

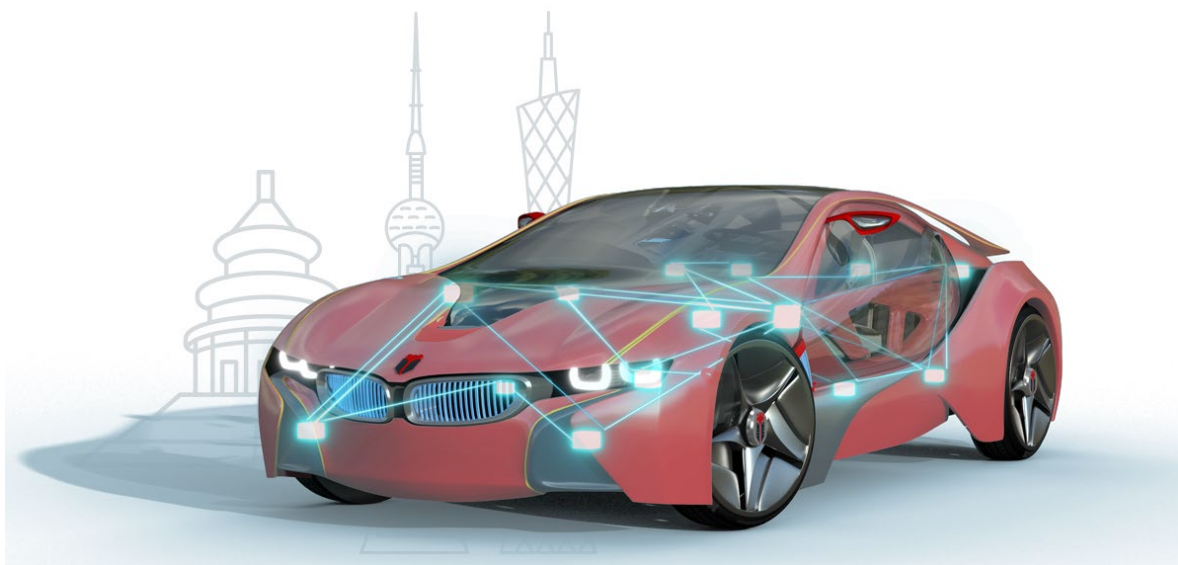


知从木牛 SAFETYLIBRARY 恩智浦 MPC5746C 产品手册

ZC.MUNIU SAFETYLIBRARY PRODUCT MANUAL

BASED ON NXP MPC5746C

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



知从木牛 SAFETYLIBRARY 恩智浦

MPC5746C 产品手册

ZC.MUNIU SAFETYLIBRARY PRODUCT

MANUAL BASED ON NXP MPC5746C

知从木牛基础软件平台功能安全库

ZC.MuNiu Basic Software Platform Safety Library

1 功能概述 FUNCTIONAL OVERVIEW

MPC5746C Safety Library 用于帮助客户实现基于 MPC5746C 平台的功能安全要求。Safety Library 具有高扩展性，可以根据不同的客户项目要求进行配置和再开发，最终满足客户的功能安全需求。

The MPC5746C Safety Library is designed to assist customers in achieving functional safety requirements based on the MPC5746C platform. The Safety Library is highly scalable and can be configured and redeveloped according to different customer project requirements, ultimately meeting the customers' functional safety requirements.

MPC5746C Safety Library 用于实现 MPC5746C 的软件安全机制，包括 MCU 内部模块的测试和硬件安全机制的驱动。

The MPC5746C Safety Library is used to implement the software safety mechanisms of the MPC5746C, including the testing of internal MCU modules and the driving of hardware safety mechanisms.

2 应用领域 APPLICATION FIELD

MPC5746C Safety Library 可应用于有功能安全等级需求的控制器。例如：

The MPC5746C Safety Library can be applied to controllers that require functional safety levels.

For example:

- 车门控制模块 Door Control Module
- 座椅模块 Seat Module
- 车身控制器 Body Controller
- 高端网关控制器 High-End Gateway Controller

通过将 Safety Library 集成到基于 MPC5746C 的控制中，并通过系统设计，可达到 ISO26262 ASIL-D 的等级要求。

By integrating the Safety Library into the control based on MPC5744C, it is possible to meet the ISO 26262 ASIL-D level requirements.

