed, turned or otherwise moved to cause an operation of the LSE

[SOURCE: IEC 60050-442:1998, 442-04-14, modified – The word "switch" has been replaced by "LSE" in the definition.]

3.52

LSE of normal-gap construction

LSE construction having a clearance between the contacts in the open position of not less than 3 mm

[SOURCE: IEC 60669-1:2017, 3.1.5, modified – The word "switch" has been replaced by "LSE" in the entry.]

3.53

LSE of mini-gap construction

LSE construction having a clearance between the contacts which is less than 3 mm but is not less than 1,2 mm

[SOURCE: IEC 60669-1:2017, 3.1.6, modified – The word "switch" has been replaced by "LSE" in the entry.]

3.54

LSE of micro-gap construction

LSE construction having a clearance between the contacts in the open position of less than 1,2 mm

[SOURCE: IEC 60669-1:2017, 3.1.7, modified – The word "switch" has been replaced by "LSE" in the entry.]

4 General requirements

4.1 General

A load-shedding equipment (LSE) shall be able to take into account:

- the measurement of the current or power within one or several circuits or meshes;
- one or several inputs (e.g. load current/power measure, energy price, user inputs, etc.).

to keep the current or power within this (or these) mesh(es) under predetermined values by connecting/disconnecting non-priority loads.

The LSE shall switch the downstream loads according to the defined time-current (power) criteria as defined in Clause 6.

Compliance is checked by meeting all the relevant requirements and tests of this document.

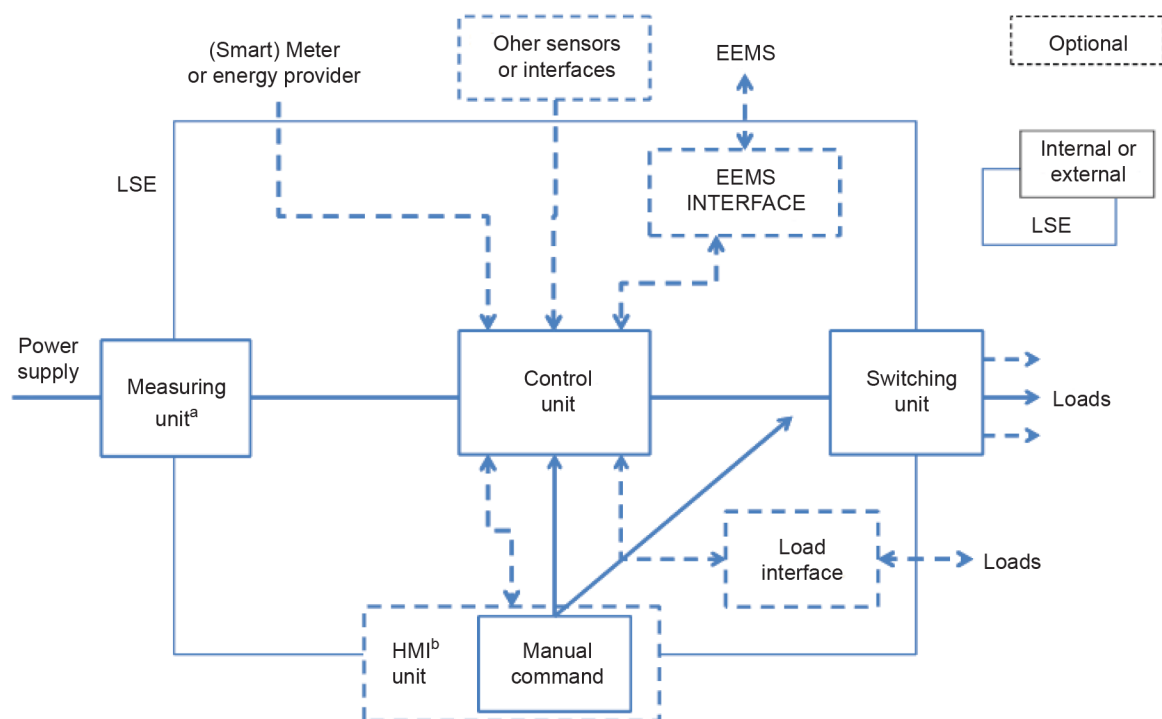
4.2 Architecture

The LSE general architecture is represented in Figure 2.

