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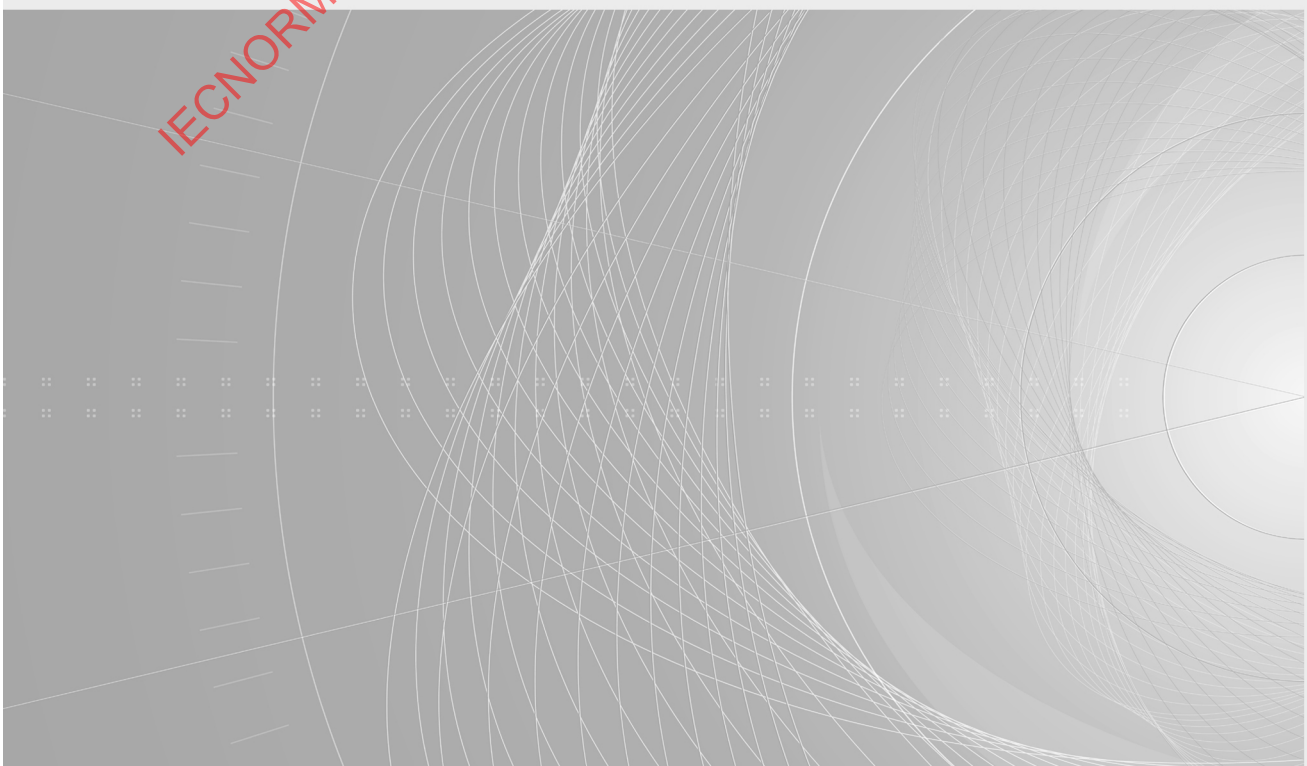
Edition 1.0 2021-10

TECHNICAL SPECIFICATION

General requirements for lighting systems – Safety



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INTERNATIONAL
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GENERAL REQUIREMENTS FOR LIGHTING SYSTEMS – SAFETY

FOREWORD

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IEC TS 63117 has been prepared by IEC technical committee 34: Lighting. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
34/809/DTS	34/840/RVDTS

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

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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- withdrawn,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.

INTRODUCTION

Lighting systems are becoming more common, not only to save energy but also to improve human well-being.

These systems are often comprised of many different products (luminaires, sensors, controllers, touch panels and other human interfaces, etc.) which are connected through communication cabling or wirelessly, where the light output can be varied based on the input from sensors or users.

