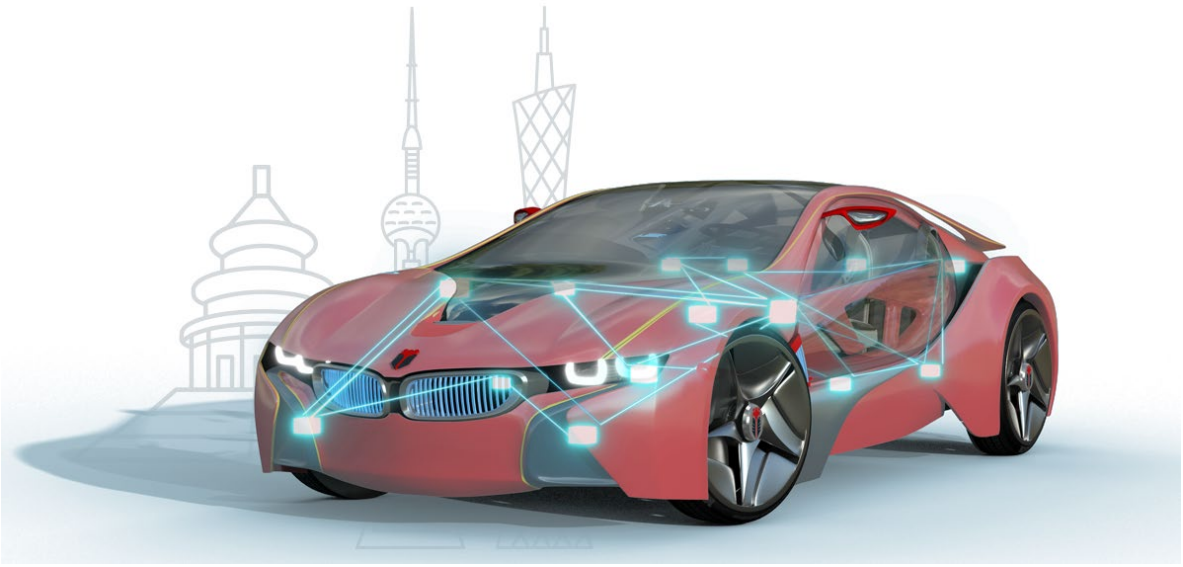
知从木牛 AFE 德州仪器 BQ756506 产品手册

ZC.MUNIU PRODUCT MANUAL BASED ON AFE TI BQ756506

知从 AUTOSAR 基础软件平台

ZC AUTOSAR Basic Software Platform



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1 功能概述 FUNCTIONAL OVERVIEW

知从木牛 AFE 系列软件旨在打造知从科技自主研发的满足客户需求的 Analog Front End（AFE）平台化软件产品。本手册说明了基于德州仪器 BQ756506 系列 AFE 实现的应用方案、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，满足功能需求。

ZC.MuNiu AFE series software is aimed at establishing a platform of Analog Front End (AFE) software products that are independently developed by ZC to satisfy customer requirements. This manual outlines the application solutions and software architecture based on the Texas Instruments BQ75650 series AFE, facilitating system and software engineers to rapidly integrate it into customer products, ensuring the fulfillment of functional requirements.

本产品实现了的 BQ756506 芯片软件驱动功能包含：

This product has implemented the software driver functions for the BQ756506 chip, which include:

- 基于 UART 通信协议功能；
  UART communication protocol function;
- 电池电压采样功能；
  Battery voltage sampling function;
- 电流采样功能；
  Current sampling function;
- 电池温度采样功能；
  Battery temperature sampling function;
- PCB 温度采样功能；
  PCB temperature sampling function;
- Shunt 温度采样功能；
  Shunt temperature sampling function;
- 模式切换功能.
  Mode switching function.

2 应用领域 APPLICATION FIELD

知从木牛 AFE 德州仪器 BQ756506 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。

ZC.MuNiu AFE Series driver software product based on Texas Instruments BQ756506 can be applied in battery management systems that require various functional safety levels.

例如：For example：

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

此 AFE 德州仪器 BQ756506 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 BQ756506 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 BQ756506 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。

This product manual is written for experienced hardware, software, and functional safety engineers, designed according to ISO 26262, and allows the BQ756506 driver software product to be integrated into the customer's application (sub)system. ZC's software integration engineers can support and ensure that the BQ756506 driver software product is suitable for the application integration services selected by the customer and complies with the corresponding software development processes.

