Investigation of Intermittent Failure in Electrical Interconnections of Avionics System

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Research Objective

- The intermittent failure is one of the causes of no-fault-found(NFF).
- According to Korea Air Force report , more than 50% of the avionics failure events of fighters are classified as NFF.
- In this study, Intermittent failure in electrical interconnections is investigated on the interconnections of avionics system.

State of Research

- The interconnections of avionics are analyzed.
- A test model is constructed that mimics the system.
- Intermittent failures are generated in thermal cycling test.
- To detect intermittent failure during the test, latching continuity tester is made.
- Failure analysis reveals the internal crack on the flexible printed circuit board (FPCB).

Expected Contributions

- Modular Low Power Radio Frequency (MLPRF) is analyzed.
- The interconnection types of the MLPRF chassis were studied and categorized into four parts.
- The four types of the interconnections are modeled proportionally to the number of the MLPRF chassis.
- Latching continuity tester was designed and made by having 100 ns of response time.
- Vibration and thermal cycling tests are conducted to generate intermittent failures.
- As a result of the analysis, the crack generation mechanism can be explained by the mismatch of coefficient of thermal expansion (CTE).

Next Steps

- We will measure the intermittent failure in different interconnections, such as D-SUB connector, and crack solder.
- We will perform analysis of failure mechanism in FPCB and different interconnections.
- Further test and analysis are expected to improve the reliability of the fighters by study on the causes and improvements of the failure mechanism in the airplane.

Research Details

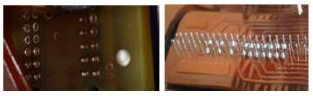
Avionics system

- Modular Low Power Radio Frequency (MLPRF) is an avionic module for the long-range pulse-doppler radar of F-16 Fighting Falcon.

Chassis of LRU MLPRF of F-16; back view.

Mockup model

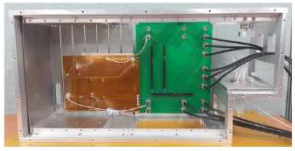
- The interconnection type of the MLPRF chassis were categorized into four parts
- The four types of the interconnections are modeled proportionally to the number of the MLPRF chassis.



(a) (b)

(c) (d)

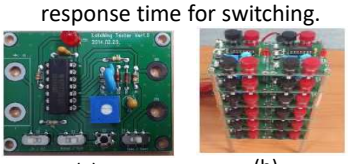
Classification of the types of the MLPRF chassis; (a) Pin to PCB, (b) Pin to FPCB, (c) FPCB to FPCB, and (d) Pin to Wire.



Mockup model of the MLPRF chassis

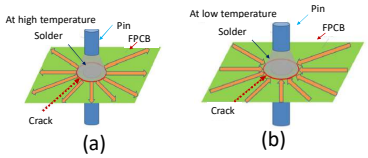
Latching continuity tester

- Latching continuity tester was made with a NAND Schmitt trigger having 100 ns of response time for switching.



(a) (b)

Latching continuity tester (a) circuit layout and (b) assembly



(a) (b)

Schematic illustration of the fatigue load generation at the boundary of Pin to FPCB at (a) high and (b) low temperature

Generation and detection of intermittent failure

- Vibration and thermal cycling tests are conducted to generate intermittent failures
- During the thermal cycling test, all the connected interconnections were monitored in real-time using tester.

Analysis of intermittent failure

- The crack generation mechanism can be explained by the mismatch of coefficient of thermal expansion (CTE) between FPCB and solder.
- At cold temperature the FPCB continues to shrink and the solder prevents it while at hot temperature the FPCB gets expanding and the solder tries to retain it as illustrated.

Acknowledgments

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