INTERNATIONAL STANDARD

IEC 60086-1

Ninth edition
2000-11

Primary batteries –

Part 1: General

Piles électriques –

Partie 1: Généralités

Reference number
IEC 60086-1:2000(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE X

For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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PRIMARY BATTERIES –

Part 1: General

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.
2) The formal decisions or agreements of the 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 National Committees.
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.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60086-1 has been prepared by IEC technical committee 35: Primary cells and batteries.

This ninth edition cancels and replaces the eighth edition and its amendments 1 and 2, published in 1996, and constitutes a technical revision.

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

FDIS	Report on voting
35/1131/FDIS	35/1141/RVD

Full information on the voting for the approval of this standard 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 3.

Annexes A, B, C, D and E form an integral part of this standard.

Annex F, G and H are for information only.

The committee has decided that the contents of this publication will remain unchanged until 2001. At this date, the publication will be

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- withdrawn;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

IEC 60086 consists of the following parts, under the general title: Primary batteries:

– Part 1: General
– Part 2: Physical and electrical specifications[1)]
– Part 3: Watch batteries
– Part 4: Safety of lithium batteries
– Part 5: Safety of batteries with aqueous electrolyte[1)]

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

1) To be published.

INTRODUCTION

The technical content of this part of IEC 60086 provides fundamental requirements and information on primary cells and batteries. In this sense, part 1 is the main component of IEC 60086 and forms the basis for the subsequent parts. For example, this part includes elementary information on definitions, nomenclature, dimensions and marking. While specific requirements are included, the content of this part tends to explain methodology (how) and justification (why).

The objective of IEC 60086-1 is to benefit primary battery users, device designers and battery manufacturers by ensuring that batteries from different manufacturers are interchangeable according to a standard form, fit and function. Furthermore, to ensure compliance with the above, this part specifies standard test methods for testing primary cells and batteries.

Over the years, this part has been changed to improve its content and remains under continual scrutiny to ensure that the publication is kept up to date with the advances in both battery and battery-powered device technologies. This current revision is the result of a reformatting initiative, as well as some content changes, aimed at making it more user-friendly, less ambiguous, and on a cross-reference basis, fully harmonized with other parts of IEC 60086 (such as IEC 60086-2 and IEC 60086-3).

NOTE Safety information has been removed from IEC 60086-1 and is now available in IEC 60086-4 and IEC 60086-5.

PRIMARY BATTERIES –

Part 1: General

1 Scope

The purpose of this part of IEC 60086 is to standardize primary batteries with respect to their electrochemical system, dimensions, nomenclature, terminal configurations, markings, test methods, typical performance, safety and environmental aspects.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60086. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60086 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60086-2, *Primary batteries – Part 2: Physical and electrical specifications*[2)]

IEC 60086-3:1995, *Primary batteries – Part 3: Watch batteries*

IEC 60086-4:2000, *Primary batteries – Part 4: Safety of lithium batteries*

IEC 60086-5, *Primary batteries – Part 5: Safety of batteries with aqueous electrolyte*[2)]

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

IEC 61429:1995, *Marking of secondary cells and batteries with the international recycling symbol ISO 7000-1135*

ISO 3951:1989, *Sampling procedures and charts for inspection by variables for percent non-conforming*

ISO/IEC Directives – Part 2: 1992

3 Definitions

For the purpose of this part of IEC 60086, the following definitions apply.

3.1
application test
test which simulates the actual use of a battery in a specific application, for example "portable lighting", "tape recorder" or "transistor radio" test

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2) To be published.

