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INTERNATIONAL STANDARD

COMMENTED VERSION

Electric vehicle battery swap system -
Part 2: Safety requirements

ICS 43.120

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Electric vehicle battery swap system - Part 2: Safety requirements

FOREWORD

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This commented version (CMV) of the official standard IEC 62840-2:2025 edition 2.0 allows the user to identify the changes made to the previous IEC 62840-2:2016 edition 1.0. Furthermore, comments from IEC TC 69 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 62840-2 has been prepared by IEC technical committee 69: Electrical power/energy transfer systems for electrically propelled road vehicles and industrial trucks. It is an International Standard.

This second edition cancels and replaces the first edition published in 2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

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b) introduces stricter interoperability requirements through detailed system interface specifications and defined state transition protocols;
c) enhances data security by defining safety message transmission protocols and integrating telecom network requirements;
d) increases electrical safety protection levels for battery swap stations (BSS) with specified capacitor discharge time limits to mitigate electric shock risks;
e) introduces enhanced mechanical safety requirements for automated battery handling systems, with technical alignment to ISO 10218-1 and ISO 10218-2;
f) strengthens overload and short-circuit protection for BSS through standardized testing methods and overcurrent protection specifications;
g) defines upgraded electromagnetic compatibility (EMC) standards to ensure system resilience against external interference, supplemented with EMC-related functional safety measures.

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

Draft	Report on voting
69/1046/FDIS	69/1062/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

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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.

This document is to be read in conjunction with IEC 62840-1:2025.

In this document, the following print types are used:

– *test specifications: in italic type;*

The following differing practices of a less permanent nature exist in the countries indicated below:

– 7.5.4: the battery passport defines the necessary data to be transmitted (EU).
– 7.6.1: RCDs of type AC may be used (JP).
– 7.6.1: a device which measures leakage current over a range of frequencies and trips at pre-defined levels of leakage current, based upon the frequency, is required (US).

– 9.4: the size and rating of the protective conductor is determined by national codes and regulations (CA, US, JP).
– 9.5.1: RCDs of type AC may be used (JP).
– 9.5.1: a device which measures leakage current over a range of frequencies and trips at pre-defined levels of leakage current, based upon the frequency, is required (US).
– 12.2.1: national standards or regulations provide the different requirements (JP).
– 12.2.2: national standards or regulations provide the different requirements (JP).
– Clause 13: the methods of protection against overcurrent and overvoltage are in accordance with national codes (US, JP, CA).
– Clause 13: the branch circuit overcurrent protection is based upon 125 % of the equipment rating (US, CA).
– Clause 13: EV charging is considered a continuous load and is limited to 80 % of the branch circuit fuse or circuit breaker rating by national rules (US, CA).
– Clause 13: the equipment earthing path complies with the test requirement in national standard (JP).
– 16.5: three-part cautionary statements are required (US).
– 16.5: the use of specific language(s) is covered by legal requirements (CN).

A list of all parts in the IEC 62840 series, published under the general title *Electric vehicle battery swap system*, 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

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

The purpose of the battery swap system is to provide energy partly or in total to electric vehicles (EV) through fast replacement of their swappable battery systems (SBS) or handheld-swappable battery systems (HBS). ~~While charging, the EV typically takes a relatively long time, whereas The battery swap process takes only a few minutes to complete. Thus it will reduce the range anxiety and will facilitate travel for longer distances.~~ **1** The battery swap system aims to provide energy to electric road vehicles by quickly replacing their swappable battery system or handheld-swappable battery system. This may help alleviate range anxiety and make longer distance travel more convenient.

As there is a possibility to charge the batteries after their removal from the vehicle in various ways, the impact of this process on the critical infrastructure of the electrical grid ~~can be~~ is minimized.

Battery swap stations mainly include one or more of the following functions:

- swap of EV ~~swappable battery system (SBS)~~ SBS or HBS;
- storage of EV SBS or HBS;
- charging and cooling of EV SBS or HBS;
- testing, maintenance and safety management of EV SBS or HBS.

This document serves as a generic approach for safety during the lifecycle of battery swap systems and stations for electric vehicles.

