

SO24 - Recommendation for 12V Charging Strategy in BEV – New Chapters

CBI ALBA+ Project

Jörg Tiburcy, Clarios

Roger Zimmermann, Combatec

Eckhard Karden, Consultant

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Recommendation for 12V Charging Strategy in BEV - New Chapters

Jörg Tiburcy – ALBA 2026 – SO24

CBI ALBA+ Project



What:

Document and apply state of the art of PbA-friendly 12V "operating strategy" from conventional IEC/alternator vehicles for usage in BEVs.

Why:

PbA-battery knowledge is fading in the established OEMs or was never present in start-up EV companies.

For Whom:

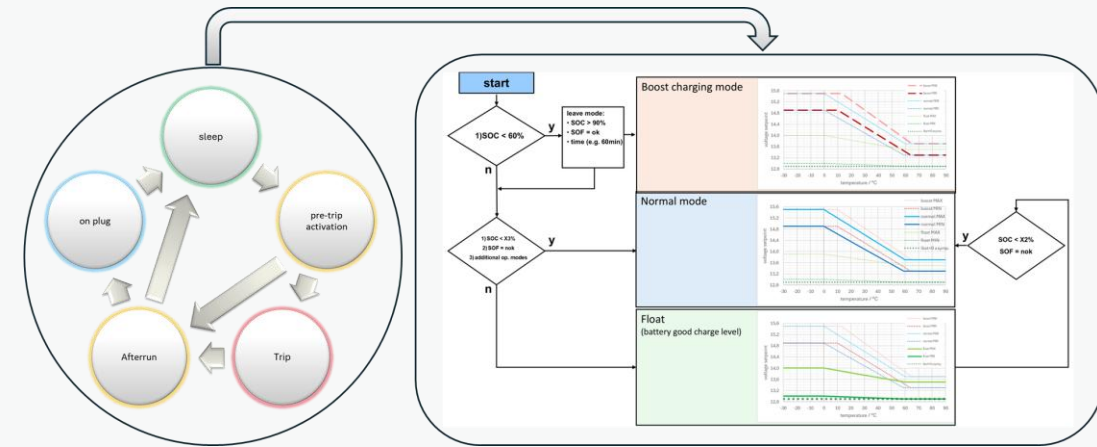
Vehicle Engineers with Lithium/Sodium-Ion battery knowledge.

Status:

First edition has been prepared by Roger Zimmermann, Combatec as CBI ALBA+ Project and presented at ALBA 2025 follow-up meetings.

Next Steps:

CBI- Webinar and initial publication (pdf) planned for June 2026



CALL FOR HELP:

Open questions at my poster:

- How to get a broader reception?
 - Media: Presentation, White Paper, Podcast....
 - Official journal: IEC technical paper,....
- Missing Chapters?

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Table of content

Introduction: 12V lead batteries in BEV

- Lead battery basics – key facts
- Case studies: Observations in OEM strategies
- Field data analysis: How 12V batteries fail in real-world HEV and BEV
- Differences versus conventional (ICE) cars, *application categories*
- Basic requirements to battery and monitoring system
- Use cases for auxiliary and backup batteries

→ NEW

→ ALBA 2025

→ ALBA 2025

→ IEC60095-8

→ NEW

→ NEW

The core of the strategy: voltage setpoint

- battery-driven requirements to setpoint choice, Z curves, charge modes, ramps
- integration of charge modes with vehicle operating modes, energy management aspects
- IBS-driven requirements to setpoint modulation

→ **UPDATES: SO25, SO26, SO27**

→ NEW

Other system design aspects

- package location, heat exposure
- cyclic throughput: prediction and control
- CCA sizing for non-cranking applications
- charge recovery: discharge power is restored much faster than state of charge
- relationship to Functional Safety (ASIL functions)

→ NEW // ZVEI Leaflet No 28e

→ NEW

→ SO15

→ ALBA 2025

→ ALBA 2025

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CALL FOR HELP:

- Missing Chapters / Topics ?
- Further Data to add?

