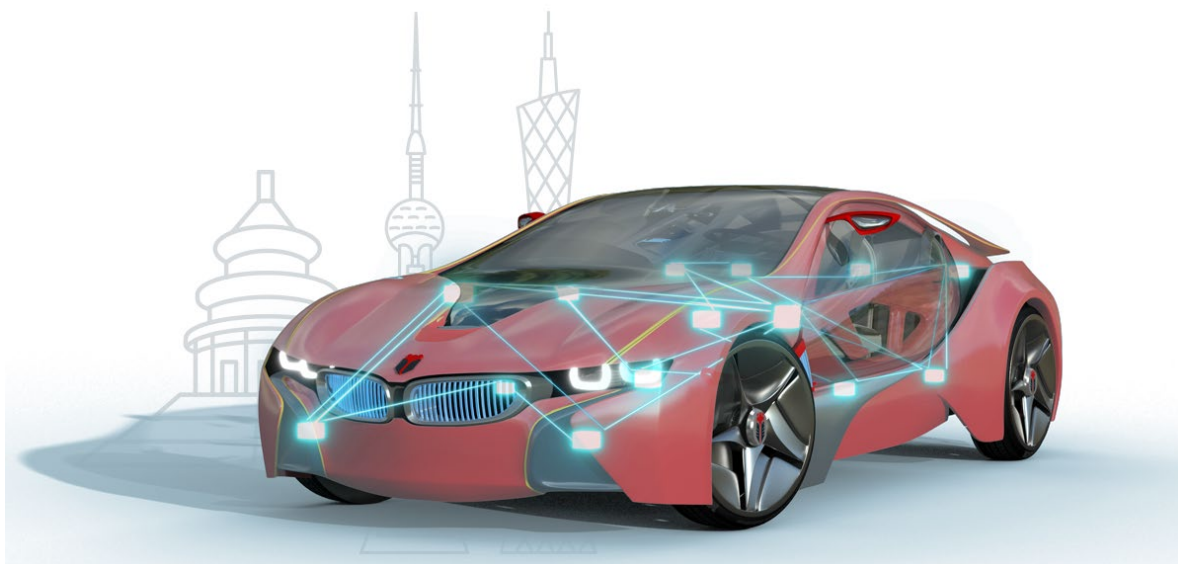


知从黑匣子软件英飞凌 TC277 产品手册

ZC BLACK BOX SOFTWARE PRODUCT MANUAL BASED ON INFINEON TC277

知从黑匣子

ZC Black Box



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1 概述 OVERVIEW

汽车黑匣子，即汽车事件数据记录系统（Event Data Record，缩写为 EDR）。作为汽车控制器的重要功能之一，这套系统主要负责记录车辆发生事故时的行车数据，包括发生碰撞前、碰撞时、碰撞后三个阶段的汽车运行数据，例如速度、ABS 状态、方向盘转向角度、气囊状态、车辆制动状态等。

The automotive black box, also known as the Event Data Recorder (EDR), is one of the important functions of a vehicle controller. This system is primarily responsible for recording driving data during vehicle accidents, including data from three stages: before, during, and after the collision, such as speed, ABS status, steering wheel angle, airbag status, and vehicle braking status.

黑匣子具有防篡改和可读写特性，与飞机上的黑匣子的功能相似。黑匣子通过 CAN 对车辆运行数据进行连续监控，当车辆在一定时间内的速度变化量达到预先设定的阈值（发生事故）时，黑匣子便将碰撞前至碰撞后共计几秒钟内的车辆情况信息储存起来，技术人员可以通过黑匣子中存储的这些数据来分析车辆存在的故障或者找到事故发生的原因。

The black box has anti-tampering and readable/writeable characteristics, similar to the functionality of the black box on an airplane. The black box continuously monitors the vehicle's operational data through CAN. When the vehicle's speed change over a certain period reaches a preset threshold (indicating an accident), the black box stores information about the vehicle's condition from several seconds before to after the collision. Technicians can use the data stored in the black box to analyze any faults in the vehicle or to determine the cause of the accident.

此文档描述了基于英飞凌 TC277 平台设计的黑匣子。目前支持多家整车厂的黑匣子规范。支持多数据存储，支持数据写入、读取及清除，支持上位机基于 UDS 诊断服务的读取、基于标定 CAN 的读取、基于 JTAG 接口的读取等多种读取方式。

This document describes the black box designed based on the Infineon TC277 platform. It currently supports the black box specifications of multiple vehicle manufacturers. It supports multiple data storage, data writing, reading, and clearing, and supports various reading methods such as reading based on UDS diagnostic services from the upper computer, reading based on calibrated CAN, and reading via the JTAG interface.

2 应用领域 APPLICATION FIELD

汽车黑匣子目前在汽车故障排查和事故调查中发挥中巨大的作用，主要有如下的应用：

The automotive black box plays a significant role in automotive fault diagnosis and accident investigation, with the following main applications:

- 交通事故重建。通过黑匣子获取汽车碰撞前、碰撞后的数据并结合计算机仿真技术进行事故现场的重现，有利于排除主观因素，在数值重建和碰撞形态重建两方面提高事故重建的精度。

Traffic Accident Reconstruction. By acquiring pre-collision and post-collision data from the black box and combining it with computer simulation technology to recreate the accident scene, it helps to eliminate subjective factors and improve the accuracy of accident reconstruction in both numerical reconstruction and collision morphology reconstruction.