The units included in an LSE are:

- current (voltage) sensor(s) or measuring unit(s);
- control: it manages the loads depending on the following conditions:
 - current (power) values: comparison between the measured currents (power) and threshold values predefined by the user or predetermined in the LSE or via its interfaces (e.g. with an EEMS);
 - special conditions coming from utilities (e.g. smart meter) or by the EEMS (optional);
 - exchange of information with the loads, local production and/or storage units (optional);
 - user settings;
 - the control of the switching unit may be performed completely in the LSE itself or shared between the LSE and the EEMS when available in the fixed installation.
- switching (of non-priority outputs): it may be shared between the LSE and external switching unit(s);
- HMI (human machine interface): it may be shared between the LSE and the EEMS;
- EEMS interface(s), optional;
- load interface(s) (optional): it allows the information exchange with the loads (e.g. a washing machine could not be switched OFF in a specific phase of its cycle);
- additional interfaces (optional), for example for external sensors, external clocks, (smart) metering equipment.

Current (voltage or power) measurement may be provided by other external units.



IEC

--- optional

^a sensors, counter, etc.

^b human machine interface

Figure 2 – LSE general architecture

4.3 Standard conditions for operation in service

The minimum implementation of an LSE contains the current (voltage or power) sensor or measuring unit, the control unit and the switching unit, all being embedded in a single equipment or into separate units (other units being optional) as part of an Electrical Energy Management System (EEMS) (see Figure 2).

Compliance with this document is covered by type tests as following:

- a) *for a standalone LSE according to 7.6.1, all tests of this document apply.*
- b) *for an LSE according to 7.6.2, the LSE shall be tested with the sensor(s) and/or the measuring units recommended by the manufacturer and the LSE class is defined according to these specified sensor(s) or measuring units. In the case of multiple configurations, the most onerous configuration shall be tested.*
- c) *for a combined LSE according to 7.6.3, compliance with this document is obtained as follows:*
 - *all tests of this document apply to the control unit as relevant;*
 - *each external unit shall comply:*
 - *with its relevant product standard (if any), and to the relevant test(s) of this document if more stringent; or*
 - *with this document as relevant, if not covered by any other standard.*
 - *the complete system shall be tested according to 12.8 and Clause 17 with all external units and, if any, with the declared external current sensors and/or external measuring unit(s) as applicable.*

Unless otherwise specified:

- any configuration of combined LSE defined by the manufacturer, for example different switching units, shall comply with the above requirements; however, only the most onerous configuration(s) shall be tested;
- LSEs with different ratings, for example different rated current and voltages, shall also be tested for each rating, as relevant (see Clause 17).

For remotely controlled LSEs, for example EEMS-connected LSEs, a manual command is required as part of the HMI unit to disable any automatic LSE mode to be able to define and change the settings whenever needed.

For automatic LSE and remotely controlled LSE with no manual command embedded locally in the control unit (e.g. remotely controlled HMI via EEMS), the LSE shall ensure a basic operating mode in case of possible communication loss between the control unit of the LSE unit and the remote HMI.

LSEs with additional functions other than those defined in 4.2 and not covered by this document (e.g. overcurrent or isolation function) shall comply with their relevant standards.

In the case of an LSE with wireless interface, relevant standards shall apply.

5 General remarks on tests

5.1 Environmental conditions

5.1.1 General

LSEs complying with this document shall be capable of operating under the following standard conditions.

5.1.2 Ambient temperature range in normal use

LSEs are suitable for normal use at ambient temperatures normally not exceeding 40 °C, with an average value over a period of 24 h not exceeding 35 °C, with a lower limit of the ambient air temperature of –5 °C.

NOTE 1 This temperature range corresponds to "AA4" of Table 51A of IEC 60364-5-51:2005, part of the temperature range of IEC 60721-3-3, class 3K5, with the high air temperature restricted to 40 °C.

NOTE 2 In certain cases, special precautions can be necessary. Equipment intended to be used in ambient air temperatures above +40 °C (particularly in tropical countries) or below –5 °C can either be specially designed or be used according to the information given by manufacturers in their technical documentation.

