BS EN 1648-1:2012

BSI Standards Publication

Leisure accommodation vehicles — 12 V direct current extra low voltage electrical installations

Part 1: Caravans

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National foreword

This British Standard is the UK implementation of EN 1648-1:2012. It supersedes BS EN 1648-1:2004 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/511, Buildings mobile and temporary.

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

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Bewohnbare Freizeitfahrzeuge - Elektrische Anlagen für DC 12 V - Teil 1: Caravans

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Foreword

This document (EN 1648-1:2012) has been prepared by Technical Committee CEN/TC 245 “Leisure accomodation vehicles”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2013, and conflicting national standards shall be withdrawn at the latest by January 2013.

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

This document supersedes EN 1648-1:2004.

The main technical changes since the previous edition are:

a) The battery capacity is no more a requirement: sub-clause 4.3.2 "Capacity" deleted;

b) Requirements on tube diameter deleted in 4.3.4 b);

c) Reference to EC directive 2007/46/EC, Annex II added in 4.3.4;

d) Clarification added to 4.3.5 and Clause 8 that the warning notice shall be written in the language(s) of the country in which the caravan is to be sold for the first time;

e) Sub-clause 4.5 amended;

f) Footnotes added in Table 1 for clarification;

g) Sub-clause 5.3 "Fixed wiring" amended;

h) Note added in 6.2;

i) Clause 7 "Installation of appliances" amended;

j) Normative references adapted according to above listed changes;

k) Annex A revised editorially;

l) Figure 1 added to Foreword.

EN 1648, Leisure accommodation vehicles - 12 V direct current extra low voltage electrical installations contains the following parts:

— *Part 1: Caravans* (the present document);

— *Part 2: Motor caravans*.

This document is based on ISO 8818 “Leisure accommodation vehicles — Caravans — 12 V direct current extra low voltage electrical installations” and takes into consideration specific aspects relating to electrical installations in caravans.

The requirements of relative ISO/IEC and CENELEC publications were taken into consideration during the preparation of this European Standard.

This document is one of a series covering the habitation aspects of leisure accommodation vehicles.

Requirements for 12 V direct current extra low voltage electrical installations for motor caravans are specified in EN 1648-2.

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Figure 1 gives an overview of the relevant European Standards for caravans, motor caravans and caravan holiday homes.

