

INTERNATIONAL STANDARD

IEC 60038

Edition 6.2
2002-07

Edition 6:1983 consolidated with amendments 1:1994 and 2:1997

IEC standard voltages

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC STANDARD VOLTAGES

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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International Standard IEC 60038 has been prepared by IEC technical committee 8: Standard Voltages, Current Ratings and Frequencies.

This sixth edition supersedes the fifth edition of IEC 60038 (1975), and now includes standard voltages below 120 V a.c. and 750 V d.c.

This consolidated version of IEC 60038 consists of the sixth edition (1983) [documents 8(CO)1132 and 8(CO)1133], its amendment 1 (1994) [documents 8(CO)1137+1137A and 8(CO)1138] and its amendment 2 (1997) [documents 8/1165/FDIS and 8/1166/RVD].

The technical content is therefore identical to the base edition and its amendments and has been prepared for user convenience.

It bears the edition number 6.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

The committee has decided that the contents of the base publication and its amendments 1 and 2 will remain unchanged until 2003. At this date, the publication will be

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- withdrawn;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

IEC STANDARD VOLTAGES

Scope

This publication applies to:

- a.c. transmission, distribution and utilization systems and equipment for use in such systems with standard frequencies 50 Hz and 60 Hz having a nominal voltage above 100 V;
- a.c. and d.c. traction systems;
- a.c. and d.c. equipment having nominal voltages below 120 V a.c. or below 750 V d.c., the a.c. voltages being intended (but not exclusively) for 50 Hz and 60 Hz applications; such equipment covers batteries (from primary or secondary cells), other power supply devices (a.c. or d.c.), electrical equipment (including industrial and communication), and appliances.

This publication shall not apply to voltages representing or transmitting signals or measured values.

This publication shall not apply to standard voltages of components and parts used within electrical devices or items of equipment.

SECTION ONE – DEFINITIONS

For alternating voltages, the voltages stated below are r.m.s. values.

1 Nominal system voltage

Voltage by which a system is designated.

2 Highest and lowest voltages of a system (excluding transient or abnormal conditions)

2.1 Highest voltage of a system

The highest value of voltage which occurs under normal operating conditions at any time and at any point on the system.

It excludes voltage transients, such as those due to system switching, and temporary voltage variations.

2.2 Lowest voltage of a system

The lowest value of voltage which occurs under normal operating conditions at any time and at any point on the system.

It excludes voltage transients, such as those due to system switching, and temporary voltage variations.

3 Supply terminals

The point where the distribution system of the electricity supply authority and the electrical system of the consumer are connected.

4 Supply voltage

The phase-to-phase or phase-to-neutral voltage at the supply terminals.

5 Supply voltage range

The voltage range at the supply terminals.

6 Utilization voltage

The phase-to-phase or phase-to-neutral voltage at the outlets or at the terminals of equipment.

7 Utilization voltage range

The voltage range at the outlets or at the terminals of equipment.

8 Rated voltage (of equipment)

The voltage assigned generally by a manufacturer, for a specified operating condition of a component, device or equipment.

9 Highest voltage for equipment

Highest voltage for which the equipment is specified regarding:

- a) the insulation;
- b) other characteristics which may be referred to this highest voltage in the relevant equipment recommendations.

The highest voltage for equipment is the maximum value of the "highest system voltage" (see 2.1) for which the equipment may be used.

NOTE 1 The highest voltage for equipment is indicated for nominal system voltages higher than 1 000 V only. It is understood that, particularly for certain nominal system voltages, normal operation of equipment cannot be ensured up to this highest voltage for equipment, having regard to voltage-sensitive characteristics such as losses of capacitors, magnetizing current of transformers, etc.

In such cases, the relevant recommendations must specify the limit to which the normal operation of this equipment can be ensured.

NOTE 2 It is understood that the equipment to be used in systems having nominal voltage not exceeding 1 000 V should be specified with reference to the nominal system voltage only, both for operation and for insulation.

NOTE 3 Attention is drawn to the fact that in some equipment standards (for example, IEC 60335-1 and IEC 60071) the term "voltage range" has a different meaning.

SECTION TWO – TABLES OF STANDARD VOLTAGES

Table 1 – A.C. systems having a nominal voltage between 100 V and 1 000 V inclusive and related equipment

In the following table, the three-phase four-wire systems and single-phase three-wire systems include single-phase circuits (extensions, services, etc.) connected to these systems.

The lower values in the first and second columns are voltages to neutral and the higher values are voltages between phases. When one value only is indicated, it refers to three-wire systems and specifies the voltage between phases. The lower value in the third column is the voltage to neutral and the higher value is the voltage between lines.

The voltage in excess of 230/400 V are intended exclusively for heavy industrial applications and large commercial premises.