- 交通事故调查与司法鉴定。非典型碰撞形态的交通事故车速鉴定、驾驶员操作行为鉴定一直是交通事故司法鉴定的难题，黑匣子数据帮助避免复杂的计算过程，同时大大降低计算误差。

Traffic Accident Investigation and Forensic Appraisal: The appraisal of vehicle speeds and driver behavior in atypical collision accidents has always been a challenge in traffic accident forensics. Data from the black box helps avoid complex calculation processes and significantly reduces computational errors.

- 车辆安全性改善。黑匣子记录了与车辆安全系统相关的大量数据，特别是与碰撞相关的速度、速度变化、气囊展开情况、乘员安全带使用情况、驾驶人应急操作行为等信息，有助于评估安全系统在实际事故中的效果，帮助车企及安全供应商针对实际情况对汽车安全性能进行迭代升级。

Vehicle Safety Improvement: The black box records a large amount of data related to vehicle safety systems, especially information related to collisions such as speed, speed changes, airbag deployment, occupant seat belt usage, and driver emergency response behaviors. This data is helpful for assessing the effectiveness of safety systems in actual accidents and aids automakers and safety suppliers in iterating and upgrading vehicle safety performance based on real-world conditions.

3 运行环境 OPERATING ENVIRONMENT

配置环境 Configuration Environment	
Hardware (Chip)	TC277
Compilers Supported	Tasking v4.2r2
Debugger	Isystem (IC5700)

Tasking 编译器 Tasking Compiler	
编译选项 Compiler Options	-Ctc27x --lsl-core=vtc -t -l-Wa-H"sfr/regtc27x.def" -Wa-gAHLs --emit-locals=-equ,-symbols -Wa-Ogs -Wa--error-limit=42 - --iso=99 --language=-gcc,-volatile,+strings --switch=auto --align=0 --default-near-size=8 --default-a0-size=0 --default-a1-size=0 -O0 --tradeoff=4 -g --source
链接选项 Linker Options	-Ctc27x --lsl-core=vtc -t -I"D:\Git\ENFAW02\ENFAW02" -Wl-o"\${PROJ}.hex":IHEX:4--hex-format=s-Wl-D_TASKING_C_TRICORE_=1 "../ENFAW02.lsl" -Wl-OtxycL -Wl-mcrfikISmNOduQ -Wl--error-limit=42 -g

4 黑匣子产品功能 BLACK BOX PRODUCT FUNCTION

4.1 产品特点 Product Feature

黑匣子用于记录汽车运行时的运行状态。在过去的汽车事故中，往往会由于车辆损毁严重，导致无法获取事故发生时的车辆状态，使得无法保证驾驶员的权益，并且不能确定车辆是否存在问题。因此，通过黑匣子中存储的数据可以有效解决上述问题。

The black box is used to record the operating status of a vehicle during its operation. In past automotive accidents, severe vehicle damage often made it impossible to obtain the vehicle's status at the time of the accident, which could not guarantee the rights and interests of the driver and could not determine if there were any issues with the vehicle. Therefore, the data stored in the black box can effectively solve the above problems.