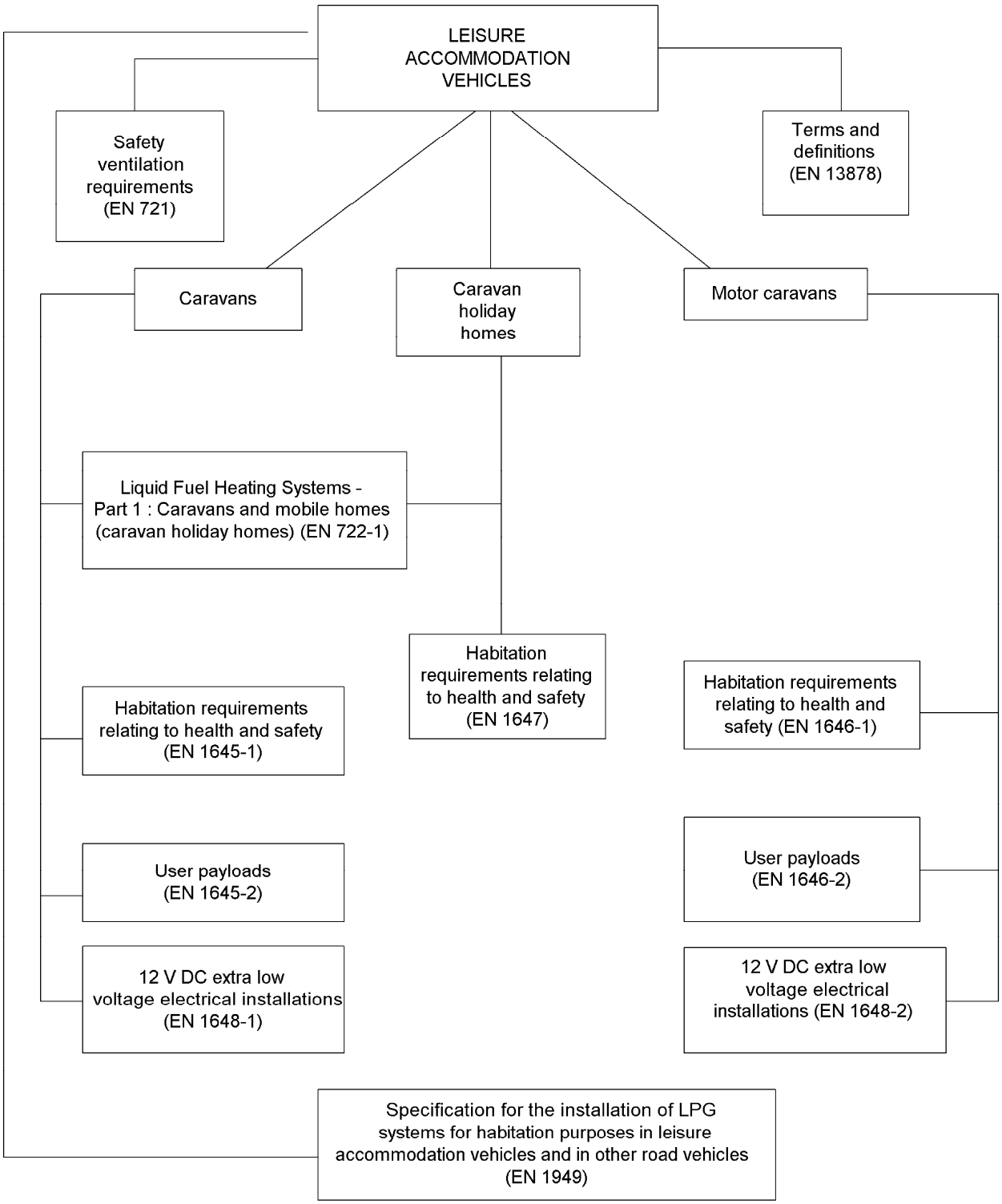


Figure 1 — Overview of relevant European Standards applying to leisure accommodation vehicles

1 Scope

This European Standard specifies safety, health and functional requirements for 12 V direct current (DC) extra low voltage (ELV) electrical installations for habitation aspects of caravans. It covers the design and integration of the caravan system with the towing vehicle system.

It does not apply to commercial trailers; nor does it include requirements for ELV road lighting and signalling lamps and their installations, except for safety requirements for the routing of cables in LPG storage compartments.

This European Standard also specifies the ELV output requirements of low voltage (LV) equipment that may be used to provide an ELV supply but it does not specify safety, technical and functional requirements for LV appliances and installations. Requirements for LV installations are specified in HD 60364-7-721.

2 Normative references

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

EN 1645-1, *Leisure accommodation vehicles — Caravans — Part 1: Habitation requirements relating to health and safety*

EN 13878:2003, *Leisure accommodation vehicles — Terms and definitions*

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529)*

EN 60898-2, *Electrical accessories — Circuit-breakers for overcurrent protection for household and similar installations — Part 2: Circuit-breakers for a.c. and d.c. operation (IEC 60898-2)*

EN ISO 11446, *Road vehicles — Connectors for the electrical connection of towing and towed vehicles — 13-pole connectors for vehicles with 12 V nominal supply voltage (ISO 11446)*

HD 21 (series), *Cables of rated voltages up to and including 450/750 V and having thermoplastic insulation*

HD 22 (series), *Cables of rated voltages up to and including 450/750 V and having cross-linked insulation*

ISO 1724, *Road vehicles — Connectors for the electrical connection of towing and towed vehicles — 7-pole connector type 12 N (normal) for vehicles with 12 V nominal supply voltage*

ISO 3732, *Road vehicles — Connectors for the electrical connection of towing and towed vehicles — 7-pole connector type 12 S (supplementary) for vehicles with 12 V nominal supply voltage*

