IEC 60095-6

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Lead-acid starter batteries –
Part 6: Batteries for micro-cycle applications

Batteries d'accumulateurs de démarrage au plomb –
Partie 6: Batteries pour applications microcycles

IEC 60095-6:2019-09(en-fr)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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The text of this International Standard is based on the following documents:

FDIS	Report on voting
21/1013/FDIS	21/1018/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60095 series, published under the general title *Lead-acid starter batteries*, can be found on the IEC website.

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

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- withdrawn,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

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LEAD-ACID STARTER BATTERIES –

Part 6: Batteries for micro-cycle applications

1 Scope

This part of IEC 60095 is applicable to lead-acid batteries with a nominal voltage of 12 V, used primarily as power source for the starting of internal combustion engines (ICE), lighting and also for auxiliary equipment of ICE vehicles. These batteries are commonly called "starter batteries".

The batteries within the scope of this document are used for micro-cycle applications in vehicles which can also be called start-stop (or stop-start, idling-stop system, micro-hybrid or idle-stop-and-go) applications. In cars with this special capability, the internal combustion engine is switched off during a complete vehicle stop, during idling with low speed or during idling where there is no need to support the vehicle movement by the internal combustion engine. During the phases in which the engine is switched off, most of the electric and electronic components of the car are supplied by the battery without support of the alternator. In addition, in most cases an additional regenerative braking (recuperation or regeneration of braking energy) function is installed. The batteries under these applications are stressed in a completely different way compared to classical starter batteries. Aside from these additional properties, these batteries need to crank the ICE and support the lighting and also auxiliary functions in a standard operating mode with the support of the alternator when the internal combustion engine is switched on. All batteries within this scope fulfil basic functions, which are tested under the application of IEC 60095-1.

This document specifies the general requirements and methods of test specific to lead-acid batteries used for micro-cycle applications.

This document is applicable to batteries for the following purposes:

- lead-acid batteries of the dimensions according to IEC 60095-2 for vehicles with the capability to automatically switch off the ICE during vehicle operation either in standstill or when moving ("start-stop");
- lead-acid batteries of the dimensions according to IEC 60095-2 for vehicles with start-stop applications with the capability to recover braking energy or energy from other sources.

Li-ion technology is excluded from this document.

NOTE The applicability of this document also for batteries according to IEC 60095-4 is under consideration.

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 60050-482, *International Electrotechnical Vocabulary (IEV) – Part 482: Primary and secondary cells and batteries*

IEC 60095-1:2018, *Lead-acid starter batteries – Part 1: General requirements and methods of test*

IEC 60095-2, *Lead-acid starter batteries – Part 2: Dimensions of batteries and dimensions and marking of terminals*

3 Terms, definitions, abbreviated terms and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-482 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

3.1.1
flooded battery
vented battery
lead-acid battery having a cover provided with one or more openings through which gaseous products may escape

3.1.2
enhanced flooded battery
EFB battery
flooded lead-acid battery with additional special design features to significantly improve the cycling capability compared to standard flooded batteries

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

3.1.3
valve regulated lead-acid battery
VRLA battery
lead-acid battery which is closed under normal conditions but which has an arrangement that allows the escape of gas if the internal pressure exceeds a predetermined value

Note 1 to entry: The VRLA battery cannot receive addition to the electrolyte and after activation of dry-charged VRLA.

Note 2 to entry: In VRLA batteries the electrolyte is immobilized.

Note 3 to entry: This note applies to the French language only.

3.1.4
absorbent glass mat battery
AGM battery
VRLA battery in which the electrolyte is immobilized by absorption in a glass mat

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

3.1.5
gel battery
VRLA battery in which the electrolyte is immobilized by fixing as a gel

3.2 Abbreviated terms and symbols

EN European Standard (Euro Norm) created by CENELEC (European Committee for Electrotechnical Standardization)

SBA Standard Battery Association created by Battery Association of Japan

CHA Charge Battery; to be charged with given parameters

DCA	Dynamic charge acceptance
DCH	Discharge Battery; to be discharged with given parameters
PAU	Pause; no charging or discharging but measurement of voltage as required. If the battery is connected to the test unit, there shall be no quiescent current
RPT	Repeat; instruction to repeat certain steps several times
CAS	Case of; decision point leading to different actions dependent on the value of the reference variable
C_e	Effective capacity [Ah]
C_n	Nominal capacity [Ah]
C_{rch}	Recharged capacity [Ah]
DoD	Depth of discharge [% of C_n]
EOS	End of step
I_{CHA}	Charge current [A]
I_{CC}	Discharge current for cranking [A]
I_{DCA}	Weighted normalized dynamic charge acceptance, measured in A per Ah nominal capacity C_n [A/Ah]
I_{DCH}	Discharge current [A]
I_c	Average charge current in DCA test after charge history [A]
I_d	Average charge current in DCA test after discharge history [A]
I_n	Nominal discharge current [A], I_n [A] = C_n [Ah] / 20 [h]
I_r	Average charge current in DCA test during regenerative braking [A]
Q_{CHA}	Charged capacity [Ah]
Q_{DCH}	Discharged capacity [Ah]
R_{dyn}	Calculated dynamic internal resistance [Ω]
R_i	Internal resistance [Ω]
RC	Reserve capacity (discharge with a fixed current of 25 A to U = 10,5 V), used in DCA test
SoC	State of charge
t_{DCH}	Discharge time [s]
U_c	Charging voltage [V]

4 Designation of batteries for micro-cycle applications – Electrolyte density and open circuit voltage

4.1 Designation according to type

Subclause 4.1 of IEC 60095-1:2018 is applicable.

