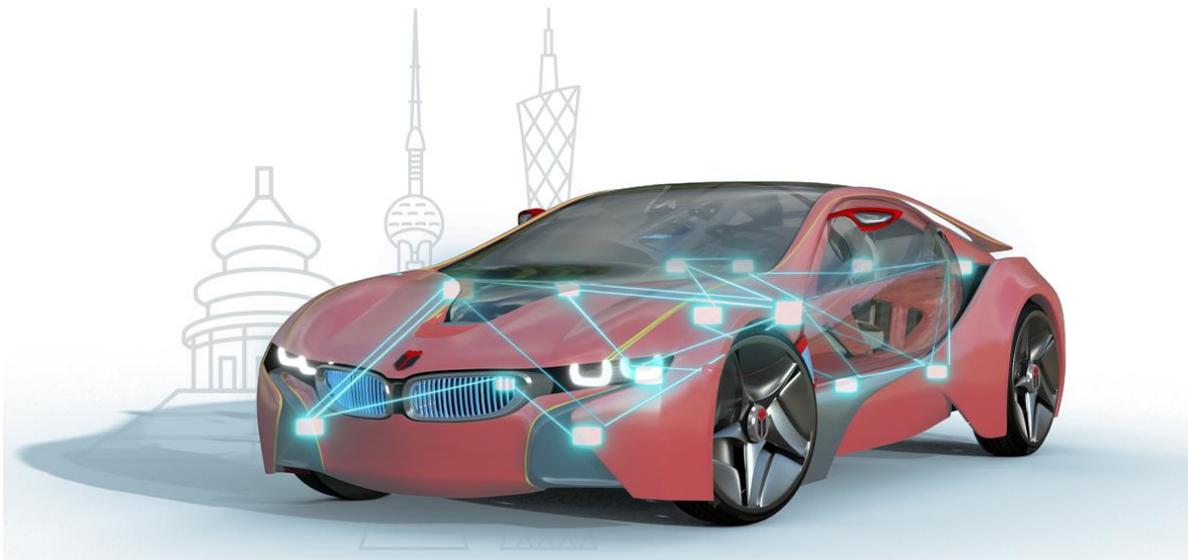


# 知从悟空 MCAL 测试工具

## ZC.WUKONG MCAL TEST TOOL

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#### 1 概述 OVERVIEW

知从悟空测试工具面向 AUTOSAR MCAL（微控制器抽象层）代码工程，提供全方位测试验证能力与自动化框架支持：

其一，实现整个 MCAL 层级的全自动化 SWE05 集成测试及 SWE06 功能测试。

其二，覆盖 VSMD（Vendor Specific Module Definition）验证。

ZC.WuKong Software provides comprehensive test and verification capabilities as well as automated testing support for AUTOSAR MCAL (Microcontroller Abstraction Layer) code projects: First, it enables fully automated integration testing (SWE05) and functional testing (SWE06) across the entire MCAL layer. Second, it covers VSMD (Vendor Specific Module Definition) validation.

知从悟空测试工具可以通过 EB\_Tresos、知从木牛等 MCAL 配置工具对 MCAL 进行不同配置及测试用例的设计。并通过 Makefile 文件和 Cygwin 环境对测试代码和 MCAL 工程进行自动编译，并可以通过劳特巴赫等调试器进行自动烧录，自动运行测试代码及测试。