This document contains the general safety requirements for battery swap system of SBS/HBS. The specific safety requirements for dedicated system are described in other parts of the IEC 62840 series.

1 Scope

This part of IEC 62840 provides the safety requirements for a battery swap system, for the purposes of swapping swappable battery system (SBS)/handheld-swappable battery system (HBS) of electric vehicles. The battery swap system is intended to be connected to the supply network. The power supply is up to 1 000 V AC or up to 1 500 V DC in accordance with IEC 60038.

This document also applies to battery swap systems supplied from on-site storage systems (e.g. buffer batteries).

Aspects covered in this document:

- safety requirements of the battery swap system and~~/or~~ its subsystems;
- security requirements for communication;
- electromagnetic compatibility (EMC);
- ~~signs~~ marking and instructions;
- protection against electric shock and other hazards.

This document is applicable to battery swap systems for EV equipped with one or more SBS/HBS.

~~NOTE Battery swap systems for light EVs according to the IEC 61851-3 series[1] are under consideration.~~

This document is not applicable to

- aspects related to maintenance and service of the battery swap station (BSS),
- trolley buses, rail vehicles and vehicles designed primarily for use off-road, and
- maintenance and service of EVs.

Requirements for bidirectional energy transfer are 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 60038, *IEC standard voltages*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60127 (all parts), *Miniature fuses*

IEC 60204-1, *Safety of machinery – Electrical equipment of machines – General requirements*

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~~[1] Under consideration.~~

IEC 60269 (all parts), *Low-voltage fuses*

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*
IEC 60364-4-41:2005/AMD1:2017

IEC 60364-5-54, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*

~~IEC 60364-7-722, *Low-voltage electrical installations – Part 7-722: Requirements for special installations or locations – Supply of electric vehicle*~~

IEC 60479 (all parts), *Effects of current on human beings and livestock*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1:~~2007~~2020, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60695-10-2, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test method*

IEC ~~TR~~ 60755, *General safety requirements for residual current operated protective devices*

IEC 60898 (all parts), *Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations*

IEC 60898-1, *Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations – Part 1: Circuit-breakers for a.c. operation*

IEC 60947-2, *Low-voltage switchgear and control gear – Part 2: Circuit-breakers*

IEC 60947-3, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 60947-4-1, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

IEC 60947-6-2, *Low-voltage switchgear and controlgear – Part 6-2: Multiple function equipment – Control and protective switching devices (or equipment) (CPS)*

~~IEC 60950-1:2005, *Information technology equipment – Safety – Part 1: General requirements*~~
~~IEC 60950-1:2005/AMD1:2009~~
~~IEC 60950-1:2005/AMD2:2013~~

IEC 60990, *Methods of measurement of touch current and protective conductor current*

IEC 61000-6-7, *Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements equipment intended to perform functions in a safety-related system (functional safety) in industrial ~~environments~~ locations*

IEC 61008 (all parts), *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs)*

IEC 61008-1, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules*

IEC 61009 (all parts), *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)*

IEC 61009-1, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 1: General rules*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61439-1:~~2011~~2020, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61439-7:2022, *Low-voltage switchgear and controlgear assemblies – Part 7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations*

IEC 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC 61511-1, *Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements*

IEC 61784-3, *Industrial communication networks – Profiles – Part 3: Functional safety fieldbuses – General rules and profile definitions*

IEC 61810-1, *Electromechanical elementary relays – Part 1: General and safety requirements*

IEC 61851-1:2017, *Electric vehicle conductive charging system – Part 1: General requirements*

IEC 61851-21-2, *Electric vehicle conductive charging system – Part 21-2: Electric vehicle requirements for conductive connection to an AC/DC supply – EMC requirements for off board electric vehicle charging systems*

IEC 61851-23:~~2014~~2023, *Electric vehicle conductive charging system – Part 23: DC electric vehicle ~~charging station~~ supply equipment*

IEC 62052-11, *Electricity metering equipment ~~(AC)~~ – General requirements, tests and test conditions – Part 11: Metering equipment*

IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

IEC 62368-1:2023, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

IEC 62423, *Type F and type B residual current operated circuit-breakers with and without integral overcurrent protection for household and similar uses*