4.2 Electrolyte density and open circuit voltage

Subclause 4.3 of IEC 60095-1:2018 is applicable.

5 Condition on delivery

Clause 5 of IEC 60095-1:2018 is applicable.

6 General requirements

6.1 Identification, labelling

6.1.1 General

Batteries according to this document shall bear the following characteristics on at least the top or one of their four sides.

6.1.2 The identification of manufacturer or supplier

The name of the manufacturer or supplier shall be indicated.

6.1.3 Nominal voltage: 12 V

The nominal voltage of 12 V shall be indicated.

6.1.4 Capacity or reserve capacity and nominal cranking current

Subclause 6.1.4 of IEC 60095-1:2018 is applicable.

6.1.5 Production date code

Batteries shall be marked with the date of production. This might be part of a more complex code.

6.1.6 Safety labelling

Subclause 6.1.6 of IEC 60095-1:2018 is applicable.

6.1.7 Recycling labelling

Subclause 6.1.7 of IEC 60095-1:2018 is applicable.

6.1.8 Identification of start and stop

In addition to the mandatory information defined in IEC 60095-1, the battery could be marked with a symbol showing the micro-cycle application.

For better identification and comparison of batteries within the scope of this document, a special marking could be used by the battery manufacturer.

Examples: Europe EN label and Japan label:

6.1.9 Valve-regulated batteries

Subclause 6.1.8 of IEC 60095-1:2018 is applicable.

6.2 Marking of the polarity

The terminals shall be identified according to the requirements of IEC 60095-2.

6.3 Fastening of the battery

Where batteries are fastened to the vehicle by means of integral parts (for example, bottom ledges), these shall be in compliance with the requirements of IEC 60095-2.

7 Functional characteristics

7.1 Electrical characteristics

7.1.1 The cranking performance, the 20 h capacity, the reserve capacity, the charge retention and the water consumption have the same definition as in IEC 60095-1:2018.

The charge acceptance tests and the endurance tests are adapted for the micro-cycle applications.

7.1.2 The cranking performance is the discharge current I_{cc}, as indicated by the manufacturer according to the option chosen (option 1 or option 2), which a battery can supply according to 9.3.

7.1.3 The capacity of a starter battery is defined for a temperature of 25 °C ± 2 °C.

It may be indicated by the manufacturer as either:

- nominal 20 h capacity C_{20}, or
- nominal reserve capacity RC_n.

C_{20} and RC_n are defined in IEC 60095-1:2018 in 7.1.2.

7.1.4 The charge acceptance consists of two parts:

- the charge acceptance 1 (at 0 °C) defined in IEC 60095-1:2018, 7.1.3.
- the charge acceptance 2 (at 25 °C) is a specific requirement for the micro-cycle applications.

7.1.5 The charge retention is defined in IEC 60095-1:2018, 7.1.4.

7.1.6 The endurance test consists in four parts:

- the "corrosion test" represents the ability of a battery to perform repeated overcharge/storage periods.
- the "cycling test 50 % DoD" represents the ability of a battery to perform repeated discharge/ recharge cycles and long rest periods on open circuit. This ability shall be tested by a series of cycles and rest periods under specified conditions after which the cold cranking or the capacity performances shall be determined.
- the "cycling test 17,5 % DoD" represents the ability to deliver energy under high cyclic conditions in a partially discharged state of charge.
- the "micro-cycle test" represents the ability of a battery to provide the power to restart the engine after frequent stop phases, its ability to recover state of charge afterwards and the aging effects due to shallow pulse loads.

7.1.7 The water consumption is defined in IEC 60095-1:2018, 7.1.6.

VRLA have a very low water consumption and are not intended to receive additional water.

Most of the time, EFB have a sealed lid and are not intended to receive additional water due to their very low water consumption.

7.2 Mechanical characteristics

7.2.1 The vibration resistance and the electrolyte retention have the same definitions as in IEC 60095-1.

7.2.2 "Vibration resistance" represents the ability of a battery to maintain service under periodic or irregular acceleration forces. Minimum requirements shall be verified by a test (see 9.7).

7.2.3 "Electrolyte retention" is the ability of a battery to retain the electrolyte under specified physical conditions (see 9.8).

8 General test conditions

8.1 Sampling of batteries

Samples shall be tested not later than:

- 45 days after production date of the manufacturer in the case of filled batteries;
- 60 days after production date of the manufacturer in the case of dry-charged batteries.

