Review on Automated Test Equipment for Maintenance Testing

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Abstract

This paper focus on the use of automated test equipment (ATE) for functional ground testing of avionics systems. Functional ground testing of air missile LRUs through automated test equipment is essential for ensuring the reliability and effectiveness of air missiles. ATE provides a reliable and efficient way of identifying any issues with LRUs before they are installed in the missile, reducing the risk of malfunction and increasing the missile's operational lifespan.

Keywords:

automatic test system, functional ground testing, line replaceable units

1. Introduction

Missile systems play a crucial role in modern warfare and are often considered the cornerstone of a nation's defence. Air missiles are complex systems that require precise and reliable components to function effectively. These complex systems require precise and reliable ground testing to ensure their proper functioning in the field. One essential aspect of missile system testing is the functional ground testing of line replaceable units (LRUs) which is a modular unit that can be quickly and easily replaced in case of malfunction.

Functional ground testing is a process that verifies the performance of an LRU while it is on the ground. This test is necessary to identify any issues with the unit before it is installed in the missile. It also helps to ensure that the LRU will operate correctly when called upon to do so.

Automated test equipment (ATE) is used in functional ground testing, reducing the risk of system failure due to faulty components. ATE is a computer-controlled system designed to perform tests automatically, eliminating human error and ensuring consistent results. ATE can perform a variety of tests, including electrical, functional, and environmental testing.

During the functional ground testing process, the LRU is first connected to the ATE. The ATE will then send a series of signals to the LRU, simulating various operational scenarios. The ATE will monitor the LRU's response, comparing it to expected results. If the LRU's response is outside the expected range, the ATE will flag the unit as faulty, and it will be removed from service.

The ATE system is equipped with various testing tools, such as power supplies, signal generators, oscilloscopes, and multimeters. These tools can be used to perform functional tests, power-up tests, and fault isolation tests.

2. Maintenance levels

An avionics system usually consists of one or multiple line-replaceable units (LRU) or line-replaceable modules (LRM). Each LRU or LRM contains a set of shop replaceable units (SRU) representing a printed circuit board assembly (PCB). The three levels of maintenance include: organizational maintenance (O-level), intermediate maintenance (I-level), and depot maintenance (D-level), based on the three-component level of avionics systems (LRU, SRU, irreparable element). O-level, I-level, D-level maintenance are terms used in military aviation to describe different levels of maintenance support. O-level maintenance includes daily checks, scheduled inspections, and minor repairs to ensure that the aircraft is airworthy and ready to fly. O-level maintenance is performed on the flight line or in hangars at the aircraft's operating base. I-level repair components that cannot be repaired at the O-level. I-level maintenance includes in-depth inspections, repairs, and replacement of components. At I-level, ATE automates most of the test procedures. D-level maintenance performs isolation of failure with depth to irreparable elements. The maintenance system may consist all three levels or comprise of the two if the only O- and I-levels or O- and D-levels are applicable.

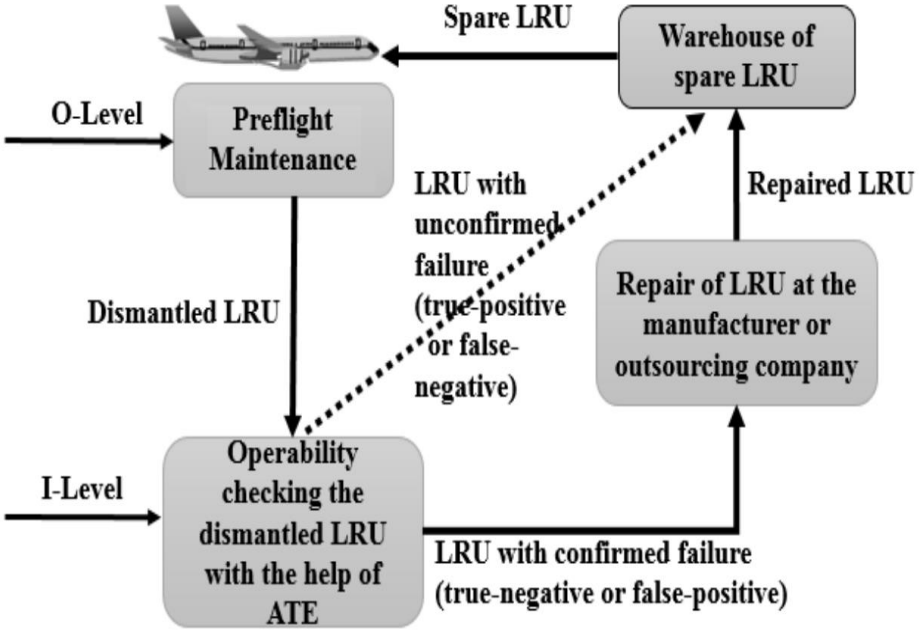

Figure 1. Diagram of LRU circulation for two-level maintenance option consisting O-level and I-level

3. System architecture

ATE systems typically consist of several components working together to test a device or system. Here are the main components of an ATE system architecture:

3.1 Test head: The test head is the component that interfaces with the device or system being tested. It contains the necessary connections, probes, and sensors required to communicate with the device and perform the necessary tests. The test head can be customized to fit specific device requirements, and multiple test heads can be used in a single ATE system.

3.2 Test Instrumentation: The test instrumentation is the equipment that generates and measures the signals required to perform the necessary tests. The test instrumentation can include digital multimeters, oscilloscopes, function generators, power supplies, and other specialized equipment.

3.3 Test Fixture: The test fixture is the physical structure that holds the device or system being tested and the test head. It ensures that the device is securely mounted and that the test head is properly aligned with the device's connections and sensors. The test fixture can be designed to fit specific device requirements, and multiple test fixtures can be used in a single ATE system.

3.4 Interface bus: The interface bus is the communication channel that connects the test head, test instrumentation, and test fixture to the test executive. The interface bus can use different protocols, such as GPIB, PXI, or Ethernet, to transfer data and commands between the components.

ATE systems can be customized to fit specific testing requirements and can support different programming languages and communication protocols.

Figure 2. Diagram of System Architecture

4. Benefits

Functional ground testing (FGT) is a critical step in the development and testing of complex systems like missiles. Functional ground testing of LRUs using ATE provides several benefits. Firstly, it improves the reliability of air missiles by identifying any issues with LRUs before they are installed in the missile. Secondly, it reduces the risk of human error by using automated testing, which leads to more consistent results. Finally, it saves time and money by identifying faulty LRUs before they cause problems in the missile, reducing the need for expensive repairs or replacements.

Functional ground testing can be performed on various LRUs, such as guidance and control systems, telemetry systems, etc. It involves testing the various components and subsystems of the system to ensure that they function as intended and can work together effectively. FGT is typically conducted before flight testing to identify and address any issues or problems that could potentially cause the system to fail during flight.

In the case of the Tomahawk missile, FGT was a critical component of the development and testing process. The Tomahawk is a highly complex system with a wide range of subsystems and components that must work together flawlessly in order for the missile to function properly. FGT helped to ensure that each of these subsystems and components was working as intended, and that they could work together effectively to achieve the missile's mission objectives.

5. Conclusion

In conclusion, functional ground testing of LRUs through ATE is a crucial process in ensuring the reliability and safety of missile systems. It allows for the identification of potential faults before the LRUs are integrated into the system, reducing the risk of failure during operation. The use of ATE can increase testing efficiency and reduce costs, making it a valuable tool in modern warfare.

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