



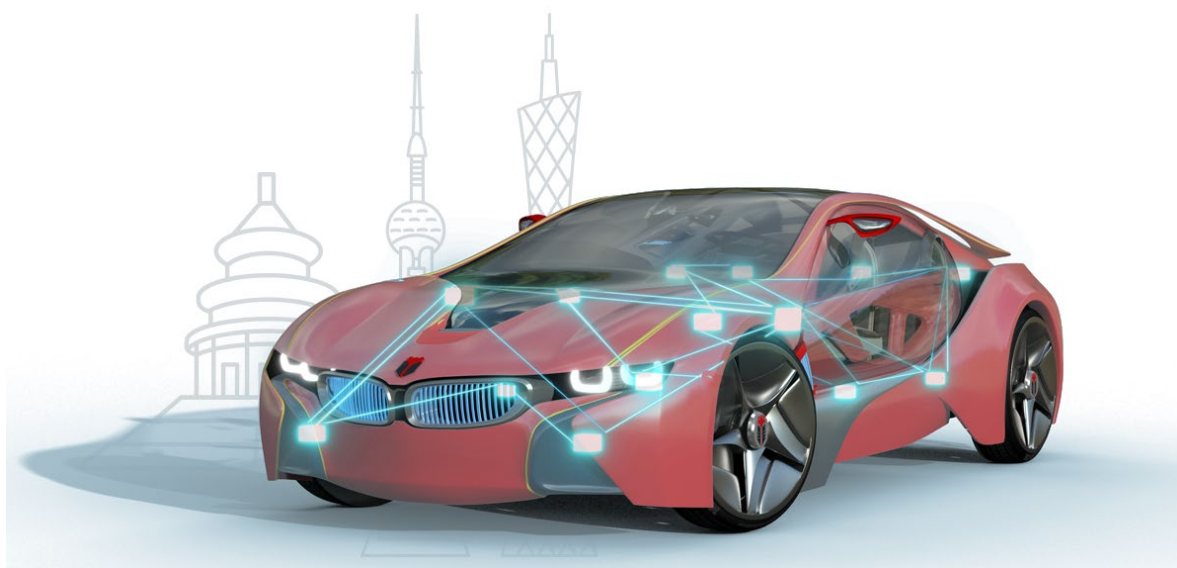
知从木牛基础软件英飞凌 TLE989X 产品手册

ZC.MUNIU BASIC SOFTWARE PRODUT

MANUAL BASED ON INFINEON TLE989X

知从木牛基础软件平台

ZC.MuNiu Basic Software Platform



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ZC.MuNiu Basic Software Platform

1 功能概述 FUNCTIONAL OVERVIEW

知从.木牛（ZC.MuNiu）为汽车电子控制器产品开发，提供完整的基础软件平台解决方案。该产品参考 AUTOSAR、OSEK 等国际规范，有基于 AUTOSAR ATOP 架构的上位机配置工具，支持上汽、一汽、吉利、广汽、长安、长城等整车厂通讯、诊断、网络管理、启动刷新规范。知从木牛英飞凌 TC264 基础软件平台，主要包括：操作系统、通讯协议栈（CAN/LIN）、诊断协议栈(UDS/J1939)、网络管理（OSEK/AUTOSAR）、标定协议栈（XCP/CCP）、存储协议栈、复杂驱动模块等，配套知从的 Bootloader 刷新程序和上位机工具，可以根据不同的客户项目要求进行配置和再开发。知从科技提供基础软件产品的同时，也提供控制器基础软件功能实现的开发服务。

ZC.MuNiu provides a comprehensive basic software platform solution for the development of automotive electronic control units. This product refers to international standards such as AUTOSAR and OSEK, and has configuration tool based on the AUTOSAR ARTOPArchitecture. ZC.MuNiu supports communication, diagnostics, and network management specifications for major OEMs like SAIC, FAW, Geely, GAC, CCAG, and GWM. ZC.MuNiu mainly includes: operating system, communication protocol stack (CAN/LIN), diagnostic protocol stack (UDS/J1939), network management (OSEK/AUTOSAR), calibration protocol stack (XCP/CCP), storage protocol stack, complex driver modules, etc. ZC.MuNiu also provide bootloader update program and configuration tool, which can be configured and redeveloped according to customer requirements. While providing basic software products, ZC also offers development services for the implementation of controller basic software functions.