5.1.3 Relative humidity

Unless otherwise specified, the maximum relative humidity of air does not exceed 50 % at the temperature of 40 °C.

Higher relative humidity values are admitted at lower temperatures (for example 90 % at 20°C).

Care should be taken by appropriate means (for example drain holes) of moderate condensation which may occasionally occur due to variations in temperature.

5.1.4 Altitude

Unless otherwise specified, LSEs are intended to be installed at an altitude not higher than 2 000 m (6 600 ft).

For installations at higher altitudes, it is necessary to take into account the reduction of the dielectric strength and of the cooling effect of the air. Equipment intended to be so used shall be designed specially or used according to an agreement between manufacturer and user. Information by manufacturers in their technical documentation may take the place of such an agreement.

5.2 General testing procedure and samples

Tests shall be carried out in test sequences and on specimens as defined in Table A.1.

Unless otherwise specified:

- the specimens are tested as delivered and under normal conditions of use;
- tests (or tests sequences) are carried out on specimens in a clean and new conditions;
- 3 specimens are tested per test sequence;

During the tests, no maintenance or dismantling of the samples is allowed and specimens shall not be lubricated.

- tests are carried out at in free air at an ambient temperature of $(20 \pm 5) ^\circ\text{C}$;
- tests are carried out at the rated frequency ± 5 Hz and at any convenient voltage;
- tolerances are set at $^{+5}_0$ % for currents, ± 5 % for voltages (including recovery voltage), at $^{0}_{-0,05}$ for power factors and at ± 5 % for time.

Where a tolerance is not specifically specified, type tests are carried out at values not less severe than those specified in this document.

Unless otherwise specified:

- the specimens are wired with appropriate cables as specified in Table 1;
- the tightening torques to be applied to the terminal screws are two-thirds of those specified in Table 14, and screws and nuts shall not be tightened in jerks;
- the specimens are fixed on a dull, black-painted plywood board of about 20 mm thickness, the method of fixing complying with any requirements relating to the means of mounting recommended by the manufacturer.

Table 1 – Cross-sectional areas (S) of test copper conductors corresponding to the rated currents

Cross-sectional areas S mm^2	Values of the rated current I_n A
1	$I_n \leq 6$
1,5	$6 < I_n \leq 13$
2,5	$13 < I_n \leq 20$
4	$20 < I_n \leq 25$
6	$25 < I_n \leq 32$
10	$32 < I_n \leq 50$
16	$50 < I_n \leq 63$
25	$63 < I_n \leq 80$
35	$80 < I_n \leq 100$
50	$100 < I_n \leq 125$

NOTE For the correspondence between ISO and AWG copper conductors, see Annex B.

Specially prepared specimens may be needed for some tests, for example for Clauses 15, 16, 17 and 26 where the manufacturer can provide specimens with a special circuit to simulate the automatic operations.

6 Ratings

6.1 Rated values

6.1.1 Rated operational voltages

The values of rated voltages are:

- AC single phase: 120 V, 230 V line to neutral;
- AC three phase: 120/208 V, 230/400 V (line to neutral/line to line);
- DC rated voltage: under consideration.

NOTE 1 Wherever in this document there is a reference to 230 V or 400 V, they can be read as 220 V or 240 V 380 V or 415 V respectively.

NOTE 2 Wherever in this document there is a reference to 120 V, 240 V or 120/240 V, they can be read as 100 V or 110 V, 200 V or 100/200 V respectively.

NOTE 3 In IEC 60038, the network voltage value of 230/400 V has been standardized. This value will progressively supersede the values of 220/380 V and 240/415 V.

6.1.2 Rated insulation voltage

Unless otherwise stated, the rated insulation voltage is the value of the maximum rated voltage of the LSE. In no case shall the maximum rated voltage exceed the rated insulation voltage.

6.1.3 Rated impulse voltage

The rated impulse voltage of an LSE shall be equal to or higher than the standard values of rated impulse voltages of Table 2.

Table 2 – Rated impulse voltage as a function of the nominal voltage of the installation

Rated impulse voltage U_{imp} kV	Nominal voltage of the installation		
	Single phase systems V	Single-phase systems with mid-point earthed V	Three-phase systems V
2,5	120	120/240	120/208
4	230	120/240, 240	230/400, 400

6.1.4 Maximum value of rated current

- AC: single/three phase: 125 A;
- DC: under consideration.

