

INTERNATIONAL STANDARD

**Lead-acid starter batteries -
Part 8: 12V Batteries used in automobiles for auxiliary or backup purposes**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Lead-acid starter batteries -
Part 8: 12 V Batteries used in automobiles
for auxiliary or backup purposes**

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IEC 60095-8 has been prepared by IEC technical committee 21: Secondary cells and batteries. It is an International Standard.

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

Draft	Report on voting
21/1307/FDIS	21/1321/RVD

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 International Standard 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/publications.

A list of all the 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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

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INTRODUCTION

With the growth of electrified vehicles (xEV), many 12 V batteries in automobiles are not (or not regularly) used for cranking or starting engines: In battery-electric vehicles, there is no engine. In hybrid-electric vehicles, depending on powertrain topology, the electric machine can start the combustion engine utilizing power by the traction battery. Additional functionalities like the ones related to functional safety (e.g. in case of disruption of 12 V supply from the main high voltage energy system) require new test methods, particularly for power capability and charge recovery, as well as potential different ageing mechanisms related to different usage profiles. For example, the 12 V system is operated for significantly more hours per month than in a conventional car with internal combustion engine under the same driving usage, adding the on-plug time during which the traction battery is recharged, and potentially kept at standby for grid-connected storage functions.

Current production vehicles, including some internal combustion engine (ICE) start-stop vehicles, but mainly xEVs, such as hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs), already feature one or more 12 V support batteries and are expected to be equipped with such batteries as long as a 12 V power supply system forms part of the vehicle electrical system.

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1 Scope

This part of IEC 60095 is applicable to lead acid batteries with a nominal voltage of 12 V, for automobile passenger cars applications, used as auxiliary energy storage and power source in vehicles, but not featuring the classical function of engine starting or cranking. This includes applications in battery-electric vehicles, as well as in vehicles with an internal combustion engine (ICE) that is started by another (12 V, 48 V or high-volt) battery. This document can be used for batteries with auxiliary or backup purposes.

This document specifies:

- the general requirements; and
- the essential functional characteristics, relevant test methods and results required for several classes of batteries in accordance with:
 - the general type of application;
 - the type of product; and
 - the categories as defined in 4.1.

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*

IEC 60095-6:2019, *Lead-acid starter batteries - Part 6: Batteries for micro-cycle applications*

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, IEC 60095-1, IEC 60095-6 apply.

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

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

3.2 Abbreviated terms and symbols

BEV	battery electric vehicle
BOL	beginning of life
C_e	effective capacity [Ah]
CF	charge factor
CHA	charge battery; to be charged with given parameters
C_n	nominal capacity [Ah]
CR	charge recovery
C_{rch}	recharged capacity [Ah]
DCH	discharge battery; to be discharged with given parameters
DoD	depth of discharge [% of C_n]
EN	European Standard (Euro Norm) created by CENELEC (European Committee for Electrotechnical Standardization)
EOL	end of life
EOS	end of step
HEV	hybrid electric vehicle
I_{CC}	discharge current for cranking [A]
ICE	internal combustion engine
I_n	nominal discharge current [A], $I_n [A] = C_n [Ah]/20 [h]$
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
PHEV	plug-in hybrid electric vehicle
PPC	Pulse Power Characterization
PP1	pulse profile 1 in accordance with Table 9
PP2	pulse profile 2 in accordance with Table 10
PSOC	partial state of charge
Q_{CHA}	charged capacity [Ah]
RC_e	effective reserve capacity
RC_n	nominal reserve capacity (discharge with a fixed current of 25 A to $U = 10,5$ V)
R_i	internal resistance [Ω]
RPT	repeat; instruction to repeat certain steps several times
SoC	state of charge
SOF	state-of-function
U_c	charging voltage [V]
U_{EOD}	voltage at the end of discharge step [V]
xEV	electrified vehicle

4 Categories and designation of batteries for auxiliary or backup applications

4.1 Categories

Batteries defined for auxiliary or backup purposes relate to vehicle applications that are highly diverse and subject to rapid technical change. However, they can typically be associated with one of the following three categories:

- Category (1): 12 V central-storage (main) battery, with most functions of modern automotive batteries except engine starting. These functions typically include low and medium rate power supply during parking, pre-trip vehicle activation, after-trip vehicle system shutdown, and software updates that can require the high-volt system to be shut down temporarily. Further, the 12 V central storage battery has a role in stabilizing the system voltage and can supply, regularly or in case of overload or failure of the primary 12 V supply, high power to peak loads during vehicle driving operation. Emergency power support can be required in system architectures where such functionality is not supported by any additional dedicated energy and power source. Sizing such batteries typically considers capacity (or energy) requirements as well as high-rate discharge current (or power) requirements. As 12 V batteries in electric vehicles can be recharged by the traction battery while parking, and as cold-cranking performance is not a requirement, they are often downsized.