英飞凌 TLE989x 的安全等级为 ASIL B，拥有 32 位 Arm Cortex-M3 内核，最高可达 60MHz，支持 Arm Cortex-M3 内核操作系统。知从科技能基于英飞凌 TLE989x 提供符合 ASPICE Level2 流程和功能安全 ASIL B 要求的基础软件产品。

The safety level of Infineon TLE989x is ASIL B, with 32-bit Arm Cortex-M3 core, up to 60MHz. TLE989x supports Arm Cortex-M3 kernel operating system. ZC can provide basic software products that comply with ASPICE Level2 processes and functional safety ASIL B requirements based on the Infineon TLE989x.

2 应用领域 APPLICATION FIELD

木牛基础软件平台可应用于使用英飞凌 TLE989x 系列芯片的汽车电子控制器产品开发。例如：
ZC.MuNiu Basic Software Platform can be applied to the development of automotive electronic control unit products using the Infineon TLE989x series of chips. For example:

- 汽车电子水泵控制器
Automotive Electronic Water Pump Controller
- 发动机冷却风扇控制器
Engine Cooling Fan Controller
- 滑动车门控制器
Sliding Door Controller
- 汽车门锁控制器
Car Door Lock Controller
- 汽车天窗控制器
Car Sunroof Controller
- 空调控制器
Air Conditioning Controller

3 配置环境 CONFIGURATION ENVIRONMENT

配置环境 Configuration Environment	
Hardware (Chip)	TLE989x
Compilers Supported	Keil uVision5.38.0.0
Evaluation Hardware	TLE9893_2QKW62S
Debugger (SW)	Keil uVision5.38.0.0
Debugger (HW)	JLINK (ARM V9)
Configuration Tools	Muniu_v5.1.3
Configuration Environment	Win7/Win10 64bit

Keil uVision5.38.0.0 编译器选项 Keil uVision5.38.0.0 Compiler Options	
编译选项 Compiler Options	<pre>-xc -std=c99 --target=arm-arm-none-eabi -mcpu=cortex-m3 - c-fno-rtti-funsigned-char -fshort-enums -fshort-wchar -D__EVAL -D__MICROLIB -gdwarf-4 -O0 -ffunction-sections -Weverything -Wno-packed -Wno-reserved-id-macro -Wno-unused-macros -Wno-documentation-unknown-command -Wno- documentation -Wno-license-management -Wno-parentheses- equality -Wno-reserved-identifier -I ./app -I ./MCAL/CAN/inc - I./MCAL_Gen/inc- I./RTE/Device/TLE9893_2QKW62SI./RTE/_Target_1IC:/Users/Admi nistrator/AppData/Local/Arm/Packs/ARM/CMSIS/5.9.0/CMSIS/Co re/IncludeI:/Users/Administrator/AppData/Local/Arm/Packs/Inf ineon/TLE988x_9x_DFP/0.7.0/device/tlelib/inc- D__UVISION_VERSION="538"-D_RTE_ DTLE9893_2QKW62S -D_RTE_-o ./Objects/*.o -MD</pre>
链接选项 Linker Options	<pre>allgraph --symbols--info sizes --info totals --info unused --info veneers—list ".\Listings\getting_started.map"-o. \Objects\getting_started.axf</pre>

4 开发背景 DEVELOPMENT BACKGROUND

AUTOSAR 组织成立于 2003 年，主要由欧洲汽车制造商、部件供应商及其他电子、半导体和软件系统公司联合建立。致力于为汽车工业开发一个开放的、标准化的软件架构，希望大家“在标准上合作，在应用上竞争”，提高控制器产品开发质量和速度。2006 年底发布了 2.1 版规范，2008 年发布 3.1 版本开始产品化，并逐步增加了功能安全、以太网等内容。目前广泛使用 4.2.1、4.2.2 以及 4.3.1 版本。

The AUTOSAR organization was established in 2003, mainly by European car manufacturers, component suppliers, and other electronics, semiconductor, and software system companies. It is committed to developing an open, standardized software architecture for the automotive industry. The goal is to "cooperate on standards and compete on applications", so can improve the stability of the basic platform, reducing costs, and enhancing the quality and speed of controller product development. The 2.1 version of the specification was released at the end of 2006, and the 3.1 version was released in 2008. Functional safety, Ethernet, and other contents are also added. Currently, the widely used versions are 4.2.1 and 4.2.2, as well as version 4.3.1.