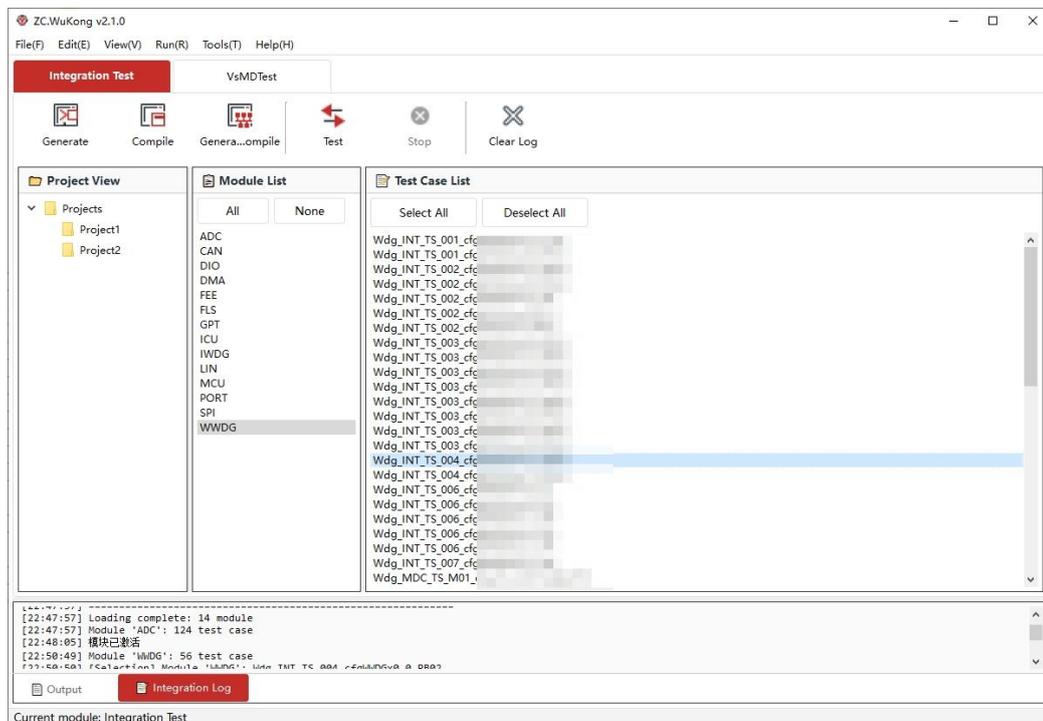
ZC.WuKong Test Tool enables different configurations of the MCAL and design of test cases via MCAL configuration tools such as EB and ZC.MuNiu. It automatically compiles the test code and MCAL projects through Makefile files and the Cygwin environment, and supports automatic flashing, automatic execution of test code, and test execution via debuggers like Lauterbach.

配置环境 Configuration Environment	
Hardware	Lauterbach, VN1640
Configuration Environment	Win7/10 64bit

## 2 功能概述 FUNCTION OVERVIEW

MCAL（微控制器抽象层）作为连接车规级芯片与上层软件的“桥梁”，直接决定硬件资源调用的稳定性与效率，其开发质量直接关联自动驾驶、动力控制等核心功能的安全表现；而 VSMD（供应商特定模块定义）作为 AUTOSAR 架构中差异化实现的关键载体，其合规性验证则是解决跨供应商模块兼容问题的核心环节。

MCAL (Microcontroller Abstraction Layer), serving as the "bridge" connecting automotive-grade chips and upper-layer software, directly dictates the stability and efficiency of hardware resource invocation. Its development quality is closely tied to the safety performance of core functions such as autonomous driving and powertrain control. Meanwhile, VSMD (Vendor Specific Module Definition), as the key carrier for differentiated implementation in the AUTOSAR architecture, has its compliance validation as the core link to resolve cross-vendor module compatibility issues.



知从悟空软件是一款专为汽车电子系统开发设计的综合性测试集成平台，该软件以 MCAL 测试和 VSMD 验证为核心功能，集成了汽车电子 MCAL 模块开发、测试、验证、质量保证等全流程的自动化解决方案。软件采用 Python 语言开发，基于 Tkinter 框架构建现代化图形用户界面，支持 Windows、Linux 等跨平台操作系统，通过模块化架构设计实现了高度可扩展性和可维护性。

ZC.WuKong Software is a comprehensive test integration platform specifically designed for automotive electronic system development. Centered on MCAL testing and VSMD validation, this software integrates end-to-end automated solutions covering the full workflow of

automotive electronic MCAL module development, testing, validation, and quality assurance. Developed in Python, it builds a modern graphical user interface (GUI) based on the Tkinter framework, supports cross-platform operating systems including Windows and Linux, and achieves high scalability and maintainability via modular architecture design.