6.1.5 Preferred rated current values (I_n)

- AC: single/three phase: 6 A, 8 A, 10 A, 13 A, 16 A, 20 A, 25 A, 32 A, 40 A, 50 A, 63 A, 80 A, 100 A and 125 A;
- DC: under consideration.

6.1.6 Minimum value of rated making and breaking capacity (I_{RMS})

1,25 I_{n} .

6.1.7 Rated frequency

50 Hz and 60 Hz.

6.1.8 Rated conditional short-circuit current

- Standard values up to and including 10 000 A: 1 500 A, 3 000 A, 4 500 A, 6 000 A, 10 000 A.

NOTE The values of 1 000 A, 2 000 A, 2 500 A, 5 000 A, 7 500 A and 9 000 A are also considered as standard in some countries.

- Values above 10 000 A up to and including 25 000 A: the preferred value is 20 000 A.

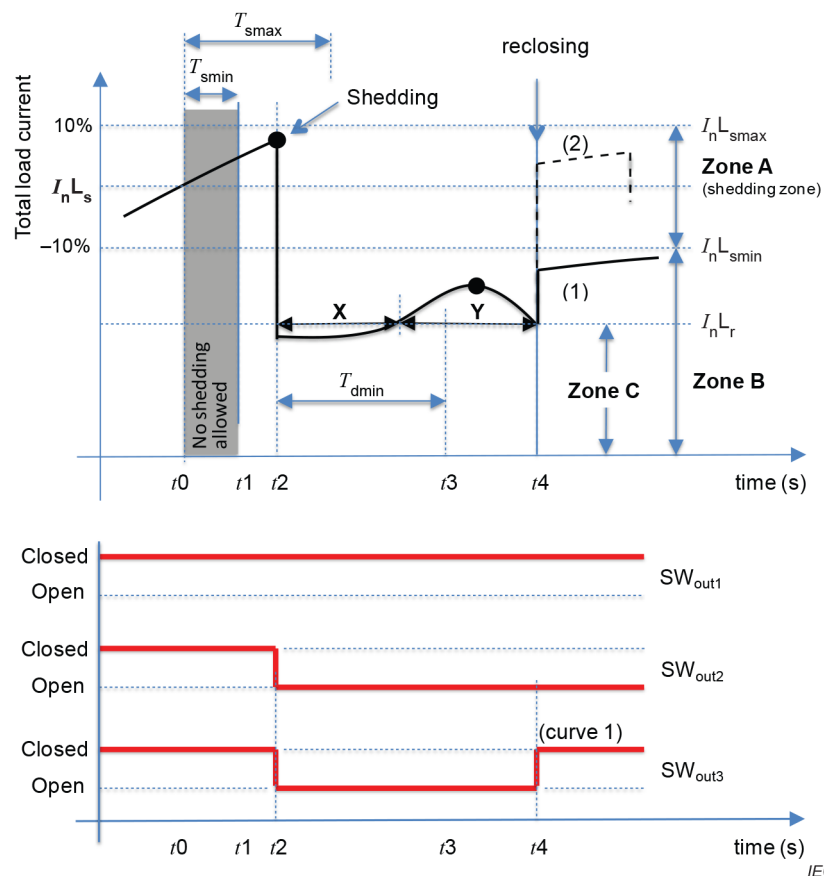
6.1.9 Preferred rated load-shedding current (power) values (I_{nLs} , P_{nLs})

Preferred values of rated load-shedding current (I_{nLs}) are: 1 A, 2 A, 4 A, 6 A, 8 A, 10 A, 13 A, 16 A, 20 A, 25 A, 32 A, 40 A, 50 A, 63 A, 80 A, 100 A and 125 A.

Preferred values of rated load-shedding power (P_{nLs}) are: 500 W, 1 kW, 2 kW, 3 kW, 4 kW, 6 kW, 9 kW, 12 kW, 15 kW, 30 kW, 45 kW, 60 kW, 80 kW and 100 kW.