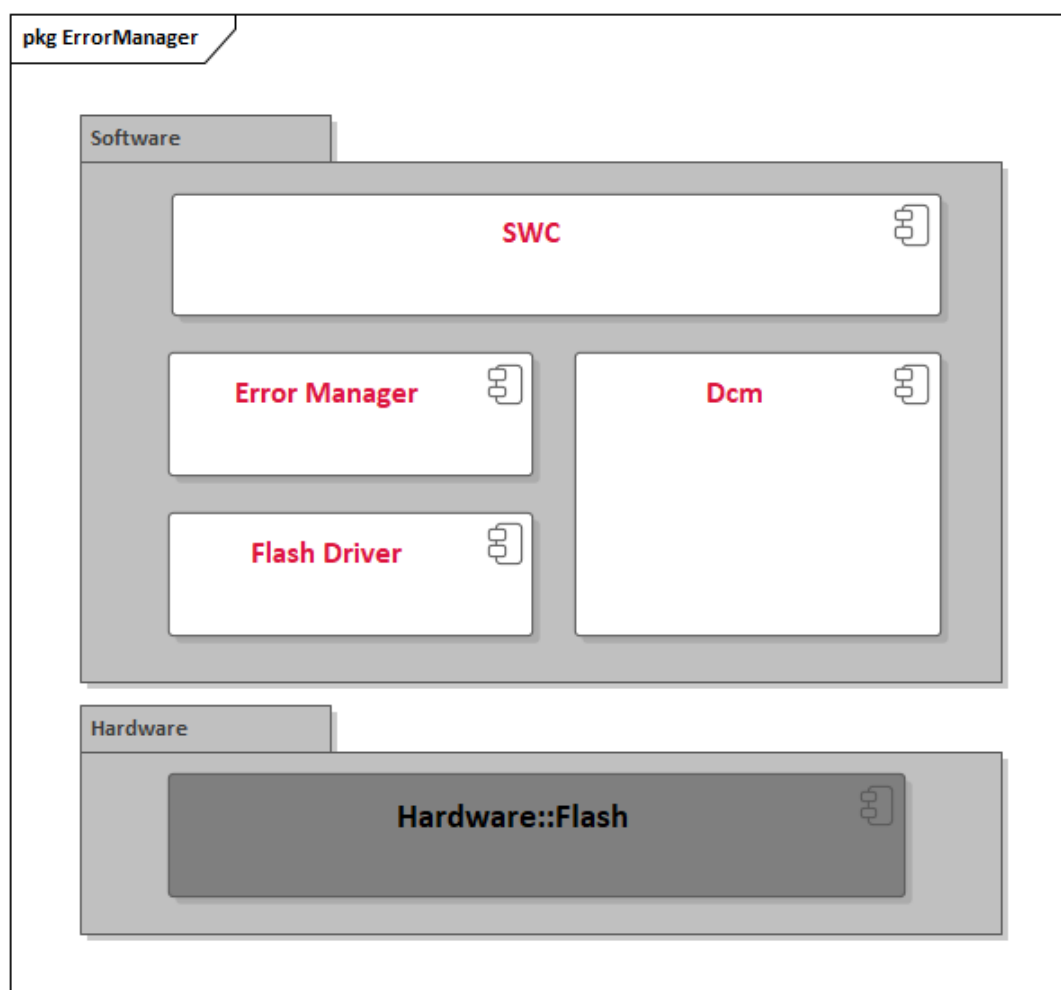


图 4- 1 架构原理图

FIGURE 4-1 ARCHITECTURAL PRINCIPLE DIAGRAM

4.2 实现方案 Implementation Plan

TC277 支持的 DFlash 空间大小为 384KB。由于 DFlash 区域有数据掉电不丢失的特点，因此用于存储故障数据。

The DFlash space supported by TC277 is 384KB. Due to the characteristic of DFlash that data is not lost when power is lost, it is used to store fault data.

在 CDD 层增加用于故障管理的 Error Manager 模块功能。上层 SWC 层出现故障时，可以调用 Error Manager 模块来传递故障相关信息，而后 Error Manager 模块将获取到的数据写入 DFlash 中储存。如下图 4-2 所示。

An Error Manager module function for fault management is added at the CDD layer. When a fault occurs at the upper SWC layer, the Error Manager module can be called to pass fault-related information, which is then written into the DFlash for storage by the Error Manager module, as shown in Figure 4-2.

SWC 层也可以调用 Error Manager 的清除功能来清除 DFlash 中存储的数据，去除掉已经无用的数据，保证有足够的空间存储后续新的故障信息。

The SWC layer can also call the Error Manager's clear function to remove data stored in DFlash that is no longer needed, ensuring there is enough space to store subsequent new fault information.

通过 Error Manager 模块的读取接口可以获取到 DFlash 中已经存储的数据，并将故障信息上报至上位机工具，方便测试人员获得故障信息以用于排查车辆存在的故障。

Fault information can be obtained through the read interface of the Error Manager module and reported to the upper computer tool, facilitating test personnel in obtaining fault information for troubleshooting vehicle issues.