3 配置环境 CONFIGURATION ENVIRONMENT

配置环境 Configuration Environment	
Hardware (Chip)	MPC 5746C
Compilers Supported	WindRiver Diab V5.9.4.0
Debugger	Lauterbach (Trace32 R.2018.02) Isystem (IC5700)
Configuration Tools	Muniu_v5.2.2
Configuration Environment	Win7 64bit

编译器选项 Compiler Options	
WindRiver Diab 编译选项 WindRiver Diab Compiler options	-tPPCE200Z4204N3VEG:simple -DMPC5746C -g3 -Wa,-Xisa-vle -DDERIVATIVE_5746C -DDIAB -DMCAL_ENABLE_SUPERVISOR_MODE -DAUTOSAR_OS_NOT_USED -DEU_DISABLE_ANSILIB_CALLS -Xdialect-ansi -XO -Xsize-opt -Xsmall-data=0 -Xsmall-const=0 -Xno-common -Xdebug-dwarf2 -Xdebug-local-all -Xdebug-local-cie -Xdebug-struct-all -Xforce-declarations -Xmacro-undefined-warn -ee1481 -Xnested-interrupts -Xaddr-sconst=0x11 -Xaddr-sdata=0x11 -Xlink-time-lint -W:as,
WindRiver Diab 链接选项 WindRiver Diab Linker Options	tPPCE200Z4204N3VEG:simple -Xelf -m6 -Xlink-time-lint -lc -YP,C:/WindRiver/diab/5.9.4.0/PPCVLEEN/simple:C:/WindRi ver/diab/5.9.4.0/PPCVLEEN:C:/WindRiver/diab/5.9.4.0/PPCVLEE/simple:C:/WindRiver/diab/5.9.4.0/PPCVLEE ./flash.dld

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。提到功能安全，大家首先想到的是功能安全的标准 ISO26262。其中，ISO 26262-5(2018) 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)。根据不同的 ASIL 等级要求，单点故障度量和潜伏故障度量需要达到相应的等级。

Currently, the electronic and electrical architecture of automobiles is becoming increasingly complex, and the safety requirements for automotive electronics are also rising. To meet the safety requirements of automobiles, functional safety is gaining more attention. When it comes to functional safety, the first thing that comes to mind is the functional safety standard ISO 26262. In particular, ISO 26262-5(2018) Clause 8 introduces two metrics: Single-point fault metric (single-point fault metric) and Latent-fault metric (latent fault metric). Depending on the required ASIL level, the single-point fault metric and latent fault metric must meet the corresponding levels.

对于微控制器(MCU，以下简称 MCU)，在电子电气系统中，作为 SEooC(safety element out of context)进行设计开发。MCU 为了满足以上提到的 2 个度量要求，需要实现相应的安全机制。而安全机制可以分配到硬件和软件模块中。MCU 的 Safety Frame 安全库就是实现分配到软件上的安全机制。