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Extract from Draft for ALBA 2026

Content

Draft Status for ALBA
2026

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Normal charge mode

This single charge mode is sufficient for 12V main battery (AUX) applications

- maybe except some extreme usage profiles like 2-3 shift operation

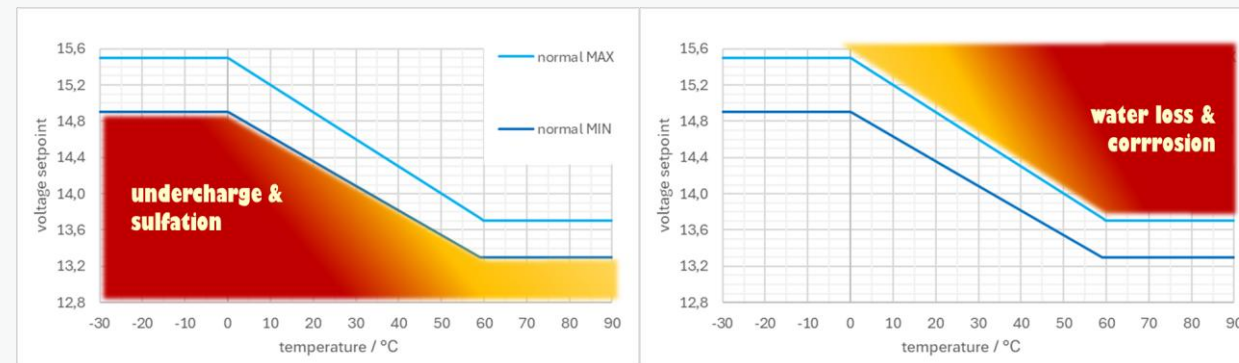
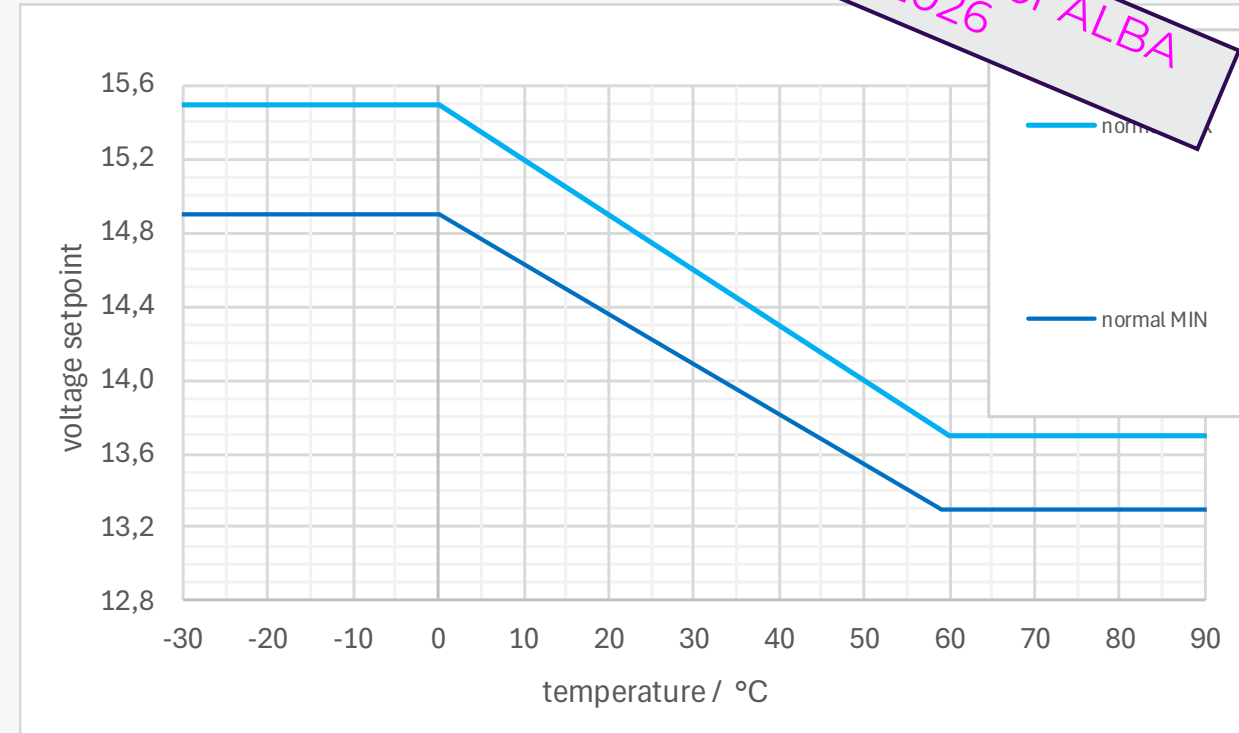
Key elements: "Z curve"