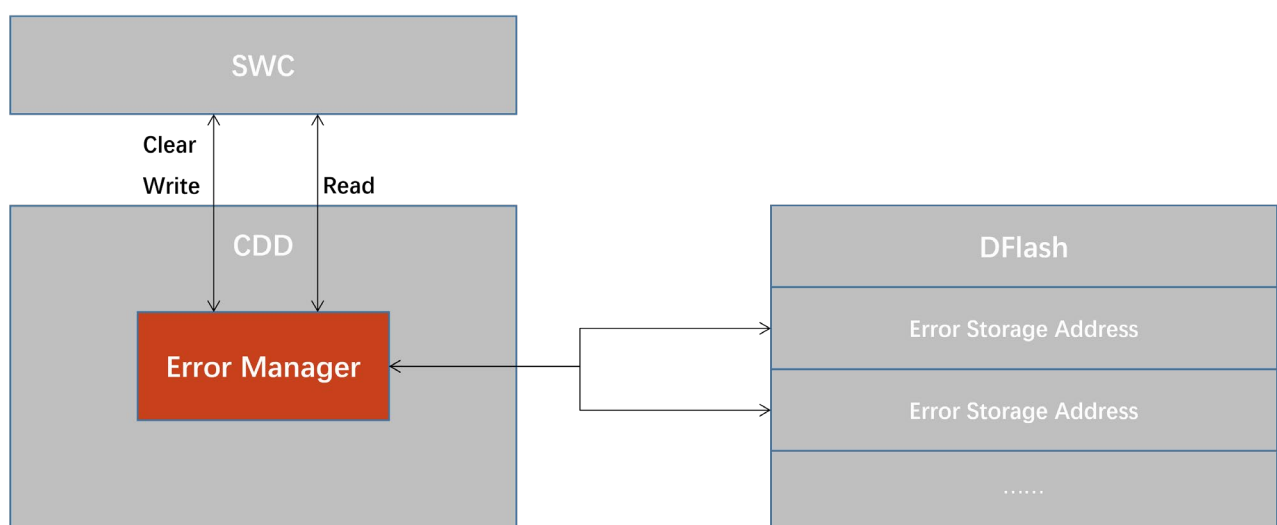


图 4- 2 故障存储框架
FIGURE 4-2 FAULT STORAGE FRAMEWORK

4.3 故障存储流程 Fault Storage Process

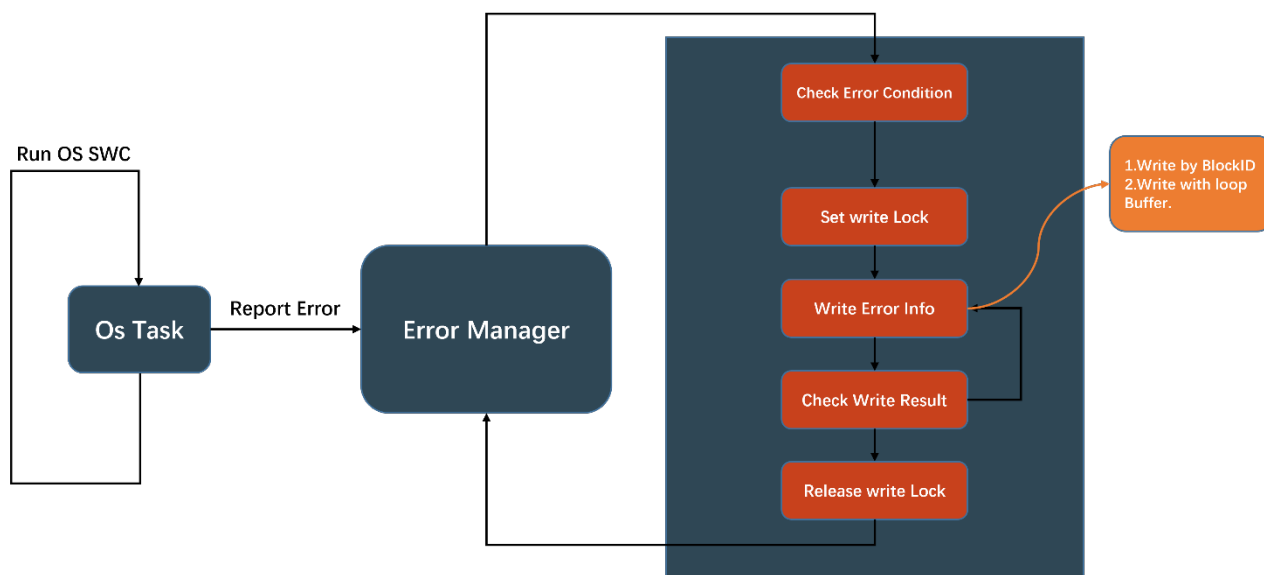


图 4- 3 故障存储流程
FIGURE 4-3 FAULT STORAGE PROCESS

在应用层周期任务中上报故障后，故障管理模块（Error Manager）会依次进行以下流程：

After faults are reported in the application layer's periodic tasks, the fault management module (Error Manager) will proceed with the following steps:

1. 检查需要记录的故障是否满足条件。
Check if the fault to be recorded meets the conditions.
2. 锁定当前要记录数据的 DFlash 区域，防止其他任务再次调用写入功能。
Lock the current DFlash area to prevent other tasks from calling the write function again.
3. 将故障信息写入 DFlash 区域。
Write the fault information into the DFlash area.
4. 检查写入的结果是否正确。
Check if the **written** result is correct.
5. Error Manager 模块写入完成。
The Error Manager module completes the write process.