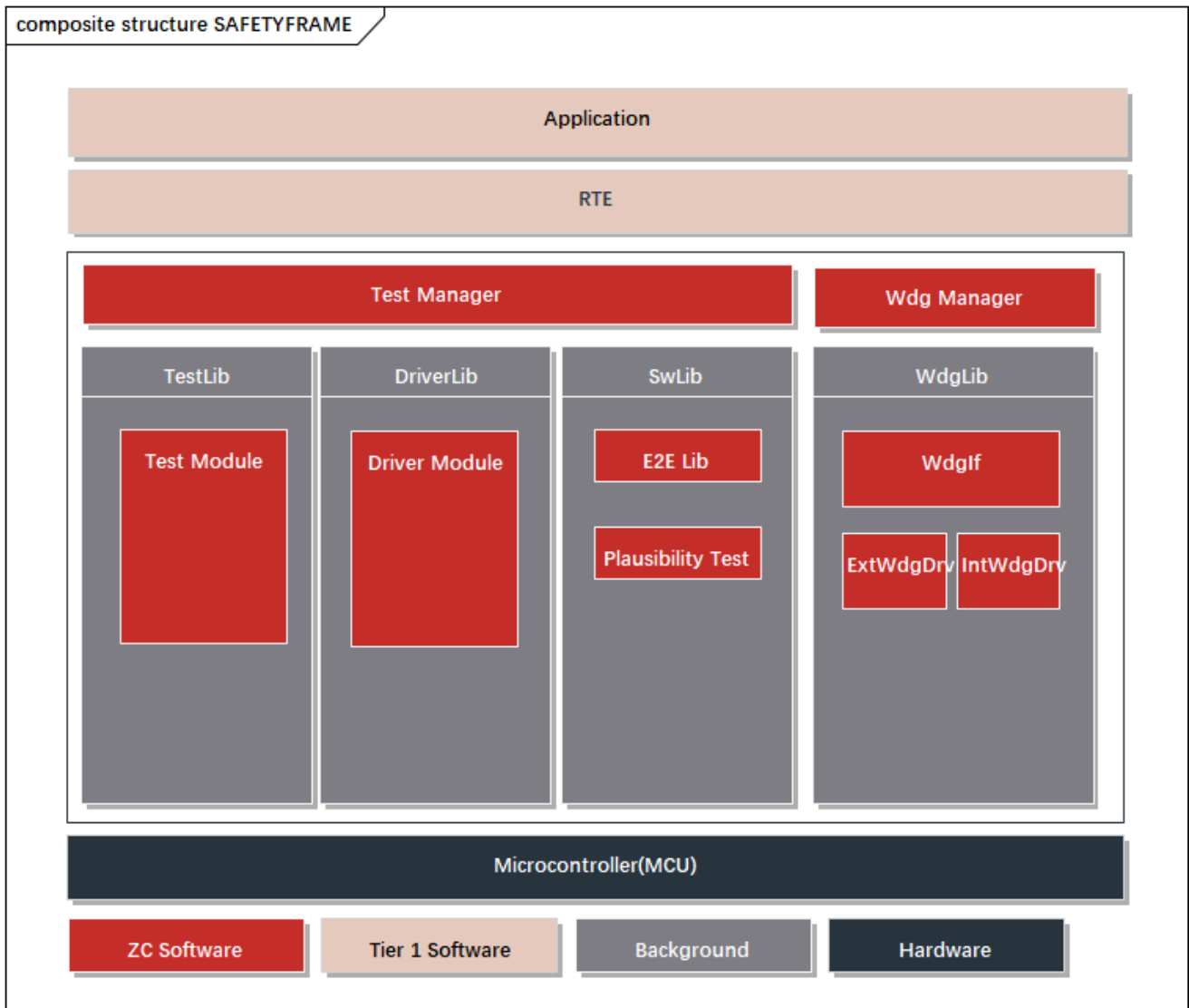
For microcontrollers (MCU, referred to as MCU below), within the electronic and electrical system, they are designed and developed as SEooC (safety element out of context). To meet the aforementioned metric requirements, MCUs need to implement corresponding safety mechanisms. These safety mechanisms can be allocated to both hardware and software modules. The Safety Frame safety library for MCUs is the implementation of safety mechanisms allocated to software.