This safety document is intended to cover those safety aspects that are specific to a lighting system and are not covered by existing standards. This document does not address safety aspects that are already covered in:

- product safety standards,
- installation safety standards.

IEC Guide 110 gives guidance on determining which electrical safety aspects of systems should be covered. Products that are considered safe, according to the relevant product safety standard, need to remain safe when connected to a network. The products need to remain safe under normal, abnormal and single fault conditions of any product connected to the lighting network.

For this purpose, the following electrical safety aspects are mentioned in IEC Guide 110:

1) protection from overvoltages on the network;
2) protection from hazards caused by connection of different types of circuits;
3) limitation of network interface leakage current;
4) protection from overheating of the communication network.

By correctly classifying a network, and by applying the required electrical insulation between different types of circuits, a manufacturer of products can design products to be safely connected to such a network.

Since it is not clear how many products will be connected to a network, due to the fact that lighting systems are often tailor-made, the designer of the lighting system is responsible for ensuring that the accumulated network interface leakage current from all products connected to the network does not exceed an acceptable limit. For the system designer it is therefore important that the product individual network touch current is specified in product documentation, and that system limits are given in a system publication. This document provides system network interface leakage current limits for different types of networks.

Communication networks can also be used for limited powering. The currents in these cables are not known to the installer, since they depend on the products used in the system as specified by the person designing the system. So, the person responsible for system design needs to take measures specified in system safety publications in order to avoid overheating of this cabling.

Functional safety is part of the overall safety that depends on functional and physical units operating correctly in response to their inputs. This document also covers functional safety aspects at the system level. For lighting systems, functional safety is normally related to communication errors, incorrect software (response), or foreseeable misuse. This document assists system designers in assessing the product characteristics for their inclusion in a system.

Lighting systems are not always considered to be associated with functional safety unless the light properties are relevant for the safety of the installation and surroundings. For example, in a tunnel, an inappropriate light level after power restoration can cause a safety issue.

GENERAL REQUIREMENTS FOR LIGHTING SYSTEMS – SAFETY

1 Scope

This document specifies the safety requirements of lighting systems at the system level, applicable when designing a lighting system.

A lighting system comprises a set of products. Safety requirements of the products are not covered in this document, but specified in product safety standards.

NOTE For emergency lighting systems, national or regional regulations provide relevant information that can be firstly consulted.

This document specifies safety requirements for lighting systems based on specific networks.

This document does not cover cyber-security and information security of lighting systems.

This document does not apply to lighting systems to be installed in potential explosive atmospheres which are under the scope of IEC TC 31.

For lighting systems based on an information and communication technology (ICT) network, refer to IEC 62949. For lighting systems based on a home and building electronic system and building automation and control system (HBES/BACS) network, refer to IEC 63044-3.

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 60364-4-44:2007, *Low-voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances*
IEC 60364-4-44:2007/AMD1:2015
IEC 60364-4-44:2007/AMD2:2018

IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage supply systems – Part 1: Principles, requirements and tests*

IEC 62504, *General lighting – Light emitting diode (LED) products and related equipment – Terms and definitions*

IEC 62949, *Particular safety requirements for equipment to be connected to information and communication technology networks*

IEC 63044-3, *Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) – Part 3: Electrical safety requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60664-1 and IEC 62504 and the following apply.

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

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

3.1
lighting system
system designed to provide lighting

Note 1 to entry: The lighting system can be dedicated to

a) the support of one of more specified visual tasks under specified conditions considering other requirements such as human comfort, safety, the appearance of the surrounding environment and energy consumption;

b) the support of other than human tasks.

Note 2 to entry: The lighting system can include a set of light sources, other physical components, communication protocols, user interfaces, software and networks to provide control and monitoring functions.

Note 3 to entry: The light source(s) and the related equipment can be integrated in a single item, e. g. an LED module, a lamp or a luminaire.

Note 4 to entry: A lighting system can be networked to provide central or remote control and monitoring functions.