汽车在电动化、网联化、智能化的大趋势下，电子电器部件日益增多，电气结构越加复杂，整车开发周期不断缩短。平台化、智能化的基础软件起到至关重要。

In the major trends of electrification, connectivity, and intelligence, the number of automotive electronic and electrical components is increasing. The electrical structure is becoming more complex, and the development cycle of the vehicle is continuously shortening. Basic software plays an increasingly important role.

知从科技掌握 AUTOSAR 平台软件的开发和应用核心技术，提供本地现场支持，质量好，速度快，成本低。

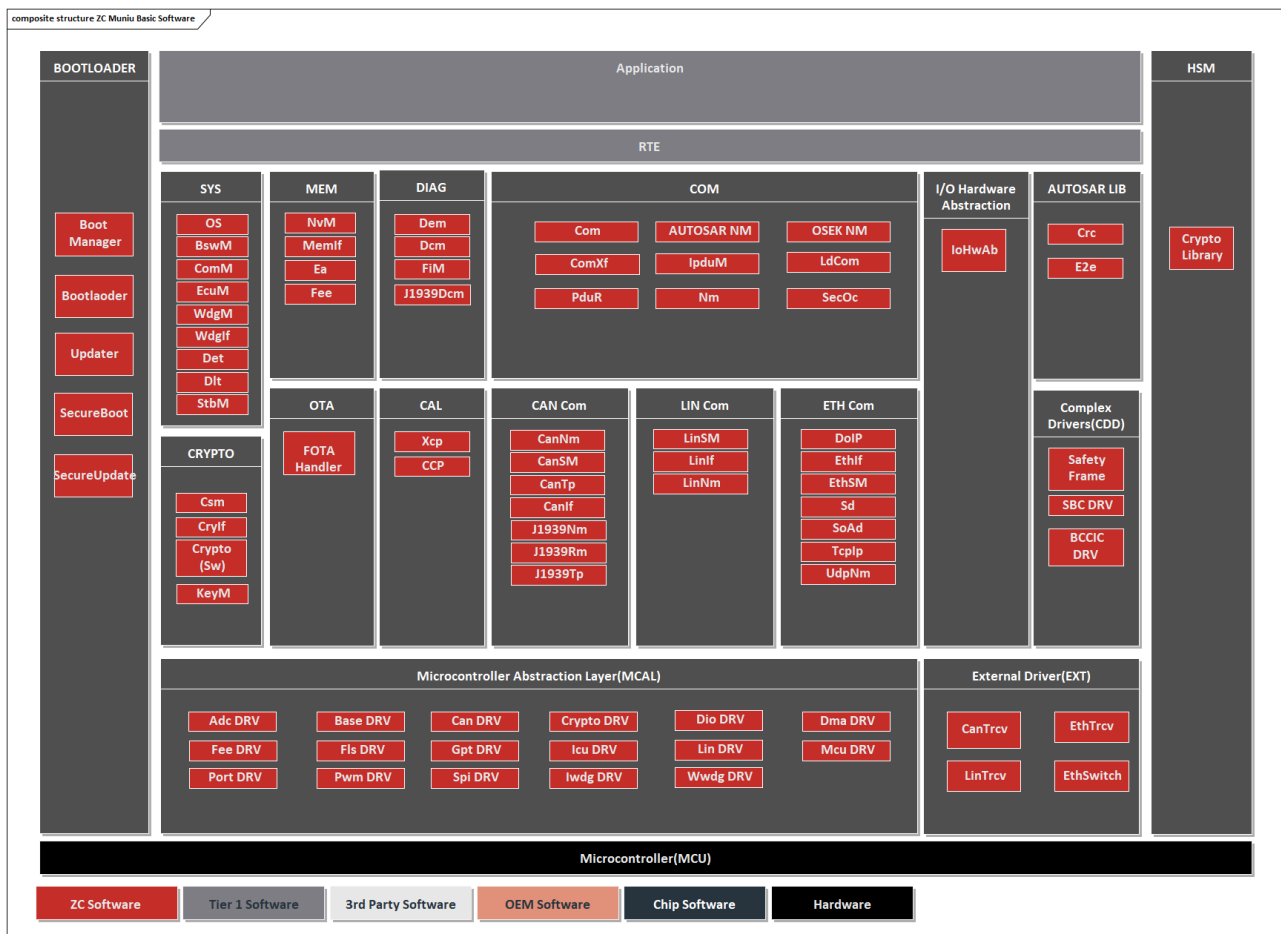
ZC has the core technology of the AUTOSAR basic software and can provide on-site support with high quality, fast speed, and low cost.