4.4 故障清除流程 Fault Clearing Process

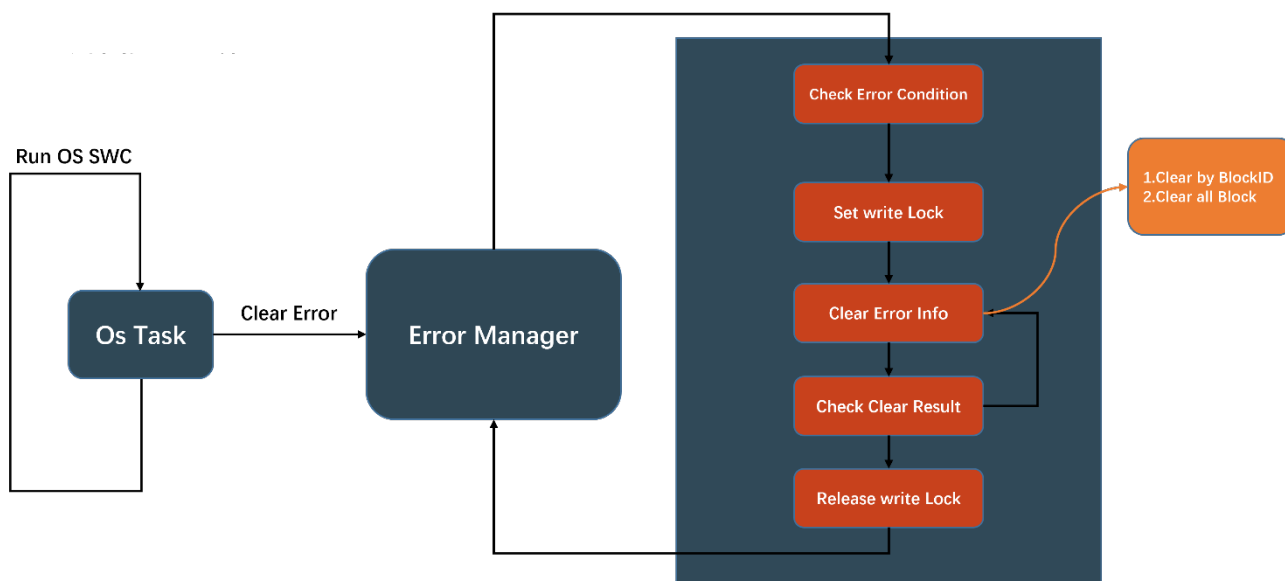


图 4- 4 故障清除流程
FIGURE 4-4 FAULT CLEARING PROCESS

在应用层周期任务中下达清除故障的要求后，故障管理模块（Error Manager）会依次进行以下流程：

After the application layer's periodic task issues a request to clear a fault, the fault management module (Error Manager) will proceed with the following steps in sequence:

1. 检查需要清除的故障是否满足条件。
Check if the fault to be cleared meets the conditions.
2. 锁定当前要操作的 DFlash 区域，防止其他任务调用清除功能。
Lock the DFlash area that is currently being operated on, preventing other tasks from calling the clear function.
3. 将存储的数据清除。
Clear the stored data.
4. 检查清除结果是否正确。
Check if the cleared result is correct.
5. Error Manager 模块清除数据完成。
The Error Manager module completes the data clearing.

4.5 故障读取流程 Fault Reading Process

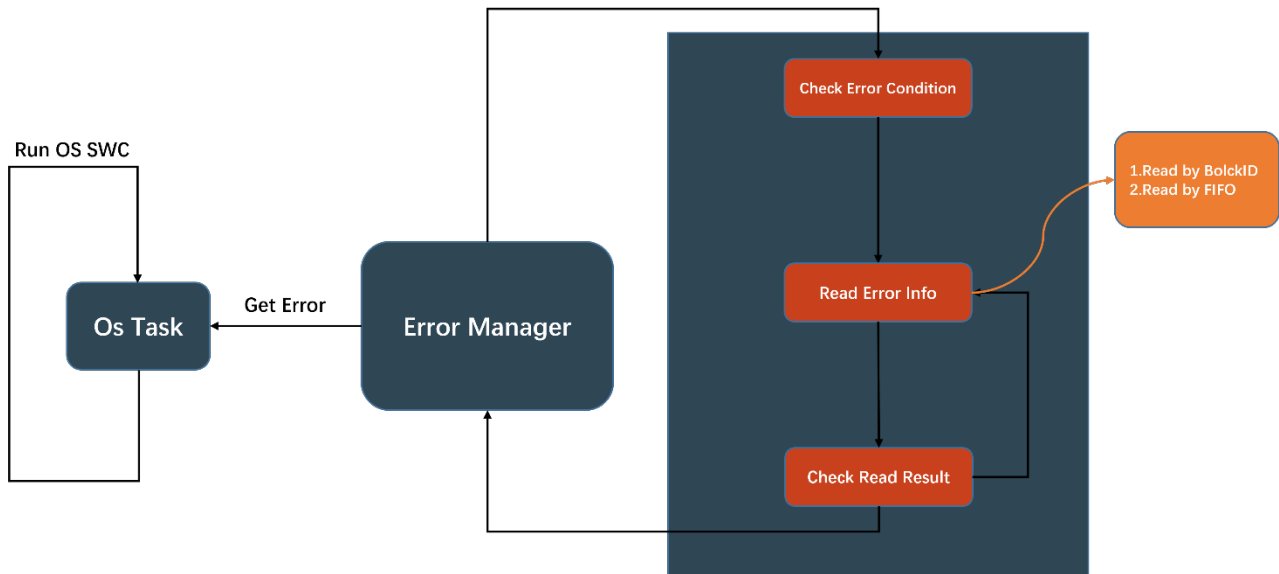


图 4- 5 故障读取流程
FIGURE 4-5 FAULT READING PROCESS

在应用层周期任务中需要获取故障信息后，故障管理模块（Error Manager）会依次进行以下流程：

When the application layer's periodic task needs to obtain fault information, the fault management module (Error Manager) will proceed with the following steps in sequence:

1. Error Manager 模块检测故障状态。
The Error Manager module detects the fault status.
2. 读取存储在 DFlash 中的数据。
Read the data stored in the DFlash.
3. 读取完成后，检测读取状态，并上报读取的数据。
After reading is completed, check the read status and report the read data.