When a downsized battery is subjected to cyclic use, the relative depth of discharge (DoD) of each individual cycle will be larger in per-cent of nominal capacity, and the annual cyclic throughput requirement will be a larger multiple of the nominal capacity. In consequence, the downsized battery for the same absolute cycling duty will face more stringent cycle-life requirements, compared to a starter or micro-hybrid battery in an ICE vehicle with otherwise identical electrical loads. Following the above consideration, this document defines three endurance requirement levels (1A), (1B), (1C), allowing to specify batteries meeting capacity turnover as predicted by the OEM for specific applications and system designs.

- Category (2): 12 V backup battery that is stabilizing voltage and providing emergency power for a sensitive – often safety relevant – electrical component or portion of the power supply system. Such batteries are often disconnected from the 12 V loads when alternator or dc/dc converter are not feeding the 12 V system, protecting them from discharge while parking etc. In such cases, the operating state-of-charge (SOC) range can be narrow (and close to fully charged)

Requirements for category (2) will take into account limited capacity throughput during life and appropriate voltage response when supporting high-rate discharge currents.

NOTE This document does not provide safety requirements

- Category (3): 12 V auxiliary batteries in start-stop or micro-hybrid vehicles that stabilize system voltage during engine restart, which would be powered out of the 12 V starter battery. This application is similar to the backup case described above, but battery discharge occurs frequently during normal operation and is not safety relevant.

Requirements for category (3) shall take into account limited capacity throughput and power.

4.2 Designation according to type

IEC 60095-1:2018, Subclause 4.1, is applicable

5 Condition on delivery

IEC 60095-1:2018, Clause 5, is applicable

6 General requirements

6.1 Identification and labelling

6.1.1 General

Batteries in accordance with this document shall bear the following characteristics on at least the top or one of their four sides.

6.1.2 The identification of the 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 high rate current CCA

6.1.4.1 General-use automotive batteries

IEC 60095-1:2018, 6.1.4, is applicable for batteries that are qualified for starter application in accordance with IEC 60095-1 or IEC 60095-6 and shall be qualified for additional use in auxiliary or backup applications.

6.1.4.2 Dedicated auxiliary or backup batteries

Batteries designed specifically for auxiliary or backup applications shall carry indications of capacity and CCA in line with IEC 60095-1:2018, 6.1.4. For batteries dedicated to auxiliary or backup applications, "(AUX)" should be added near the rated CCA value.

NOTE The CCA rating remains the indicator of power performance for such 12 V batteries in automobiles that are not designed to crank engines. To enable application-specific design optimization, this document defines a shorter cranking performance test for such batteries that will be combined with a new, more application-specific pulse-power performance characterization (PPC) test. Though backward-compatible to a first-order approximation, the designation "(AUX)" clarifies that a full cold-cranking test in accordance with IEC 60095-1 is not required.

6.1.5 Production date code

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

6.1.6 Safety labelling

IEC 60095-1:2018, 6.1.6, is applicable

6.1.7 Recycling labelling

IEC 60095-1:2018, 6.1.7, is applicable

6.1.8 Valve-regulated batteries

IEC 60095-1:2018, 6.1.8, is applicable

6.2 Marking of the polarity and fastening of the battery

For batteries whose dimensions are defined by IEC 60095-2, the terminals shall be identified in accordance with the requirements of IEC 60095-2. Where batteries are fastened to the vehicle by means of integral parts (e.g. bottom ledges), these parts shall comply with the requirements of IEC 60095-2.

7 Functional characteristics

7.1 Electrical characteristics

7.1.1 The 20 h capacity, the reserve capacity and the charge retention are defined in IEC 60095-1:2018.

The high-rate discharge performance is defined by the discharge current I_{cc} , as indicated by the manufacturer, which a battery can supply in accordance with 9.3. Engine-cranking not being a requested function, the test result shall be used as an indicator of general power performance and as a parameter for the Pulse Power Characterization (PPC) procedure.

7.1.2 The capacity is defined for a temperature of $25\text{ °C} \pm 2\text{ °C}$. 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, 7.1.2.

7.1.3 The Pulse Power Characterization (PPC) is a sequence of short pulses at progressively increasing currents, executed at partial state of charge (PSOC) and low temperature:

- at the beginning of life, as part of the initial characteristics sequence;
- at the end of life or when the specification target (number of cycles, number of units) of the intended performance level is achieved, proving minimum power performance is maintained throughout specified endurance.
- See Annex B for further information on the background and interpretation of test results.

7.1.4 The charge acceptance (at 0 °C) defined in IEC 60095-1:2018, 7.1.3.

7.1.5 The charge recovery (at -18 °C) is the ability of the battery to restore vehicle-target levels of both energy (state of charge) and discharge power (state of function), starting from a slow-discharged condition. See Annex C for further information on the background and interpretation of test results.