8.2 Charging method – Definition of a fully charged battery

This is defined in IEC 60095-1:2018, 8.2.

8.3 Test equipment

8.3.1 Measuring instruments

This is defined in IEC 60095-1:2018, 8.3.1.

Specific requirements for measuring equipment capability are given in Annex A for the dynamic charge acceptance test of 9.4.2 and micro-cycle test of 9.6.4.

8.3.2 Water bath

This is defined in IEC 60095-1:2018, 8.3.2.

8.3.3 Environmental chamber

This is defined in IEC 60095-1:2018, 8.3.3.

8.4 Test sequence

a) Initially, the batteries are subjected to the following series of tests:
   - first C_e or RC_e check;
   - first cranking performance test;
   - second C_e or RC_e check;
   - second cranking performance test;
   - third C_e or RC_e check;
   - third cranking performance test.

   The 20 h capacity test C_e is defined in IEC 60095-1:2018, 9.1, the reserve capacity test RC_e is defined in IEC 60095-1:2018, 9.2.

   For C_e or RC_e and the cranking performance, the specified values shall be met in at least one of the relevant discharges given in a).

It is not necessary to complete the sequence if the specified values are achieved on the first or second test.

NOTE 1 The choice between testing C_e or RC_e is the decision of the customer or user.

b) The tests according to Tables 1 or 2 shall be carried out only if the batteries have complied with the tests mentioned in a), and no more than one week after completion of the said tests.

NOTE 2 The choice between testing C_e or RC_e is the decision of the customer or user.

Table 1 – Test/battery OPTION A

Test		Battery					
		*B_1	B_2	B_3	B_4	B_5	B_6
Initial charge prior to test		✓	✓	✓	✓	✓	✓
1st 20 h capacity	1st reserve capacity	✓ C_{20}		✓	✓	✓	✓
1st cranking performance		✓		✓	✓	✓	✓
2nd 20 h capacity	2nd reserve capacity	✓ C_{20}		(✓)	(✓)	(✓)	(✓)
2nd cranking performance		(√)		(✓)	(✓)	(✓)	(✓)
3rd 20 h capacity	3rd reserve capacity	✓ C_{20}		(✓)	(✓)	(✓)	(✓)
3rd cranking performance		✓					
Charge acceptance 1 (9.4.1)		✓					
Charge acceptance 2 (SBA) (9.4.2)		✓	✓				
Endurance tests (9.6)	Corrosion test Cycling test 50 % DoD Cycling test 17,5 % DoD Micro-cycling SBA (9.4.2)	✓	✓	✓	✓		
Charge retention (9.5)						✓	
Electrolyte retention (9.8)							✓
Vibration resistance (9.7)							✓
Key √ test to be fulfilled. (√) test to be fulfilled only if the previous identical test carried out failed.							
* Important: Battery B_1 shall perform the full sequence of 3 tests at 20 h capacity (not RC) before the charge acceptance test of 9.4.1.							

Table 2 – Test/battery OPTION B

Test		Battery						
		*B_1	B_2	**B_3	B_4	B_5	B_6	B_7
Initial charge prior to test		✓	✓	✓	✓	✓	✓	✓
1st 20 h capacity	1st reserve capacity	✓ C_{20}	✓	✓ C_{20}	✓	✓	✓	
1st cranking performance		✓	✓	✓	✓	✓	✓	
2nd 20 h capacity	2nd reserve capacity	✓ C_{20}	✓	✓ C_{20}	(✓)	(✓)	(✓)	
2nd cranking performance		(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	
3rd 20 h capacity	3rd reserve capacity	✓ C_{20}	(✓)	✓ C_{20}	(✓)	(✓)	(✓)	
3rd cranking performance		(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	
Charge acceptance 1 (9.4.1)		✓	(✓)					
Charge acceptance DCA (9.4.2)								✓
Endurance tests (9.6)	Corrosion test	✓						
	Cycling test 50 % DoD		✓					
	Cycling test 17,5 % DoD			✓				
	Micro-cycling MHT (9.6.4)				✓			
Charge retention (9.5)						✓		
Electrolyte retention (9.8)							✓	
Vibration resistance (9.7)							✓	

Key

✓ test to be fulfilled

(✓) test to be fulfilled only if the previous identical test carried out failed

* Important: Battery B_1 shall perform the full sequence of 3 tests at 20 h capacity (not RC) before the charge acceptance test, in 9.4.1.

** Important: Battery B_3 shall perform the full sequence of 3 tests at 20 h capacity (not RC) before the cycling test at 17,5 % DoD, in 9.6.3.

9 Tests methods

9.1 20 h capacity check C_e

This test is defined in IEC 60095-1:2018, 9.1.

9.2 Reserve capacity check RC_e

This test is defined in IEC 60095-1:2018, 9.2.

9.3 Cranking performance test

9.3.1 Cranking performance test – Standard temperature (−18 °C)

This test is defined in IEC 60095-1:2018, 9.3.1.