6.2 Time-current characteristic for LSEs monitoring the current**6.2.1 LSE operating principle**

In case of currents higher than predefined limits, LSEs shall be able to react within defined conditions of time and currents as defined in Table 3 and Table 4 and as shown Figure 3.



Key

t_0	time when the value of $I_n L_s$ is reached
$t_1 (= t_0 + T_{smin})$	time limit until which shedding is not allowed (no switching OFF to prevent hysteresis, i.e. to prevent unwanted switching in case of short LSE overloads)
$t_2 (\geq t_0 + T_{smin})$	opening of one (or more) output(s), reducing the current to a value lower than $I_n L_{smin}$ Opening shall happen before the measure current reaches $I_n L_{smax}$ and before T_{smax} (in this example, outputs 2 and 3 of the LSE are switched OFF. Output 1 is not switched OFF since the current is already low enough).
$t_3 (= t_2 + T_{dmin})$	time limit until which reclosing is not allowed
$t_4 (t_4 \geq t_3)$	LSE reclosing (the measured current is lower or equal than $I_n L_r$) since enough time has elapsed In this example, output 3 is reclosed (curve 1) but output 2 is not reclosed (the current is already higher than $I_n L_r$ after reclosing output 3). Curve (2): example where the current being too high after reclosing output 2, the LSE would again switch OFF its output(s).
Range X	current is low enough but reclosing is not allowed because not enough time has elapsed
Range Y	reclosing is not allowed because the current is too high (current $> I_n L_r$) even when enough time has elapsed ($t \geq t_3$)
$I_n L_s$	rated load-shedding current (current settings)
$I_n L_{smax}$	maximum current for load-shedding
$I_n L_{smin}$	minimum current for load-shedding
$I_n L_r$	load-reclosing current
T_{smax}	maximum time for load-shedding
T_{smin}	minimum time for load-shedding
T_{dmin}	minimum disconnection time during which reclosing is not allowed
Zone A	range of currents within which the LSE shall switch OFF one (or more) outputs as long as the measured currents are located within these values according to the declared LSE class
Zone B	range of currents within which the LSE shall never switch OFF any output as long as the measured currents are lower than $I_n L_{smin}$
Zone C	range of currents within which the LSE shall reclose its outputs once enough time (T_{dmin}) has elapsed

Figure 3 – Time-current characteristic of a Class A LSE

In Table 3, load-shedding classes of LSE are defined. LSEs may be classified according to different classes in which case tests shall be carried out for each class:

- standard load-shedding classes (LSE classes): A; B; C and D. D is the maximum allowed class;
- preferred values for T_{smin} : 0,5 s; 1 s; 1,5 s; 2 s; 3 s; 4 s; 5 s; 6 s; 8 s. 0,5 s is the minimum allowed time;
- preferred values for T_{dmin} : 1 min; 2 min; 5 min; 10 min ... 60 min;
- preferred values of T_{smax} : 1 s; 2 s; 5 s; 10 s. T_{smax} values shall comply with Table 4.

6.2.2 Current limits ($I_n L_s$)

The LSE shall be able to successively or simultaneously disconnect all its outputs as long as the current measured by the LSE is within the values of currents defined in Table 3 for load-shedding.

Table 3 – Load-shedding classes

Load-shedding class (LSE class)	Minimum value for load-shedding $I_n L_{smin}$	Maximum value for load-shedding $I_n L_{smax}$
A	$> 0,95 I_n L_s$	$< 1,05 I_n L_s$
B	$> 0,9 I_n L_s$	$< 1,1 I_n L_s$
C	$> 0,8 I_n L_s$	$< 1,2 I_n L_s$
D	$> 0,8 I_n L_s$	$< 1,5 I_n L_s$

Compliance of the LSE is tested according to 17.1.2 and 17.1.3.

For an LSE of class A, current tolerance is reduced to 0_{+2} % in the case of functional tests in 17.1.2 and 17.1.3.

6.2.3 Minimum switch OFF-time

To avoid unwanted switching, no switching shall ever happen for times lower than $T_{smin} = 0,5$ s.

NOTE 1 Lower values can be needed depending on local country regulations or on needs from local energy providers.

In case of currents higher than current values of $I_n L_{smin}$ in Table 3, the LSE shall be able to successively or simultaneously disconnect all its monitored outputs within time values lower than T_{smax} as defined Table 4.