Note 5 to entry: A lighting system can be connected to or integrated with other systems or devices.

[SOURCE: IIEC 60050-845:2020, 845-27-010]

3.2
lighting system network
interconnection (wired or wireless) between lighting system products used for communication

Note 1 to entry: A lighting system network can carry digital data as well as analogue signals.

Note 2 to entry: Interconnection can also be used for powering.

3.3
low voltage
LV
any rated voltage up to 1 000 V in alternative current with rated frequencies up to 30 kHz or 1 500 V in direct current

3.4
extra-low voltage
ELV
voltage which does not exceed 50 V in alternative current or 120 V in direct current (ripple free) between conductors or between any conductor and earth

Note 1 to entry: "Ripple free" is conventionally defined for sinusoidal ripple voltage as a ripple content of not more than 10 % RMS: the maximum peak value does not exceed 140 V for a nominal 120 V ripple-free DC system.

Note 2 to entry: This voltage corresponds with the value given in IEC 61140:2016, Table 1.

Note 3 to entry: For interrupted direct current, for frequencies between 10 Hz and 200 Hz, the maximum peak voltage limit for ELV is 50 V, this limit includes a possible ripple. For frequencies outside this frequency range the limits of direct current apply.

3.5
SELV system
electric system in which the voltage cannot exceed the value of extra-low voltage:

- under normal conditions and
- under single fault conditions, including earth faults in other electric circuits

Note 1 to entry: SELV is the abbreviatedd term for "safety extra-low voltage".

[SOURCE: IEC 60050-826:2004, 826-12-31]

3.6
FELV system
electric system with ELV voltage for functional reasons and not fulfilling the requirements for SELV or PELV

Note 1 to entry: FELV has basic insulation from LV.

Note 2 to entry: Requirements for basic and fault protections of FELV circuits are given in IEC 60364-4-41:2005, 411.7.

Note 3 to entry: FELV is the abbreviated term for "functional extra-low voltage".

3.7
PELV system
electric system in which the voltage cannot exceed the value of extra-low voltage:

- under normal conditions and
- under single fault conditions, except earth faults in other electric circuits

Note 1 to entry: PELV is the abbreviated term for "protective extra-low voltage".

[SOURCE: IEC 60050-826:2004, 826-12-32]

3.8
functional safety
part of the overall safety that depends on functional and physical units operating correctly in response to their inputs

[SOURCE: IEC 60050-351:2013, 351-57-06, modified – The Note 1 to entry has been deleted.]

3.9
system designer
<of lighting systems> any individual or organization responsible for the design of the lighting system

3.10
network interface leakage current
electric current in an unwanted conductive path under normal operating conditions in the network interface

3.11
touch current
electric current passing through a human body or through an animal body when it touches one or more accessible parts of an electrical installation or electrical equipment

[SOURCE: IEC 60050-826:2004, 826-11-12]

4 General

A lighting system shall be designed, constructed and installed so that in normal use it operates safely for the user or surroundings. Safety is achieved by reducing risk to a tolerable level as specified in ISO/IEC Guide 51.

NOTE Standards for installation can be found in IEC 60364 (all parts), especially IEC 60364-4-41, IEC 60364-4-42, IEC 60364-4-43 and IEC 60364-5-53, as well as local installation regulations.

Lighting product interfaces to another system shall comply with the relevant interface standard. All product interfaces to the lighting system shall be classified and selected to comply with the insulation requirements of this document.

Where in this document the terms "product(s)", "equipment" and "device(s)" are used, it is understood to stand for "component(s) of a lighting system or its subsystem", except where it is obviously assigned to another meaning.

Compliance is checked by meeting the requirements of Clause 6 and Clause 7.

5 Classification of lighting system network

Lighting systems networks are classified as follows:

ICT network – Information and communication technology networks, for example, network based on Power over Ethernet (POE).

HBES/BACS network – Network and product interfaces specified in the IEC 63044 series.

Lighting system specific network – Lighting system specific networks include all networks applied to the lighting system that are not ICT or HBES/BACS networks. Types of networks of a lighting system specific network are LV, FELV, SELV and PELV.