5 功能描述 FUNCTIONAL DESCRIPTION

5.1 产品特点 Product Feature

- 符合 AUTOSAR 4.3.1 版本
Compliant with AUTOSAR 4.3.1
- ARTOP 架构上位机配置工具，最高适配 AUTOSAR 4.4.0 版本
ARTOP configuration tool, compatible up to AUTOSAR 4.4.0
- 操作系统
Operating System
- 通讯协议栈
Communication Protocol Stack (CAN\LIN)
- 诊断协议栈
Diagnostic Protocol Stack (UDS\J1939)
- 网络管理
Network Management (OSEK\AUTOSAR)
- 标定协议栈
Calibration Protocol Stack (XCP\CCP)
- 存储协议栈
Storage Protocol Stack
- 复杂驱动定制开发
Custom Development of Complex Drivers
- 工程服务
Engineering Services

5.2 软件架构 Software Architecture



知从木牛基础软件平台架构
ZC.MUNIUI BASIC SOFTWARE PLATFORM ARCHITECTURE

模块 Module	子模块 Submodule	描述 Description
微控制器底层驱动 Microcontroller Abstraction Layer (MCAL)	Can DRV	CAN 驱动 CAN Driver
	CanFD DRV	CANFD 驱动 CANFD Driver
	Lin DRV	LIN 驱动 LIN Driver
	Adc DRV	Adc 驱动 Adc Driver
	Base DRV	Base 驱动 Base Driver
	Crypto DRV	Crypto 驱动 Crypto Driver
		实现 AUTOSAR 基础软件中 硬件驱动的部分 Implement the hardware driver in AUTOSAR

模块 Module	子模块 Submodule		描述 Description
	Dio DRV	Dio 驱动 Dio Driver	
	Fee DRV	Fee 驱动 Fee Driver	
	Fls DRV	Fls 驱动 Fls Driver	
	Gpt DRV	Gpt 驱动 Gpt Driver	
	Icu DRV	Icu 驱动 Icu Driver	
	Mcu DRV	Mcu 驱动 Mcu Driver	
	Port DRV	Port 驱动 Port Driver	
	Pwm DRV	Pwm 驱动 Pwm Driver	
	Spi DRV	Spi 驱动 Spi Driver	
	Iwdg DRV	Iwdg 驱动 Iwdg Driver	
	Wwdg DRV	Wwdg 驱动 Wwdg Driver	
微控制器底层驱动集成包 Microcontroller Abstraction Layer Integrated Package	可集成第三方 MCAL 的集成工程服务包 ZC has an Integrated engineering service package that can be integrated with third-party MCAL		
外部底层驱动 External Low-Level Driver (EXT)	CanTrcv DRV	CAN收发器驱动 CAN Transceiver Driver	实现外部硬件组件的AUTOSAR基础软件模块 Implement the AUTOSAR basic software module for communication with external hardware components.
	EthTrcv	Eth收发器驱动 Eth Transceiver Driver	
	LinTrcv	Lin收发器驱动 Lin Transceiver Driver	
	EthSwitch	Eth交换机驱动 Eth Switch	

模块 Module	子模块 Submodule	描述 Description
系统服务 System Service (SYS)	OS	操作系统 Operating System
	BSWM	基础软件模式管理 Basic Software Mode Management
	COMM	通信管理 Communication Management
	DET	开发错误追踪 Development Error Tracking
	ECUM	ECU管理 ECU Management
	WDGIF	看门狗接口 Watchdog Interface
	WDGM	看门狗管理器 Watchdog Manager
	Dlt	诊断日志和跟踪 Diagnostic Log and Trace
	StbM	同步时基管理器 Synchronized Time-Base Manager
诊断服务 Diagnostic Service (DIAG)	Dcm	诊断通信管理器 Diagnostic Communication Manager
	Dem	诊断事件管理器 Diagnostic Event Manager
	FiM	功能抑制管理器 Functional Suppression Manager
	J1939Dcm	J1939诊断通信管理器 J1939 Diagnostic Communication Manager
存储服务 Memory Service (MEM)	EA	EEPROM抽象层
	FEE	Flash 的 EEPROM 模拟器
	MEMIF	存储器抽象层接口

