

Ultra-low temperature performance of automotive 12V lead batteries: Experimental parameters and reference data

ALBA Workshop, Mainz, 19/20 May 2026

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Ultra-low temperature performance of automotive LAB

Purpose

1. document CCA, PPC, CR performance at -18°C , -29°C , -40°C :
 - By which **factor is I_{cc}** reduced with falling temperature?
 - How consistent is **PPC at ~50% SOC** (est. at nominal condition)?
Can we confirm equivalence of 1-step and **2-step response**?
 - How consistent is **SOF Recovery boost** out of charging?
Demonstrate SOC-limited charge steps between SOF tests.
2. justify or improve experimental parameters in IEC 60095-8 versus new SIB data, in particular:
 - How long should **pause duration** be between PPC discharge steps to assure heat dissipation?



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Approach

- **4 types** * 3 samples of typical automotive products
(JIS FLA aftermarket, LN EFB, LN AGM prism., AGM spiral-wound)
- monitor **OCV and R_i relaxation** after discharge peaks with Hioki BT-3554 & logger (5s sampling rate)
- at each temperature: **empirical I_{cc}** at 7.8 V, **PPC**: 80% & 50% SOC, **modified CR**: 50% → 51% → 53% → 60% → 70% SOC



Test procedure

- 1) I_{cc} (7.8V) and PPC(80%):
1 sample @-18°C, 1 sample @-30°C

where & order	no.	T / °C	Step	t	U / V	I / A
1) water bath	01	25 °C	DCH	22 h	>10.5V	I_{20}
	02	25 °C	CHA	24 h	EFB: 16 V AGM: 14.8 V	$5 \cdot I_{20}$
2) freezer / floor	03	-18 °C	PAU	min 22 h max 48 h		
	04	-18 °C	DCH	10 sec	7.8V	$1.5 \cdot I_{cc}$
	07	-18 °C	PAU	1 h		
3) climate chamber	08	25 °C	PAU	min 4 h max 24 h		
	09	25 °C	CHA	16 h	EFB: 16 V AGM: 14.8 V	$5 \cdot I_{20}$
	10	25 °C	PAU	1 h		
	11	25 °C	DCH		>10.5V	I_{20}
	13	-18 °C	PAU	min 22 h max 48 h		
	18	-18 °C	DCH	2 sec	> 6	$0.1 \cdot I_{cce18}$
	19	-18 °C	PAU	10 min		
	20	-18 °C	DCH	2 sec	> 6	$0.3 \cdot I_{cce18}$
	21	-18 °C	PAU	20 min		
	22	-18 °C	DCH	5 sec	> 6	$0.5 \cdot I_{cce18}$
	23	-18 °C	PAU	45 min		
	24	-18 °C	DCH	2 sec	> 6	$0.7 \cdot I_{cce18}$
	25	-18 °C	PAU	60 min		
	26	-18 °C	DCH	30 sec	>9	$0.05 \cdot I_{cce18}$
	27	-18 °C	DCH	2 sec	> 6	$0.5 \cdot I_{cce18}$
	28	-18 °C	PAU	10 min		
	29	-18 °C	DCH	5 sec	> 6	$0.5 \cdot I_{cce18}$
	30	-18 °C	PAU	90 min		

- 2) %Cn-limited CR out of 50% SOC:
1 sample @-18°C, 1 sample @-30°C

where & order	no.	T / °C	Step	t	U / V	I / A
4a) water bath	31	25 °C	PAU	min 4 h max 24 h		
	32	25 °C	CHA	16 h	EFB: 16 V AGM: 14.8 V	$5 \cdot I_{20}$
	33	25 °C	PAU	min 12 h max 48 h		
5) climate chamber	34	-18 °C	PAU	min 20 h max 48 h		
	35	-18 °C	DCH	10 h	>10.5V	I_{20}
	36	-18 °C	PAU	10 min		
	37	-18 °C	DCH	5 sec	> 6	$0.5 \cdot I_{cce18}$
	38	-18 °C	PAU	10 sec		
	39	-18 °C	CHA	Ah balance <=-49%	15 V	$20 \cdot I_{20}$
	40	-18 °C	DCH	5 sec	> 6	$0.5 \cdot I_{cce18}$
	41	-18 °C	PAU	10 sec		
	42	-18 °C	CHA	Ah balance <=-47%	15 V	$20 \cdot I_{20}$
	43	-18 °C	DCH	5 sec	> 6	$0.5 \cdot I_{cce18}$
	44	-18 °C	PAU	10 sec		
	45	-18 °C	CHA	Ah balance <=-40%	15 V	$20 \cdot I_{20}$
	46	-18 °C	DCH	5 sec	> 6	$0.5 \cdot I_{cce18}$
	47	-18 °C	PAU	10 sec		
	48	-18 °C	CHA	Ah balance <=-30%	15 V	$20 \cdot I_{20}$
	49	-18 °C	DCH	30 sec	> 6	$0.5 \cdot I_{cce18}$
	50	-18 °C	PAU	60 min		

- 3) PPC at gradually falling SOC 50% → 40%:
1 sample @-18°C, -25°C, -30°C (sequentially)
1 sample @-30°C, -40°C, -18°C (sequentially)

- 4) *planned*:
%Cn-limited CR @-40°C:
1 sample out of 50% SOC,
1 sample out of 75% SOC



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The test plan has been coordinated with standardization and application specialists in ALBA CP virtual workstream and in IEC 63711-1 SG2 project team, assuring maximum synergies with ongoing SIB procedure validation.

We thank CBI for funding as an ALBA Plus project.

First results: Cold cranking 7.8V at 3 temperatures