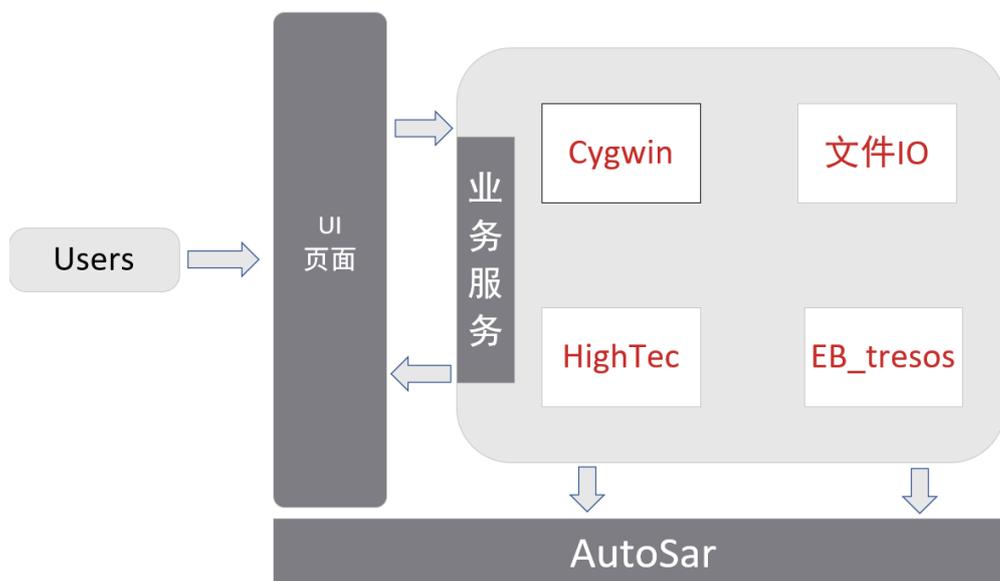
例如 ST Stella E1 芯片，知从悟空软件满足 17 个 MCAL 模块全自动化测试，支持可测试的模块如下：

For example, for the ST Stella E1 chip, ZC.WuKong Software supports fully automated testing for 17 MCAL modules. The supported testable modules are as follows:

- ADC 模块
- CAN 模块
- CRYPTO\_27\_HSM0 模块
- CRYPTO\_27\_HSM1 模块
- DIO 模块
- DMA 模块
- FEE 模块
- FLS 模块
- GPT 模块
- ICU 模块
- LIN 模块
- MCU 模块
- PORT 模块
- PWM 模块
- SPI 模块
- WDG\_27\_IWDG1 模块
- WDG\_27\_WWDG1 模块