5 知从玄武产品功能 ZC XUANWU PRODUCT FUNCTION

5.1 产品特点 Product Feature

为了配合黑匣子的数据回放，知从科技推出的玄武诊断测试工具可以对黑匣子内存储的数据进行读取，使得技术人员可以更轻松地获取故障数据。

To facilitate the data playback of the black box, ZC has launched the XuanWu diagnostic testing tool, which can read the data stored in the black box, allowing technicians to more easily access fault data.

知从玄武有如下特点：

ZC Xuanwu has the following features:

➤ 操作简易 Easy to Operate

■ 图形化界面，方便配置

Graphical interface for convenient configuration

■ 自动解析黑匣子数据如 DID, DTC 并生成 excel

Automatically parses black box data such as DID and DTC and generates Excel files

■ 支持不同 OEM 的诊断配置和诊断规范

Supports diagnostic configurations and standards for different OEMs

➤ 使用灵活 Flexible to Use

■ 支持 CAN、CAN FD、Kline 协议

Supports CAN, CAN FD, and Kline protocols

■ 支持 ISO 14229、ISO 15765、ISO 14230 等标准

Supports standards such as ISO 14229, ISO 15765, and ISO 14230

■ 支持多种硬件接口

Supports various hardware interfaces

➤ 支持定制服务 Customization Services Available

5.2 回放功能 Playback Function

玄武上位机能够通过诊断服务获取黑匣子存储空间的故障信息、完成故障信息的解析，并将解析的故障数据信号以图形界面的形式展示。

The Xuanwu upper computer can obtain fault information from the black box's storage space through diagnostic services, complete the parsing of fault information, and display the parsed fault data signals in a graphical interface.

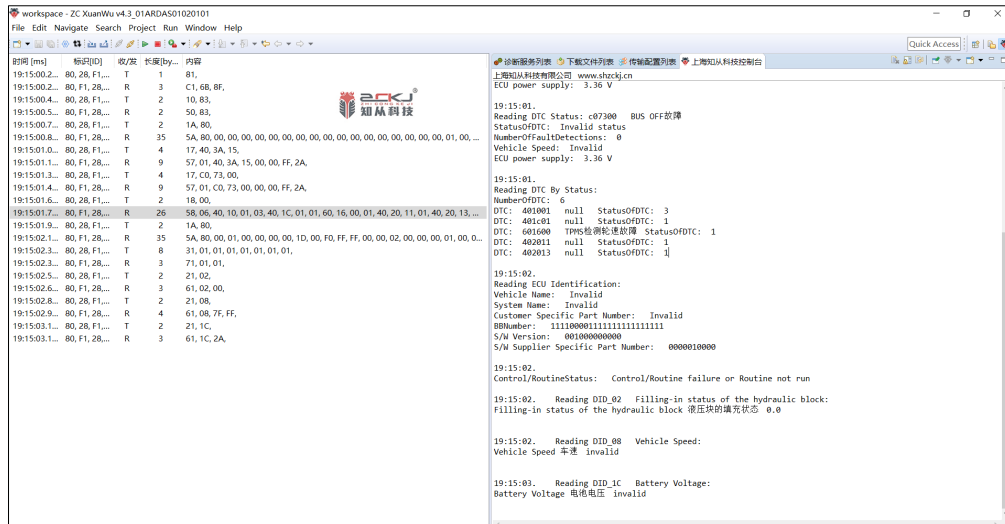


图 5- 1 数据回放

FIGURE 5-1 DATA PLAYBACK

玄武上位机能够将解析的故障发生时的数据如 U 相电流、V 相电流、W 相电流随时间的变化绘制成波形图。

The Xuanwu upper computer can plot waveform charts of the data such as U-phase current, V-phase current, and W-phase current at the time of fault occurrence over time.

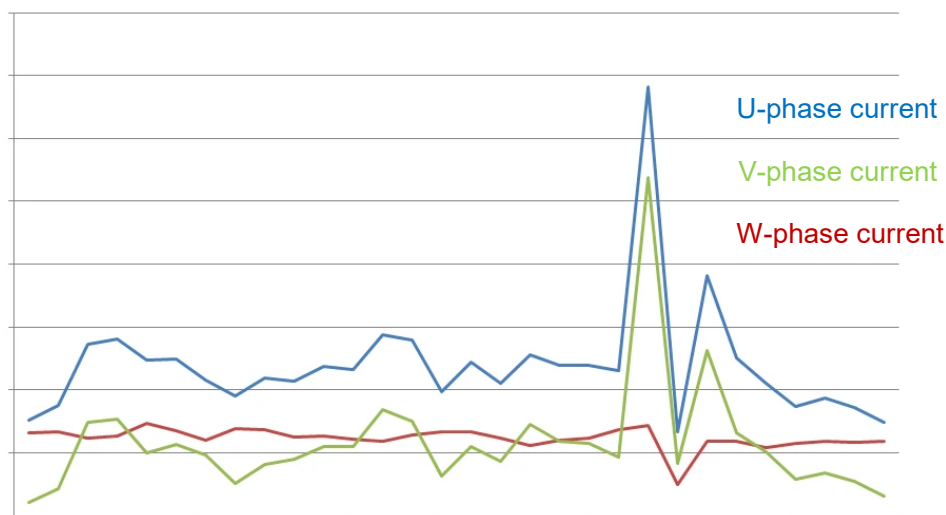


图 5- 2 数据回放图形界面

FIGURE 5-2 DATA PLAYBACK GRAPHICAL USER INTERFACE

5.3 测试用例 Test Cases

玄武支持基于 Python 的测试用例开发，同时提供了诊断服务的 Python API 接口，方便用户二次开发。

Xuanwu supports the development of test cases based on Python and provides a Python API interface for diagnostic services, facilitating secondary development by users.