3 配置环境 CONFIGURATION ENVIRONMENT

知从木牛 AFE 德州仪器 BQ756506 驱动软件产品可适配多家芯片厂商的 MCU，目前已实现适配的 MCU 如下：

ZC.MuNiu AFE Series driver software product based on Texas Instruments BQ756506 is compatible with MCUs from multiple chip manufacturers. The currently adapted MCUs are as follows:

知从木牛 AFE 驱动软件产品支持的英飞凌 AURIX 系列芯片软件配置：

This product supports software configuration for the Infineon AURIX series of chips.

配置环境 Configuration Environment	
Hardware (Chip)	INFINEON SAK-TC366DP-64F300S AA
Compilers Supported	Tasking v6.3r1
Evaluation Hardware	TriBoard TC366 + BQ756506
Debugger	Lauterbach(Trace32 R.2021.09.000142921) / IC5700 + WinIdea
Configuration Environment	Win10 64bit

Tasking v6.3r1 编译器选项 Tasking v6.3r1 Compiler Options	
编译选项 Compiler Options	-Ctc36x --lsl-core=tc0 -Wa-H"sfr/regtc36x.def" -Wa-gAHLs --emit-locals=-equs,-symbols -Wa-Ogs -Wa--error-limit=42 --iso=11 --language=-gcc,-volatile,+strings,-kanji --fp-model=3 --switch=auto --align=0 --no-clear --default-near-size=0 --default-a0-size=0 --default-a1-size=0 -O0 --tradeoff=0 -g --error-limit=42 --source
链接选项 Linker Options	-Ctc36x --lsl-core=tc0 -t -Wl-o"${PROJ}.hex":IHEX:4 --hex-format=s "..\Lcf_Tasking_Tricore_Tc.lsl" -Wl-OtxycL -Wl--map-file="${PROJ}.mapxml":XML -Wl-mcrfiklSmNOduQ -Wl--error-limit=42 -g --fp-model=3 --c++=14

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；德州仪器 BQ756506 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 more complex, and the safety requirements for automotive electronics are increasingly stringent. To meet these safety requirements, functional safety in automobiles is gaining more and more attention. In recent years, the industry has referred to the ISO 26262 standard for functional safety; the Texas Instruments BQ756506 is fit for the selected applications and complies with the standards of such applications, and the SEooC (safety element out of context) is used for design and development in the electronic and electrical system.

由于 AFE 为特定 ASIL-x 等级电池管理系统提供电压采样、电流采样、温度检测功能，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 AFE offers voltage sampling, current sampling, and temperature detection for battery management systems at a specific ASIL level, according to Clause 8 of ISO 26262-5(2011), it discusses two metrics: the Single-point fault metric and the Latent-fault metric. Different ASIL levels require and fault failure analysis methods all require it to achieve the corresponding ASIL-x level for both the single-point fault metric and the latent fault metric.

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

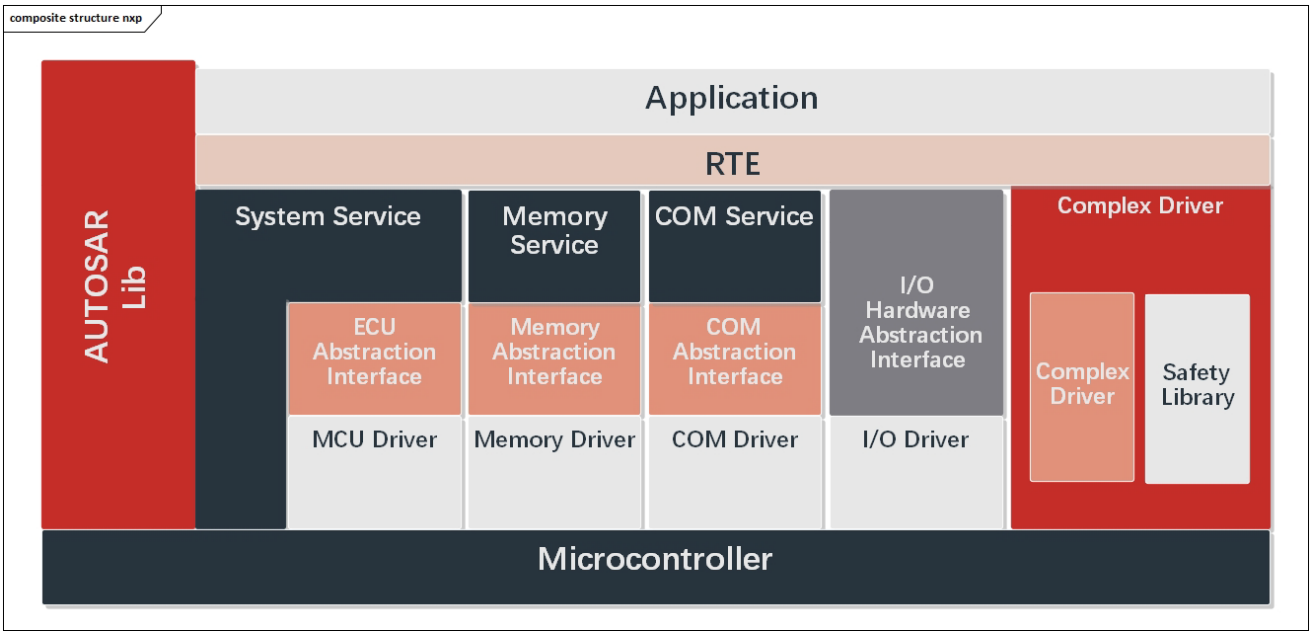
	ASIL B	ASIL C	ASIL D
Latent-fault metric	≥60 %	≥80 %	≥90 %

