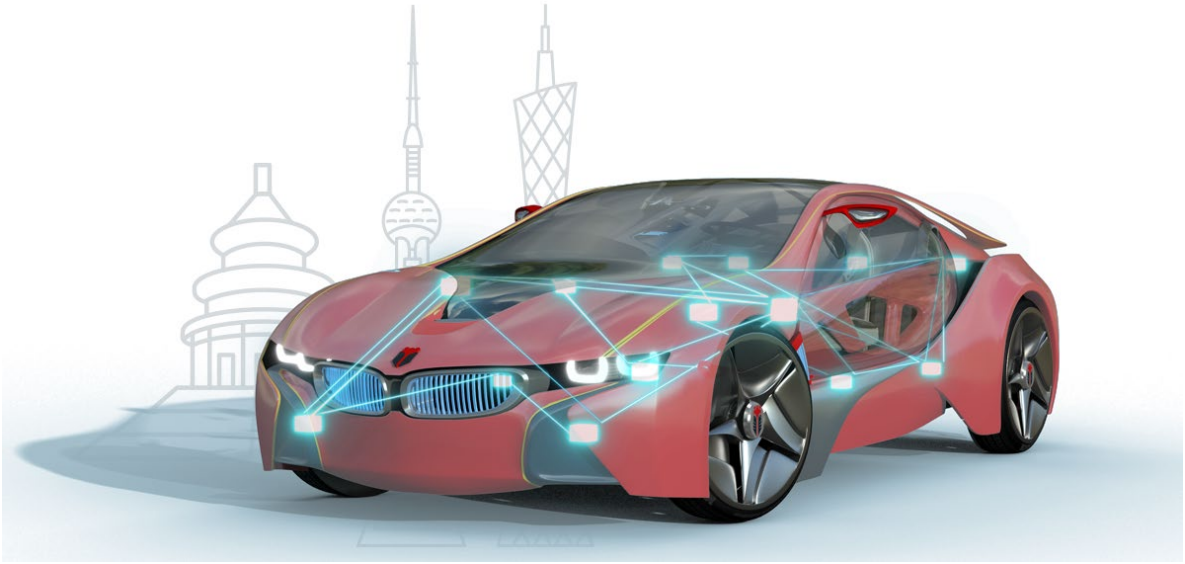
知从木牛 SAFETYLIBRARY 意法半导体 SPC58NH 产品手册

ZC.MUNIU SAFETYLIBRARY PRODUCT MANUAL

BASED ON ST SPC58NH

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 意法半导体 SPC58NH 产品手册

ZC.MUNIU SAFETYLIBRARY PRODUCT MANUAL BASED ON ST SPC58NH

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

ST SPC58NH Safety Library 用于帮助客户实现基于 SPC58NH 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 ST SPC58NH Safety Library is designed to assist customers in achieving functional safety requirements based on the SPC58NH 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.

SPC58NH Safety Library 用于实现 SPC58NH 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 SPC58NH Safety Library is used to implement the software safety mechanisms of the SPC58NH, including the testing of internal MCU modules and the driving of hardware safety mechanisms.

2 应用领域 APPLICATION FIELD

SPC58NH Safety Library 可应用于有功能安全等级需求的控制器。例如：

The SPC58NH Safety Library can be applied to controllers that require functional safety levels.

For example:

- 电机控制器
  Motor Controller
- 电池管理系统(BMS)
  Battery Management System
- 底盘系统应用
  Chassis System Applications
- 电气稳定控制(ESC)
  Electronic Stability Control
- 电动助力转向(EPS)
  Electric Power Steering
- 安全气囊和传感器集成应用
  Chassis Domain Line Control System Applications
- 雷达的应用
  Radar Applications

通过将 Safety Library 集成到基于 SPC58NH 的控制器中，可达到 ISO26262 ASIL-D 的等级要求。

By integrating the Safety Library into the control based on SPC58NH, it is possible to meet the ISO 26262 ASIL-D level requirements.

