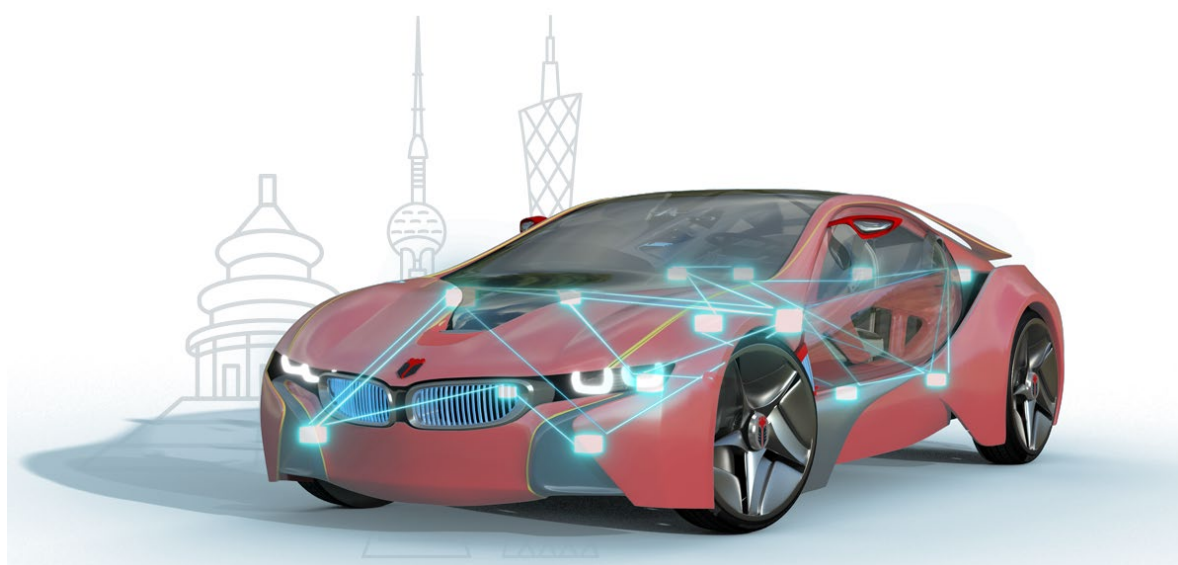




知从木牛复杂驱动 CDD 恩智浦 MC33774 产品手册 ZC.MUNIU COMPLEX DRIVER CDD PRODUCT MANUAL BASED ON NXP MC33774

知从木牛基础软件平台功能安全库
ZC Basic Software Platform Safety Library



知从木牛复杂驱动 CDD 恩智浦 MC33774 产品手册

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1 功能概述 FUNCTIONAL OVERVIEW

知从木牛复杂驱动 CDD 系列软件旨在打造知从科技自主研发的满足客户功能安全要求的复杂驱动 CDD 平台化软件产品。本手册说明了基于恩智浦 MC3377x 系列 CDD 实现的功能安全应用方案、软件架构等内容。本软件产品可帮助系统工程师和软件工程师能够快速地应用到客户产品中，满足功能安全需求。

The ZC.MuNiu Complex Drive CDD Series Software aims to develop a platform-based software product for complex drive CDD that meets customer functional safety requirements, independently developed by ZC. This manual describes the functional safety application solutions and software architecture based on the NXP MC3377x series CDD. This software product can help system engineers and software engineers quickly apply it to customer products to meet functional safety requirements.

本产品实现了的 MC33774 芯片软件驱动功能包含：

The software driver functions implemented for the MC33774 chip include:

- 基于 SPI 或 TPL3（菊花链）通信协议功能；
Communication protocol functions based on SPI or TPL3 (daisy-chain);
- 单体电压的采样功能； Cell voltage sampling function;
- Pack 温度采样功能； Pack temperature sampling function;
- Pack 电流采样功能； Pack current sampling function;
- Pack 电压采样功能； Pack voltage sampling function;
- 单体电压均衡管理功能； Pack voltage sampling function;
- 模式管理功能； Mode management function;
- 硬件诊断功能； Hardware diagnostics function;
- 双向唤醒功能； Bidirectional wake-up function.