Table 4 applies in case of overload conditions, i.e. when currents are higher than $I_n L_s$.

Table 4 – Disconnecting time

LSE class	$I_m/I_n L_s$	Minimum time T_{smin} s	Maximum time T_{smax} s
A	1,05	0,5	30
B	1,1	0,5	10
C	1,2	0,5	4
D	1,4	0,5	2

A value of T_{smin} different from 0,5 s can be used, in which case T_{smin} shall be declared and tests shall be passed as declared.

NOTE 2 Faster reaction times can be needed depending on local country regulations or local energy providers.

For LSEs declared according to classes A or B, an additional test shall be carried out according to 17.1.2 and 17.1.3.

LSEs which are equipped to receive information or orders from external systems such as an EEMS, or from the energy provider, shall be able to disconnect their controlled outputs as declared by the manufacturer, depending on possible specific needs.

Compliance of the LSE is tested according to 17.1.2 and 17.1.3.

6.2.4 Reclosing conditions

6.2.4.1 General

If the measured current is higher than the no-load shedding current ($I_n N_s$), the LSE shall not reclose any of its open output(s).

The LSE shall be able to successively or simultaneously connect back (reclose) its monitored outputs, as long as the current at the LSE input is lower than $I_n L_r$ as declared by the manufacturer.

Reclosing can be subjected to:

- conditions according to 6.2.4.2, or
- other conditions such as:
 - shedding sequence (see 6.4), or
 - to information received from external systems (e.g. information from energy systems providers), or
 - to other possible conditions as declared by the manufacturer,

in which case Table 3 and 6.2.4.2 may not apply, and switching/reclosing conditions shall be tested as declared by the manufacturer according to Clause 17.

6.2.4.2 Minimum disconnecting time (after switching OFF)

This is the minimum disconnection time (T_{dmin}) during which the opening means remain in open position. This is applicable whenever the outputs were set in open mode because of too high currents (higher than the settings). This value may be fixed or adjustable.

A minimum disconnection time is needed to prevent the LSE to enter in unstable conditions (LSE switching OFF and ON if the values of the measured current are too closely located within $I_n L_s$ range when the outputs are switched).

The value of T_{dmin} shall be declared and tests conducted accordingly.

Compliance of the LSE is tested according to Clause 17.

6.3 Time-power characteristic

For an LSE monitoring the power, a complete analogy is to be made with 6.2 to define the LSE time-power characteristic, in which case shedding and reclosing as described in 6.2 (for current monitoring) shall comply with Table 5 and Table 6 for power monitoring (see also 17.1.1).

Table 5 – Load-shedding classes

Load-shedding class (LSE class)	Minimum value for load-shedding $P_n L_{\text{smin}}$	Maximum value for load-shedding $P_n L_{\text{smax}}$
A	> 0,95	< 1,05
B	> 0,9	< 1,1
C	> 0,8	< 1,2
D	> 0,8	< 1,5

Table 6 – Disconnecting time

LSE class	$P_m/P_n L_s$	Minimum time T_{smin} s	Maximum time T_{smax} s
A	1,05	0,5	30
B	1,1	0,5	10
C	1,2	0,5	4
D	1,4	0,5	2

For an LSE of class A, current and voltage tolerances are reduced to respectively $^{+2}_0$ % and ± 1 % in the case of functional tests in 17.1.2 and 17.1.3.

6.4 LSE shedding sequence

Some current using equipment may not allow to be switched ON and OFF all the time. Shedding might cause premature aging of such current using equipment within installations in case of multiple reclosing attempts. To prevent this, manufacturers may define sequences for LSE operation after a first reclosing attempt. These may depend on local parameters or information gathered by the LSE from the EEMS.

Manufacturers may define sequences based on (including but not limited to):

- a maximum number of operations, for example 3, before which the LSE enters in a lockout mode for a defined time, for example 1 h;
- lockout periods during which reclosing cannot happen after previous attempt(s);
- a mix of above or similar sequences.

When doing so, manufacturers shall declare LSE sequences, for example:

- the number of operations and time/sequences, lockout delays, etc.;
- conditional reclosing parameters, LSE setups.

These may be fixed or adjustable and can be given in terms of seconds, minutes or hours.