Examples of LV

- power line communication (PLC) on mains wiring;
- "push dim", using mains voltage as a signal to change settings.

Examples of SELV

- DMX 512 for entertainment lighting system or landscape lighting.

Examples of FELV

- Digital addressable lighting interface according to the IEC 62386 series, 1 V to 10 V dimming protocol according to IEC 63128.

6 Electrical safety

6.1 Protection against hazards in the system products

All system components (products) of a lighting system shall comply with the relevant product safety standards, and shall be selected and constructed into the system according to manufacturer's instructions taking into consideration the environment in which they are installed and compatibility with the surrounding products.

Compliance is checked by verifying the product documentation.

6.2 Protection against network overvoltage and leakage current

6.2.1 Lighting system based on an ICT network

Where the system comprises products connected via an ICT network interface, interconnection circuits and cabling shall be selected by the system manufacturer and/or the system designer to provide continued conformance to the requirements of IEC 62949.

6.2.2 Lighting system using an HBES/BACS network

Where the system comprises products connected via an HBES/BACS network interface, interconnection circuits and cabling shall be selected by the system manufacturer and/or the system designer to provide continued conformance to the requirements of IEC 63044-3.

6.2.3 Lighting system based on a specific network

6.2.3.1 Insulation between the circuits

All interconnected components of the lighting system shall have the same insulation classification as that of the network interfaces (e.g. SELV-SELV; FELV-FELV).

NOTE Components can be designed to be appropriate for multiple classifications, e.g. a controlgear control circuit can be suitable for both SELV and FELV providing suitable insulation for both systems.

Where the system comprises products connected via a lighting system specific network that has no standardized insulation requirements, the insulation between the lighting system specific network, including interfaces, and other circuits shall comply with Table 1. System designers and installers are recommended to ask product manufacturers for insulation characteristics of the interface in order to verify the insulation between the various networks, as given in Table 1.

Table 1 – Insulation requirements

		Types of lighting system specific networks (interfaces)		
		LV	**SELV or PELV**	**FELV[a]**
Types of other circuits	**LV**	For each circuit, basic insulation rated for the highest voltage present	Double or reinforced insulation	Basic insulation rated for the highest voltage present
	SELV or PELV	Double or reinforced insulation	For each circuit, basic insulation	Double or reinforced insulation
	FELV[a]	For each circuit, basic insulation rated for the highest voltage present	Double or reinforced insulation	Not required except for functional purpose[b]

To fulfil the requirements of IEC 61140, provisions for basic protection and for fault protection are needed. The term "protective separation" covers: double insulation, or basic insulation and electrically protective screening (shielding), or reinforced insulation.

[a] The power source of the FELV system shall be either a transformer with at least basic insulation between windings or shall comply with SELV or PELV requirements. If the FELV system is supplied by equipment which does not provide at least basic insulation between the input circuit and the FELV system, the output circuit is deemed to be an extension of the input circuit and should be protected by the protective measure applied in the input circuit.

[b] See IEC 61347-1:2015, 15.4.3.

No insulation between circuits is required where the hazard of insulation breakdown does not exist, for example:

– control signals are injected via the mains terminals of circuits connected to the mains;
– control signal receiver and antenna are inside the product case and the signal is wireless;
– control interfaces are only to be used together with products inside the luminaire and external wired network connection is not available.

6.2.3.2 Protection against overvoltage

Products to be connected to a lighting system specific network shall be selected to have the appropriate overvoltage category according to IEC 60664-1:2020, 4.3 and IEC 60364-4-44:2007, Clause 443.6 and IEC 60364-4-44/AMD1:2015, Clause 443.6. System designers and

installers shall obtain the overvoltage category information from product manufacturers or responsible vendors in order to provide a safe interconnection.

NOTE 1 For products that are part of the fixed installation, overvoltage category III applies.

NOTE 2 Luminaires, controlgear and light sources that comply with the relevant safety standard without further information comply with the requirements of overvoltage category II.