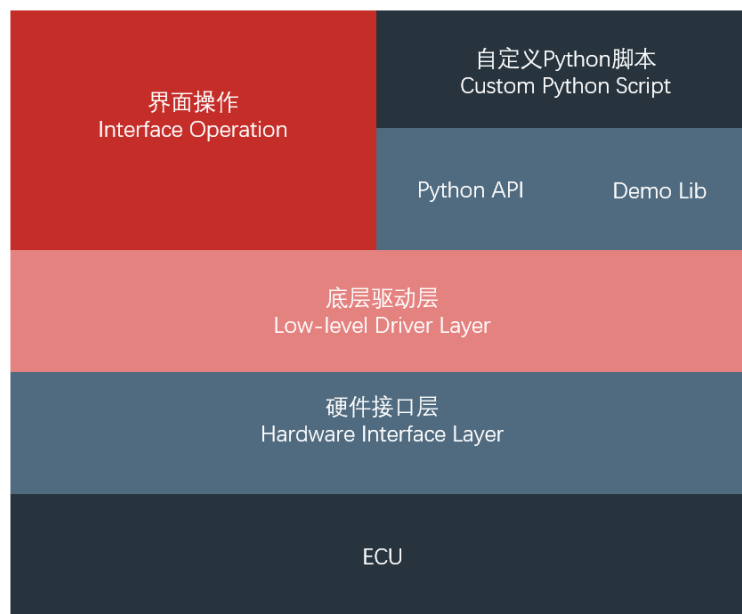


图 5- 3 PYTHON API 示意
FIGURE 5-3 PYTHON API ILLUSTRATION

根据黑匣子回放功能的需求，测试工程师编写了一套完整的测试用例，包括数据的存储、擦除、反复读写、压力测试等，通过玄武工具可实现自动化的测试。

Based on the requirements of the black box playback function, test engineers have written a complete set of test cases, including data storage, erasure, repeated read/write, stress testing, etc., which can be automated through the Xuanwu tool.

