ITECH Applications in eFuse and Intelligent Fuse Box Testing

The development of automotive electrical and electronic systems has evolved from simplicity to complexity. Early vehicles were equipped with basic circuits for ignition and lighting. In the mid-20th century, with the rise of semiconductor technology, voltage regulators and transistor ignition systems were gradually adopted. After the 1980s, the microprocessor revolution drove the widespread use of electronic control units (ECUs), enabling the digital control of core components such as engines and transmissions. In the 21st century, the development of in-vehicle network architectures and intelligent sensors made distributed electronic systems possible, leading to the emergence of 48V mild hybrid systems and high-voltage electrical platforms. Currently, automotive electrical and electronic systems are evolving toward domain controller architectures, supporting advanced driver-assistance systems (ADAS) and connected vehicle functions. Their complexity has surpassed that of traditional mechanical systems, becoming the technological core of modern vehicles.

Fuses play a critical role in circuit protection. When an overload or short circuit occurs, the fuse quickly melts due to the abnormal increase in current, actively disconnecting the faulty circuit. This prevents overheating, fire hazards, and damage to electronic devices. This "sacrificial protection" not only avoids fire risks but also ensures the safety of essential electrical components, such as the ECU and lighting systems. Modern vehicle fuse boxes typically integrate dozens of fuses, grouped by

function for protection, and work in conjunction with intelligent distribution modules to form a multi-level circuit protection system.

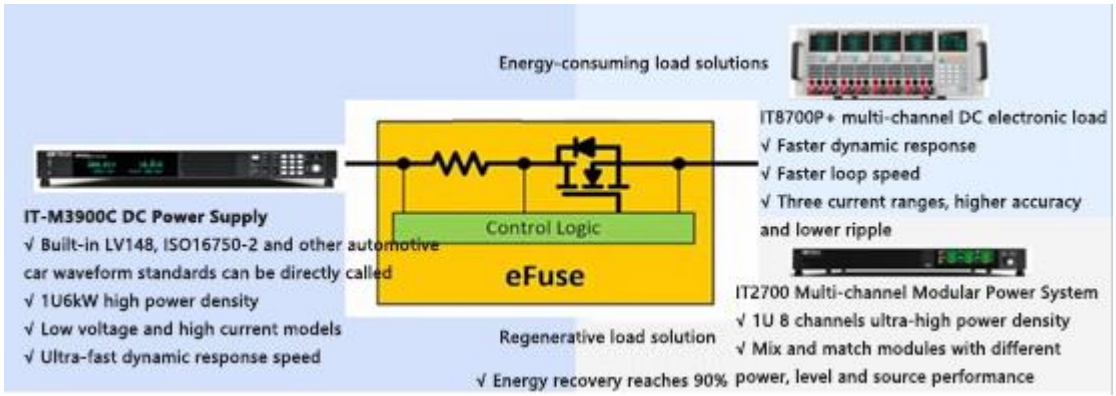
As electrical architectures become more complex, some high-end vehicles have adopted electronic fuses (eFuses). These fuses use integrated protection circuits to limit circuit current and voltage to safe levels in the event of a fault, enabling more precise overcurrent monitoring and remote diagnostic capabilities. The intelligent fuse box can not only monitor electrical parameters such as current and voltage in real-time but also communicate with the vehicle management system through a built-in communication module, allowing for remote monitoring and fault warning. Compared to traditional fuses, intelligent fuse boxes offer higher response speeds and precision, capable of disconnecting faulty circuits in microseconds, effectively enhancing vehicle safety. Their self-resetting function reduces the need for manual intervention, lowering maintenance costs. Additionally, the intelligent distribution functionality can meet the varying power supply needs of autonomous driving equipment. In the future, intelligent fuse boxes will evolve toward higher voltage capabilities, miniaturization, and further integration.