- temperature compensation (-24 ... -36) mV/K is essential
- minimum voltage cutoff compensates self-discharge
- maximum voltage cutoff only defined by vehicle, not battery
 - load dump: keep system voltage <16V while alternator continues generating excess current for 50~100 ms

Background

- premature battery failures if voltage below band:
 - undercharge, stratification, sulfation
 - fast dc/dc converter allows higher maximum voltage than with alternator (keep system <16V after load dump)
- premature battery failures if voltage above band:
 - corrosion, water loss, dry-out
- carry over from conventional ICE cars (>100 years experience):
 - typically, 0.5 ... 3 h operation per day, otherwise quiescent drain ~20mA

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Boost charge mode

Rationale / when recommended

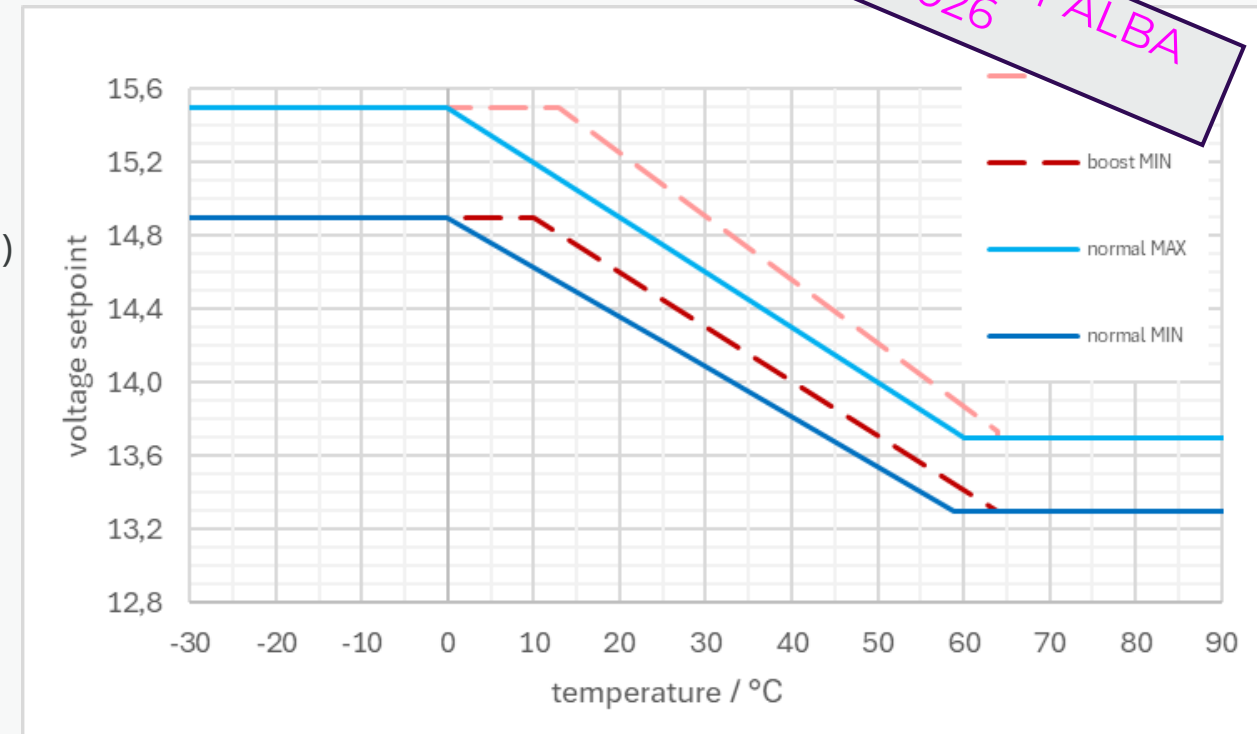
- fast recovery from low SOC or SOF
- equalization / refresh charge (maintenance against sulfation)
- (brake energy recuperation in micro-hybrids = mainstream EU ICE)

Key elements

- 0.3 ... 0.7 V above normal mode, dU/dT may be chosen steeper
- maintain MIN and MAX cut-off voltages

Implementation

- trigger by
 - low SOF (e.g., 0.5V above min. requirement)
 - low SOC (e.g., <60%)
 - calendar time (e.g., every week or every month)
 - throughput, e.g., 3x Cn
- duration should be limited
 - terminate when SOF back >10.0V above requirement or SOC>90%
 - terminate by duration, e.g., 4h total (per event)
 - limit cumulated time per calendar month (e.g., 30 h/month)



