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## **Road vehicles — Functional safety — Application to generic rechargeable energy storage systems for new energy vehicle**

*Véhicules routiers — Sécurité fonctionnelle — Application des  
systèmes génériques rechargeables de stockage d'énergie aux  
véhicules utilisant les énergies nouvelles*



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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 32, *Electrical and electronic components and general system aspects*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

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## Introduction

The rechargeable energy storage systems (RESS) (e.g. lithium-ion battery systems) used for new energy vehicles can introduce specific hazards like thermal runaway, toxic chemical release, high voltage electric shock, etc.

To prevent and mitigate the risk of RESS related hazards, E/E related technology, such as battery management systems (BMS), are integrated into the RESS. However, based on accident investigations and statistics, a large proportion of RESS safety-related incidents are caused by faults within the E/E systems (e.g. BMS), elements of other technologies (e.g. battery cells) or both<sup>[15]</sup>. Due to the possibility of the mechanical and electrochemical characteristics of the battery changing constantly over the lifecycle [e.g. state of health (SOH), state of health energy (SOHE), direct current resistance (DCR) for electrochemistry, and mechanical stress, air-dust tightness, resistance to chemicals for mechanical parts] the correlated safety threshold parameters of the battery can also change accordingly which can lead to reduced or even incorrect monitoring and control of the BMS.

Effective safety design and management of RESS relies on system capability to adaptively adjust the logic and control according to the alteration of mechanical and electrochemical related characteristics of the battery. The ISO 26262 series is focused on the malfunctioning behaviour of E/E systems. An item (as well as external measures) can include systems or elements of other technologies. Malfunctioning behaviour can be caused by failures of systems or elements of other technologies. However, the ISO 26262 series includes limited guidance concerning such failures, for example, sudden failures or wear out of other technologies.

The purpose of this document is to present a case study of functional safety for RESS considering E/E systems (e.g. BMS) and mechanical, electrical and electrochemical factors for elements of other technologies (e.g. battery cells) according to the methodology of the ISO 26262 series, and to show examples of functional safety development for E/E systems (e.g. BMS) and systems of other technologies as a reference.

Based on the ISO 26262:2018 series, the case study in this document provides an additional methodology to cover the strong interaction between E/E systems (e.g. BMS) and systems of other technologies (e.g. battery cells) by considering E/E, mechanical and electrochemical related factors. This document follows the V model framework defined in the ISO 26262 series and provides corresponding functional safety strategies, and verification and validation methods for the development of a functionally safe RESS.

All the technical information and the associated data in this document are combined with the state-of-the-art technologies of current automotive battery industry, which will be updated with the development of battery cell technology and other related technology.