因此，在客户应用项目中若需符合一定的 ASIL 安全等级，知从驱动软件产品也可提供软件方案，满足功能安全需求，实现 BQ756506 安全手册中相关的安全机制。

Therefore, for customer application projects that require compliance with certain ASIL safety levels, ZC's driver software product can also provide a software solution to meet functional safety requirements, implementing the safety mechanisms outlined in the BQ756506 safety manual.

5 功能描述 FUNCTIONAL DESCRIPTION

5.1 产品特点 Product Feature



AUTOSAR 架构
AUTOSAR Architecture

- 可作为复杂驱动集成到 AUTOSAR 中

  It can be integrated as a complex driver into AUTOSAR

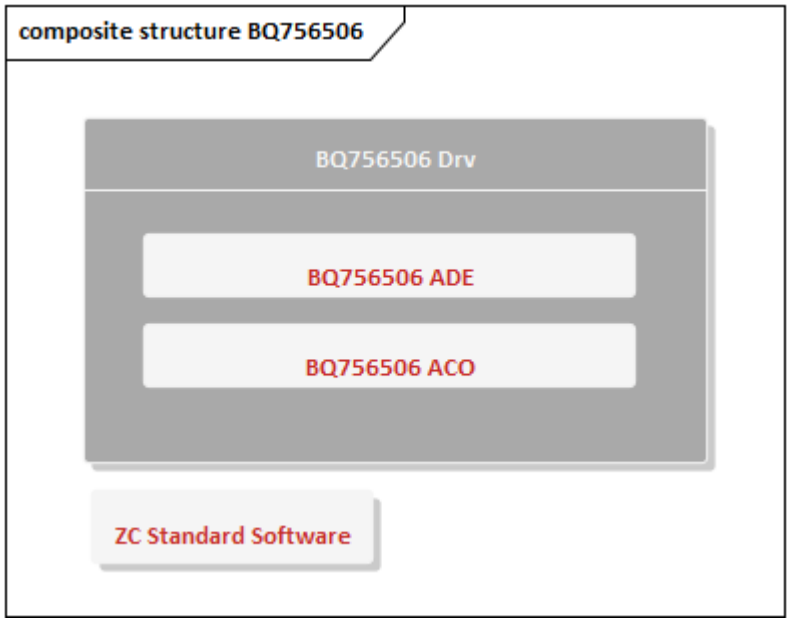
- 可集成到非 AUTOSAR 软件架构中，灵活适配

  It can be integrated into non-AUTOSAR software architectures, with flexible adaptation

- 高扩展性：各模块可配置满足不同客户的应用需求

  High extensibility: Modules 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:
Software modules include:

模块 Module	子模块 Sub-module	描述 Description
BQ756506Drv	BQ756506ADE	将温度、电流、电压寄存器的值转换为实际值 Convert the values of temperature, current, and voltage registers to actual values.
	BQ756506ACO	发送读取温度、电流、电压寄存器的值的指令 Send commands to read the values of temperature, current, and voltage registers.

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	客户需求文档 Customer Requirement Document
软件需求分析 Software Requirement Analysis	需求分析 Requirement Analysis
	需求分析规格书 Requirement Specification Document
	软件需求追踪表 Software Requirement Traceability Matrix
	客户问题沟通表 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 Software Detailed Design and Unit Design	详细设计说明书 Detailed Design Specification
	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