	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 %

5 功能描述 FUNCTIONAL DESCRIPTION

5.1 产品特点 Product Feature

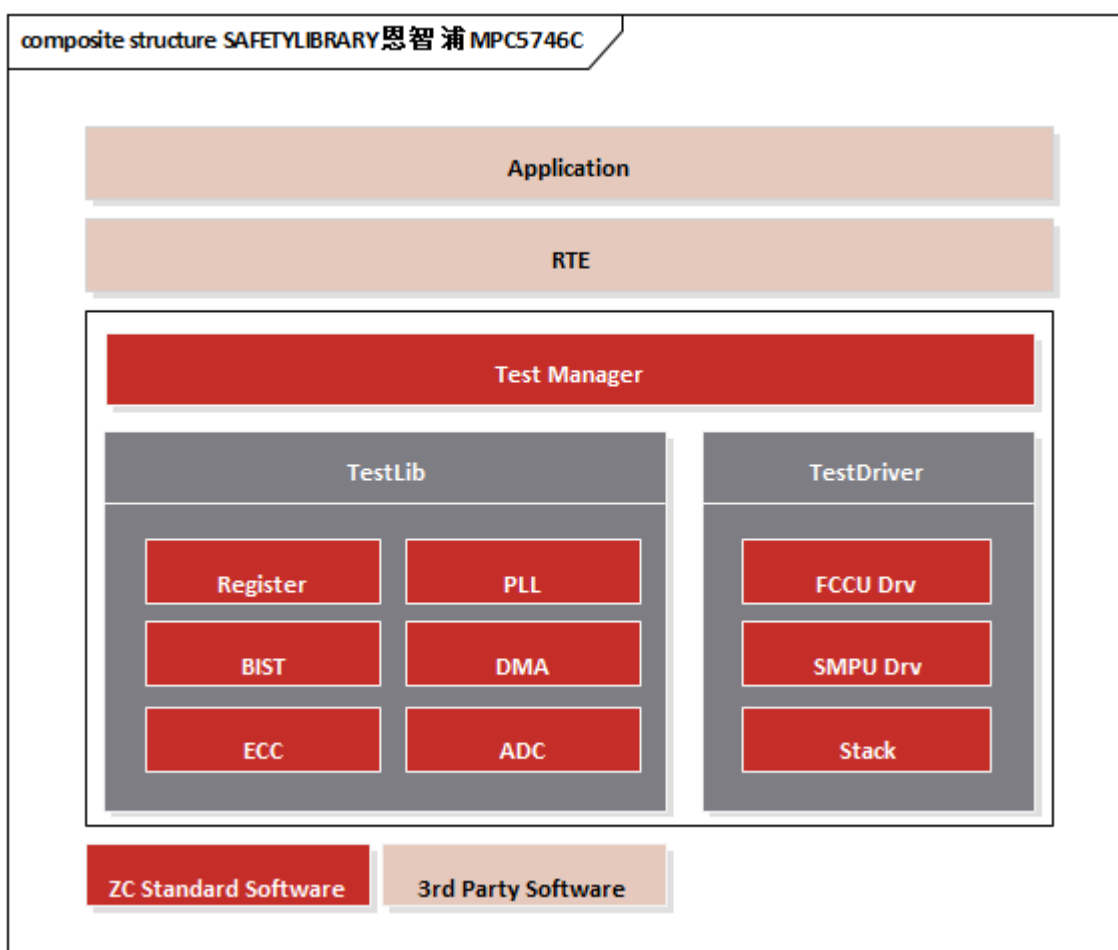


- 可作为复杂驱动集成到 AUTOSAR 中
Can be integrated as a complex driver into AUTOSAR .
- 可集成到非 AUTOSAR 软件架构中，灵活适配
Can be integrated into non-AUTOSAR software architectures.
- 支持多核测试及应用
Support multi-core testing and applications.
- Safety Library 具有内部程序流监控

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.

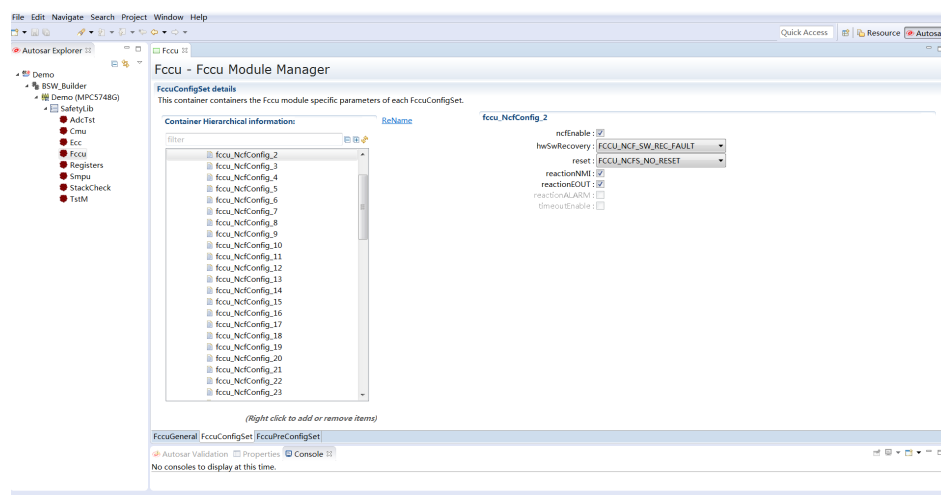
5.2 软件架构 Software Architecture



模块 Module	子模块 Sub-module	描述 Description
管理模块 Management Module	Test Manager	Safety Library 的管理 Management of the Safety Library
测试库 Test Library	BIST Test	BIST检测模块 BIST Detection Module
	Dma Monitor	DMA检测模块 DMA Detection Module
	ECC Test	ECC检测模块 ECC Detection Module
	CMU Test	CMU时钟检测模块 CMU Clock Detection Module
	ADC Test	ADC检测模块 ADC Detection Module
	Register Test	寄存器检测模块 Register Detection Module
驱动库 Driver Library	System MPU Driver	SMPU驱动 SMPU Driver
	Stack Monitor	堆栈监控模块 Stack Monitoring Module
	FCCU Driver	FCCU驱动 FCCU Driver
通用模块 Common Module	Common	通用类型定义、MemMap定义等 General Type Definitions, MemMap Definitions, etc.