ISO 6722 (series), *Road vehicles — 60 V and 600 V single-core cables*

ISO 7010, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

ISO 8820-1, *Road vehicles — Fuse-links — Part 1: Definitions and general test requirements*

ISO 8820-3, *Road vehicles — Fuse-links — Part 3: Fuse-links with tabs (blade type) Type C (medium), Type E (high current) and Type F (miniature)*

ISO 8820-4, *Road vehicles — Fuse-links — Part 4: Fuse-links with female contacts (type A) and bolt-in contacts (type B) and their test fixtures*

3 Terms and definitions

For the purposes of this document the terms and definitions given in EN 13878:2003 apply.

4 Power supply

4.1 General

The power supply shall be a nominal DC 12 V (minimum 11 V and maximum 15 V).

NOTE A power supply with a nominal voltage different than DC 12 V is not allowed.

4.2 Sources of supply

The supply shall be obtained from one or more of the following sources:

a) the electrical installation of the towing vehicle;

b) an auxiliary battery mounted within the caravan (see 4.3);

c) LV supply via an on-board mounted AC/DC converter (e.g. transformer, switching power supply) that complies with the requirements of the relevant standards in accordance with directive 2006/95/EC and subsequent amendments;

d) DC generator (see 4.4.1);

e) regenerative energy sources (see 4.4.2).

If several sources of supply are used it shall be ensured that there is no unfavourable interaction.

4.3 Auxiliary batteries

4.3.1 Type of battery

An auxiliary battery shall be of the rechargeable type. Non-rechargeable batteries are not auxiliary batteries according to 4.3. They may be used however, provided that they are used in circuits separated from other sources of electrical supply.

4.3.2 Terminals

Auxiliary battery terminals shall be clearly and durably marked “+” and “–“. Connections to auxiliary battery terminals shall be securely clamped or bolted to ensure continuous contact and shall be insulated unless the auxiliary battery is provided with an insulating cover.

4.3.3 Location

An auxiliary battery shall be placed in a compartment according to 4.3.4, which is designed to protect it from mechanical damage, with easy access for maintenance or removal and secured to prevent movement of the battery, e.g. when the caravan is in motion.

4.3.4 Auxiliary battery compartment

An acid resistant liquid tight tray shall be installed under an auxiliary battery whose electrolyte is liquid capable of holding at least 20 % of the electrolyte capacity of the recommended battery, when in place.

The interior of an auxiliary battery compartment shall be ventilated and protected against the corrosive effect of acid-laden gases, either by

a) installing a sealed auxiliary battery that incorporates an external ventilating kit that is taken to the exterior of the caravan; or

b) installing an auxiliary battery in an enclosed battery compartment that is protected internally against corrosion and is ventilated directly to the exterior of the caravan by means of a suitable tube in accordance with the battery manufacturer's instructions or as supplied by the manufacturer of the auxiliary battery; or

c) ventilating the compartment at both low-level and high-level to the exterior of the caravan. The construction of the interior of the compartment shall have gas tight joints and seams, including the sides of the ventilator openings, be of acid-resistant material or have an anti-corrosive finish. The minimum size of ventilation shall be not less than 80 mm^2 at low level and not less than 80 mm^2 at high level. If the compartment opens into the interior of the caravan, the lid shall provide an air seal.

The requirements concerning the protection against corrosion and ventilation are not applicable if batteries with bound electrolytes are used.

If an auxiliary battery is not provided, then the position and instructions for the installation of the battery and compartment, in accordance with a), b) or c), shall be included in the User's Handbook according to Clause 8 and a notice shall be fixed in or near the proposed location stating:

“For instructions on auxiliary battery installation, see User's Handbook”.

When the manufacturer makes no provision for the installation of an auxiliary battery, the following statement shall be made in the User's Handbook:

“This caravan has not been designed to accommodate an auxiliary battery. Do not fit one.”

For underslung battery, a minimum ground clearance shall be observed in compliance with directive 2007/46/EC, Annex II.