Compliance is checked by inspection.

6.2.3.3 Summation of network interface leakage current from the lighting system specific network interfaces

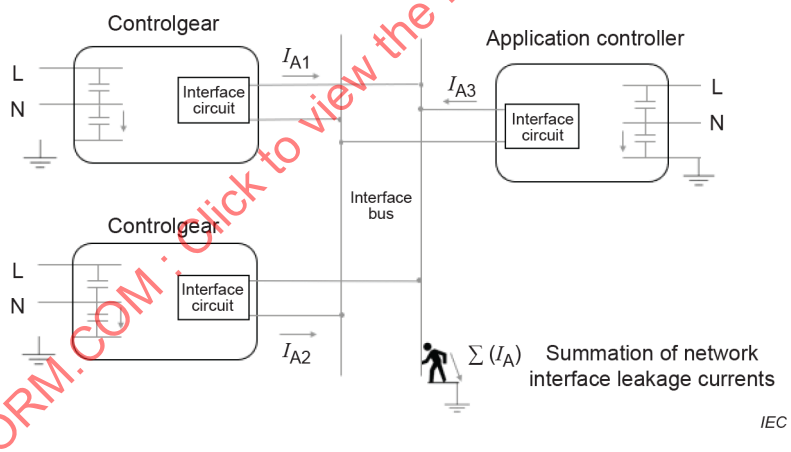
6.2.3.3.1 General

A lighting system specific network shall not create a hazard due to summation of network interface leakage current.

For SELV networks and FELV networks, the system maximum value, $\Sigma(I_A)_{max}$, of the network interface leakage current summation from all connected system components, $\Sigma(I_A)$ (see Figure 1 for illustration), is specified as follows:

– for alternating current: 5 mA (RMS),
– for direct current: 30 mA,
– for alternating current + direct current: $I_{AC\ peak} = 7{,}176 \times \exp(-0{,}143\ 4 \times I_{DC}) - 0{,}106\ 1$ mA.

NOTE The value is the threshold of let-go specified in IEC 60479-2:2019, 5.3.3.



Key

I_A network interface leakage current contributed by the connected product

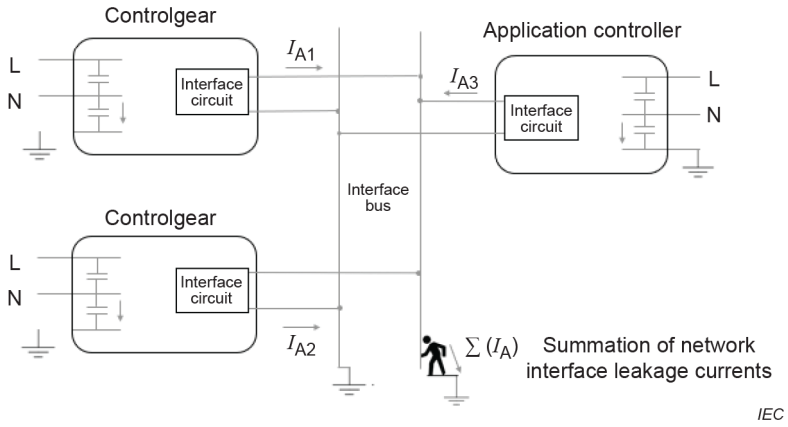
$\Sigma(I_A)$ summation of network interface leakage currents (I_A) on the system network

Figure 1 – Example of summation of network interface leakage current in a lighting system

The following requirements given in 6.2.3.3.2 or 6.2.3.3.3 as applicable, shall be met.

6.2.3.3.2 System networks with earthed external circuits

For system networks connected to earth, see Figure 2 for illustration, the following items 1) or 2) shall be followed.