2 应用领域 APPLICATION FIELD

知从木牛复杂驱动 CDD 恩智浦 MC33774 驱动软件产品可应用于有各功能安全等级需求的电池管理系统中。例如：

The ZC.MuNiu Complex Drive CDD NXP MC33774 driver software product can be applied in battery management systems with various functional safety level requirements. Examples include:

- Hybrid electric (HEV)
- Electric vehicles (EV)
- Energy storage systems (ESS)
- Uninterruptible power supply(UPS)

此 CDD 恩智浦 MC33774 驱动软件产品手册是为有经验的硬件、软件和功能安全工程师编写的，根据 ISO 26262 设计，可以将 MC33774 驱动软件产品集成到客户应用产品的(子)系统中。知从软件集成工程师可支持和确保 MC33774 驱动软件产品适合客户选择的应用程序集成服务，并符合相应的软件开发流程，协助实现达到最高 ISO26262 ASIL-D 的等级要求。

This CDD NXP MC33774 driver software product manual is written for experienced hardware, software, and functional safety engineers. It is designed in accordance with ISO 26262 and can be integrated into the (sub)systems of customer application products. ZC software integration engineers can support and ensure that the MC33774 driver software product is suitable for customer-selected application integration services, and complies with the corresponding software development processes, assisting in achieving the highest ISO 26262 ASIL-D level requirements.

3 配置环境 CONFIGURATION ENVIRONMENT

知从木牛复杂驱动 CDD 恩智浦 MC33774 驱动软件产品目前可适配多家芯片厂商的 MCU, MCU 包括:

The ZC.MuNiu Complex Drive CDD NXP MC33774 driver software product is currently compatible with MCUs from multiple chip manufacturers. The supported MCUs include:

- 知从木牛复杂驱动 CDD 驱动软件产品支持的恩智浦 MC3377X 系列芯片软件配置:
The ZC.MuNiu Complex Drive CDD driver software product supports the software configuration for the NXP MC3377X series chips:

配置环境 Configuration Environment	
Hardware (Chip)	MC33774A
Compilers Supported	S32 Design Studio for S32 Platform Version: 3.4
Evaluation Hardware	S32K344 + MC33774A
Debugger	Lauterbach(Trace32 P.2023.02.000158454) or Isystem (IC5700)
Configuration Tools	Muniu_v5.1.3
Configuration Environment	Win10 64bit

S32DS 3.4 编译器选项 Compiler Options	
编译选项 Compiler Options	-DD_CACHE_ENABLE -DI_CACHE_ENABLE -DENABLE_FPU -DGCC - DS32K3XX -DS32K344 -DCPU_S32K344 - DVV_RESULT_ADDRESS=0x2043FF00 -DMPU_ENABLE -DDSPI=1 - DSSPI=0 -O0 -g3 -Wall -c -fmessage-length=0 -ffunction-sections -fdata-sections -mcpu=cortex-m7 -mfloat-abi=hard -mfpu=fpv5- sp-d16 --sysroot="/arm-none-eabi/lib"
链接选项 Linker Options	-nostartfiles -Wl,- Map,"Phy_665a_example_S32K344_DSPI_Timing_DS.map" -Xlinker -- gc-sections -n -mcpu=cortex-m7 -mfloat-abi=hard -mfpu=fpv5- sp-d16 --sysroot="/arm-none-eabi/lib"

4 开发背景 DEVELOPMENT BACKGROUND

目前，汽车上的电子电气架构越来越复杂，对汽车电子的安全性要求也越来越高，为了满足汽车的安全性需求，汽车功能安全越来越受到重视。业界近年来，在功能安全标准上参考 ISO 26262；恩智浦 MC33774 适合所选应用，并符合此类应用标准，并在电子电气系统中，应用 SEooC(safety element out of context)进行设计开发。

Currently, the electronic and electrical architecture in vehicles is becoming increasingly complex, and the safety requirements for automotive electronics are also rising. To meet the safety demands of vehicles, functional safety is gaining more and more attention. In recent years, the industry has been referring to ISO 26262 for functional safety standards. The NXP MC33774 is suitable for the selected applications and complies with the standards for such applications. In the electronic and electrical systems, SEooC (Safety Element out of Context) is used for design and development.

