Defence Science Journal, Vol 47, No 2, April 1997, pp 207-210.

SHORT COMMUNICATION

Automatic Checkout System for Ground Electronics of a Weapon System

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ABSTRACT

An automatic checkout system (ACOS) designed and developed for a surface-to-air missile system is described. The system has a built-in self-check and has been extensively used for checking faults in the subsystems of ground electronics. It has resulted in saving a lot of effort in quickly diagnosing and rectifying faults. The salient features of the ACOS have been described and the scope for further work in this area has been outlined.

1. INTRODUCTION

The missile project of the Defence Research & Development Organisation aims at the development of a short-range, quick-reaction surface-to-air missile system using a command to line of sight (CLOS) guidance scheme. The system consists of a launcher, the missile and the ground electronics. The system is being developed for all the three Services. The need for an automatic checkout system for ground electronics for offline subsystem level checkout was felt by the project team and Defence Electronics Research Laboratory (DLRL), Hyderabad, accepted the responsibility for developing the same. The time required for functional diagnosis of the subsystems with the ACOS has to be minimum, say, a few minutes.

The ACOS has been designed, developed, tested and integrated with the other subsystems. It has been extensively used for checking the subsystems of the weapon system for their readiness for preflight link checks. The test results have given tremendous confidence about the performance of the subsystems under test.

The ACOS is the first full-fledged checkout system of its kind in DLRL. It generates all the required test inputs to the subsystems, receives the responses from them and validates the responses for its correctness. All the subsystems can be checked in about 8 min. The ACOS eliminates the need for an elaborate test set-up required otherwise to test the subsystems.

2. THE GROUND ELECTRONICS

The ground electronics consist of subsystems for tracking the target and locating and directing the missile along the line of sight. The ACOS checks the following subsystems of ground electronics: phase sensitive detector (PSD), command generation system (CGS), digital range tracking system (DRTS), command encoder/decoder and impact point predictor (IPP). The subsystems are based on analog, digital and microprocessor-based hardware.

The PSD extracts the angular deviation of the missile with respect to the line of sight. The DRTS tracks the missile in range. Based on the angular deviation and range, the CGS computes the correction commands to be applied to the missile. The command encoder ensures coding of