5.3 配置工具

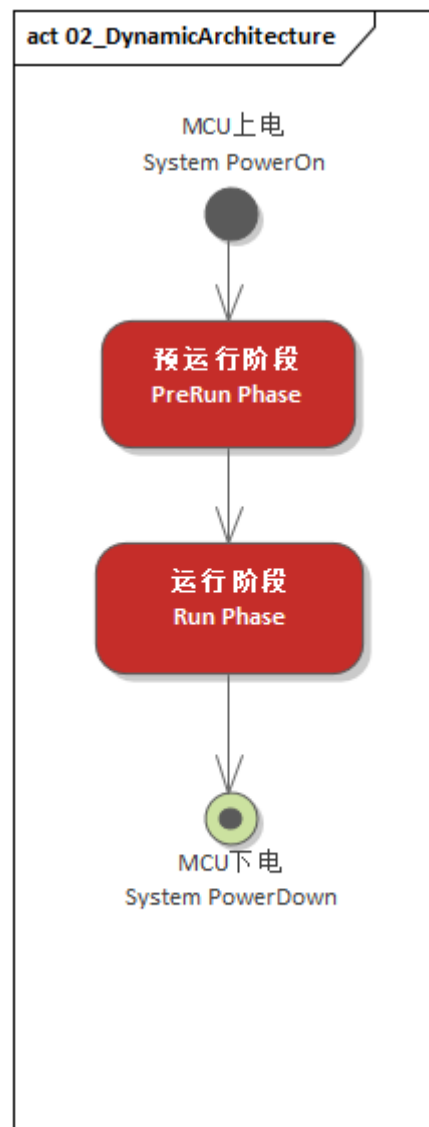
Configuration Tool



为了满足客户的不同项目需求，提高 Safety Library 的扩展性，MPC5746C Safety Library 实现了各个模块可配置性，并且实现了 Safety Library 的配置工具。客户可根据不同需求，在配置工具上完成 Safety Library 各个模块的配置工作，可生成配置代码文件，将生成的配置文件集成到工程中即可。

To meet the diverse project requirements of customers and enhance the scalability of the Safety Library, the MPC5746C Safety Library has implemented the configurability of each module and has developed a configuration tool for the Safety Library. Customers can complete the configuration of various modules of the Safety Library using the configuration tool according to different needs. They can generate configuration code files, and integrate the generated configuration files into the project.

5.4 运行阶段 Run Phase



➤ 预运行阶段 PreRun Phase

此阶段是对 MCU 的安全机制进行测试，一般此阶段在 OS 启动之前进行。

This phase involves testing the safety mechanisms of the MCU, which is generally conducted before the OS starts up.

➤ 运行阶段 Run Phase

此阶段是在任务运行时进行，在 OS 运行时进行，同时部分 MCU 的安全机制在此阶段进行测试。

This phase takes place during task execution, while the OS is running, and some of the MCU's safety mechanisms are tested during this phase.

6 过程文档 PROCESS DOCUMENTATION

开发流程 Development Process	文档描述 Document Description
需求收集 Requirement Collection	客户的需求文档 Customer Requirements Document
软件需求分析 Software Requirement Analysis	软件的需求分析 Software 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	FCCU 详细设计说明书 FCCU Detailed Design Document
	FCCU 错误处理列表 FCCU Error Handling List
	FCCU 模块评审记录 FCCU Module Review Record
	BIST 详细设计说明书 BIST Detailed Design Document
	Register 详细设计说明书 Register Detailed Design Document
	register 评审记录 Register Review Record
	SMPU 详细设计说明书 SMPU Detailed Design Document
	SMPU 评审记录 SMPU Review Record
	Stack 详细设计说明书 Stack Detailed Design Document