由于 CDD 为特定 ASIL-x 等级电池管理系统提供单体电压、Pack 电流、温度检测，按照 ISO 26262-5(2011) Clause 8 中介绍了 2 个度量：Single-point fault metric(单点故障度量)和 Latent-fault metric(潜伏故障度量)，不同的 ASIL 等级要求和故障失效分析方法均要求其达到单点故障度量和潜伏故障度量需要达到相应同等 ASIL-x 等级。

Since the CDD provides cell voltage, pack current, and temperature detection for battery management systems of specific ASIL-x levels, ISO 26262-5 (2011) Clause 8 introduces two metrics: Single-point fault metric and Latent-fault metric. Different ASIL levels and failure analysis methods require that these metrics meet the corresponding ASIL-x levels.

	ASIL B	ASIL C	ASIL D
Single-point fault metric	≥90 %	≥97 %	≥99 %

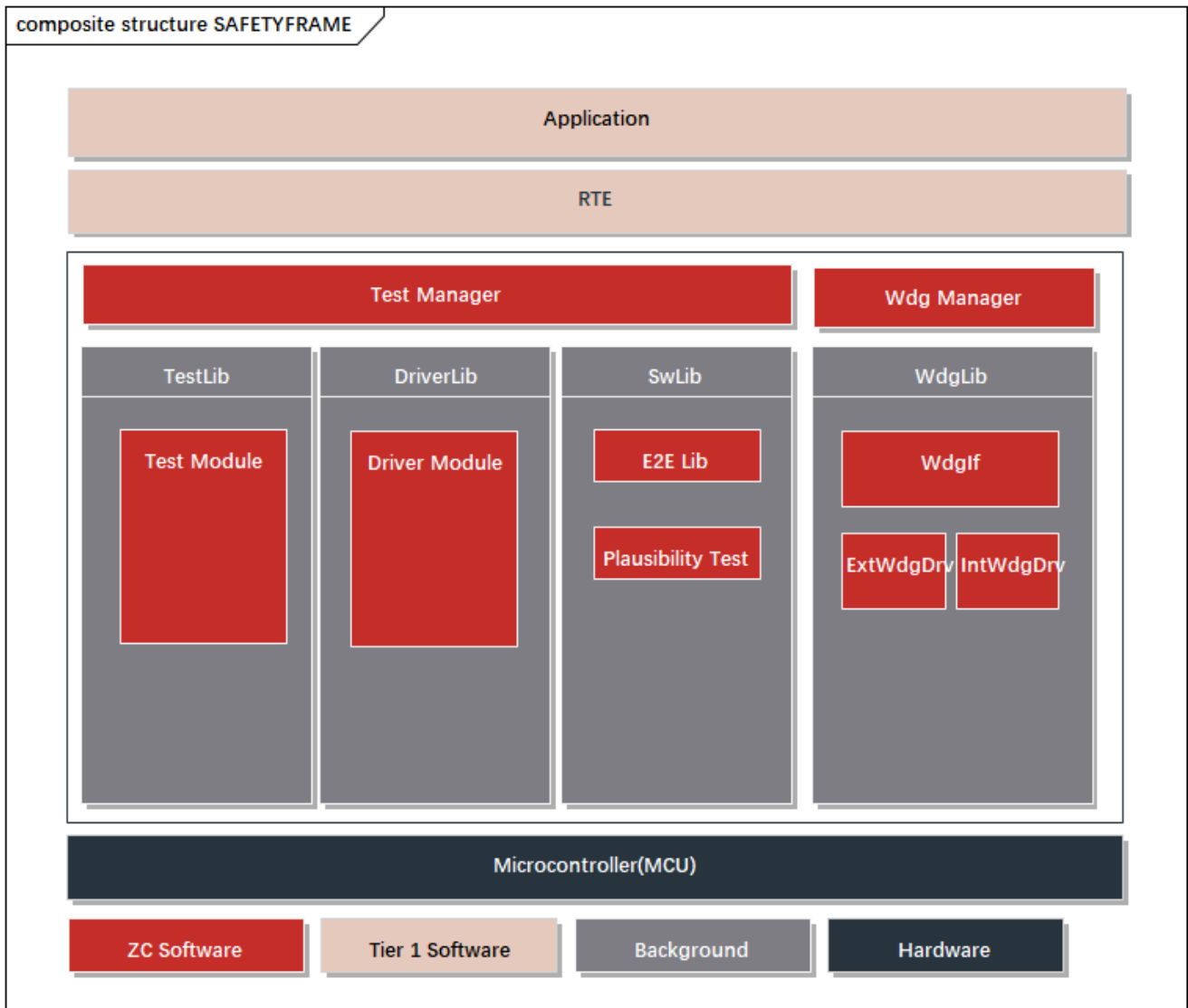
	ASIL B	ASIL C	ASIL D
Latent-fault metric	≥60 %	≥80 %	≥90 %