To ensure the performance of automotive electronic products, several testing items are required, such as:

- **Electrical Parameter Testing**: Measuring the rated current, rated voltage, and other specification parameters of the fuse.
- **Fuse Characteristics Testing**: Simulating actual fault conditions to test the fuse's melting time, breaking capacity, and other performance indicators.
- **Temperature Characteristics Testing**: Measuring the temperature rise of the fuse under different operating conditions.

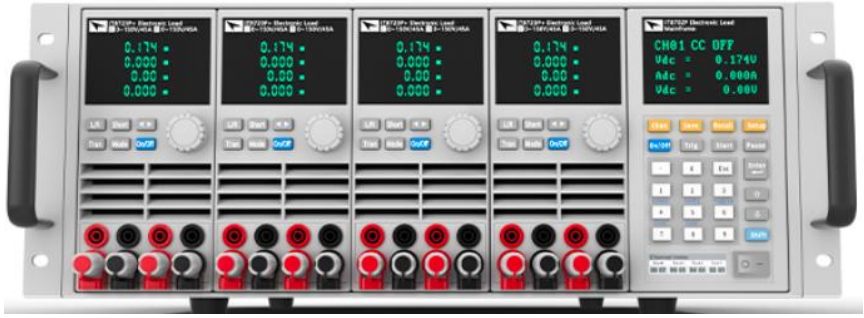
- **Durability Testing**: Simulating the characteristic changes after long-term usage.

These tests require the use of programmable DC power supplies and electronic loads to simulate different operating conditions. ITECH has extensive industry experience in fuse and automotive junction box products and offers high-speed, high-performance testing solutions for new integrated circuit products. These solutions cater to various stages, including research and development, production, and testing.



The IT2700 series Multi-channel Modular Power System offers ultra-high power density. The 1U chassis can accommodate up to eight 200W modules or four 500W modules. The modules can be bi-directional DC power supplies, unidirectional DC power supplies, or regenerative DC electronic loads. The modules support mixed configurations, synchronization, and can be connected in series

or parallel. Standard features include LAN, USB, CAN communication interfaces, digital I/O interfaces, and free PC software. The bi-directional power supply modules can simulate the charge and discharge characteristics of battery-powered systems, while the regenerative DC load modules have a feedback efficiency of up to 90%, making the testing process more energy-efficient. The IT2700 series significantly enhances the integration and flexibility of automotive electronics testing.



The IT8700P+ series high-speed multi-channel DC electronic loads offer eight operating modes and comprehensive protection features. The module can achieve a current rise rate of 12A/μs for a single module, and through master-slave parallel configuration, power and current rise speed can be expanded. The IT8700P+ module provides faster dynamic response, lower conduction resistance, making it ideal for low-voltage load testing. With faster loop speed, it can precisely control current without overshoot, improving testing efficiency. It features three current ranges, offering higher accuracy and lower ripple. The voltage and current measurement speed has been upgraded to 250kHz. With built-in LAN, USB, and RS232 interfaces, and supporting SCPI protocol, the IT8700P+ is well-suited for system integration.

The IT-M3900C bi-directional DC power supply is available in models with 32V/240A/6kW and 80V ratings, which are suitable for automotive electronics low-voltage parameters and meet the high current testing requirements of fuses. It comes with built-in automotive power network voltage

curves for standards such as LV123, LV148, DIN40839, ISO-16750-2, SAEJ1113-11, LV124, and ISO21848, making it easy to perform general testing of automotive electronic products.

The control system of a vehicle is based on electronic devices, and the reliability of automotive electronic products directly affects the safety and reliability of the entire vehicle. ITECH has extensive experience and products, providing mature, reliable, and professional automotive electronic testing solutions for various fields, including in-vehicle electronics, automotive wiring harnesses, automotive generators, high-voltage fuses, high-voltage connectors, in-vehicle controllers, DC motors/DC-DC converters, brushless DC motors, automotive lighting, and more. For more information, visit the ITECH official website: https://www.itechate.com.

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