4.3.5 Warning notice

A warning notice shall be fixed in a prominent position near the auxiliary battery or displayed on the lid of the auxiliary battery compartment. This warning shall be in the official language(s) of the country in which the caravan is to be sold for the first time and shall state:

“Switch off all appliances and lamps before connecting or disconnecting the auxiliary battery.”

The auxiliary battery compartment shall be additionally marked “smoking prohibited” in accordance with ISO 7010-P003 and in the language(s) of the country in which the caravan is to be sold for the first time.

4.4 Other sources of supply

4.4.1 Generators and transformer/rectifiers unit

If a supply is obtained from a generator or from a low voltage supply via a transformer/rectifier unit without a battery in the circuit, the extra low voltage at the output terminals of the supply unit shall be maintained between 11 V minimum and 15 V maximum. The voltage ripple shall not exceed 1,2 V.

4.4.2 Regenerative energy sources

Regenerative energy sources, such as wind energy, solar energy etc., shall only be used in conjunction with voltage or charging regulators with an output voltage according to 4.4.1.

If one of these energy sources is used for charging batteries, protection against overcharging shall be provided.

4.5 Protective measures

The ELV installation shall be so installed that the protective measures of the LV installation for basic protection and for fault protection are not impaired.

It shall be ensured that the protective conductors of the LV installation are not loaded by operating currents of the ELV installation.

5 Wiring

5.1 Connection to electrical system of towing vehicle

5.1.1 Connecting cables

The connection between the fixed wiring of a caravan and the electrical connector to the towing vehicle shall be by means of flexible connecting cable(s) with cores having minimum cross-sectional areas as shown in Table 1. The length of the cables shall not exceed 5 m. To these cables shall be attached plugs with contact allocations in accordance with ISO 1724 and ISO 3732 or EN ISO 11446. A connecting cable shall be of sufficient length to allow the plug to extend 500 mm in front of the coupling head of the caravan.

5.1.2 Protecting of disconnected plug

When the plug is disconnected it shall be protected against the ingress of water and foreign objects.

5.1.3 Contact allocation

The functional allocation of the single cores of the connecting cables shall be in accordance with Table 1.

5.1.4 Charging of auxiliary battery and operation of refrigerator

5.1.4.1 The circuit to charge an auxiliary battery shall be separate from a circuit to operate a refrigerator.

5.1.4.2 The charging circuit for an auxiliary battery from the power supply of the towing vehicles shall be completed only when the towing vehicles engine is running.

5.1.4.3 The 12 V heating element of a refrigerator shall be activated only when the engine of the towing vehicle is running.

Table 1 — Functional allocation and cross-sectional areas of the single cores of the connecting cable(s)

Cable No.	Function	Contact numbers		Minimum cross-sectional area mm^2
		EN ISO 11446	ISO 1724	
1	Left-hand direction — indicator light	1	1	1,5
2	Rear fog light	2	2	1,5
3	Common return for cable No. 1, 2 and 4 to 8	3[a]	3[a]	2,5
4	Right-hand direction — indicator light	4	4	1,5
5	Right hand-rear position and marker lights, and rear-registration-plate illumination device	5	5	1,5
6	Stop lights	6	6	1,5
7	Left-hand rear position and marker lights, and rear-registration-plate illumination device	7	7	1,5
			ISO 3732	
8	Reversing light	8	1	1,5
9	Continuous power supply	9	4	2,5
10	Power supply controlled by ignition switch	10	6	2,5
11	Return for cable No. 10 [b]	11[a]	7[a]	2,5
12	Coding for coupled trailer	—	—	—
	Reserved for future allocation	12	—	—
13	Return for cable No. 9 [c]	13[a]	3[a]	2,5
14	No allocation	—	2, 5	1,5

a These return circuits shall not be connected electrically in the trailer.

b ISO 3732 reads "Return for contact No. 6".

c ISO 3732 reads "Return for contact No. 4".

5.1.5 Protection of terminal block

If the connection between the connecting cable(s) and the caravan's fixed wiring is by means of a terminal block, it shall have a protective cover. If the terminal block is positioned externally, it shall have a cover that will provide protection to a minimum of IP 44 according to EN 60529.