3.2
discharge (of a primary battery)
operation during which a battery delivers current to an external circuit

3.3
dry (primary) battery
primary battery in which the liquid electrolyte is immobilized

3.4
effective internal resistance – DC method
resistance of any electrical component determined by calculating the ratio between the voltage drop ΔU across this component and the range of current Δi passing through this component and causing the voltage drop $R = \Delta U / \Delta i$

NOTE As an analogy, the internal d.c. resistance R_i of any electrochemical cell is defined by the the following relation:

$$R_i\,(\Omega) = \frac{\Delta U\,(\mathrm{V})}{\Delta i\,(\mathrm{A})} \tag{1}$$

The internal d.c. resistance is illustrated by the schematic voltage transient as given below:

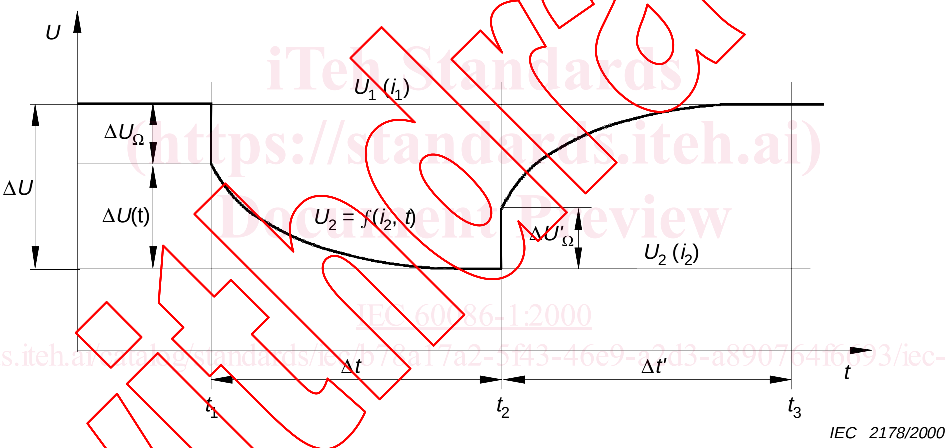


Figure 1 – Schematic voltage transient

As can be seen from this diagram, the voltage drop ΔU of the two components differs in nature, as shown in the following relation:

$$\Delta U = \Delta U_\Omega + \Delta U\,(t) \tag{2}$$

The first component ΔU_Ω for ($t = t_1$) is independent of time, and results from the increase in current Δi according to the relation:

$$\Delta U_\Omega = \Delta i \times R_\Omega \tag{3}$$

In this relation, R_Ω is a pure ohmic resistance. The second component ΔU (t) is time dependent and is of electrochemical origin.

3.5
end-point voltage
specified closed circuit voltage at which a service output test is terminated

3.6
leakage
unplanned escape of electrolyte, gas or other material from a battery

3.7
minimum average duration (MAD)
minimum average time on discharge which is met by a set of batteries

NOTE The discharge test is carried out according to the specified methods or standards and designed to show conformity with the standard applicable to the battery types.

3.8
nominal voltage of a primary battery
suitable approximate value of voltage used to identify the voltage of a primary battery

3.9
on-load voltage
closed circuit voltage (CCV)
voltage across the terminals of a battery when it is on discharge

3.10
open-circuit voltage (OCV)
off-load voltage
voltage across the terminals of a battery when no external current is flowing

3.11
primary battery
one or more primary cells, including case, terminals and marking

3.12
primary cell
source of electrical energy obtained by the direct conversion of chemical energy not designed to be charged by any other electrical source

3.13
service output (of a primary battery)
service life, or capacity, or energy output of a battery under specified conditions of discharge

3.14
service output test
test designed to measure the service output of a battery

NOTE A service output test may be prescribed, for example, when:

a) an application test is too complex to replicate;

b) the duration of an application test would make it impractical for routine testing purposes.

3.15
storage life
duration, under specified conditions, at the end of which a battery retains its ability to perform a specified service output

3.16
terminals (of a primary battery)
conductive parts provided for the connection of a battery to external conductors

4 Requirements

4.1 General

4.1.1 Design

Primary batteries are sold mainly in consumer markets. In recent years, they have become more sophisticated in both chemistry and construction, for example both capacity and rate capability have increased to meet the growing demands from new, battery-powered equipment technology.

When designing primary batteries, the aforementioned considerations shall be taken into account. Specifically, their dimensional conformity and stability, their physical and electrical performance and their safe operation under normal use and foreseeable misuse conditions shall be assured.