模块 Module	子模块 Submodule		描述 Description
	NVM	NVRAM管理器	Non-Volatile Storage Management
通信服务 Communication Service (COM)	COM	通信 Communication	实现通信管理的基础软件协议栈 Implement the basic software protocol stack for communication management.
	AUTOSAR NM	网络管理接口 Network Management Interface	
	OSEK NM	OSEK网络管理 Network Management Interface	
	PduR	PDU路由 PDU Routing	
	ComXf	COM通信序列化 COM Based Transformer	
	IpduM	I-PDU多路复用 I-PDU Multiplexer	
	LdCom	大数据信号通信 Large Data COM	
	Nm	网络管理 Network Management	
	SecOc	安全车载通信 Secure Onboard Communication	
CAN通信 CAN Communication	CANIF	CAN接口 CAN Interface	实现CAN通信的AUTOSAR基础软件模块 Implement the AUTOSAR basic software module for CAN Communication
	CANNM	CAN网络管理 CAN Network Management	
	CANSM	CAN状态管理器 CAN State Manager	
	CANTP	CAN传输协议 CAN Transmission Protocol	
	J1939Nm	J1939网络管理 J1939 Network Management	
	J1939Rm	J1939请求消息管理 J1939 Request Manager	
	J1939Tp	J1939传输协议	

模块 Module	子模块 Submodule		描述 Description
		J1939 Transmission Protocol	
ETH通信 ETH Communication	DoIP	IP诊断协议 IP Diagnostic Protocol	实现ETH通信的AUTOSAR基础软件模块 Implement the AUTOSAR basic software module for ETH Communication
	EthIf	ETH接口 ETH Interface	
	EthSM	ETH状态管理器 ETH State Manager	
	Sd	服务发现 Service Discovery	
	SoAd	Socket适配器 Socket Adapter	
	TcpIp	TCP IP协议栈 TCP IP Protocol Stack	
	UdpNm	UDP网络管理 UDP Network Management	
复杂驱动 Complex Driver (CDD)	SBC DRV	电源芯片驱动 Power Chip Driver	实现复杂驱动功能的AUTOSAR基础软件模块 Implement the AUTOSAR basic software module for Complex Driver
	BCCIC DRV	电池管理系统采样芯片驱动 Battery Management System Sampling Chip Driver	
	Safety Frame	功能安全框架 Safety Frame	
... ..			

5.3 CANFD MCAL 功能介绍 Introduction to CANFD MCAL Feature

CANFD MCAL 满足 AUTOSAR 4.3.1 版本，可支持最大 64 字节的 CAN FD 报文，在 CAN 模式下可达到 1 Mbit/s 的速率，在 CANFD 模式下可达到 2 Mbit/s。消息对象可以配置为接收 11 位标识符的标准帧或 29 位标识符的扩展帧，或者同时接收标准帧和扩展帧。也可以被分组为不同的优先级类，用于发送和接收。

The CANFD MCAL complies with the AUTOSAR 4.3.1 version and can support CAN FD messages with a maximum of 64 bytes. It can achieve a rate of 1 Mbit/s in CAN mode and 2 Mbit/s in CANFD mode. Message objects can be configured to receive standard frames with an 11-bit identifier or extended frames with a 29-bit identifier, or to receive both standard and extended frames simultaneously. They can also be grouped into different priority classes for transmission and reception.

- 发送功能 Sending Function

在发送 CANFD 数据时调用 Can_Write()函数请求传输 CANFD 消息，当 CANFD 的数据传输完成后，会触发发送中断，通知上层模块进行后续操作。

When transmitting CANFD data, the Can_Write() function is called to request the transmission of CANFD messages. Once the data transmission of CANFD is completed, a transmission interrupt is triggered to notify the upper layer module for subsequent operations.

- 接收功能 Receiving Function

在接收 CANFD 总线上传输的数据帧时触发接收中断处理函数 Can_IsrReceiveHandler (), 对接收到的 CANFD 数据帧进行检查，将提取到的数据解析并转换为控制器或处理器可读取的格式，存储在 Can_RxMessageData Buffer 中。

When receiving data frames transmitted on the CANFD bus, a receive interrupt is triggered to execute the Can_IsrReceiveHandler() function. This function checks the received CANFD data frames, parses the extracted data, and converts it into a readable format by the controller or processor, and storing it in the Can_RxMessageData Buffer.