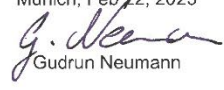
开发流程 Development Process	文档描述 Document Description
	ECC 详细设计说明书 ECC Detailed Design Document
	ECC 模块评审记录 ECC Module Review Record
	DMA 详细设计说明书 DMA Detailed Design Document
	PLL 模块详细设计说明书 PLL Module Detailed Design Document
	PLL 模块评审记录 PLL Module Review Record
	ADC 模块详细设计说明书 ADC Module Detailed Design Document
	Test Manger 详细设计说明书 Test Manager Detailed Design Document
	配置工具评审 Configuration Tool Review
	软件详细设计追踪表 Software Detailed Design Traceability Matrix
	SafetyLib 工程评审 SafetyLib Engineering Review
软件单元测试 Software Unit Testing	第二次测试的 QAC 分析报告 Second Test 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 Software Integration and Integration Testing	集成策略 Integration Strategy
	集成手册 pdf Integration Manual (PDF)
	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

开发流程 Development Process	文档描述 Document Description
	木牛.SafetyLibrary 配置工具使用指导书 MuNiu.SafetyLibrary Configuration Tool User Guide
	木牛.SafetyLibrary 配置工具软件配置管理文档 MuNiu.SafetyLibrary Configuration Tool Software Configuration Management Document
软件认可测试 Software Qualification Testing	BIST 软件测试报告 BIST Software Test Report
	FCCU 软件测试报告 FCCU Software Test Report
	Register 软件测试报告 Register Software Test Report
	SMPU 软件测试报告 SMPU Software Test Report
	Stack 软件测试报告 Stack Software Test Report
	ECC 软件测试报告 ECC Software Test Report
	DMA 软件测试报告 DMA Software Test Report
	PLL 软件测试报告 PLL Software Test Report
	ADC 软件测试报告 ADC Software Test Report
	Test Manger 软件测试报告 Test Manager Software Test Report
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		PAGE 1/1 SEITE(N)
ZERTIFIKAT NR.:		
LICENCE HOLDER & MANUFACTURER GENEHMIGUNGSINHABER & 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	LICENSED TEST MARK GENEHMIGTES PRUFZEICHEN	CERT. REPORT NO. ZERTIFIKATSBERICHT NR.
T4A8-AU01		T4A80002 is an integral part of this certificate. Ist ein integraler Bestandteil dieses Zertifikats.
Certified product(s) Zertifizierte(s) Produkt(e)	SafetyFrame Version 2.1.0	
Tested according to Gepüft 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-TUV Saar GmbH have to be complied, see www.sgs-tuv-saar.com/tcr-muc and www.sgs-tuv-saar.com/gtc-muc.		
Certification Body for Functional Safety & Cyber Security SGS-TUV Saar GmbH Zertifizierungsstelle für Funktionale Sicherheit & Cyber Sicherheit		Munich, Feb 22, 2023  Gudrun Neumann
		SGS-TUV Saar GmbH, Hofmannstr. 50, 81279 München, Deutschland / Germany Website: www.sgs-tuv-saar.com E-Mail: ts@sgs.com
Reference to SGS Certification Database 		

8 证书 CERTIFICATE

	
中华人民共和国国家版权局	
计算机软件著作权登记证书	
证书号： 软著登字第4226054号	
软件名称：	知从安全库软件 [简称：知从SafetyLib] V1.0
著作权人：	上海知从科技有限公司
开发完成日期： 2019年05月31日	
首次发表日期： 未发表	
权利取得方式： 原始取得	
权利范围： 全部权利	
登记号： 2019SR0805297	
根据《计算机软件保护条例》和《计算机软件著作权登记办法》的 规定，经中国版权保护中心审核，对以上事项予以登记。	
	
No. 04322276	 中华人民共和国国家版权局 计算机软件著作权 登记专用章 2019年08月02日

木牛软件著作权登记证书
ZC.MUNIU SOFTWARE COPYRIGHT REGISTRATION CERTIFICATE



木牛软件产品登记证书
ZC. MUNIU SOFTWARE PRODUCT REGISTRATION CERTIFICATE



公众号



业务联系

成为全球领先的**汽车基础软件**公司
To Be the Global Leading **Automotive Basic Software** Company

