Design and Implementation of a Weapon System Detector for Air-to-ground Missile

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Abstract. Based on the theories of modular design, single-chip microcomputer system and ARINC429 bus communication technology, a feasible design scheme of a detector circuit is put forward. The design we proposed can meet the urgent demand of testing and maintaining new military equipment for the forces. The proposed detector we have designed can meet all the technical requirements of certain air-to-ground missile installed on certain aircraft. The detector is portable and convenient to be operated. The detector can test in-flight fire control system, the launcher and the whole air-to-ground missile system. The design scheme has some reference value to other detectors of air-to-ground missile system.

1. Introduction
It is vital for individuals in-charge of maintenance to check whether detection equipment of a weapon system is functioning well, easy to carry and easy to operate. The proposed detector we have designed is a small box-shaped device, equipped with different interface and connection cables. To select a weapon subsystem of the tested air-to-ground missile weapon system, one can choose a function switch on the panel. The detector can simulate the data exchange between the air-to-ground missile and the launcher; the data exchange between the launcher and the onboard weapon fire control system, and the data exchange among the aircraft, its launcher and air-to-ground missile.

2. Application, Composition and Main Functions

2.1. Use
The detector can off-position independently detect three kinds of air-to-ground missile launchers of a certain type of aircraft; can independently detect the fire control system of air-to-ground missile on board; and can detect online the whole weapon system of air-to-ground missile on board.

2.2. Composition
The detector is mainly composed of a single-chip microcomputer system, photoelectric isolation module, input/output module, detection status setting, ARINC429 communication module, RS422 communication module, dedicated test cable, result display, power conversion module, software system and the case.

2.3. Main function
(1) self-detection;
(2) independently off-position detect three kinds of launchers of the two types of aircraft;
(3) simultaneously detect the input/output status of four missile position signals of a launcher;
(4) detect the communication status of ARINC429 between the weapon fire control system and the launcher;
(5) detect the RS422 communication status between the launcher and the air-to-ground missile;
(6) detect the electronic unit channel of the launcher;
(7) detect the concerned fire control equipment related to on-board air-to-ground missile;
(8) online whole-system detection of air-to-ground missile weapon system;
(9) quickly locate the channel failure.

3. Detector Panel Design
The selection of the detected subsystem is mainly controlled by the mode switch on the detector panel. The detector panel is mainly installed with a socket of fire control system, four missile position sockets (M1, M2, M3 and M4), missile type selection switches, selected missile position change-over switches, working mode change-over switches, working status display indicators and other parts.

The DC voltages of +5V and ±15V used in the detector system are obtained by the DC/DC conversion of the +28V DC power supply output by the internal rechargeable battery of the detector or the weapon fire control system.

The panel diagram of the detector is shown in figure 1.

Parts on the detector panel are divided into three areas: upper area, middle area and lower area.

There are 5 cable sockets in the upper area, namely a fire control system socket and 4 missile position sockets (M1, M2, M3 and M4). There are 5 transfer switches in the middle area, and the lower area is the display area of the detection status.
4. Circuit Composition and Design

4.1. Circuit Composition
Detector circuit is mainly composed of a single-chip microcomputer control system, bus interface dedicated chips, decoding control circuits, etc.

See figure 2 Circuit composition diagram of the detector of air-to-ground missile system.
When the launcher is tested independently, the socket of the fire control system on the detector panel is connected to the signal input/output socket of the launcher’s fire control system through the detection cable. The detector will simulate the fire control system of air-to-ground missile system on board, and send/receive ARINC429 data and signals to/from the launcher. The missile sockets on the launcher are connected to the corresponding air-to-ground missile sockets on the panel of the detector through No.1 detection cable. The detector will simulate air-to-ground missile and launcher to receive/send RS422 bus data and signals.

The connection diagram between the detector and the on-board fire control system or launcher is shown in figure 3.

When using out-of-position test method to detect the launcher, detector, air-to-ground missile and launchers constitute a closed loop path (see the right part in figure 3). In this kind of status, the detector simulates fire control system on the aircraft to send/receive launcher’s ARINC429 bus data and other signals. In the meantime the detector simulates air-to-ground missile to receive/send RS422 bus data and other signal from/to the launcher. During the process, indicators on the display panel of the detector show the testing results of the launcher.
4.2. Circuit Design

The circuit schematic diagram of the detector mainly consists of a single-chip microcomputer circuit (T1), ARINC429 (T2-T4) and RS422 (T5) bus input/output circuit, decoding circuit, detection result output control circuit, signal input control circuit, etc. The total circuit diagram is omitted.

ARINC429 bus data transmission needs dedicated communication processing chip to receive and send signals.

The ARINC429 bus data transmission control circuit diagram is shown in figure 4.

Figure 4. ARINC429 bus data transmission control circuit diagram

RS422 bus communication circuit connection is shown in T1 and T5; RS422 bus communication is realized through serial port in the single-chip microcomputer and dedicated conversion chip on the RS422 bus communication.
RS422 bus communication circuit diagram is shown in figure 5.

Figure 5. RS422 bus communication circuit diagram

5. Conclusion
The design scheme we put forward is feasible. The proposed detector we have designed is small in size and portable. The detector is convenient for operation. The design we proposed can meet the urgent demand of testing and maintaining of the whole or a single device of certain air-to-ground missile weapon system for the forces. The circuit scheme of the detector may have some reference value for the design of similar equipment of other models.

6. References
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