5.2 Cable and fixed wiring cross-sectional areas

The cross-sectional areas of the connecting cables shall comply with Table 1. The cross-sectional areas of the fixed wiring shall be selected in such a way that the permissible voltage drop of 0,8 V will not be exceeded (see Annex A). Consideration shall be given to other elements in the circuit (e.g. fuses). Annex A does not apply to sensor and data lines.

5.3 Fixed wiring

5.3.1 Cables

All ELV circuits shall be comprised of a positive supply and negative return. Each positive supply shall be protected by a suitably rated overcurrent protective device. The negative return for a circuit may be joined to a common negative distribution point.

5.3.2 Type of cable

Cables shall conform to HD 21, HD 22 or ISO 6722.

5.3.3 Cable installation

Cables may be run either visibly or concealed. Cables shall be protected by suitable means against mechanical damage, thermal overload and chemical reaction.

Cables of ELV circuits and cables of other circuits (cables for LV current) may be run together, if the insulation of the cables or the individual circuits are designed for the highest value of voltage which is likely to be present.

5.3.4 Supporting of cables

Cables shall be supported at maximum intervals of 400 mm for vertical runs. Horizontal runs, unless run in conduits or ducts, shall be secured at maximum intervals of 250 mm. In the case of horizontal runs of a cable on a fixed substructure, cables shall be supported at maximum intervals of 400 mm.

5.3.5 Connections

All cable connections shall be accessible; connectors shall be protected against unintentional contact.

Connections of external cables shall be enclosed to provide ingress protection of not less than IP 44 according to EN 60529.

5.3.6 Auxiliary battery cables

Cables from an auxiliary battery shall be protected by additional sheathing or taping up to the overcurrent protective device (see 6.1).

5.3.7 Prohibited cable runs and LPG installations

No electrical equipment including wiring systems, except

a) ELV (extra low voltage) equipment for gas supply control, and

b) cables running through a gas compartment without connection

shall be installed in any gas cylinder compartment.

Such electrical installations and components shall be constructed and installed so that they are not a potential source of ignition. Where cables need to run through such a compartment, such cables shall be protected against mechanical damage by installation within a conduit or duct passing through the compartment. Where installed in a position where it is likely to be subject to mechanical damage, this conduit or duct shall be able to withstand an impact equivalent to AG3.

6 Overcurrent protection

6.1 Protection of positive conductors

The ELV installation shall be protected by at least one overcurrent protective device for each circuit which disconnects the circuit in the case of overload or short circuit. The nominal current I_n of this protective device shall not exceed the permissible current rating I_z of the cable.

The overcurrent protective device for the power supply from the towing vehicle shall be fitted as near as possible to the auxiliary battery, but in no case more than 1 000 mm away. The overcurrent protective device for the auxiliary battery shall be fitted at the end of the battery cable within a cable length of 1 000 mm from the auxiliary battery or its compartment and before the fixed installation. In cases where no auxiliary battery is installed, the overcurrent

protective device shall be installed before the fixed installation. The ELV output of any transformer/rectifier unit and of any DC generator shall be provided with a suitably rated overcurrent protective device located between the transformer/ rectifier unit or DC generator and any distribution panel or board unless such a protective device is incorporated in the transformer/rectifier unit or the DC generator.

6.2 Types of device

Overcurrent protective devices shall be either fuse links according to ISO 8820-1, ISO 8820-3 and ISO 8820-4 or circuit breakers to EN 60898-2.

NOTE The maximum permissible current load and the required maximum fuse rating for cables are specified in HD 60364-4-43 [1].

6.3 Installation of fuses

Fuses shall be suitably placed or guarded to protect against unintentional damage.

6.4 Prohibited locations

Overcurrent protective devices shall not be fitted in a fuel storage compartment or fuel storage housing intended for the storage of liquefied petroleum gas cylinders or in the compartment for housing an auxiliary battery.

7 Installation of appliances

7.1 General

Appliances suitable for operation on both AC and DC 12 V systems are allowed provided that AC and DC systems are segregated and interconnection is prevented.