配置环境 Configuration Environment	
Hardware (Chip)	SPC58NH
Compilers Supported	Green Hills v7.1.4
Evaluation Hardware	SPC58NH
Debugger	Lauterbach (Trace32 R.2018.02) Isystem (IC5700)
Configuration Tools	Muniu_v4.4.0
Configuration Environment	Win10 64bit

Green Hills v7.1.4 编译器选项 Green Hills v7.1.4 Compiler Options	
编译选项 Complier options	-a -archive --arm -asm=<args> -[no]bigswitch -c -check -cpu=<cpu_name>-D<name>[=<val> --diag_suppress -dual_debug -dwarf2 -E -entry=symbol -farcalls -fsoft -fnone -G -H -I<dir> -L<dir> -l<name> --long_long -lnk=<arg> -list[=name] -list/<type> -map[=name] -nofloatio -noobj -nostartfiles -no_misalign_pa-nostdlib -obj -o name -Ospeed -Ospace -O -object_dir="my -OI -OI=name,... -OL -Onopeep -P -p -pg -passsource -S -syntax -thumb -U<name> -v -w -# CXX_ENV CXX CFLAGS_VECTOR_MAKESUPPORT CXXFLAGS_VECTOR_OPTIONS CXXFLAGS_CUSTOMER_OPTIONS –lgcc -lc
链接选项 Linker Options	-dwarf2 --entry=symbol -map[=name] -lnk=<arg> -L<dir> -nostartfiles -object_dir="my" -T <scriptfile> --preprocess_linker_directive_full -map=$(PROJECT_NAME).map

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。

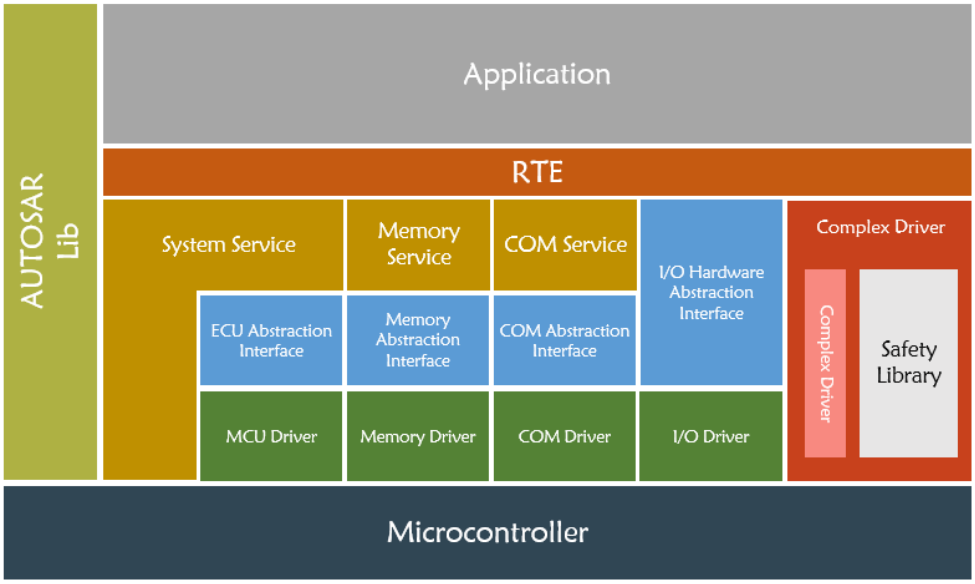
For microcontrollers (MCU, referred to as MCU below), within the electronic and electrical system, they are designed and developed as SEooC (safety element out of context). To meet the aforementioned metric requirements, MCUs need to implement corresponding safety mechanisms. These safety mechanisms 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 .

- 满足控制器 ASIL-D 需求

  Meet the ASIL-D requirements of the controller.

- 可集成到非 AUTOSAR 软件架构中

  Can be integrated into non-AUTOSAR software architecture.