Compliance of the LSE is tested according to Clause 17.

7 Classification

7.1 General

The load-shedding capability may be applied in different installation schemes, depending on the EE design of the installation itself.

7.2 According to the LSE functional category

LSEs are classified according to four functional categories as defined in Table 7: basic, advanced, smart meter ready and EEMS connected.

In Table 7, the functionalities of each functional category are defined.

Table 7 – Load-shedding functional categories

Functions	Basic	Advanced	Smart meter ready	EEMS connected
Current or power sensing	X	X	X	X
Processing and evaluation	X	X	X	X
Switching	X	X	X	X
Manual command	X	X	X	X
HMI	O	X	O	X
EEMS interface	O	O	O	X
Load interface	O	X	O	X
Smart meter interface	O	O	X	X
Key X: required O: optional				

LSEs may integrate all these functionalities in a single stand-alone equipment or may have external units (e.g. external current sensor). In 4.2, the LSE general architecture is presented together with the functionalities.

Each function shall be tested according to the functional category and the LSE class specified by the manufacturer based on the following classification according to:

- the switching means (see 7.3);
- the possibility of adjusting the load-shedding current(s) (see 7.4);
- the load-shedding sequence (see 7.5);
- the design (see 7.6);
- the method of mounting (see 7.7);
- the type of terminals (see 7.8);
- the contact openings (see 7.9);
- the protection against external influences (see 7.10);
- the number of poles (see 7.11);
- the type of monitored parameters (see 7.12).

7.3 According to the switching means

- electromechanical switching ON/OFF means;
- solid state switching ON/OFF means.

Specific requirements for solid state switching devices are under consideration.

7.4 According to the possibility of adjusting the rated load-shedding current(s) (or power)

- LSE with a single value of rated load-shedding current (power);
- LSE with multiple settings of load-shedding currents (power).

In case of EEMS, the load-shedding current (power) maybe any value within a fixed interval.

7.5 According to the shedding sequence

- LSE without a shedding sequence;
- LSE with a declared shedding sequence.

7.6 According to the design

7.6.1 Stand-alone LSE with internal or external sensors or measuring units

An LSE designed within one single enclosure including opening means for switching ON/OFF, terminals and all necessary features such as the monitoring units (timers, settings, logic, human interface if any etc.). In the case of external sensors or measuring devices, they are specified to be used with that LSE model.

7.6.2 LSE with external sensor

An LSE reliant on external sensors or measuring units which are not dedicated to such LSE.

7.6.3 Combined LSE (or assembled LSE)

An LSE being assembled on site and comprising of several, units with at minima the control unit, one switching unit and one current sensing/measuring unit as declared by the manufacturer. Such an LSE may also comprise optional units in addition.

7.7 According to the method of mounting

With reference to the general classification of IEC 60669-1:2017, LSEs are classified as:

- surface-type;
- flush-type;
- semi flush-type;
- panel-type (also referred as panel board type or distribution board).

NOTE This type is intended to be rail mounted.

7.8 According to the type of terminals

- with screw type terminals;
- with screwless type terminals.

NOTE 1 In the following countries, LSEs with screw terminals for rigid conductors only are not allowed: DE, DK, IT, ZA.

NOTE 2 In the following country, LSEs with screwless terminals for rigid conductors only are not allowed: IT.

7.9 According to the contact openings

- LSE of micro-gap construction;

- LSE of mini gap construction;
- LSE of normal gap construction;
- LSE with semiconductors.

7.10 According to the protection against external influences

With reference to the general classification reported in this document, LSEs are classified as:

- enclosed-type (not requiring an appropriate enclosure);
- unenclosed-type (for use with an appropriate enclosure).

7.11 According to the number of poles

- a single-pole LSE;
- a two-pole LSE;
- a three-pole LSE;
- a three-pole plus switched neutral LSE;
- a four pole LSE.

7.12 According to the type of monitored parameters

- LSE monitoring the current;
- LSE monitoring the power.

8 Markings and information

8.1 General

Markings and information shall comply with the requirements reported in Table 8.

Markings shall be easily legible, durable and indelible. They shall not be placed on screws, washers or other removable parts.