## 2.1 技术架构 Technical Architecture

- Python(3.10.10)
- Cygwin
- HighTec(window64)
- EB Tresos

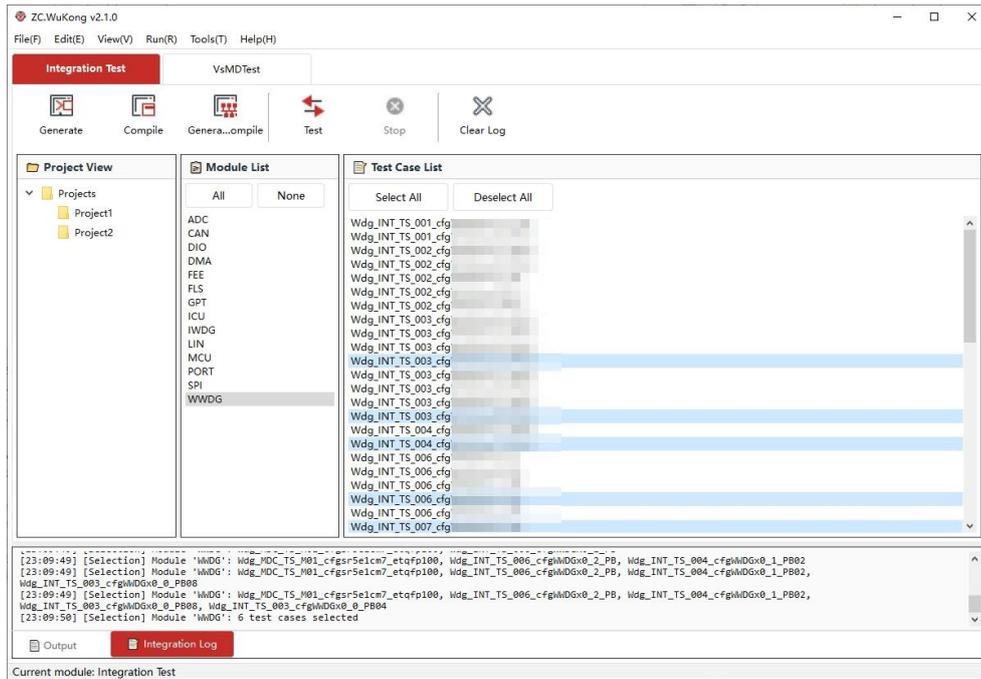


### 3 使用介绍 USAGE INTRODUCTION

#### 3.1 选择测试内容 Select the TestCase

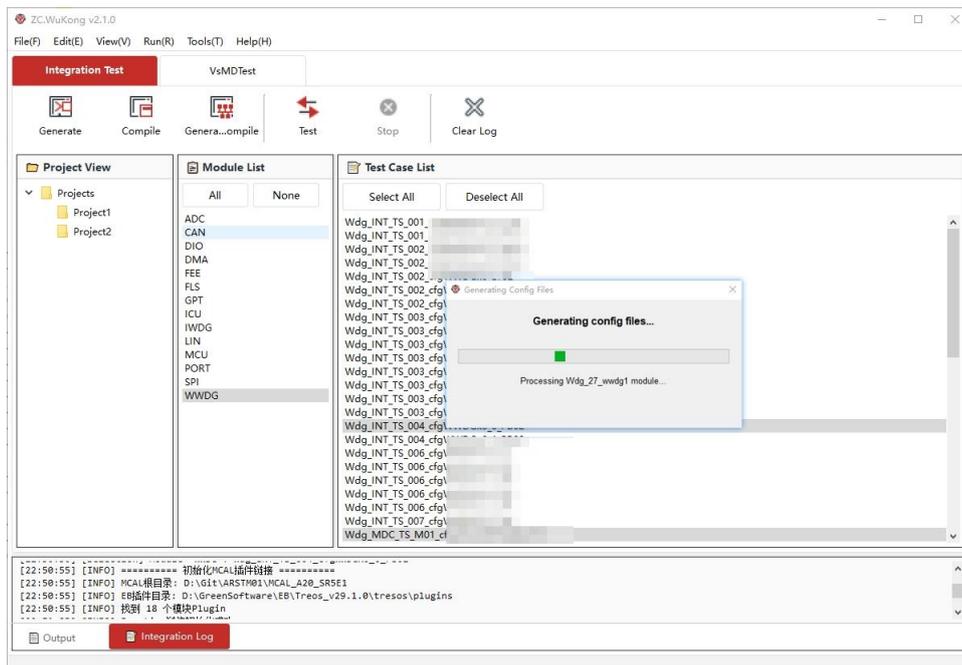
点击 Integration Test 可以看到如下页面，可以这里选择 MCAL 进行测试，也可以使用 VSMD 测试。左键单击测试用例可以进行选择。

Click on Integration Test to view the following page, where you can select MCAL for testing or use VSMD testing. Left-click on a test case to select it.



