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Road vehicles — Functional safety — The application to generic rechargeable energy storage systems for new energy vehicle

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Foreword

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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.

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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[15]. 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.

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TECHNICAL REPORT **ISO/TR 9968:2023**

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1 Scope

This document is intended to be applied to the usage of ISO 26262 methodology for rechargeable energy storage systems (RESS), for example, lithium-ion battery systems, that are installed in series-production road vehicles, excluding mopeds.

This document does not address unique E/E systems in special vehicles such as E/E systems designed for drivers with disabilities.

This document provides:

a) a generic informative framework regarding the interaction of E/E systems with elements of other technologies with respect to the ISO 26262 series aspects of item definition, hazard analysis and risk assessment (HARA), functional safety concept (FSC), verification and validation (V&V), and production, operation, service and decommissioning (POSD)*;*

b) various examples elaborating the generic framework;

c) topics which could be considered in future editions of the ISO 26262 series.

RESS includes BMS, cells, harnesses, connectivity, etc. In order to achieve product safety non-E/E functional safety requirements need to be fulfilled by the other technology itself without the support of E/E technology. These requirements are not in scope of this document.

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.

ISO 26262-1, *Road vehicles — Functional safety — Part 1: Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 26262-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
RESS
rechargeable energy storage system
system that stores energy for delivery of electrical energy and which is rechargeable

EXAMPLE RESS including batteries, capacitors, *battery management system (BMS)* (3.2), etc.

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