Three-phase four-wire or three-wire systems		Single-phase three-wire systems
Nominal voltage V		Nominal voltage V
50 Hz	60 Hz	60 Hz
–	120/208	120/240
–	240	–
230/400 ¹⁾	277/480	–
400/690 ¹⁾	480	–
–	347/600	–
1 000	600	–

¹⁾ The nominal voltage of existing 220/380 V and 240/415 V systems shall evolve toward the recommended value of 230/400 V. The transition period should be as short as possible and should not exceed the year 2003. During this period, as a first step, the electricity supply authorities of countries having 220/380 V systems should bring the voltage within the range 230/400 V +6 %, –10 % and those of countries having 240/415 V systems should bring the voltage within the range 230/400 V +10 %, –6 %. At the end of this transition period, the tolerance of 230/400 V ± 10 % should have been achieved; after this the reduction of this range will be considered. All the above considerations apply also to the present 380/660 V value with respect to the recommended value 400/690 V.

Concerning supply voltage range, under normal service conditions, it is recommended that the voltage at the supply terminals should not differ from the nominal voltage of the system by more than ±10 %.

For the utilization voltage range, in addition to the voltage variations at the supply terminals, voltage drops may occur within the consumer's installations. For low-voltage installations, this voltage drop is limited to 4 %, therefore, the utilization voltage range is +10 %, –14 %¹⁾. This utilization range should be taken into account by Product Committees.

¹⁾ At the end of the transition period, the reduction of this range will be considered.

Table 2 – D.C. and a.c. traction systems*

	Voltage			Rated frequency of a.c. systems Hz
	Lowest V	Nominal V	Highest V	
D.C. systems	(400) 500 1 000 2 000	(600) 750 1 500 3 000	(720) 900 1 800 3 600**	
A.C. single-phase systems	(4 750) 12 000 19 000	(6 250) 15 000 25 000	(6 900) 17 250 27 500	50 or 60 16 ² / ₃ 50 or 60
<p>* The values indicated in parentheses should be considered as non-preferred values. It is recommended that these values should not be used for new systems to be constructed in future. In particular for a.c. single-phase systems, the nominal voltage 6 250 V should be used only when local conditions make it impossible to adopt the nominal voltage 25 000 V.</p> <p>The values indicated in the table above are the values agreed by the International Mixed Committee on Electric Traction Equipment (C.M.T.) and by IEC Technical Committee 9, Electric Traction Equipment.</p> <p>** In certain European countries, this voltage may reach 4 000 V. The electrical equipment of vehicles operating international services in these countries shall be capable of withstanding this absolute maximal voltage for brief periods of up to 5 min.</p>				

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Table 3 – A.C. three-phase systems having a nominal voltage above 1 kV and not exceeding 35 kV and related equipment*

Two series of highest voltages for equipment are given below, one for 50 Hz and 60 Hz systems (Series I), the other for 60 Hz systems (Series II – North American practice). It is recommended that only one of the series should be used in any one country.

It is also recommended that only one of the two series of nominal voltages given for Series I should be used in any one country.

Series I			Series II	
Highest voltage for equipment kV	Nominal system voltage kV		Highest voltage for equipment kV	Nominal system voltage kV
3,6 ¹⁾	3,3 ¹⁾	3 ¹⁾	4,40 ¹⁾	4,16 ¹⁾
7,2 ¹⁾	6,6 ¹⁾	6 ¹⁾	–	–
12	11	10	–	–
–	–	–	13,2 ²⁾	12,47 ²⁾
–	–	–	13,97 ²⁾	13,2 ²⁾
–	–	–	14,52 ¹⁾	13,8 ¹⁾
(17,5)	–	(15)	–	–
24	22	20	–	–
–	–	–	26,4 ²⁾	24,94 ²⁾
36 ³⁾	33 ³⁾	–	–	–
–	–	–	36,5 ²⁾	34,5 ²⁾
40,5 ³⁾	–	35 ³⁾	–	–

* These systems are generally three-wire systems unless otherwise indicated. The values indicated are voltages between phases.
The values indicated in parentheses should be considered as non-preferred values. It is recommended that these values should not be used for new systems to be constructed in future.

NOTE 1 It is recommended that in any one country the ratio between two adjacent nominal voltages should be not less than two.

NOTE 2 In a normal system of Series I, the highest voltage and the lowest voltage do not differ by more than approximately $\pm 10\%$ from the nominal voltage of the system. In a normal system of Series II, the highest voltage does not differ by more than $+5\%$ and the lowest voltage by more than -10% from the nominal voltage of the system.

1) These values should not be used for public distribution systems.
2) These systems are generally four-wire systems.
3) The unification of these values is under consideration.

Table 4 – A.C. three-phase systems having a nominal voltage above 35 kV and not exceeding 230 kV and related equipment*

Two series of nominal system voltages are given below. It is recommended that only one of the two series should be used in any one country.

It is recommended that in any one country only one value in the following groups should be used for the highest voltage for equipment:

123 kV-145 kV

245 kV-300 kV (see table 5)-363 kV (see table 5).

Highest voltage for equipment kV	Nominal system voltage kV
(52)	(45) –
72,5	66 69
123	110 115
145	132 138
(170)	(150) –
245	220 230

* The values indicated in parentheses should be considered as non-preferred values. It is recommended that these values should not be used for new systems to be constructed in future. The values are voltages between phases.