#### 3.2 开始测试 Start Testing

点击 Test 开始测试 Click Test to start Testing



## 生成代码 Generation Code

```
#####
Clean Done!
#####
2025-09-01 15:58:28 CST - DEBUG - Run command: make CFG_DIR="TestCase/test_wdg_wdg" MAK_DIR="TestCase/test_wdg_wdg/make/Wdg_INT_TS_001.mak" GENERATE_DIR="EBtresos_Cfg/wdg_27_wdg1/Wdg_INT_TS_001_cfgWdGx0_0_LT01/generate/epc" EXTRA_C_FLAGS="-DEXTERNAL_TIMER_SERVICE -DM4_WDG_MIP=wdg_27_WWDG1 -DM4_WDG_BUILD_MODE=VARIANT-LINK-RATE -DM4_WDG_WDG_INSTANCE=WWDG1 -DM4_WDG_WDG_PRESCALER=DIV_128 -DM4_WDG_FAST_TIMEOUT=0.04 -DM4_WDG_FAST_WINDOW_TIMEOUT=0.02 -DM4_WDG_SLOW_TIMEOUT=0.05 -DM4_WDG_SLOW_WINDOW_TIMEOUT=0.025 -DM4_WDG_INTERNAL_TRIGGER_CHANNEL=TIM2_CH0 -DM4_WDG_DEFAULT_MODE=WDGIF_SLOW_MODE -DM4_WDG_DEV_ERROR_DETECT=0 -DM4_WDG_DISABLE_DEM_REPORT=1 -DM4_WDG_SLOW_WN_MODE=0 -DM4_WDG_WDG_TEST=0" SILENT="0" MODULE="wdg_27_WWDG1" CURRENT_CFG_SET="Wdg_INT_TS_001_cfgWdGx0_0_LT01" -j8
2025-09-01 15:58:28 CST - INFO - Attempt 1/1 for Wdg_27_WWDG1 - Wdg_INT_TS_001_cfgWdGx0_0_LT01
TestCase/test_wdg_wdg/make/wdg_wdg_common.mk:28: ##### MIP: Wdg_27_WWDG1
TestCase/test_wdg_wdg/make/wdg_wdg_common.mk:29: ##### VENDOR_API_INFIX: WWDG1
TestCase/test_wdg_wdg/make/wdg_wdg_common.mk:60: ##### TEST_COMMON_CFG:
TestCase/test_wdg_wdg/make/wdg_wdg_common.mk:61: ##### DERIVATIVE_FOLDER: SR5E1CM7
TestCase/test_wdg_wdg/make/wdg_wdg_common.mk:62: ##### ALL: SR5E1CM7
TestCase/test_wdg_wdg/make/Wdg_INT_TS_001.mak:408: ../MCAL_A20_SR5E1_0.4.00_Unsigned_With_noM4/Rte_TS_T40D68MOI4R4/src/ht/SchM_Mcu.c TestCase/test_wdg_wdg/TS/TS_COMMON/SR5E1CM7/source/Wdg_TestSetup.c TestCase/test_wdg_wdg/TC/source/HALLib_Common.c TestCase/test_wdg_wdg/TC/source/HALLib_Wdg.c TestUtil/source/Dem_stub.c TestUtil/source/Dem_stub.c EBtresos_Cfg/wdg_27_wdg1/Wdg_INT_TS_001_cfgWdGx0_0_LT01/generate/epc/src/Mcu_CMU_LLD.c EBtresos_Cfg/wdg_27_wdg1/Wdg_INT_TS_001_cfgWdGx0_0_LT01/generate/epc/src/Mcu_FCCU_LLD.c EBtresos_Cfg/wdg_27_wdg1/Wdg_INT_TS_001_cfgWdGx0_0_LT01/generate/epc/src/Mcu_Flash_LLD.c EBtresos_Cfg/wdg_27_wdg1/Wdg_INT_TS_001_cfgWdGx0_0_LT01/generate/epc/src/Mcu_Reg.c EBtresos_Cfg/wdg_27_wdg1/Wdg_INT_TS_001_cfgWdGx0_0_LT01/generate/epc/src/Wdg_27_WWDG1_LCfg.c TestUtil/source/Partitions.c TestUtil/source/Ext_TimerService.c TestCase/test_wdg_wdg/TS/TS_001/Wdg_INT_TS_001.c TestCase/test_wdg_wdg/TC/source/Wdg_Wdg_TC_GetVersionInfo_x001.c TestCase/test_wdg_wdg/TC/source/Wdg_Wdg_TC_Init_x001.c TestCase/test_wdg_wdg/TC/source/Wdg_Wdg_TC_SetMode_x001.c
mkdir -p build
===== BUILD CONFIGURATION =====
mkdir -p build/dep
TARGET: SR5E1_GPT_Demo.e1f
mkdir -p build/dep/./MCAL_A20_SR5E1_0.4.00_Unsigned_With_noM4/Base_TS_T40D68MOI4R4/src/CC: /cydrive/c/HighTec/toolchains/arm/v8.1.0/bin/clang
```