因此，在客户应用项目中若需符合 ASIL-D 安全等级，知从 CDD 恩智浦 MC33774 驱动软件产品提供软件方案，满足功能安全需求，实现 MC33774 安全手册中相关的安全机制。

Therefore, in customer application projects that require compliance with the ASIL-D safety level, the ZC CDD NXP MC33774 driver software product provides a software solution to meet functional safety requirements and implement the relevant safety mechanisms in the MC33774 Safety Manual.

5 功能描述 FUNCTIONAL DESCRIPTION

5.1 产品特点 Product Features



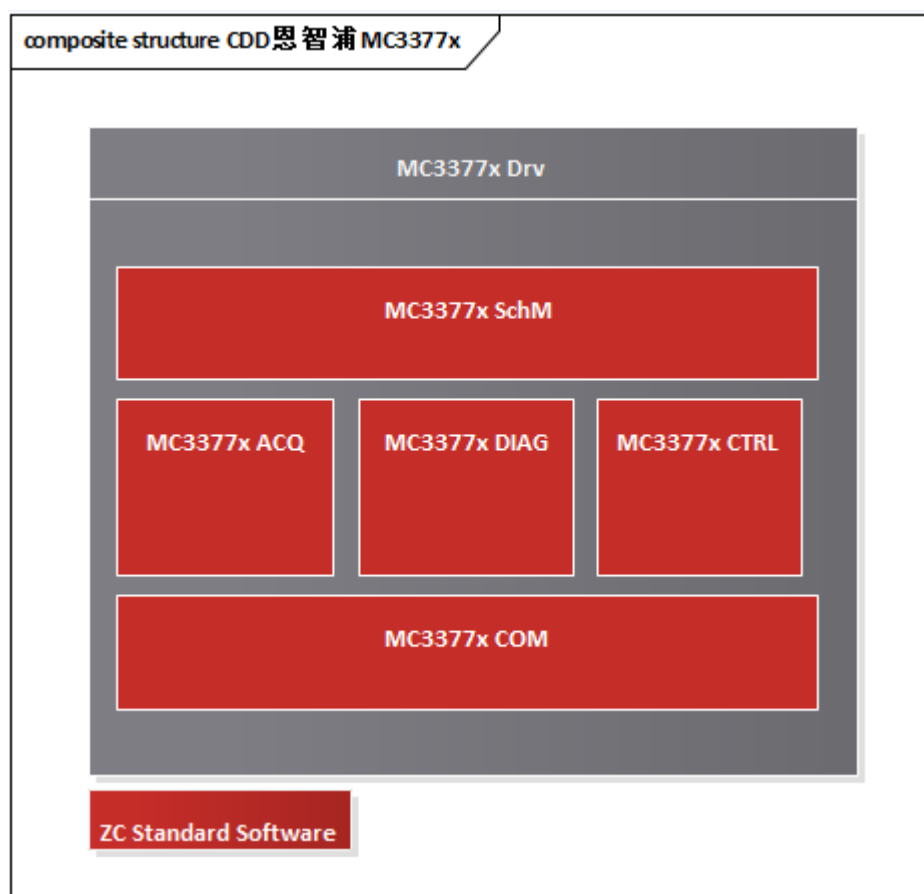
AUTOSAR 架构
 AUTOSAR Architecture

- 可作为复杂驱动集成到 AUTOSAR 中
 Can be integrated as a complex driver into AUTOSAR .
- 可集成到非 AUTOSAR 软件架构中，灵活适配
 Can be integrated into non-AUTOSAR software architectures.
- 支持多核测试及应用
 Support multi-core testing and applications.
- Safety Library 具有内部程序流监控

Safety Frame has internal program flow monitoring.

- 高安全性：支持多核自检测试，搭配知从科技 TLF35584Lib 可实现高达 ASIL-D 需求
High security: Supports multi-core self-testing, and can achieve up to ASIL-D requirements when paired with ZC 's TLF35584Lib.
- 高扩展性：各模块可配置满足不同客户的应用需求
High scalability: Each module can be configured to meet the application requirements of different customers.

5.2 软件架构 Software Architecture



软件架构
Software Architecture

软件模块包括：

模块	子模块	描述
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MC3377x Drv	MC3377x COM	实现MC33774的通信管理功能，包括SPI通信与TPL通信处理 Implement the communication management function of the MC33774, including SPI communication and TPL communication processing.