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

7.1.7 The endurance test consists in the following 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 and 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 optional endurance cycle test represents the ability to perform significantly high number of shallow charge or recharge cycles at a relatively high state of charge.
- The cycling test 17,5 % DoD represents the ability to deliver energy under high cyclic conditions in a partially discharged state of charge.
- The water consumption is defined in IEC 60095-1:2018, 7.1.6.

7.2 Mechanical characteristics

The vibration resistance and the electrolyte retention are defined in IEC 60095-1:2018.

8 General test conditions

8.1 Sampling of batteries

Samples shall be tested not later than 60 days after production date of the manufacturer

8.2 Charging method – Definition of a fully charged battery

Batteries shall be considered fully charged if they have undergone the charging procedures. Prior to the first capacity test, the battery charge shall be limited to 16 h.

Unless otherwise specified by the battery manufacturer, batteries tested in accordance with this document shall be charged in accordance with Table 1.

Table 1 – Charging method

Battery type	Voltage U_c	Current	Time	Remarks
Flooded batteries	16,00 V $\pm$ 0,05 V	5 I_n	24 h (16 h) ^a	
Valve-regulated batteries VRLA	14,80 V $\pm$ 0,05 V	5 I_n	24 h (16 h) ^a	
^a A charging time of 16 h is sufficient after a cranking performance test and prior to first capacity check.				

All charges shall be performed with batteries in a water bath at 25 °C $\pm$ 2 °C. After completion of charging, the battery shall rest 1 h to 5 h unless otherwise specified in the test procedures that refer to 8.2.

8.3 Test equipment

8.3.1 Measuring instruments

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

8.3.2 Water bath

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

8.3.3 Environmental chamber

Environmental chamber is defined in IEC 60095-1:2018, 8.3.3

8.4 Test sequence

8.4.1 General-use automotive batteries

Batteries that are qualified for starter application in accordance with IEC 60095-1 or IEC 60095-6 may be qualified for additional use in auxiliary or backup applications by testing only the sequence shown for battery No.7 of Table 2 in this document.

Rationale: One and the same automotive battery type may be used in starter battery applications as well as in auxiliary or backup applications. For such cases, incremental test effort following the present document is minimized.

8.4.2 Dedicated auxiliary or backup batteries

As an alternative to amending existing starter battery test plans, an auxiliary or backup battery may be tested in accordance with Table 2. No additional tests or requirements in accordance with IEC 60095-1 or IEC 60095-6 apply in this case.

Rationale: Auxiliary or backup applications impose different requirements to batteries compared to traditional starter batteries, particularly regarding performance and sizing for discharge power (lower rates at higher voltage allowance), but also for charge recovery (on a time scale of minutes to hours) as opposed to dynamic charge acceptance (for recuperation events lasting seconds or tens of seconds). Consequently, their design may be optimized away from legacy starter battery design rules. The test matrix for dedicated auxiliary or backup batteries is tailored for the new applications, and several typical requirement levels are suggested (see 10.2).

Table 2 – Test sequence

Step	Test	Reference	Battery						
			No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7
1	Initial charge prior to test	8.2	✓	✓	✓	✓	✓	✓	✓
2	First 20 h capacity C_e or RC_e	9.1 or 9.2	✓	✓	✓	✓	✓	✓	✓
3	CCA AUX	9.3.1	✓	✓	✓	✓	✓	✓	✓
4	Second 20 h capacity C_e or RC_e	9.1 or 9.2	(✓)	✓	(✓)	(✓)	(✓)	(✓)	(✓)
5	CCA AUX	9.3.1	(✓)	✓	(✓)	(✓)	(✓)	(✓)	(✓)
6	Third 20 h capacity C_e or RC_e	9.1 or 9.2	(✓)	✓	(✓)	(✓)	(✓)	(✓)	(✓)
7	CCA AUX	9.3.1	(✓)		(✓)	(✓)	(✓)	(✓)	(✓)
8	Charge acceptance test	9.5	✓						
9	Charge Recovery test	9.6							✓
10	PPC BOL - Pulse Power Characterization	9.4.2	✓	✓	✓				♦
11	Corrosion test	9.7.1	✓						
12	Cycling test 17,5 % DoD	9.7.4		✓					
13	Cycling test 50 % DoD or Optional endurance cycle test	9.7.2 or 9.7.3			✓				
14	Charge retention	9.8				✓			
15	Electrolyte retention	9.9				✓			
16	Vibration resistance	9.10					✓		
17	Water consumption	9.11						✓	
18	PPC EOL - Pulse Power Characterization	9.4.3	✓	✓	✓				
Key ✓ Test to be fulfilled. (✓) Test to be fulfilled only if the previous identical test carried out failed. ♦ Test mandatory for dedicated auxiliary and backup batteries and recommended for general-use batteries.									