7.2 Selection and connection of appliances

All appliances shall be fitted and connected in accordance with the appliance manufacturer's instructions. When polarity-sensitive appliances are fitted and connected, only those that have terminals clearly marked “–“ and “+”, or that have two conductors, indicating polarity by colour or by identification tags or sleeves marked “–“ or “+”shall be used.

7.3 Socket outlets

ELV socket outlets shall provide a means to ensure that correct polarity is made by the connector and shall be of a different type from those provided for any low voltage installation. The voltage (12 V DC) and maximum power (W) or current (A) rating of the circuit shall be stated on or adjacent to each of the socket outlets.

7.4 Battery charger

The charging profile of the battery charger fitted shall match the charge profile of the type of battery recommended. When the charger can supply charging profiles for different types of battery e.g. lead/acid, Gel, NiMH etc, this shall be stated in the handbook or literature supplied with the charger.

If the battery emits a combustible gas whilst on charge the charger output shall be limited to 10 % of the capacity of the auxiliary battery in Ah at 20 h discharge rate.

7.5 External Luminaires

Luminaires fixed on a caravan exterior shall be constructed or enclosed to provide protection of not less than IP 44 according to EN 60529.

7.6 Voltage drop

Under normal service conditions, the voltage at the terminals of any fixed current-using equipment shall be not less than the lower limit required to ensure safe functioning of that equipment. In the absence of a specific voltage, a voltage drop of 0,8 V from the power supply to each individual piece of equipment shall not be exceeded.

The voltage drop between the LV battery charger and the auxiliary battery shall not exceed 0,3 V. The charging current I_c [A] to determine the voltage drop is established by formula (1).

$$I_c = \frac{Q \times 0{,}1}{t} \quad (1)$$

where

Q is the battery capacity, in ampere-hours;

t is the period 1 h (hour).

8 User's Handbook

As required by EN 1645-1, the following information shall be provided in the User's Handbook and shall be in the official language(s) of the country in which the caravan is to be sold for the first time:

a) A warning worded as follows: Any replacement of an auxiliary battery shall be of the same type and specification as that originally fitted or as specified by the manufacturer.

b) Instructions on the maintenance and recharging of an auxiliary battery when it is fitted. When a battery charger is provided, instructions on its safe use shall be included.

c) Instructions for selecting and the procedure for connecting and disconnecting an auxiliary battery in a compartment, if the caravan is intended for the installation of an auxiliary battery.

d) Details of the warning notice specified in 4.3.6 and its importance for safety.

e) Details of the electrical installation in a simplified form, including the circuits of the LV and ELV and values of the overcurrent protective devices shall be provided.

f) Type of appliances that can be used and from what source of supply.

g) Instructions for the correct operation and maintenance of fitted appliances, as supplied by the appliance manufacturer.

h) A warning worded as follows: Always disconnect the electrical connector between the towing vehicle and the caravan before connecting an LV supply to the caravan and before charging the caravan battery by any other means.

i) Instructions for replacing fuses (e.g. type, rated current).