	MC3377x SchM	实现MC33774的调度管理功能，用于对MC33774功能的调度以及与应用层接口 Implement the scheduling management function of the MC33774, used for scheduling of MC33774 functions and interfacing with the application layer.
	MC3377x ACQ	实现MC33774的采样功能，包括单体电压、Pack电流、Pack电压、温度等采样 Implement the sampling function of the MC33774, including sampling of cell voltage, pack current, pack voltage, and temperature.
	MC3377x CTRL	实现MC33774的单体均衡管理功能，主要对单体电芯的均衡处理 Implement the cell balancing management function of the MC33774, mainly for balancing individual battery cells.
	MC3377x DIAG	实现MC33774的诊断功能，主要实现安全手册中的安全机制 Implement the diagnostic function of the MC33774, mainly to realize the safety mechanisms in the safety manual.

5.3 诊断功能 Diagnostic Function

为了满足功能安全需求，恩智浦 MC33774 实现了通用的安全机制设计。基于此安全机制的实现，MC33774 可实现对芯片硬件内部电路的诊断以及对外的通信等诊断功能。

To meet functional safety requirements, the NXP MC33774 implements a general safety mechanism design. Based on this safety mechanism, the MC33774 can perform diagnostics on the internal hardware circuits of the chip as well as on external communications.

基于此安全机制的设计，知从 CDD 恩智浦 MC33774 驱动软件产品提供软件方案，可根据客户实际需求进行配置，实现的相关安全机制包括：

Based on this safety mechanism design, the ZC CDD NXP MC33774 driver software product provides a software solution that can be configured according to customer requirements to implement relevant safety mechanisms.