IEC 62477-1:2022, *Safety requirements for power electronic converter systems and equipment – Part 1: General*

IEC 62840-1:~~2016~~2025, *Electric vehicle battery swap system – Part 1: General and guidance*

IEC 63066: —[2], *Low-voltage docking connectors for removable energy storage units*

~~ISO 2972, *Numerical control of machines – Symbols*~~

~~ISO 7000, *Graphical symbols for use on equipment – Registered symbols*~~

ISO 10218-1:2011, *Robots and robotic devices – Safety requirements for industrial robots – Part 1: Robots*

ISO 10218-2:2011, *Robots and robotic devices – Safety requirements for industrial robots – Part 2: Robot systems and integration*

~~ISO 12405-1, *Electrically propelled road vehicles – Test specification for lithium-ion traction battery packs and systems – Part 1: High-power applications*~~

ISO 13849-1, *Safety of machinery –Safety-related parts of control systems – Part 1: General principles for design*

ISO 14119, *Safety of machinery – Interlocking devices associated with guards – Principles for design and selection*

ISO 19353:2019, *Safety of machinery – Fire prevention and fire protection*

[2] Under preparation. Stage at the time of publication: IEC CCDV 63066:2024

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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– *test specifications: in italic type;*

The following differing practices of a less permanent nature exist in the countries indicated below:

– 7.5.4: the battery passport defines the necessary data to be transmitted (EU).

– 7.6.1: RCDs of type AC may be used (JP).

– 7.6.1: a device which measures leakage current over a range of frequencies and trips at pre-defined levels of leakage current, based upon the frequency, is required (US).

– 9.4: the size and rating of the protective conductor is determined by national codes and regulations (CA, US, JP).

– 9.5.1: RCDs of type AC may be used (JP).

– 9.5.1: a device which measures leakage current over a range of frequencies and trips at pre-defined levels of leakage current, based upon the frequency, is required (US).

– 12.2.1: national standards or regulations provide the different requirements (JP).

– 12.2.2: national standards or regulations provide the different requirements (JP).

– Clause 13: the methods of protection against overcurrent and overvoltage are in accordance with national codes (US, JP, CA).

– Clause 13: the branch circuit overcurrent protection is based upon 125 % of the equipment rating (US, CA).

– Clause 13: EV charging is considered a continuous load and is limited to 80 % of the branch circuit fuse or circuit breaker rating by national rules (US, CA).

– Clause 13: the equipment earthing path complies with the test requirement in national standard (JP).

– 16.5: three-part cautionary statements are required (US).

– 16.5: the use of specific language(s) is covered by legal requirements (CN).

A list of all parts in the IEC 62840 series, published under the general title *Electric vehicle battery swap system*, 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

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

The purpose of the battery swap system is to provide energy partly or in total to electric vehicles (EV) through fast replacement of their swappable battery systems (SBS) or handheld-swappable battery systems (HBS). The battery swap system aims to provide energy to electric road vehicles by quickly replacing their swappable battery system or handheld-swappable battery system. This may help alleviate range anxiety and make longer distance travel more convenient.

As there is a possibility to charge the batteries after their removal from the vehicle in various ways, the impact of this process on the critical infrastructure of the electrical grid is minimized.

Battery swap stations mainly include one or more of the following functions:

- swap of EV SBS or HBS;
- storage of EV SBS or HBS;
- charging and cooling of EV SBS or HBS;
- testing, maintenance and safety management of EV SBS or HBS.

This document serves as a generic approach for safety during the lifecycle of battery swap systems and stations for electric vehicles.

This document contains the general safety requirements for battery swap system of SBS/HBS. The specific safety requirements for dedicated system are described in other parts of the IEC 62840 series.

1 Scope

This part of IEC 62840 provides the safety requirements for a battery swap system, for the purposes of swapping swappable battery system (SBS)/handheld-swappable battery system (HBS) of electric vehicles. The battery swap system is intended to be connected to the supply network. The power supply is up to 1 000 V AC or up to 1 500 V DC in accordance with IEC 60038.

This document also applies to battery swap systems supplied from on-site storage systems (e.g. buffer batteries).