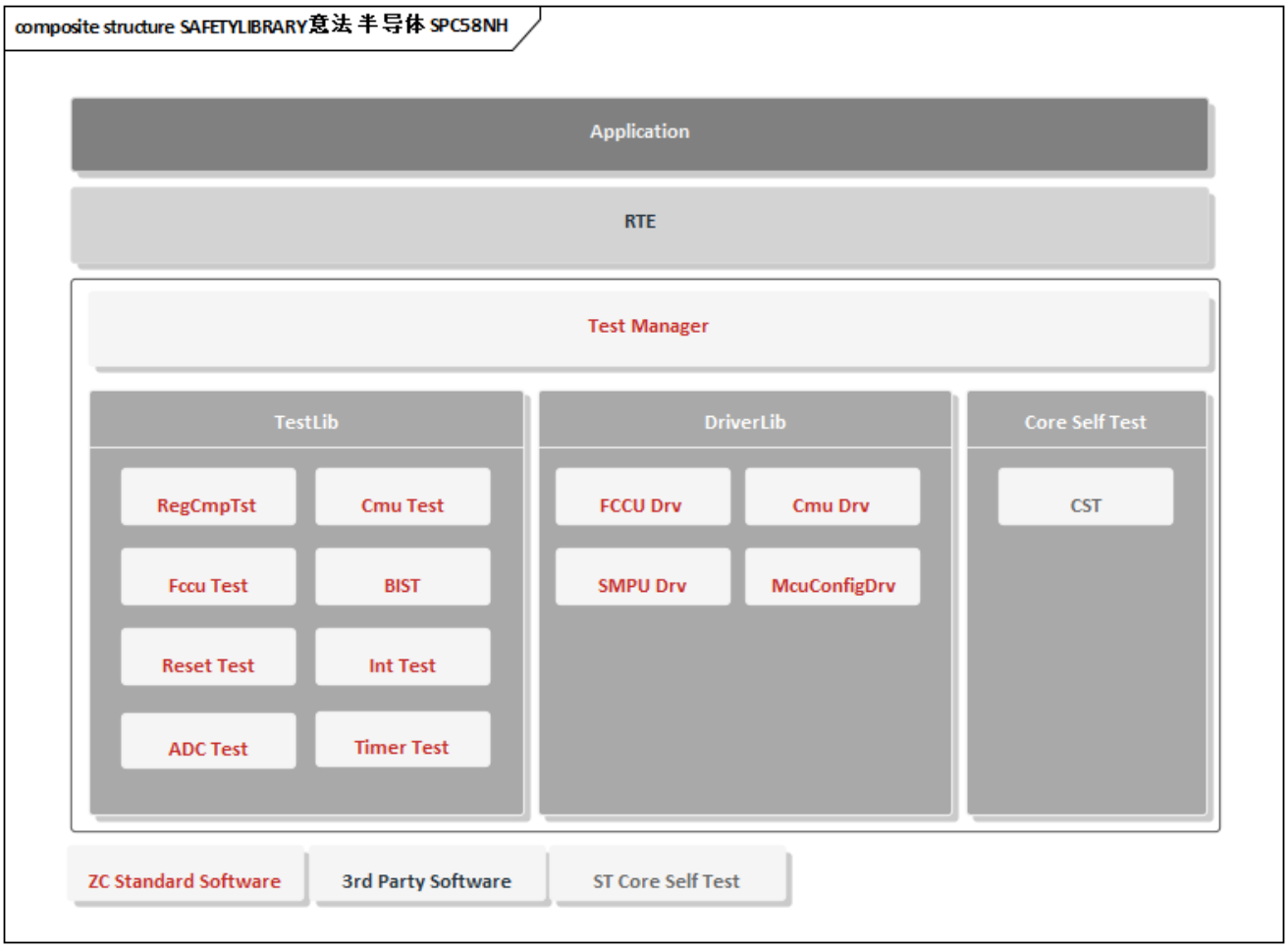
- 高扩展性：每个模块实现可配置性，满足不同的客户需求

  High scalability: Each module is configurable to meet different customer requirements.

