

White Paper:

Interpreting 0.000V, 5.000V, and Other Erroneous Cell Readings in an LFP Battery Management System (BMS) Application

Executive Summary

BMS mobile apps occasionally display extreme or nonsensical readings (0.000V, 5.000V, negative values, 65.535V, etc.) that are artifacts of measurement error. In contrast, true low-voltage conditions ($<2.000\text{V}/\text{cell}$ but $>0.000\text{V}$) may represent genuine cell depletion, often caused by leaving the battery under load through the sensing circuit. This paper addresses both categories: false values (diagnostic anomalies) and true low-end readings (genuine risk conditions), and provides practical corrective measures.

1. Background

- **Normal LFP Operating Range:** 2.500V – 3.650V (per major datasheets such as EVE LF280K).
- **Absolute Limits:** $\sim 2.000\text{V}$ (deep discharge threshold) – $\sim 4.200\text{V}$ (destructive overcharge).
- **Error vs. Reality:** Some abnormal readings are firmware artifacts, but readings between 0.100V–2.000V may indeed reflect actual cell voltages.

2. Erroneous Readings and Meanings

- **0.000V:** Open circuit, broken sense wire, or BMS input fault.
- **5.000V:** Floating input, ADC saturation, or firmware placeholder for invalid input.
- **65.535V (65535 mV):** Overflow value from 16-bit registers, commonly used as invalid or unknown in CAN protocols.
- **Negative Values:** Typically caused by polarity reversal on harness or software parse errors.
- **Constant Placeholders (e.g., identical 3.300V or 4.200V across all cells):** Vendor-specific default values when communication or measurement is lost.
- **Fluctuating or Jumping Readings:** Loose terminals, vibration-induced harness chatter, or EMI coupling.
- **Missing Cell (N/A or dash):** Disabled channel, unpopulated harness lead, or firmware masking.

3. True Low-Voltage Readings (<2.000V but >0.000V)

Root Causes:

- **Parasitic Drain via Sensing Circuits:** Even in standby, microamp-level currents through balance resistors and monitor ICs slowly discharge cells.
- **Accessory Loads Left Connected:** Devices such as GPS trackers or LED lighting bypass the main cutoff relay.
- **Seasonal Idle Discharge:** Months of idle storage without disconnecting can drag cells below 2.000V.

Meaning:

- Values such as **1.800V, 1.500V, 1.200V** are often **real**.
- Below ~2.000V, **copper dissolution and shunt formation** occur, raising the risk of internal shorts and permanent degradation.
- Cells kept well below ~2.000V for extended time are often deemed **irrecoverable**.

Corrective Measures:

- **Disconnect** all loads and sense harnesses if possible.
- Attempt recovery with **controlled pre-charge** at a **reduced current (~10–20 percent of the normal charge current, as specified by the BMS/charger IC)** until the cell exceeds 2.500V.
- Only then resume normal CC-CV charging.
- For **prevention**, use main cutoffs/contactors, periodic maintenance charging, and ultra-low quiescent-current BMS with ship/sleep modes.
- If a cell remains **far below ~2.0V** for a prolonged period, most manufacturers classify it as **permanently damaged**.

4. Diagnostic Workflow

1. Validate suspect readings with a handheld DMM.
2. Differentiate:
 - If exactly 0.000V or 5.000V -> measurement anomaly.
 - If 0.100–2.000V -> true undervoltage event.
3. Run open-wire diagnostic tests (if supported) to confirm wiring faults.
4. Check for parasitic loads and seasonal discharge.
5. Recover with controlled pre-charge or replace the cell if irrecoverable.

4. Implications for Technicians

- Misinterpreting true undervoltage as a phantom error can result in lost cells.
- Misinterpreting phantom values as real may cause unnecessary replacements.
- Clear distinction between **diagnostic artifacts** and **genuine undervoltage** ensures safety and reliability.

5. Recommendations

- **For Manufacturers:** Replace extreme app values with clear error codes instead of misleading voltages.
- **For Technicians:** Always verify <2.000V readings with a DMM and follow controlled recovery methods.
- **For Fleet Operators:** Standardize seasonal disconnect or maintenance charging to prevent parasitic drain.

Conclusion

Extreme values like **0.000V** or **5.000V** almost always indicate diagnostic anomalies rather than true chemistry. However, sub-2.000V but non-zero readings should be treated as genuine undervoltage conditions requiring immediate corrective action. Proper distinction and workflow protect LFP cells from irreversible damage and reduce unnecessary warranty claims.

Prepared for: Field Technicians, Engineers, and Battery Integration Specialists

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Date: September 2025

Appendix — LFP Reference Cell Parameters

Manufacturer / Cell	Nominal Voltage	Charge Cutoff	Discharge Cutoff	Notes
EVE LF280K (280Ah prismatic)	3.2V	3.65V	2.50V	Datasheet standard values
CATL 302Ah Prismatic	3.2V	3.65V	2.50V	Common EV-grade reference
Winston 160Ah LFP	3.2V	3.65V	2.80V	Datasheet allows higher low cutoff
Generic LFP Cylindrical (IFR18650)	3.2V	3.65V	2.00–2.50V	Range depends on vendor
Industry Consensus	3.2V	3.65V	~2.50V	Below 2.0V = risk of copper dissolution