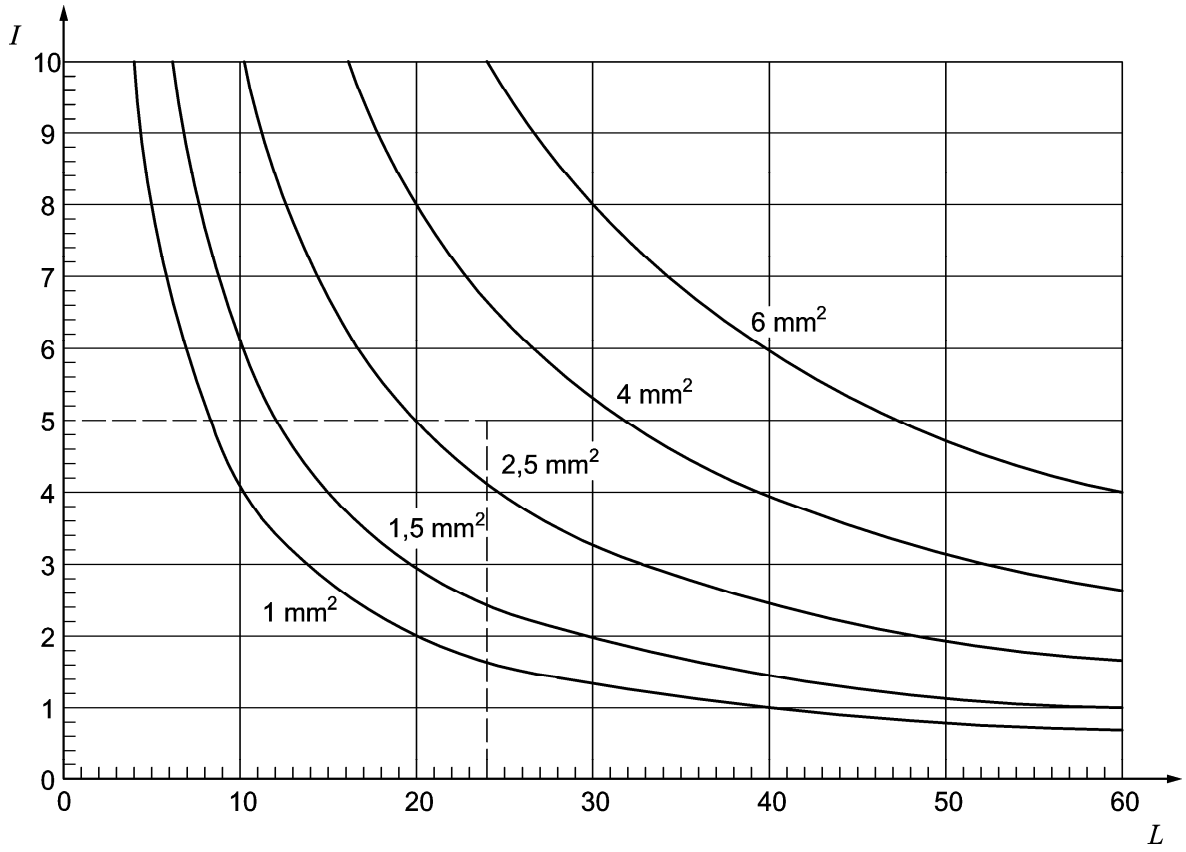
Annex A
(informative)

Relation of cable cross-sectional area, current flow and cable length for fixed wiring installations

A.1 General

The minimum conductor cross-sectional areas may be selected from graphs (see A.2) or calculated according to formula A.1 (see A.3).