Key

I_A network interface leakage current contributed by the connected product

$\Sigma(I_A)$ summation of network interface leakage currents (I_A) on the system network

Figure 2 – Illustration of lighting system network with reference to earth

1) If $\Sigma(I_A)$ exceeds $\Sigma(I_A)_{max}$

   – the system networks shall have provision for a permanent connection to earth, and the installation instructions of the system designer shall specify the provision of a permanent connection to earth, and

   – a label with the following wording or similar wording is recommended to be affixed adjacent to the permanent earth connection:

   WARNING – HIGH TOUCH CURRENT

   EARTH CONNECTION ESSENTIAL BEFORE MAKING NETWORK CONNECTIONS

2) If $\Sigma(I_A)$ does not exceed $\Sigma(I_A)_{max}$

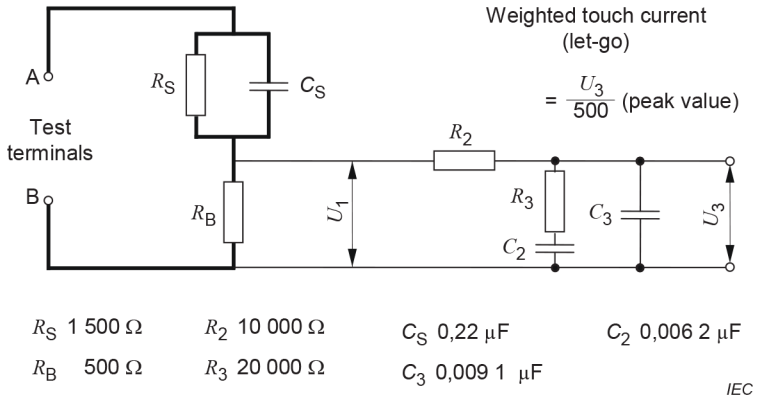
In this case no additional requirements are necessary for the connection to earth.

Compliance is checked by inspection, calculation and if necessary by the following test.

System designers and installers are recommended to ask product manufacturers or responsible vendors for the maximum touch current of the connected products. In case no value is available, 0,5 mA is recommended for each connected product for the calculation of network interface leakage current summation.

If the system network has provision for a permanent earth connection in accordance with item 1) above, it is not necessary to make any measurements.

If needed, the touch current shall be tested with the network as given in Figure 3 below.



SOURCE: IEC 60990:2016, Figure 5.

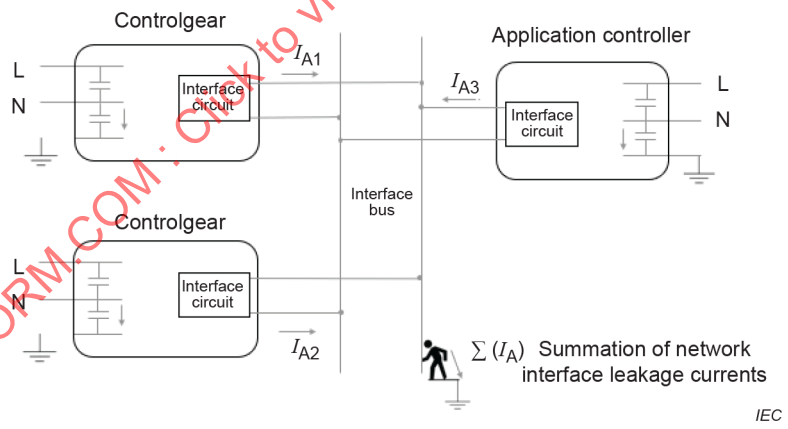
Figure 3 – Measuring network of $\Sigma(I_A)$

The test shall be carried out in normal conditions with the network connection to earth disconnected. Terminal A of the measuring network shall be applied to each accessible connecting interface of the system network. Terminal B of the measuring network shall be applied to:

– the earth of the system network,
– all other simultaneously accessible interfaces of the system network.

6.2.3.3.3 System networks without reference to earth

For system networks without connection to earth, see Figure 4 for illustration, $\Sigma(I_A)$ shall not exceed the system maximum value, $\Sigma(I_A)_{max}$.



Key

I_A network interface leakage current contributed by the connected product

$\Sigma(I_A)$ summation of network interface leakage currents (I_A) on the system network

Figure 4 – Illustration of lighting system network without reference to earth

Compliance is checked by calculation and test specified in 6.2.3.3.2 if necessary.