- Safety Library 内部程序流监控

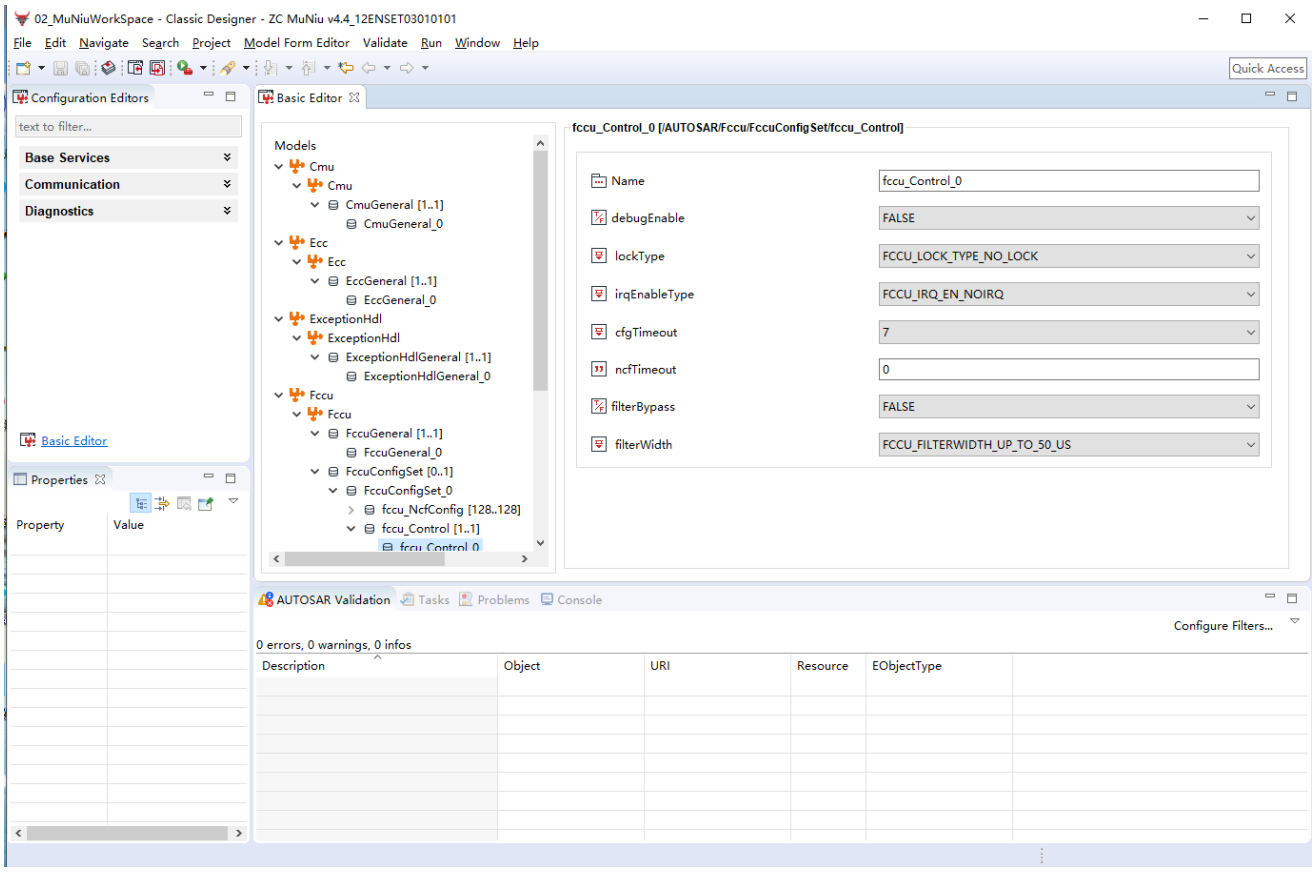
  Internal Program Flow Monitoring of the Safety Library.

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
	Cmu Test	CMU时钟检测模块 CMU Clock Detection Module
	RegCmpTst Test	寄存器检测模块 Register Detection Module
	FCCU Test	FCCU检测模块 FCCU Detection Module
	ADC Test	ADC检测模块 ADC Detection Module
	Reset Test	复位检测模块 Reset Detection Module
	Timer Test	计时器检测模块 Timer Detection Module
	Int Test	中断检测模块 Interrupt Detection Module
驱动库 Driver Library	SMPU Driver	SMPU驱动 SMPU Driver
	Cmu Driver	Cmu配置模块 Cmu Configuration Module
	McuConfigDrv	启动配置模块 Boot Configuration Module
	FCCU Driver	FCCU驱动 FCCU Driver
Core自检模块 Core Self-Check Module	Core self Test	执行Core 自检 Execute Core Self-Check
通用模块 Common Module	Common	通用类型定义、MemMap定义等 General Type Definitions, MemMap Definitions, etc.

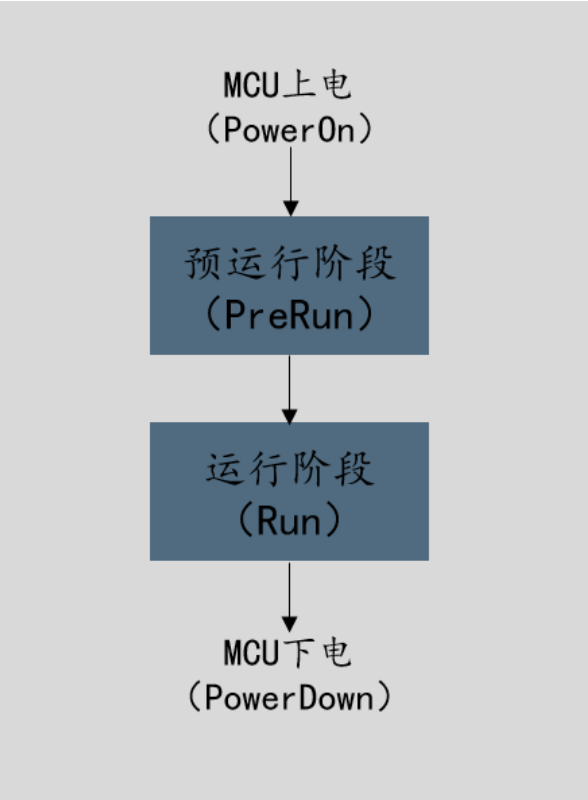
5.3 配置工具 Configuration Tool



为了满足客户的不同项目需求，提高 Safety Library 的扩展性，SPC58NH 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 SPC58NH 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 Pre-Run Phase

  此阶段是对 MCU 的安全机制进行测试，此阶段下 FCCU 为 Normal 状态，一般此阶段在 OS 启动之前进行。

  This phase is for testing the safety mechanisms of the MCU. During this phase, the Fault Control and Communication Unit (FCCU) is in the Normal state, and this phase is generally performed before the operating system (OS) starts up.