Low charge mode

Rationale / why OEMs may decide to use it

- vehicle energy management by operating mode: prioritize charging on-plug or while driving – use lower Z curve for low priority charging
 - ❖ range effect is marginal: usable energy (12V bat.) < 1% (traction bat.)
- water consumption “angst”: compensate additional 12V “on” hours in BEV while on-plug charging
 - ❖ despite all field evidence: 12V BEV batteries fail from undercharge, not overcharge
 - ❖ trade-off with water consumption requirement (if high, charge more conservatively)

Challenges / risks / observed issues

- complexity (software, controls) by using **SOC and SOF** as inputs
- vicious cycle of undercharging and sulfation: **SOC** accuracy is poor, with large positive systematic errors (fooled by low charging current and persistently high OCV after marginal charging)
- More robust is **event or time**-based triggering of equalization charge (whenever plugged in, or every week, every month, ...)

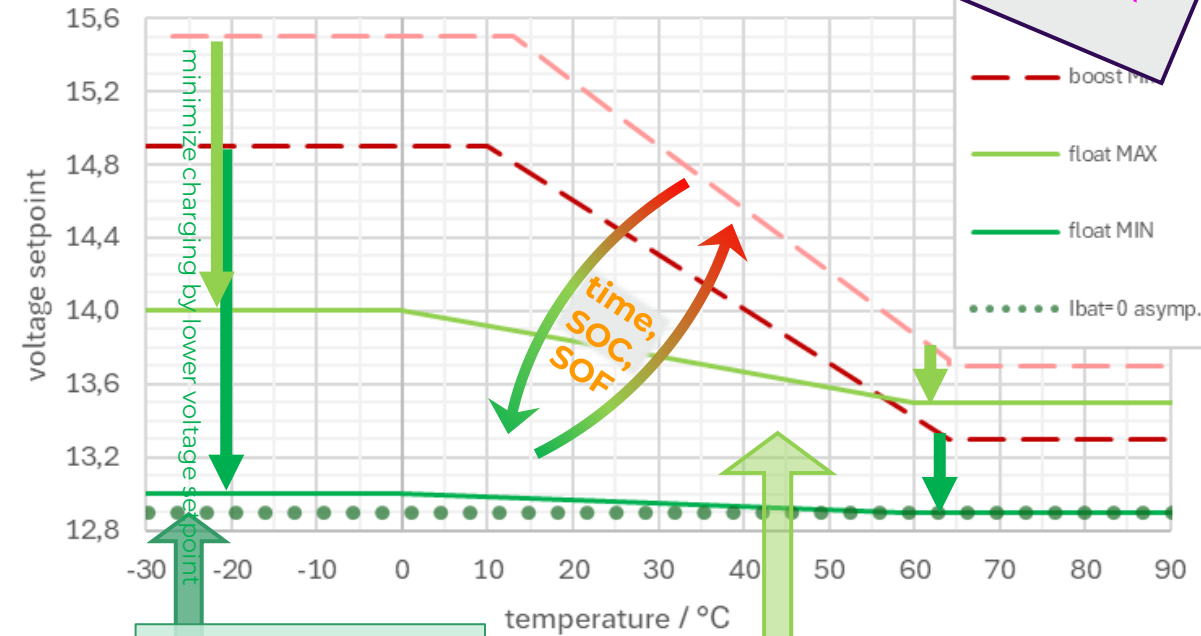
Implementation

▪ **If a “low” charge mode is added, make sure that equalization charge (rather boost than normal mode) is applied regularly !**

- **Option 1: zero current control** – use battery sensor current signal to dynamically regulate voltage setpoint such that battery current is ~0
- **Option 2: float charging** – apply a Z curve between normal mode and equilibrium voltage, or just clip charging voltage from normal Z curve

Low charge mode alone for AUX & ... will cause frequent premature battery failures due to undercharging.