4.1.2 Battery dimensions

The dimensions for individual types of batteries are given in IEC 60086-2 and IEC 60086-3.

4.1.3 Terminals

Terminals shall be in accordance with clause 7 of IEC 60086-2.

Their physical shape shall be designed in such a way that they ensure that the batteries make and maintain good electrical contact at all times.

They shall be made of materials that provide adequate electrical conductivity and corrosion protection.

4.1.3.1 Contact pressure resistance

When mentioned in the battery specification tables or the individual specification sheets in IEC 60086-2, the following applies:

– a force of 10 N applied through a steel ball of 1 mm diameter at the centre of each contact area for a period of 10 s shall not cause any apparent deformation which might prevent satisfactory operation of the battery.

NOTE See also IEC 60086-3 for exceptions.

4.1.3.2 Cap and base

This type of terminal is used for batteries which have their dimensions specified according to figures 1, 2, 3 or 4 of IEC 60086-2, and which have the cylindrical side of the battery insulated from the terminals.

4.1.3.3 Cap and case

This type of terminal is used for batteries which have their dimensions specified according figures 2, 3 or 4 of IEC 60086-2, but in which the cylindrical side of the battery forms part of the positive terminal.

4.1.3.4 Screw terminals

This contact consists of a threaded rod in combination with either a metal or insulated metal nut.

4.1.3.5 Flat contacts

These are essentially flat metal surfaces adapted to make electrical contact by suitable contact mechanisms bearing against them.

4.1.3.6 Flat or spiral springs

These contacts comprise flat metal strips or spirally wound wire which are in a form that provides pressure contact.

4.1.3.7 Plug-in sockets

These are made up of a suitable assembly of metal contacts, mounted in an insulated housing or holding device and adapted to receive corresponding pins of a mating plug.

4.1.3.8 Snap-fasteners

These contacts are composed of a combination comprising a stud (non-resilient) for the positive terminal and a socket (resilient) for the negative terminal.

They shall be of suitable metal so as to provide efficient electrical connection when joined to the corresponding parts of an external circuit.

4.1.3.8.1 Spacing of contacts

The spacing between the stud and socket is given in the following table, and applies from centre to centre. The stud always forms the positive connection and the socket the negative connection on the battery.

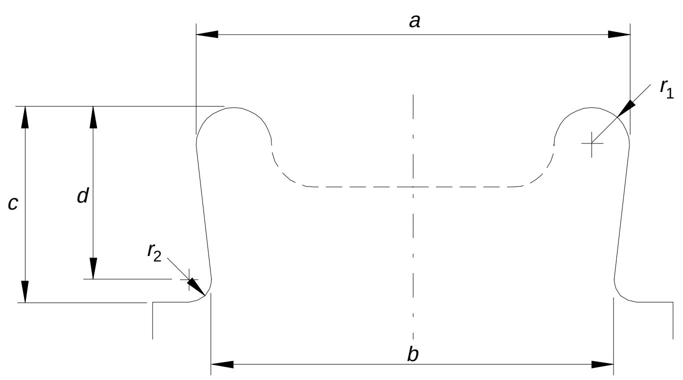
Table 1 – Spacing of contacts

Nominal voltage V	Standard mm	Miniature mm
9	35 ± 0,4	12,7 ± 0,25

4.1.3.8.2 Non-resilient snap-fastener connectors (studs)

Dimensions are given in millimetres.

All dimensions not specified are free. The shape of the stud shall be chosen so that the dimensions specified are conformed to.