- 运行阶段 Run Phase

  此阶段是在任务运行时进行，此阶段下 FCCU 为 Normal 状态，在 OS 运行时进行。

  This phase occurs while tasks are running. The FCCU remains in the Normal state, and this phase takes place during the operation of the OS.

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
	TestManger 详细设计说明书 TestManger Detailed Design Specification
	TestManger 模块评审记录 TestManger Module Review Record
	CMU 详细设计说明书 CMU Detailed Design Specification
	CMU 模块评审记录 CMU Module Review Record
	RegCmpTst 详细设计说明书 RegCmpTst Detailed Design Specification
	RegCmpTst 模块评审记录 RegCmpTst Module Review Record

开发流程 Development Process	文档描述 Document Description
	AdcTst 详细设计说明书 AdcTst Detailed Design Specification
	AdcTst 模块评审记录 AdcTst Module Review Record
	ResetTst 模块详细设计说明书 ResetTst Module Detailed Design Specification
	ResetTst 模块评审记录 ResetTst Module Review Record
	TimerTst 模块详细设计说明书 TimerTst Module Detailed Design Specification
	TimerTst 模块评审记录 TimerTst Module Review Record
	IntTst 详细设计说明书 IntTst Detailed Design Specification
	IntTst 模块评审记录 IntTst Module Review Record
	SMPU 详细设计说明书 SMPU Detailed Design Specification
	SMPU 模块评审记录 SMPU Module Review Record
	McuConfigDrv 详细设计说明书 McuConfigDrv Detailed Design Specification
	McuConfigDrv 模块评审记录 McuConfigDrv Module Review Record
	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 Project Review
软件单元测试 **Software Unit Testing**	单元测试的 QAC 分析报告 Unit Test QAC Analysis Report
	Tessy 测试报告 Tessy Test Report
	软件单元验证策略 Software Unit Verification Strategy

开发流程 Development Process	文档描述 Document Description
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
	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
软件系统测试 Software System Testing	BIST 软件测试报告 BIST Software Test Report
	CMU 软件测试报告 CMU Software Test Report
	RegCmpTst 软件测试报告 RegCmpTst Software Test Report
	FCCU 软件测试报告 FCCU Software Test Report
	AdcTst 软件测试报告 AdcTst Software Test Report
	ResetTst 软件测试报告 ResetTst Software Test Report
	TimerTst 软件测试报告 TimerTst Software Test Report
	IntTst 软件测试报告 IntTst Software Test Report
	SMPU 软件测试报告 SMPU Software Test Report
	McuConfigDrv 软件测试报告 McuConfigDrv Software Test Report
	TestManger 软件测试报告

开发流程 Development Process	文档描述 Document Description
	TestManger 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

SGS

SGS TÜV SAAR

CERTIFICATE NO FS/71/220/23/1031
ZERTIFIKAT NR.:

PAGE 1/1
SEITE(N)

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 PRÜFZEICHEN*	CERT. REPORT NO. *ZERTIFIKATSBERICHT NR.*
T4A8-AU01	SGS TÜV SAAR ASIL D COMPLIANT Functional Safety ISO 26262 www.sgs-tuv-saar.com	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
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/tcr-muc and www.sgs-tuv-saar.com/gtc-muc

Certification Body for Functional Safety & Cyber Security SGS-TÜV Saar GmbH
Zertifizierungsstelle für Funktionale Sicherheit & Cyber Sicherheit

Reference to SGS Certification Database

Munich, Feb 22, 2023
Gudrun Neumann

SGS-TÜV Saar GmbH, Hofmannstr. 50,
81379 München, *Deutschland* / Germany

Website: www.sgs-tuv-saar.com
E-Mail: fs@t-gs.com

CERTIFICATE

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。

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

No. 04322276

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

上海市软件行业协会

软件产品证书

经评估,知从安全库软件V1.0　　符合《进一步鼓励软件产业和集成电路产业发展的若干政策》和《软件产品评估规范》的有关规定，评估为软件产品，特发此证。

申请企业:上海知从科技有限公司
软件类别:应用软件
证书编号:沪ZC-2019-0123
有 效 期：五年

上海市计算机软件评测重点实验室
（上海计算机软件技术开发中心）
二〇一九年 五月二十五日

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