Received 21 May 1996, revised 17 January 1997

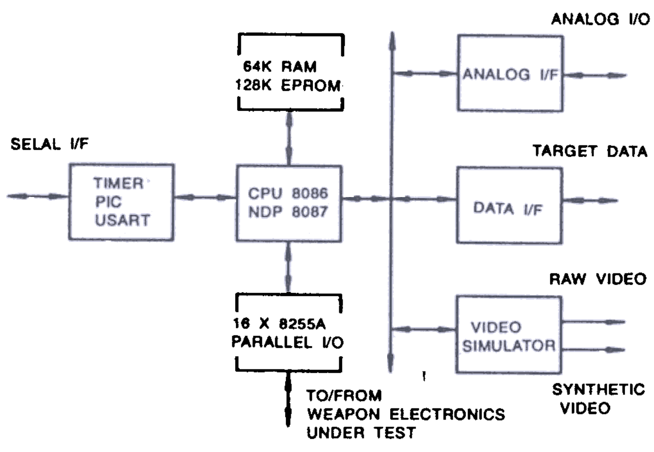

Figure 1. Block diagram of ACOS

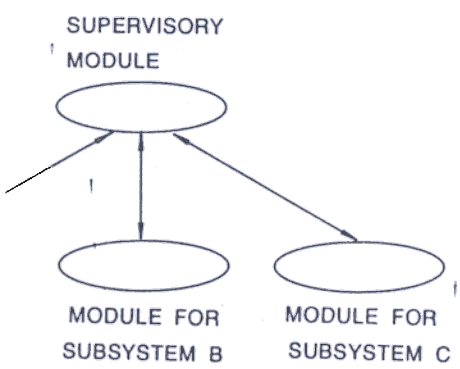

Figure 2. Modular structure of software

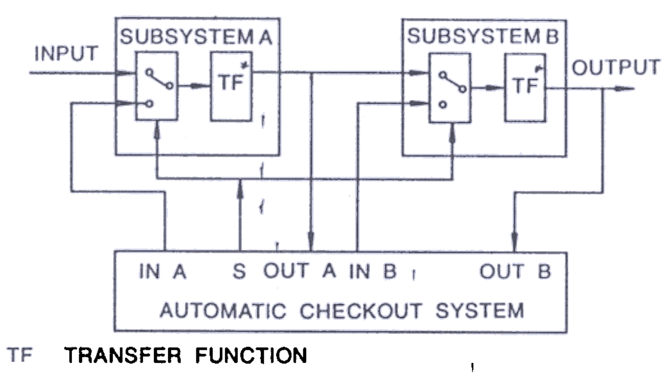

Figure 3. Role of switching elements

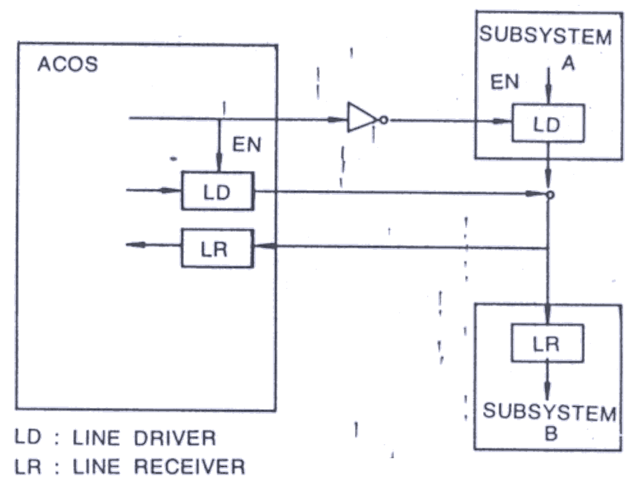

Figure 4. Party line configuration for digital signals

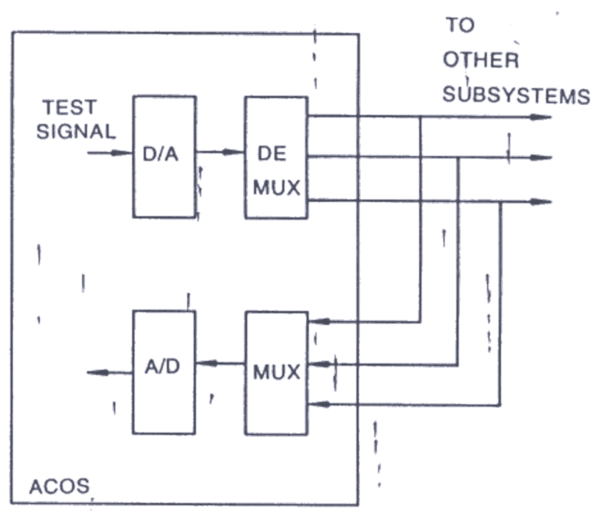

Figure 5. Analog signal loop check

commands. The IPP serves as the launch computer and decides the launch event.

3. THE ACOS SYSTEM

ACOS hardware is microcomputer-based with necessary numeric processor, I/O ports, D/As, A/Ds and special circuits. The block diagram is given in Fig. 1. The microprocessor used is Intel 8086 along with coprocessor 8087. The ACOS system uses 128K EPROM and 64K RAM. The parallel I/O required is of the order of a few hundred I/O channels. Programmable peripheral chips (Intel 8255A) have been used to meet this requirement of I/O. A programmable counter/timer (8253), a programmable interrupt controller (8259) and an USART (8251) have been employed in the system. The analog interface consists of two analog output channels (2 x 12-bit D/As), one analog input channel (12-bit A/D), analog multiplexer and analog demultiplexer. Special circuits have been included to generate raw video.

The software for the ACOS has been designed using a modular structure (Fig. 2). For each subsystem, a module has been developed that executes the test methodology. A supervisory module controls and activates modules as per operator's instructions. The software has been developed using high level language and assembly language. User-friendly menus are provided by all the modules.

In each subsystem, in the case of analog signals, switching elements have been provided, as indicated in Fig. 3. Relays and analog multiplexers are employed to select actual analog signals and test analog signals from the ACOS. For digital signals, party line configuration is used as given in Fig. 4. Subsystem B gets differential digital input signal from subsystem A through a line driver. The test signal to B from the ACOS is also applied to the same line receiver. The complementary enable signals ensure that only one line driver is active at a time. Also, A's output is received by the ACOS.

Being a checkout system for a complex and mission critical weapon electronics system, the ACOS should be able to validate itself. A fault in the ACOS should not go undetected. Otherwise, a false alarm may be generated declaring the subsystem under test as faulty. Analog test signals from the ACOS are looped back and checked for their proper generation, as shown in Fig. 5. Due to the advantage of using the party line configuration, there exists a loop between digital output test signals and digital input test signals. This loop is efficiently used for digital I/O hardware checking.

One of the design objectives of the ACOS is that there should be minimal hardware changes in the subsystems under test. As seen from Figs 3 and 4, except for switching elements and enabling of line drivers, no other hardware changes are required in the subsystems.

4. SALIENT FEATURES

(a) The ACOS provides fast and exhaustive diagnosis of faults.

(b) The system is configured as an integral part of the weapons electronic system. This reduces the set-up time required for initiating diagnosis.

(c) The ACOS is a part of all three versions, viz., Army, Airforce and Naval versions of the missile system.

(d) The ACOS can be used in the development, operational and maintenance phases of the missile system.

(e) The ACOS has been configured in such a way that minimal hardware changes are required in the subsystems under test.

(f) The ACOS has built-in self-test. The support software helps in guided troubleshooting of other subsystems in case of fault.

5. SCOPE FOR FURTHER WORK

The job of ACOS is not over with the detection of faults. It can also aid in the correction of faults. This involves generation of repetitive inputs for the subsystems during troubleshooting. By tapping different intermediate signals from the subsystems under test, the location of faults at card/component level is achievable. Also, the ACOS can be used as a recording system during the mission. Its use can be extended to check the system by way of hardware-in loop simulation.

6. CONCLUSIONS

The design features, system and functional description, test methodology and scope for further work of the ACOS designed and developed for ground electronics of the missile system have been detailed in this paper. Inherent advantages of automatic checking increase the confidence of the system in actual field.

ACKNOWLEDGEMENTS

The author expresses his thanks to Dr K.K. Srivastava, Director, DLRL, for giving permission to communicate this paper and other colleagues for their valuable suggestions. The ACOS has been developed by the team consisting of Mr G.P. Seshasai, Mrs V. Sobha Shankar, Mr N. Srinivas Rao, Mr. D. Raghu Ram, Mrs Uma Ramachandran and the author himself.

Contributor

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