A.2 Graphs for obtaining minimum cross-sectional areas



Key

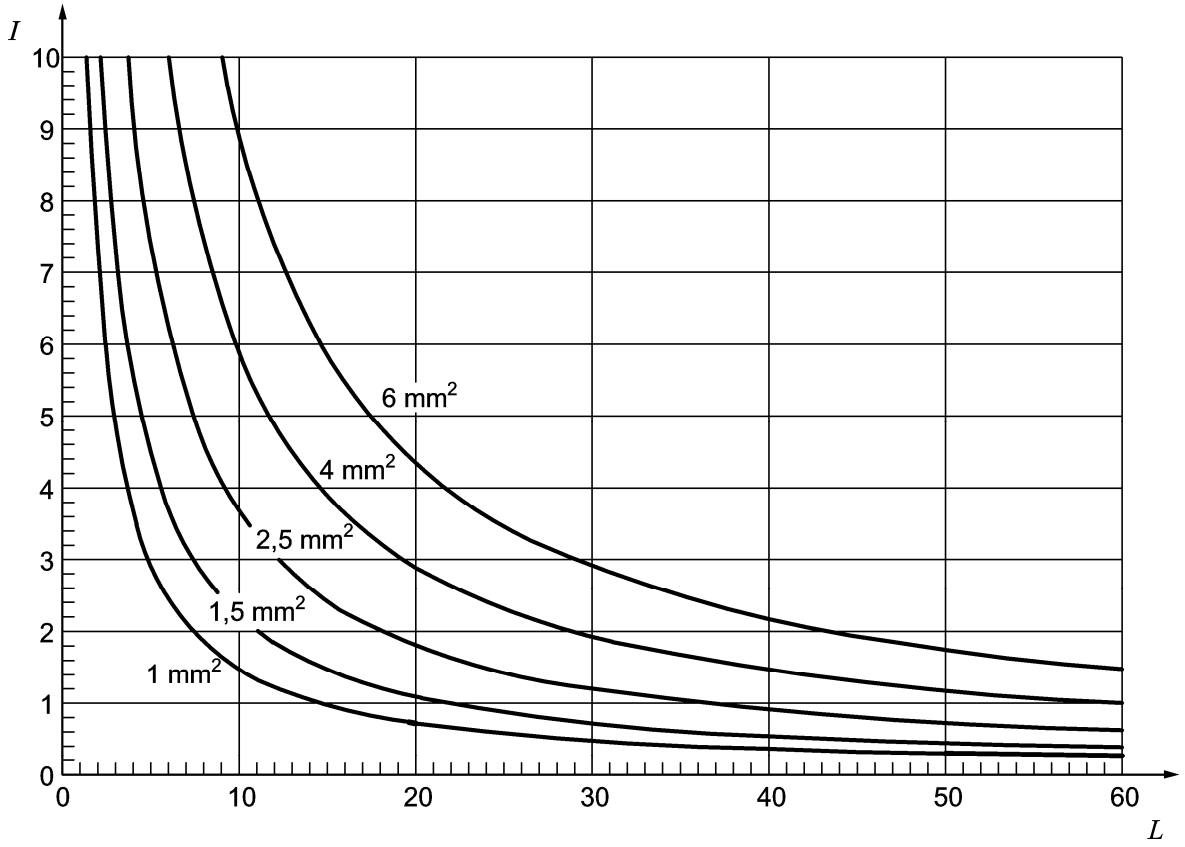
I current, in amperes

L total length of conductors, in metres

Total lengths of conductors (positive and negative), in metres
(Route length is half above length)

Figure A.1 — Graph for obtaining minimum cross-sectional area for conductors for fixed wiring installations with a voltage drop of 0,8 V

EXAMPLE To obtain minimum cross-sectional area for design current of 5 A and total cable length of 24 m (2 × route length),the cross-sectional area of conductors is 4 mm^2.



Key

I current, in amperes

L total length, in metres

Total lengths (positive and negative), in metres
(Route length is half above length)

Figure A.2 — Graph for obtaining minimum cross-sectional area for conductors for battery cable installations with a voltage drop of 0,3 V

A.3 Calculation of the minimum cross-sectional areas

The cross-sectional areas are to be calculated according to the following formula:

$$A = \frac{\rho \cdot L \cdot I}{U_V} \qquad \text{(A.1)}$$

where

A is the cross-sectional area of conductor, in square millimetres;

ρ is the resistivity of copper (0,01989 Ω mm^2 / m at 50 °C);

L is the total length (feed and return cable) of the conductors, in metres;

I is the total current, in amperes;

U_V is the permissible voltage drop. (0,3 V for auxiliary battery charging cables, 0,8 V for fixed wiring cables).

With intermediate values, the result of the calculation shall be rounded to the next higher cross-sectional area.

The graphs in Figures A.1 and A.2 and the formula A.1 are based on a conductor operating temperature of 50 °C.

If cables are installed for use under conditions of high temperature, the minimum cross-sectional area of fixed wiring will need to be increased.

If the appliance manufacturer requires a voltage drop which is different from 0,3 V or 0,8 V, this value shall be inserted for U_V in the formula A.1.

Bibliography

[1] HD 60364-4-43, *Low-voltage electrical installations — Part 4-43: Protection for safety — Protection against overcurrent (IEC 60364-4-43)*

[2] HD 60364-7-721, *Low-voltage electrical installations — Part 7-721: Requirements for special installations or locations — Electrical installations in caravans and motor caravans (IEC 60364-7-721)*

[3] EN 50102, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

[4] Directive 2006/95/EC, *Harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits*

[5] Directive 2007/46/EC, *Establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles (Framework Directive)*

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