ID	Description	Kind	ASIL
SM.e.1	Cell voltage - Comparison of primary and secondary measurement data	FUNCTIONAL Requirement	D
SM.e.2	Cell voltage - Cell connection test (BMS level)	FUNCTIONAL Requirement	D
SM.e.3	Cell voltage - Range check primary cell measurement	FUNCTIONAL Requirement	A(D)
SM.e.4	Cell voltage - Open-load detection primary cell measurement input	FUNCTIONAL Requirement	A(D)
SM.e.5	Cell voltage - Range check secondary cell measurement	FUNCTIONAL Requirement	A(D)
SM.e.6	Cell voltage - Open-load detection secondary cell measurement input	FUNCTIONAL Requirement	A(D)
SM.e.7	External temperature sensor - Plausibility check/Comparison	FUNCTIONAL Requirement	D
SM.e.8	General purpose voltage - Range check primary general purpose measurement	FUNCTIONAL Requirement	A(D)
SM.e.9	General purpose voltage - Open-load detection primary general purpose measurement input	FUNCTIONAL Requirement	A(D)
SM.e.10	General purpose voltage - Range check secondary general purpose measurement	FUNCTIONAL Requirement	A(D)
SM.e.11	General purpose voltage - Open-load detection secondary general purpose measurement input	FUNCTIONAL Requirement	A(D)
SM.e.12	Thermistor supply voltage read-back and compare	FUNCTIONAL Requirement	D
SM.e.13	Intermediate circuit voltage - Comparison of primary and secondary measurement data	FUNCTIONAL Requirement	D
SM.e.18	Multiplexer test primary measurement	FUNCTIONAL Requirement	A(D)
SM.e.19	Multiplexer test secondary measurement	FUNCTIONAL Requirement	A(D)

ID	Description	Kind	ASIL
SM.e.20	Configuration register - CRC check	FUNCTIONAL Requirement	D
SM.e.21	Configuration register - Read-back and compare after write	FUNCTIONAL Requirement	D
SM.e.22	Result register - Invalidate on read check (optional)	FUNCTIONAL Requirement	B(D)
SM.e.23	Primary ADC reference voltage check	FUNCTIONAL Requirement	A(D)
SM.e.24	Secondary ADC reference voltage check	FUNCTIONAL Requirement	A(D)
SM.e.25	Primary IC temperature read-back and compare	FUNCTIONAL Requirement	A(D)
SM.e.26	Secondary IC temperature read-back and compare	FUNCTIONAL Requirement	A(D)
SM.e.27	Communication - Information redundancy	FUNCTIONAL Requirement	D
SM.e.28	Communication - Timeout monitoring	FUNCTIONAL Requirement	D
SM.e.29	Communication - Message counter	FUNCTIONAL Requirement	D
SM.e.30	Communication - Unique device address	FUNCTIONAL Requirement	D

ID	Description	Kind	ASIL
SM.i.1	Result register - Invalidate on read	FUNCTIONAL Requirement	D
SM.i.2	Thermistor supply voltage monitoring	FUNCTIONAL Requirement	D
SM.i.3	Thermistor supply voltage monitoring check	FUNCTIONAL Requirement	B(D)
SM.i.4	Calibration data - CRC check primary processing	FUNCTIONAL Requirement	B(D)
SM.i.5	Calibration data - CRC check secondary processing	FUNCTIONAL Requirement	B(D)
SM.i.6	Analog supply voltage monitoring	FUNCTIONAL Requirement	D
SM.i.7	Analog supply voltage monitoring check	FUNCTIONAL Requirement	B(D)
SM.i.8	Configuration register - Test mode register area	FUNCTIONAL Requirement	D
SM.i.9	Primary Clock Monitoring	FUNCTIONAL Requirement	B(D)
SM.i.10	Secondary Clock Monitoring	FUNCTIONAL Requirement	B(D)
SM.i.11	BIST completion code	FUNCTIONAL Requirement	A(D)
SM.i.12	Digital supply voltage monitoring	FUNCTIONAL Requirement	D
SM.i.13	Digital supply voltage monitoring check	FUNCTIONAL Requirement	B(D)
SM.i.14	Cell balancing - Cell undervoltage protection	FUNCTIONAL Requirement	A
SM.i.15	Internal bus communication - EDC	FUNCTIONAL Requirement	D

5.4 软件测试 Software Testing

测试环境 Testing Environment	
静态测试 QAC Static Testing QAC	Helix QAC 2019.1 MISRA-C: 2012
动态测试 Tessy Dynamic Testing Tessy	4.3.12
Evaluation Hardware	NXP PC33774A
Configuration Environment	Win7 64bit / Win10 64bit