IEC 2179/2000

Figure 2 – Standard stud

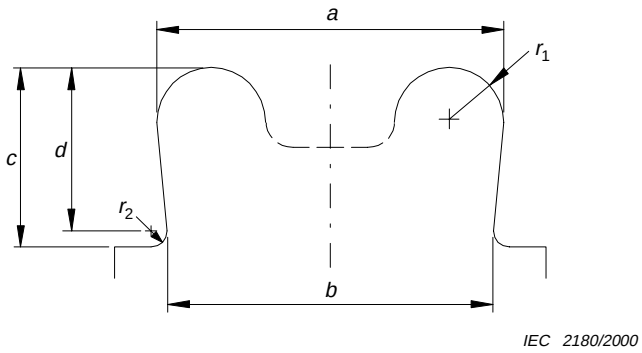


Figure 3 – Miniature stud

Table 2 – Snap-fastener connectors

	Standard mm	**Miniature** mm
a	7,16 ± 0,05	5,72 ± 0,05
b	$6{,}65^{+0{,}07}_{-0{,}05}$	5,38 ± 0,05
c	3,20 ± 0,1	3,00 ± 0,1
d	2,67 ± 0,05	2,54 ± 0,05
r_1	$0{,}61^{+0{,}05}_{-0{,}08}$	$0{,}9^{+0{,}1}_{-0{,}3}$
r_2	$0{,}4^{+0{,}3}_{0}$	$0{,}3^{+0{,}2}_{0}$

4.1.3.8.3 Resilient snap-fastener connectors (sockets)

Dimensions and requirements:

The dimensions of the resilient (socket) parts of snap-fastener connectors are not specified as such. The properties shall be such that:

a) the resiliency ensures that the standardized studs can be properly mated;

b) good electrical contact is maintained.

4.1.3.9 Wire

Wire leads shall be single- or multi-strand flexible insulated tinned copper. The insulation may be cotton braid or suitable plastic. The positive terminal wire covering shall be red and the negative black.

4.1.3.10 Spring clips

Spring clips are generally used on batteries not readily available to the consumer, when the corresponding parts of the external circuit are not precisely known. They shall be of spring brass or of other material having similar properties.

4.1.4 Classification (electrochemical system)

Primary batteries are classified according to their electrochemical system.

Each system, with the exception of the zinc-ammonium chloride, zinc chloride-manganese dioxide system, has been allocated a letter denoting the particular system.

The electrochemical systems that have been standardized up to now are given in table 3.

Table 3 – Standardized electrochemical systems

Letter	Negative electrode	Electrolyte	Positive electrode	Nominal voltage V	Maximum open circuit voltage V
–	Zinc	Ammonium chloride, Zinc chloride	Manganese dioxide	1,5	1,725
A	Zinc	Ammonium chloride, Zinc chloride	Oxygen	1,4	1,55
B	Lithium	Organic electrolyte	Carbon monofluoride	3	3,7
C	Lithium	Organic electrolyte	Manganese dioxide	3	3,7
E	Lithium	Non-aqueous inorganic	Thionyl chloride ($SOCl_2$)	3,6	3,9
F	Lithium	Organic electrolyte	Iron disulfide (FeS_2)	1,5	1,83
G	Lithium	Organic electrolyte	Copper (II) oxide (CuO)	1,5	2,3
L	Zinc	Alkali metal hydroxide	Manganese dioxide	1,5	1,65
P	Zinc	Alkali metal hydroxide	Oxygen	1,4	1,68
S	Zinc	Alkali metal hydroxide	Silver oxide (Ag_2O)	1,55	1,63

NOTE 1 The value of the nominal voltage is not verifiable, therefore it is only given as a reference.

NOTE 2 The maximum open-circuit voltage is measured as defined in 5.4 and 6.7.1.

NOTE 3 When referring to an electrochemical system, common protocol is to list negative electrode first, followed by positive electrode, i.e. lithium-iron disulfide.

4.1.5 Designation

The designation of primary batteries is based on their physical parameters, their electrochemical system as well as modifiers, if needed.

A comprehensive explanation of the designation system (nomenclature) can be found in annex A.

4.1.6 Marking

4.1.6.1 General

With the exception of batteries designated as small, each battery shall be marked with the following information:

a) designation;

b) year and month or week of manufacture, which may be in code, or the expiration of a guarantee period, in clear;

c) polarity of terminals (when applicable);

d) nominal voltage;

e) name or trade mark of the manufacturer or supplier.