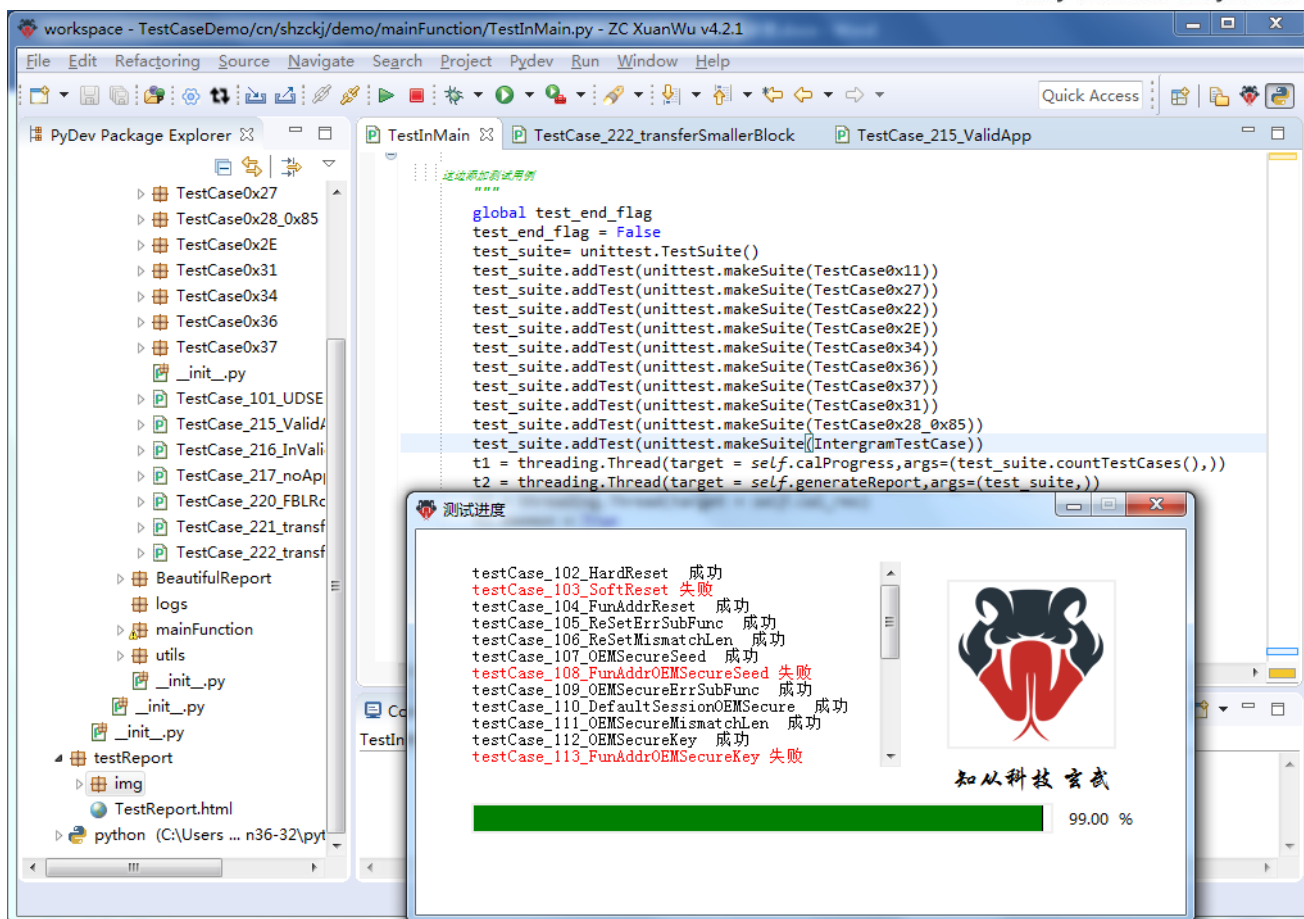


图 5- 4 自定义测试程序
FIGURE 5-4 CUSTOM TEST PROGRAM

5.4 测试报告 Test Report

针对测试结果，玄武工具可以自动生成测试报告。

In response to test results, the Xuanwu tool can automatically generate test reports.

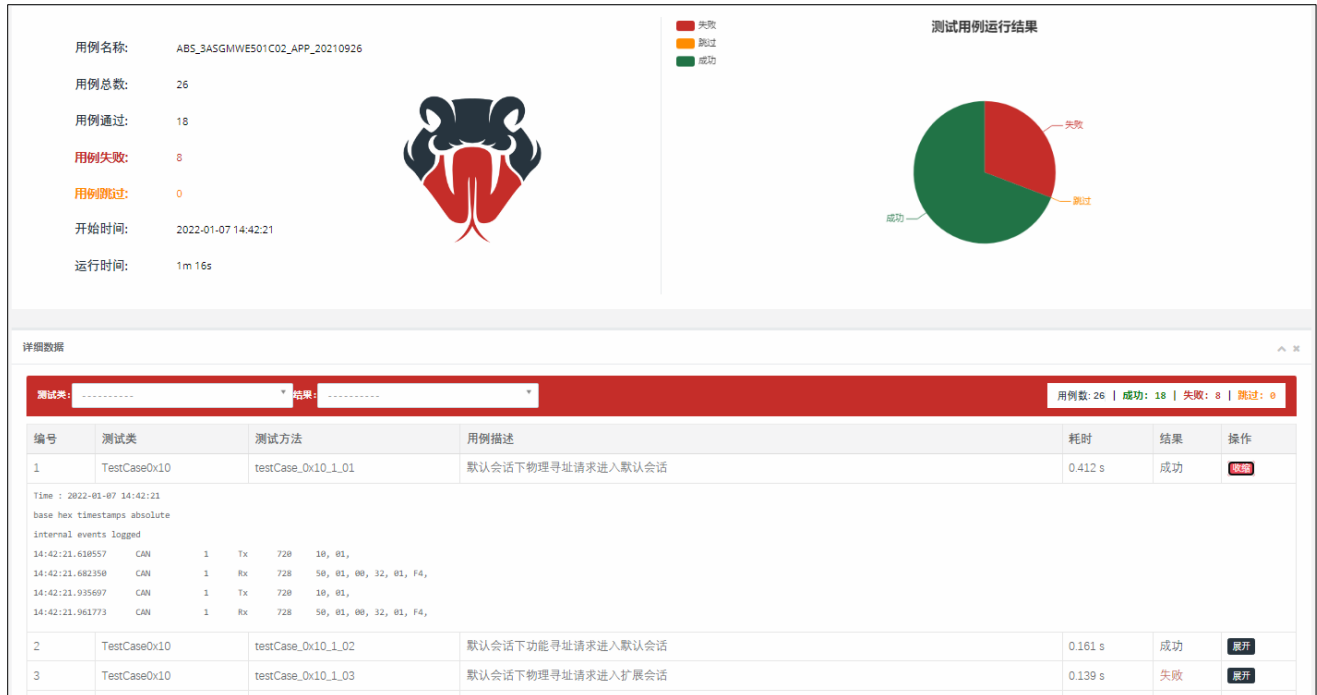


图 5- 5 测试报告
FIGURE 5-5 TEST REPORT

6 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3613614号	
软件名称：	知从玄武软件 [简称：玄武] V2.8
著作权人：	上海知从科技有限公司
开发完成日期：	2018年06月01日
首次发表日期：	2018年09月17日
权利取得方式：	原始取得
权利范围：	全部权利
登记号：	2019SR0192857
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成为全球领先的**汽车基础软件**公司
To Be the Global Leading **Automotive Basic Software** Company