6 过程文档

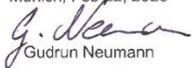
开发流程 Development Process	文档描述 Document Description
需求收集 Requirement Collection	客户需求文档 Customer Requirements Document
软件需求分析 Software Requirement Analysis	需求分析 Requirements Analysis
	需求分析规格书 Requirements Analysis Specification
	软件需求追踪表 Software Requirements Traceability Matrix
	客户的问题沟通表 Customer Issue Communication Form
软件架构设计 Software Architecture Design	软件架构说明书 Software Architecture Specification
	软件架构的追踪表 Software Architecture Traceability Matrix
软件详细设计和 单元设计 Detailed Software Design and Unit Design	详细设计说明书 Detailed Design Document
	MuNiu 配置工具设计 MuNiu Configuration Tool Design
	软件详细设计追踪表 Software Detailed Design Traceability Matrix
	详细设计评审 Detailed Design Review
软件单元测试 Software Unit Testing	QAC 分析报告 QAC Analysis Report
	Tessy 测试报告 Tessy Test Report
	软件单元验证策略 Software Unit Verification Strategy
软件集成和集成 测试	集成策略 Integration Strategy

开发流程 Development Process	文档描述 Document Description
Software Integration and Integration Testing	集成手册 Integration Manual
	集成测试策略 Integration Test Strategy
	集成测试报告 Integration Test Report
	资源分析报告 Resource Analysis Report
软件认可测试 Software Qualification Testing	软件测试报告 Software Test Report
	软件测试报告评审 Software Test Report Review
发布 Release	发布文档 Release documentation

7 功能安全 FUNCTIONAL SAFETY

7.1 功能安全评估报告 Functional Safety Assessment Report

7.2 功能安全证书 Functional Safety Certificate

 			
CERTIFICATE NO FS/71/220/23/1031 ZERTIFIKAT NR.:		PAGE 1/1 SEITE(N)	
LICENCE HOLDER & MANUFACTURER GENEHMIGUNGSIHABER & HERSTELLER Shanghai ZC Technology Co., Ltd. Building C, 888 Huanhu West 2nd Road, Pudong New Area, Shanghai, P.R. China			
PROJECT NO-/ID PROJEKT-NR-/ID T4A8-AU01	LICENSED TEST MARK GENEHMIGTES PRÜFZEICHEN 	CERT. REPORT NO. ZERTIFIKATSBERICHT NR. T4A80002 is an integral part of this certificate. ist ein integraler Bestandteil dieses Zertifikats.	
Certified product(s) Zertifizierte(s) Produkte SafetyFrame Version 2.1.0			
Tested according to Geprüft nach ISO 26262-2:2018 ISO 26262-6:2018 ISO 26262-8:2018 ISO 26262-9:2018			
Technical Data and Parameter Technische Daten und Parameter		The judgement of the achieved functional safety for the above-mentioned SafetyFrame Software is "accepted" according to above mentioned standards ASIL D requirements. The SafetyFrame Software is suitable for integration into systems up to ASIL D.	
The certificate is based on voluntary tests. The compliance of the certified product against the requirements of above listed functional safety standards was evaluated. Any changes to the design, components or processing may require repetition of some parts of the certification to retain the certification. All applicable requirements of the testing and certification regulations of SGS-TÜV Saar GmbH have to be complied, see www.sgs-tuv-saar.com/functional-safety and www.sgs-tuv-saar.com/glc-csdc.			
Certification Body for Functional Safety & Cyber Security SGS-TÜV Saar GmbH Zertifizierungsstelle für Funktionale Sicherheit & Cyber Sicherheit		Munich, Feb 22, 2023  Gudrun Neumann	
Reference to SGS Certification Database 		 SGS-TÜV Saar GmbH, Hofmannstr. 50, 81379 München, Deutschland / Germany Website: www.sgs-tuv-saar.com E-Mail: fs@sgs.com	



成为全球领先的汽车基础软件公司

To Be the Global Leading Automotive Basic Software Company