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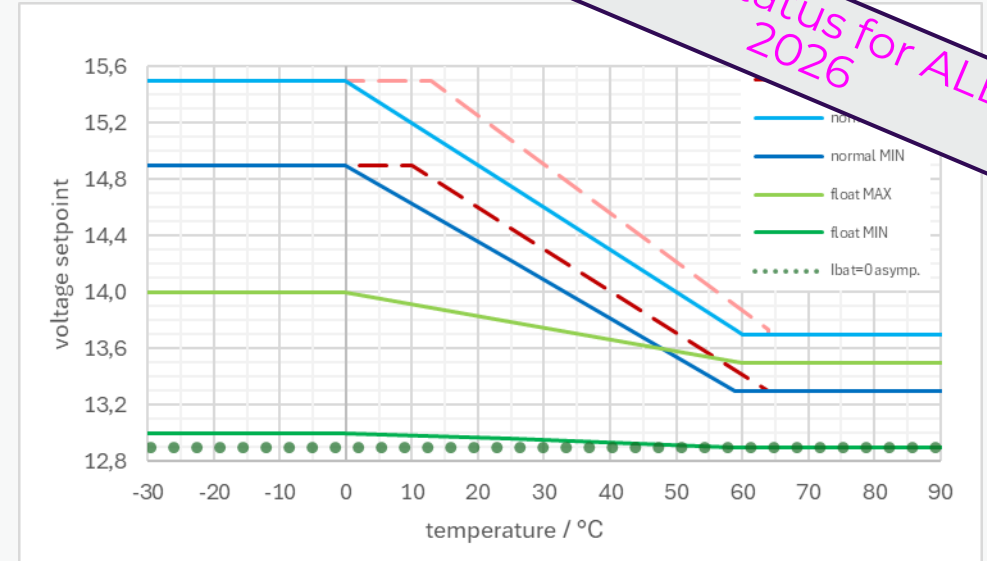
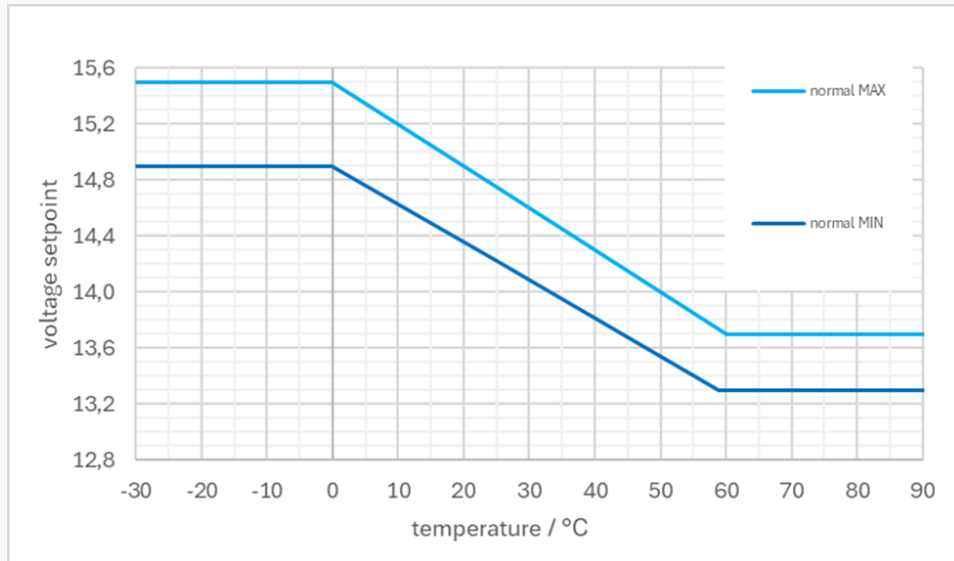


- requires LIN/ CAN communication IBS – dc/dc
- eases OCV-based SOC estimation
- avoids discharge first minutes after charging

- additional Z curve – straightforward implementation
- variant (even more complex): 2D lookup $U_{setp} = f(\text{temp}, \text{SOC})$
- fast setpoint drop removes 1...3%SOC after each charge

Discussion: Two extreme use cases and solution

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main 12V battery

- ❑ dc/dc supply "on": driving / key-on, charging on-plug, replenish 12V battery while parking
- ❑ 12V loads supplied out of battery: over-the-air update, parking lights etc., key-off / quiescent loads (BEV: >>20mA)
- ❑ either out of battery or dc/dc "on": vehicle activation & afterrun

→ Lead **battery** is OK with only **normal mode**

→ OEM may require **low mode** for **other reasons**

backup battery 24/7

- ❑ assume permanent 12V supply out of HV battery via low-power low-loss dc/dc converter (or normal dc/dc when needed)
- ❑ 12V battery for backup (comfort and/or safety) only
- ❑ additional battery discharge tests may be actively performed for battery monitoring or diagnostic purposes

→ **low mode** may support battery durability

→ **boost mode** equalization is **then** mandatory

Recommendations for Z curves – Discussion

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Charging voltage setpoints for lead batteries must be adjusted with temperature

- Recommended parameterization (blue curves) in this document represent expert consensus and long (ICE) experience.