- 中断处理 Interrupt Handling

CANFD 中断可以用于处理以下事件：

CANFD interrupts can be used to handle the following events:

接收中断：当接收到 CANFD 总线上的新消息时，控制器会产生接收中断，进入接收中断处理函数 Can_Isr ReceiveHandler(), 处理接收事件和唤醒事件，并调用 CanIf_RxIndication()通知函数。

Receive Interrupt: When a new message is received on the CANFD bus, the controller generates a receive interrupt and enters the receive interrupt handling function `Can_IsrReceiveHandler()`. It processes the reception event and wake-up event, and calls the `CanIf_RxIndication()` notification function.

错误中断: 当 CAN FD 总线发生错误时, 例如有错误帧或者总线错误等情况, 控制器会产生错误中断, 以便处理器及时处理。

Error Interrupt: When an error occurs on the CAN FD bus, such as an erroneous frame or bus error, the controller generates an error interrupt to allow the processor to handle it promptly.

发送中断: 当 CAN FD 总线上的数据传输完成时, 控制器会产生传输中断, 进入发送中断处理函数 `Can_IsrTransmitHandler()`, 处理帧传输成功事件, 并调用 `CanIf_TxConfirmation()` 通知函数, 以便处理器进行后续操作。

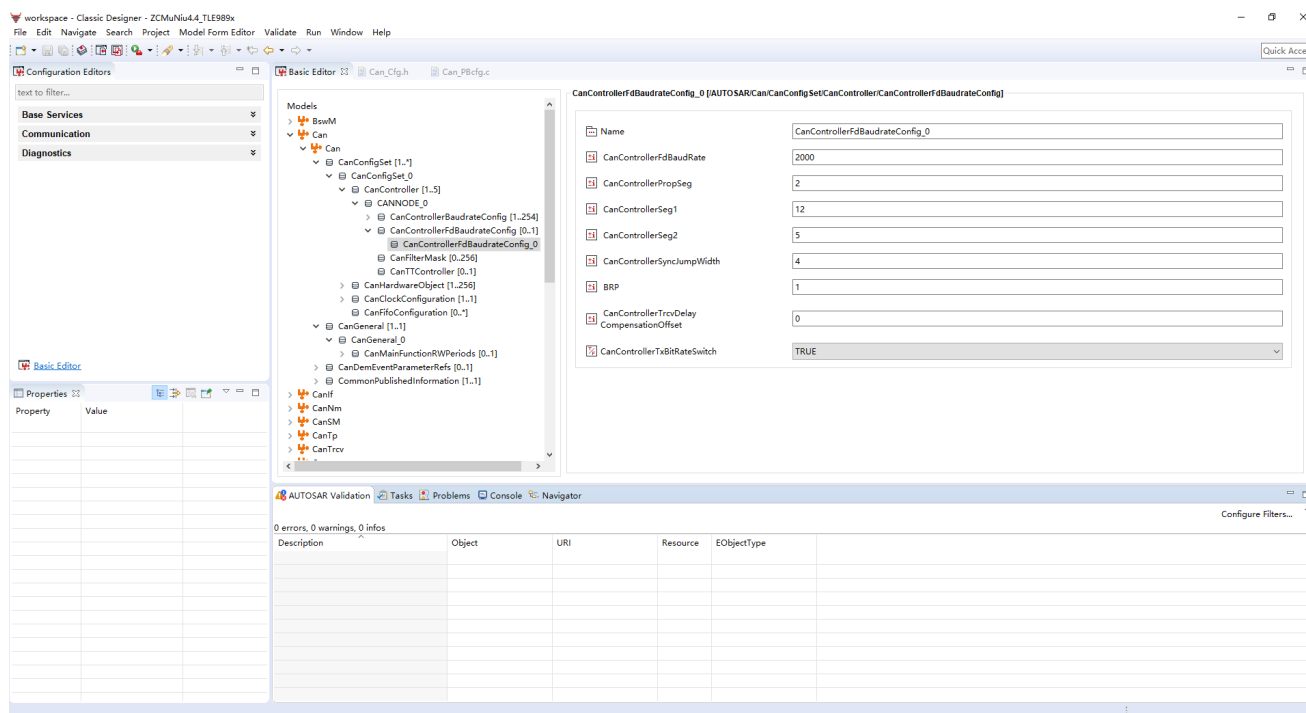
Transmit Interrupt: When the data transmission on the CAN FD bus is completed, the controller generates a transmission interrupt and enters the transmit interrupt handling function `Can_IsrTransmitHandler()`. It processes the frame transmission success event and calls the `CanIf_TxConfirmation()` notification function, allowing the processor to proceed with subsequent operations.