## 开始测试 Start testing

```
251 2025-11-21 17:01:16 - Wukong_HaIshIIndou - INFO - 读取模块配置文件: D:\GIT\ASSTH01\MCAL_A20_SR5E1\CAN\TestCase\comp11ieCAN.py
253 2025-11-21 17:01:16 - Wukong_HaIshIIndou - INFO - 成功读取 166 个测试用例的 mak 映射
254 2025-11-21 17:01:16 - Wukong_HaIshIIndou - INFO - 成功获取 2/2 个测试用例的 mak 映射
255 2025-11-21 17:01:16 - Wukong_HaIshIIndou - INFO - 读取模块 DID 的 2 个测试用例...
256 2025-11-21 17:01:16 - Wukong_HaIshIIndou - INFO - 读取模块配置文件: D:\GIT\ASSTH01\MCAL_A20_SR5E1\ID01\TestCase\comp11ieID01.py
257 2025-11-21 17:01:16 - Wukong_HaIshIIndou - INFO - 成功读取 166 个测试用例的 mak 映射
258 2025-11-21 17:01:16 - Wukong_HaIshIIndou - INFO - 成功获取 2/2 个测试用例的 mak 映射
259 2025-11-21 17:01:16 - Wukong_HaIshIIndou - INFO - MAK 映射读取完成: 成功 1/6 个测试用例
260 2025-11-21 17:01:16 - Wukong_HaIshIIndou - INFO - MAK 映射已保存, 今天测试用例
261 2025-11-21 17:01:16 - Wukong_HaIshIIndou - INFO - 准备运行完整测试流程 - 模块和用例: {'ADC': ['Adc_EXT_TS_002_cfg2', 'Adc_EXT_TS_001_cfgPC'], 'CAN': ['Can_EXT_TS_Baudrate_cfg2', 'Can_EXT_TS_Baudrate_cfg6'], 'DIO': ['Dio_INT_TS_001_cfg6'], 'MIP': ['Mip_EXT_TS_002_cfg2', 'Mip_EXT_TS_001_cfgPC'], 'Mcu': ['Mcu_EXT_TS_Baudrate_cfg2', 'Mcu_EXT_TS_Baudrate_cfg6'], 'Mcu_Reg': ['Mcu_Reg_EXT_TS_002_cfg2', 'Mcu_Reg_EXT_TS_001_cfgPC'], 'Wdg': ['Wdg_EXT_TS_002_cfg2', 'Wdg_EXT_TS_001_cfgPC']}
262 2025-11-21 17:01:16 - Wukong_HaIshIIndou - INFO - 并行线程管理初始化完成
263 2025-11-21 17:01:16 - Wukong_HaIshIIndou - INFO - 开始并行生成 2 个模块
264 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: ADC, 用例数: 2, 线程数: 1
265 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: CAN, 用例数: 2, 线程数: 1
266 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: DIO, 用例数: 2, 线程数: 1
267 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: MIP, 用例数: 2, 线程数: 1
268 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: Mcu_Reg, 用例数: 2, 线程数: 1
269 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: Wdg, 用例数: 2, 线程数: 1
270 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: Wdg, 用例数: 2, 线程数: 1
271 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: Wdg, 用例数: 2, 线程数: 1
272 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: Wdg, 用例数: 2, 线程数: 1
273 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: Wdg, 用例数: 2, 线程数: 1
274 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: Wdg, 用例数: 2, 线程数: 1
275 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: Wdg, 用例数: 2, 线程数: 1
276 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始并行生成 模块: Wdg, 用例数: 2, 线程数: 1
277 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - ===== 进入_generate_config_for_module =====
278 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 模块: ADC, 测试用例数: 2
279 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 测试用例列表: D:\GIT\ASSTH01\MCAL_A20_SR5E1
280 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 输出路径: D:\GIT\ASSTH01\MCAL_A20_SR5E1\ID01\IntegrationTest\W3Rum\EBtresos_Cfg
281 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - ===== 进入_generate_config_for_module =====
282 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - EPC源路径: D:\GIT\ASSTH01\MCAL_A20_SR5E1\VAOC\TestCase\Config
283 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 模块: DIO, 测试用例数: 2
284 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 使用测试用例列表: ['Adc_EXT_TS_002_cfg2', 'Adc_EXT_TS_001_cfgPC']
285 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - ===== 进入_generate_config_for_module =====
286 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 测试用例列表: D:\GIT\ASSTH01\MCAL_A20_SR5E1
287 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 模块: CAN, 测试用例数: 2
288 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 输出路径: D:\GIT\ASSTH01\MCAL_A20_SR5E1\IntegrationTest\W3Rum\EBtresos_Cfg
289 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 测试用例列表: D:\GIT\ASSTH01\MCAL_A20_SR5E1
290 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - EPC源路径: D:\GIT\ASSTH01\MCAL_A20_SR5E1\ID01\TestCase\Config
291 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始检测VBA变量_目录: D:\GIT\ASSTH01\MCAL_A20_SR5E1\VAOC\TestCase\Config\Add_EXT_TS_001_cfgPC\generate\output
292 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 输出路径: D:\GIT\ASSTH01\MCAL_A20_SR5E1\IntegrationTest\W3Rum\EBtresos_Cfg
293 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 使用测试用例列表: ['Dio_INT_TS_001_cfg6', 'Dio_INT_TS_001_cfg2']
294 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - VBA变量检测结果: false
295 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - EPC源路径: D:\GIT\ASSTH01\MCAL_A20_SR5E1\CAN\TestCase\Config
296 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 开始检测VBA变量_目录: D:\GIT\ASSTH01\MCAL_A20_SR5E1\ID01\TestCase\Config\Wdg_INT_TS_001_cfg2\generate\output
297 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 输出路径: D:\GIT\ASSTH01\MCAL_A20_SR5E1\ID01\TestCase\Config\Wdg_INT_TS_001_cfg2\generate\output
298 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - 使用测试用例列表: ['Can_EXT_TS_Baudrate_cfg2', 'Can_EXT_TS_j_Rover_read file']
299 2025-11-21 17:01:17 - Wukong_HaIshIIndou - INFO - VBA变量检测结果: false
```