Table 8 – Marking and position of marking

	Marking or information item	Position of the marking or information		
		Visible on product when installed	On the product	In a leaflet
a	Manufacturer's name or trade mark		X	X
b	Type designation, catalogue number or serial number		X	X
c	Rated voltage(s) and symbol for the nature of supply	X		X
d	Rated current (I_n) ^a	X		
e	Rated frequency; LSEs with more than one rated frequency (e.g. 50/60 Hz) shall be marked accordingly		X	X
f	Rated making and breaking capacity in amperes (I_{RMS})		X	X
g	The degree of protection (only if different from IP 20)			X
h	The position of use, if necessary			X
i	Wiring diagram, unless the correct connection mode is evident		X	X
j	Rated load-shedding current ($I_n L_s$) or power ($P_n L_s$) value(s)			X
k	LSE class		X	X
L	Length of insulation to be removed before the insertion of the conductor into the screwless type terminal, if applicable		X	X

	Marking or information item	Position of the marking or information		
		Visible on product when installed	On the product	In a leaflet
m	Symbol "r" for the suitability to accept rigid conductors only		X	X
n	Load reclosing current ($I_n L_r$) or power ($P_n L_r$)			X
o	Minimum time for load shedding (T_{smin})			X
p	Minimum disconnection time (T_{dmin})			X
q	Shedding sequences (if declared, see 6.4)			X
r	SCPD characteristics			X
s	Rated conditional short-circuit current (I_{nc})			X
a	Rated current value of the LSE input(s) and of its outputs, if necessary.			

If there is no marking on the terminals, they are considered suitable to accept both rigid and flexible conductors.

Terminals intended for the protective conductor, if any, shall be indicated by the symbol  (IEC 60417-5019:2006-08).

Marking related to embedded functions (e.g. overcurrent protection) not covered by this document shall comply with their relevant standards, and the standards of reference shall be stated by manufacturers in their technical documentation.

Compliance with this 8.1 is checked by inspection and by the test of 8.2. Markings made by impression, mouldings or engraving are not subjected to this test.

8.2 Test of markings

The test is made by rubbing the marking by hand for 15 s with a piece of cotton soaked with water and again for 15 s with a piece of cotton soaked:

- with aliphatic solvent hexane with a content of aromatics of maximum 0,1 % by volume, a kauributanol value of 29, an initial boiling-point of approximately 65 °C, a dry-point of approximately 69 °C and a density of approximately 0,68 g/cm³; or
- with n-hexane 95 % (chemical abstracts service registry number CAS RN 110-54-3).

NOTE n-hexane 95 % (chemical abstracts service registry number, CAS RN, 110-54-3) is available from a variety of chemical suppliers as a high-pressure liquid chromatography (HPLC) solvent.

After this test, the marking shall be easily legible.

Markings shall also remain easily legible after all the tests of this document.

It shall not be possible to remove labels easily and they shall show no curling.

9 Protection against electric shock

9.1 General

Live parts of the LSE shall not be accessible when it is mounted and wired as in normal use and even after removal of parts which may be removed without the use of a tool.

A part is considered accessible if it can be touched by the test finger (see 9.2).

External parts, other than screws or other means for fixing covers and labels, which are accessible when they are mounted and wired as for normal use shall either be made of insulating material or be lined throughout with insulating material, unless the live parts are within an internal enclosure of insulating material.

Linings shall be fixed in such a way that they are not likely to be lost during installation. They shall have adequate thickness and mechanical strength and shall provide adequate protection at places where sharp edges occur.

Inlet openings for cables or conduits shall either be made of insulating material or be provided with bushings or similar devices of insulating material. Such equipment shall be reliably fixed and shall have adequate mechanical strength.

Push-buttons and the like shall be made of insulating material. Metallic operating means, if any, shall be insulated from live parts and their exposed conductive parts shall be covered by insulating material.

Compliance is checked by inspection and by tests of 9.2.

9.2 Test for protection against electric shock

This verification is applicable to those parts of equipment which are exposed to the operator when mounted for normal use.

The test is made with the standard test finger shown in Figure 4, on the specimen mounted for normal use and fitted with conductors of the smallest cross-sectional areas specified in Table 9. The test is then repeated with conductors of the largest cross-sectional areas specified in Table 9.