- FIFO 功能 FIFO Function

FIFO 用于避免传入消息的丢失(接收 FIFO) 并尽量减少传出消息 (发送 FIFO) 的设置时间。FIFO 结构也可用于自动接收或发送一系列 CAN 消息, 并在整个 CAN 帧完成后产生一个单一的报文中断。

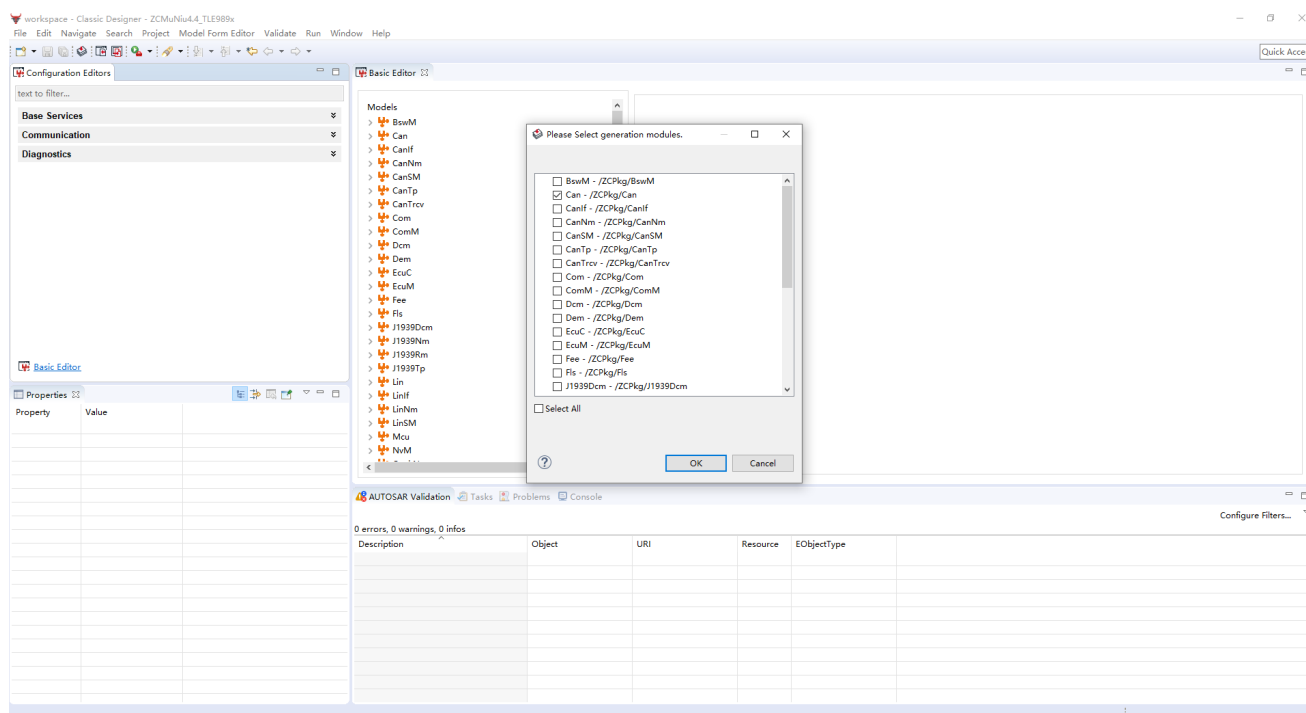
FIFO is used to prevent the loss of incoming messages (Receive FIFO) and to minimize the setup time for outgoing messages (Transmit FIFO). The FIFO structure can also be used to automatically receive or transmit a series of CAN messages, and generate a single message interrupt after the entire CAN frame is completed.