Aspects covered in this document:

- safety requirements of the battery swap system and its subsystems;
- security requirements for communication;
- electromagnetic compatibility (EMC);
- marking and instructions;
- protection against electric shock and other hazards.

This document is applicable to battery swap systems for EV equipped with one or more SBS/HBS.

This document is not applicable to

- aspects related to maintenance and service of the battery swap station (BSS),
- trolley buses, rail vehicles and vehicles designed primarily for use off-road, and
- maintenance and service of EVs.

Requirements for bidirectional energy transfer are 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 60038, *IEC standard voltages*

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-78*, Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60127 (all parts), *Miniature fuses*

IEC 60204-1, *Safety of machinery – Electrical equipment of machines – General requirements*

IEC 60269 (all parts), *Low-voltage fuses*

IEC 60364 (all parts), *Low-voltage electrical installations*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*
IEC 60364-4-41:2005/AMD1:2017

IEC 60364-5-54, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*

IEC 60479 (all parts), *Effects of current on human beings and livestock*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60695-10-2, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test method*

IEC 60755, *General safety requirements for residual current operated protective devices*

IEC 60898 (all parts), *Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations*

IEC 60898-1, *Electrical accessories – Circuit-breakers for overcurrent protection for household and similar installations – Part 1: Circuit-breakers for a.c. operation*

IEC 60947-2, *Low-voltage switchgear and control gear – Part 2: Circuit-breakers*

IEC 60947-3, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 60947-4-1, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

IEC 60947-6-2, *Low-voltage switchgear and controlgear – Part 6-2: Multiple function equipment – Control and protective switching devices (or equipment) (CPS)*

IEC 60990, *Methods of measurement of touch current and protective conductor current*

IEC 61000-6-7, *Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements equipment intended to perform functions in a safety-related system (functional safety) in industrial locations*

IEC 61008 (all parts), *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs)*

IEC 61008-1, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules*

IEC 61009 (all parts), *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)*

IEC 61009-1, *Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) – Part 1: General rules*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61439-1:2020, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61439-7:2022, *Low-voltage switchgear and controlgear assemblies – Part 7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations*

IEC 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

IEC 61511-1, *Functional safety – Safety instrumented systems for the process industry sector – Part 1: Framework, definitions, system, hardware and application programming requirements*

IEC 61784-3, *Industrial communication networks – Profiles – Part 3: Functional safety fieldbuses – General rules and profile definitions*

IEC 61810-1, *Electromechanical elementary relays – Part 1: General and safety requirements*

IEC 61851-1:2017, *Electric vehicle conductive charging system – Part 1: General requirements*

IEC 61851-21-2, *Electric vehicle conductive charging system – Part 21-2: Electric vehicle requirements for conductive connection to an AC/DC supply – EMC requirements for off board electric vehicle charging systems*

IEC 61851-23:2023, *Electric vehicle conductive charging system – Part 23: DC electric vehicle supply equipment*

IEC 62052-11, *Electricity metering equipment – General requirements, tests and test conditions – Part 11: Metering equipment*

IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

IEC 62368-1:2023, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

IEC 62423, *Type F and type B residual current operated circuit-breakers with and without integral overcurrent protection for household and similar uses*

IEC 62477-1:2022, *Safety requirements for power electronic converter systems and equipment – Part 1: General*

IEC 62840-1:2025, *Electric vehicle battery swap system – Part 1: General and guidance*

IEC 63066: —[1], *Low-voltage docking connectors for removable energy storage units*

ISO 10218-1:2011, *Robots and robotic devices – Safety requirements for industrial robots – Part 1: Robots*

ISO 10218-2:2011, *Robots and robotic devices – Safety requirements for industrial robots – Part 2: Robot systems and integration*

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[1] Under preparation. Stage at the time of publication: IEC CCDV 63066:2024

ISO 13849-1, *Safety of machinery –Safety-related parts of control systems – Part 1: General principles for design*

ISO 14119, *Safety of machinery – Interlocking devices associated with guards – Principles for design and selection*

ISO 19353:2019, *Safety of machinery – Fire prevention and fire protection*