## 4 产品特性 PRODUCT FEATURE

知从悟空工具作为一款专为汽车电子 MCAL 的综合性测试验证工具，主要优势可以总结为以下几个方面：

ZC.WuKong Tool, as a comprehensive test and verification tool specifically designed for automotive electronic MCAL, its key advantages can be summarized as follows:

1) 高度集成化的工具链：平台内置 linux 虚拟环境及适配 EB\_Tresos 等配置工具，实现“安装即用”，极大减少了环境配置的工作量，有效解决因环境差异导致的效率问题。

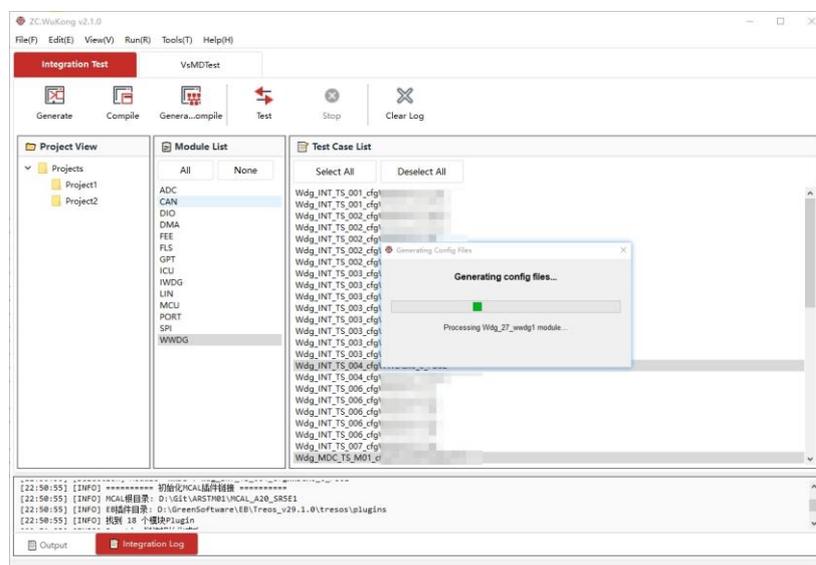
Highly integrated toolchain: The platform comes with a built-in Linux virtual environment and is compatible with configuration tools such as EB\_Tresos, enabling "out-of-the-box" usage. This greatly reduces the workload of environment configuration and effectively addresses efficiency issues caused by environmental discrepancies.

2) 全流程自动化测试：支持从配置生成、编译、烧录、测试到报告生成的一键自动化操作，显著减少人工干预，提高测试效率和一致性。

End-to-end automated testing: It supports one-click automated operations from configuration generation, compilation, flashing, and testing to report generation, significantly reducing manual intervention and improving test efficiency and consistency.

3) 灵活的测试扩展能力：能够依据客户的实际环境，定制满足个性化需求的 MCAL 测试和 VSMD 验证方案，展现出良好的适应性和扩展性。

Flexible test extensibility: Based on the customer's actual environment, it can customize MCAL testing and VSMD validation solutions to meet personalized requirements, demonstrating excellent adaptability and scalability.



## 4.1 产品优势 Product Advantages

知从悟空软件平台测试优势如下:

The characteristics of the test environment in ZC.WuKong Software Platform are as follows:

- 全流程自动化测试  
End-to-end automated testing
- 高度集成化工具环境  
Highly integrated tool environment
- 支持 VSMD 与 MCAL 测试  
Support for VSMD and MCAL testing
- 跨平台兼容性与模块化架构  
Cross-platform compatibility
- 可定制的 MCAL 集成测试  
Customizable MCAL integration testing
- 一体化质量保障体系  
Integrated quality assurance system
- 图形化操作与实时监控  
Graphical operation and real-time monitoring
- 智能测试日志分析  
Intelligent test log analysis



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