5.4 配置工具 Configuration Tool



木牛配置工具主界面

MUNIU CONFIGURATION TOOL MAIN INTERFACE

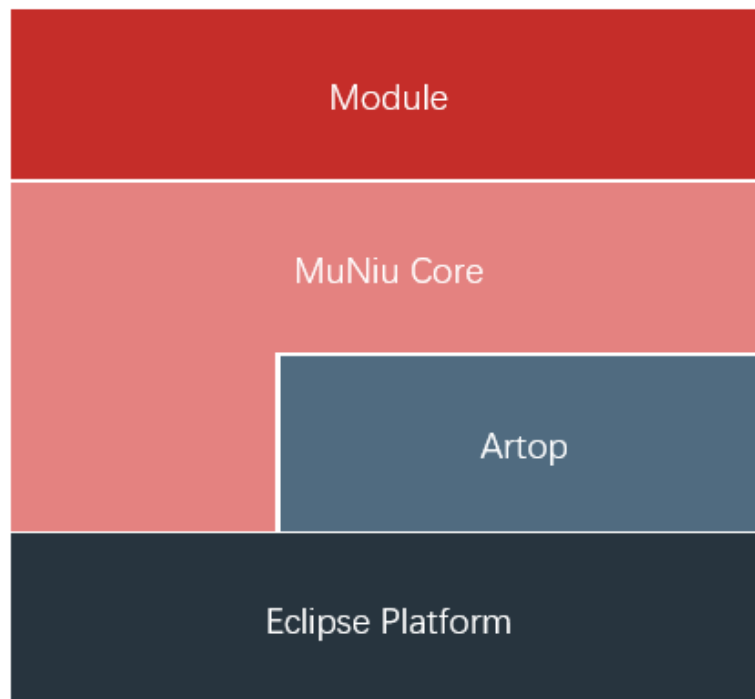


木牛配置工具生成配置代码

MUNIU CONFIGURATION TOOL GENERATES CONFIGURATION CODE

为了满足客户的不同项目需求，提高基础软件平台的扩展性，木牛基础软件平台实现了各个模块可配置性，并且实现了配置工具。客户可根据不同需求，在配置工具上完成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 requirements of customer and enhance the extensibility of the basic software platform, ZC.MuNiu has implemented configurable modules and configuration tool. Customers can use the configuration tool to configthe modules according to their specific needs, generate configuration code files, and integrate these files into projects.



木牛配置工具架构
ZC.MUNIU CONFIGURATION TOOL ARCHITECTURE

木牛基础软件平台的配置工具是基于 Eclipse 平台，并基于 ARTOP 架构，实现 AUTOSAR 模型和 ARXML 的解析。MuNiu Core 完成配置工具的 UI 界面，在 MuNiu Core 之上的 Module，实现 AUTOSAR 各个模块的配置。配置完成后，可生成各个模块的配置代码。

ZC.MuNiu basic software platform configuration tool is based on the Eclipse platform and is built on the ARTOP architecture, which implements the parsing of the AUTOSAR model and ARXML. ZC.MuNiu Core completes the UI interface of the configuration tool, and the Module on top of ZC.MuNiu Core realizes the configuration of each AUTOSAR module. After the configuration is completed, the configuration code for each module can be generated.

6 过程文档 PROCESS DOCUMENTATION

开发流程 Development Process	文档描述 Documentation 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	需求分析文档 Requirement Analysis Document
	软件需求追踪表 Software Requirement Traceability Matrix
	问题沟通表 Issue Communication Form
软件架构设计 Software Architectural 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	软件详细设计说明书 Software Detailed Design Specification
	配置工具设计文档 Configuration Tool Design Document
	软件详细设计追踪表 Software Detailed Design Traceability Matrix
	软件详细设计评审表 Software Detailed Design Review Form
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
	集成手册

开发流程 Development Process	文档描述 Documentation Description
Software Integration and Integration Testing	Integration Manual
	集成测试策略
	Integration Test Strategy
	集成测试报告
	Integration Test Report
软件系统测试 Software System Testing	资源分析报告
	Resource Analysis Report
	系统测试报告
	System Test Report
发布 Release	系统测试报告评审
	System Test Report Review
	发布文档
	Release Documentation

7 试用包 TRIAL PACKAGE

知从木牛 TLE989x 基础软件平台已经推出基础软件试用包，主要包括基础软件集成工程、配置手册、StartUp 手册等内容。方便客户深入了解产品。如有需要可以访问 <http://www.shzckj.cn/>，联系我们获取。

ZC.MuNiu S32K3 basic software platform has released a trial package. Includes basic software integrated projects, configuration manuals, technical reference manuals, test projects. If needed, you can visit <http://www.shzckj.cn/> to contact us and obtain it.

8 证书 CERTIFICATE

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计算机软件著作权登记证书

证书号： 软著登字第6824926号

软件名称： 知从木牛基础软件平台
[简称： 知从木牛]
V4.4

著作权人： 上海知从科技有限公司

开发完成日期： 2020年06月18日

首次发表日期： 2020年09月30日

权利取得方式： 原始取得

权利范围： 全部权利

登记号： 2021SR0100609

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2021年01月19日

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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