“Normal Mode” voltage control is preferred from LAB perspective

- Evidence-based optimum trade-off between undercharge / sulfation and overcharge / gassing / corrosion
- Charging should be invoked in parking BEVs to avoid deep cycles (→wear) and long periods at low SOC (→sulfation):
The dc/dc converter should be activated based on high-load condition and 12V-battery SOC.
- Wide field data demonstrate that undercharge, sulfation, and excessive cycling drive 12V battery failures in HEV & BEV, but **not** water consumption and corrosion (not even in hot climate) -
- “Float” voltage 24/7 is insufficient to maintain (or even restore) high SOC and avoid undercharge / sulfation.

OEMs may still require Low Charge Mode for energy management reasons only.

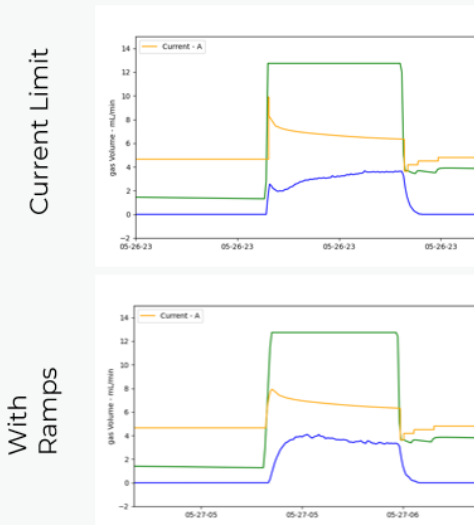
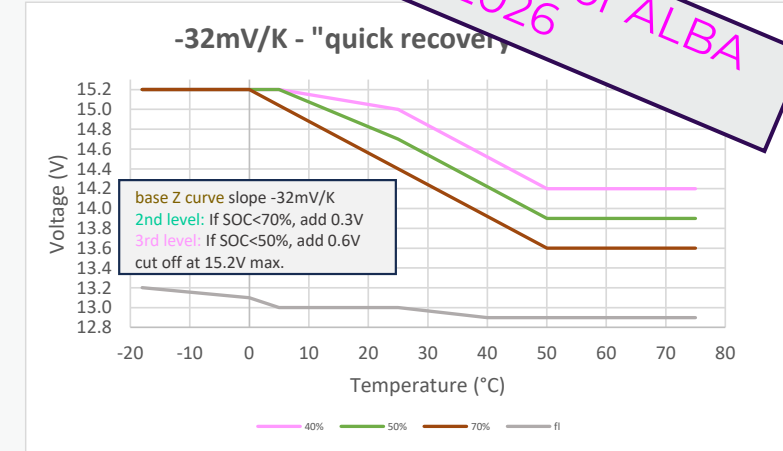
- examples: brake energy recuperation in 12V micro-hybrid, power consumption of 12V resistive loads
- In such cases, make sure that equalization charge is applied regularly, preferably applying **Boost Charge Mode** !

Further optimizing the Charging Strategy

- Wide field data demonstrate that undercharge, sulfation, and excessive cycling drive 12V battery failures in HEV & BEV, but **not** water consumption and corrosion (not even in hot climate)
- Opportunity for more efficient charging (i.e. higher charging voltages) especially at lower SOC and lower temperatures.
- SOC-dependent charging strategies could replace one traditional Z-Curve charging to reduce/postpone failure mode of undercharged batteries

→ **Set of Z-Curves (to keep T-dependence) for a different SOC.**

- Vehicle implementation should limit the number of Z-Curves to a small number (3-4 different SOC) as the correct SOC determination is challenging.



- At the beginning of a charging event (or when raising the charging voltage) the negative electrode polarises leading to an initial burst of H₂ evolution (i.e. water consumption). This is even present in AGM batteries as not enough oxygen is present for an effective recombination.
- This initial gas burst can be suppressed by either limiting the charging current (difficult to implement in vehicles) or by ramping up the charging voltage slowly (within 1-5 minutes).

ALBA 2023: XXX Sylvain Angoujard / Clarios
ALBA 2025: CS05 Jörg Tiburcy / Clarios
ALBA 2025: CS06 Sebastian Mauer / Moll