System designers and installers are recommended to ask product manufacturers or responsible vendors for the maximum touch current of the connected products. In case no value is available, 0,5 mA is recommended for each connected product for the calculation of network interface leakage current summation.

6.2.3.4 Protection against overheating of cables

Lighting system specific networks that are connected to earth shall have only one cable connection to earth.

The cables in the lighting system shall be selected to support the system maximum current to prevent overheating.

Compliance is checked by inspection.

NOTE 1 See IEC 60364-5-52:2009, Clause 523 for more information on current-carrying capacities of the insulated conductors and cables. See IEC 60364-5-52:2009, Clause 524 for more information on cross-sectional areas of conductors of the cables.

NOTE 2 More information on the installation of the wiring system, including cables, can be found in IEC 60364-5-52 and IEC 60364-4-42.

7 Functional safety

7.1 General requirements

The lighting system and its interface to other systems shall be designed and installed with acceptable risk against errors of networks and application operations by using risk assessment consideration.

Safety risk assessment should be used for remote control operation in lighting systems. IEC Guide 116 can be used as a possible process description for safety risk assessment.

Functional safety of a lighting system relies upon the performance of both the network and the connected products. The system designer shall consider if any system malfunction creates unsafe lighting conditions. The requirements in the following subclauses (7.3 to 7.5) have been designed for system designers and installers, and are based on the following principles:

a) Failure of either the network or any other part of the system shall not cause the system, the products or the controlled equipment to become unsafe.

b) While in operation, individual products shall not rely solely upon the system for their safe operation.

c) While in operation, communication of any lighting system product(s) with any other connected product(s) shall not result in unsafe operation of the system.

Clause 7 applies where system malfunctioning creates unsafe lighting conditions.

NOTE 1 For example, in a tunnel lighting system, consideration is given to the light level after restoration of power to avoid glare or insufficient light level.

NOTE 2 The requirements in 7.2 to 7.5 are the result of applying IEC 61508-1 to lighting systems in general. The same approach has been taken in ISO/IEC 14762 which applies IEC 61508-1 to HBES.

NOTE 3 Guidance on the establishment of the requirements for functional safety are specified according to the life-cycle used in IEC 61508-1, as follows:

– concept phase of products;
– application environment;
– identification of hazards and hazard events;
– hazard and risk analysis, risk reduction measures;
– realization of risk reduction measures;
– validation;
– maintenance;
– installation and commissioning;
– decommissioning.

7.2 Restart after power restoration

The system designer shall select products that can restart in a functionally safe manner, after interruption and restoration of power.

Compliance is checked according to product and lighting system documentation to verify the proper functionality after power restoration.

7.3 Reasonably foreseeable misuse

7.3.1 Accidental download

The system designer shall select products that have measures to reduce the safety related risk of accidental download of the wrong software or parameters into the system products. The following measures can apply, depending on specific applications:

– design of configuration tool;
– password protection, to protect the settings of the system;
– access only allowed after an authentication process has been performed;
– identification of products and comparison of their profiles by the network management;
– training of installers and operators;
– product documentation.

Compliance is checked according to product and lighting system documentation.

7.3.2 Proper configuration

Proper configuration and related parameters shall be ensured by the system designer, installer and/or commissioner.

The following measures can be addressed:

– specification of parameter ranges;
– multiple authority levels for configuration access;
– check of conformity with configuration;
– improper configuration prevented by product design;
– improper configuration prevented by the configuration tool.

Compliance is checked by inspection of the system configuration.

7.4 Software and communication

The system designer shall select products that have measures to restrict access to modification of the software and configuration. The following measures should be considered:

– use of password and/or authentication;
– ensuring unauthorized access is not possible;
– other measures introduced in the relevant bus specification or product standards.

Measures shall be provided to check the proper operation of the software and the integrity of the configuration.

System designers shall select proper protocols to ensure that the reception of messages from more than one control terminal does not disturb the proper function of the system products or cause hazards.