A study on the Vibration and Impact Behavior of a Small Printed Circuit Board

In Jun Jung, Jae Young Jang, Kwang Soo Jung, Dong-Kil Shin*

[1]School of Mechanical Engineering, Yeungnam University, R. of Korea (South)

*Corresponding author: dkshin@yu.ac.kr

1. Introduction

Small electronic components for handheld products and next generation automotive application need high level drop reliability and vibration reliability [1]. Electronic packages on a printed circuit board (PCB) need to endure the impact load. In general, solder balls and copper pads are the weakest locations under the drop test. Solder ball absorbs impact energy. Copper pad should be of the shape and type that can survive during the test [2, 3].

Solid state drive has various configurations depending on their applications. Next generation form factor, commonly known as M.2 form factor, is widely used for ultrabooks or tablet computers. Slender shape of the PCB weakens the reliability under the drop test because large deflection is induced in the transversal direction. In order to evaluate the drop reliability, the effect of inertia force and the stress concentration at the crack are very important [4]. In addition, the deflection behavior of the PCB is strongly dependent on the vibration characteristic of the PCB [5,6].

In this study, the impact and vibration behavior of a PCB for M.2 module was investigated.

2. Impact behavior of a PCB

Fig. 1 shows a small PCB considered in this study. The size of specimen was110 mm × 22 mm × 0.9 mm.

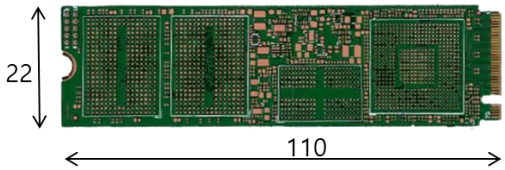


Fig. 1 Printed circuit board

Drop behavior was evaluated by a drop tester. Note that the shock levels are defined in the JEDEC standards [7, 8]. Acceleration, strain, and bending deflection were measured by accelerometer, strain gage, and gap sensor, respectively. Fig. 2 shows a schematic of the experimental setup for drop test.

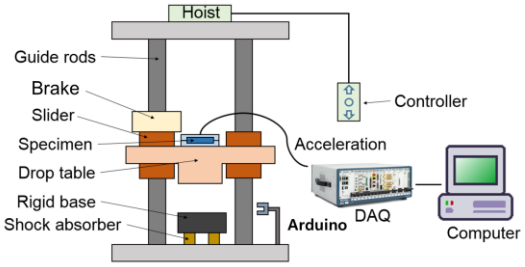


Fig. 2 Schematic of a drop tester

Fig.3 shows typical results of the acceleration at the center of the board. As shown in this figure, applied acceleration in the drop table is 1500 G / 0.5 msec. The peak acceleration at the board is about 3500 G and shows fluctuation period about 1.7 msec.

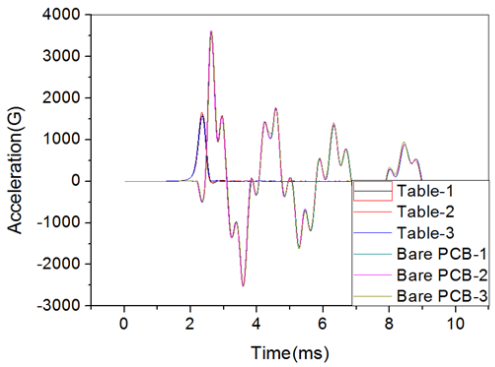
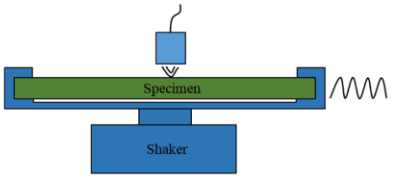


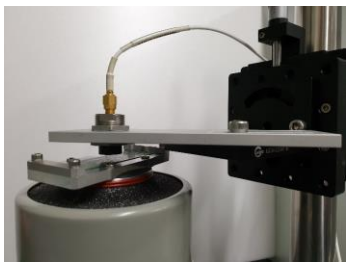
Fig.3 Acceleration at the drop table and at the center of the PCB

3. Vibration behavior of a PCB

Vibrational behavior was measured by a vibration measurement system as shown in Fig. 4. A shaker excites the specimen with random block excitation. Deflection was measured by a gap sensor.



(a)



(b)
Fig.4 Vibration measurement system

Fig. 5 shows a measured power spectrum density of the PCB. It shows that the first natural frequency appears at about 431.9 Hz.

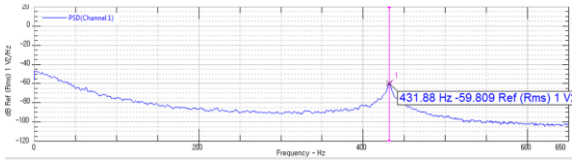


Fig.5 Power spectrum density of a PCB

4. Summary

Drop behavior and vibration behavior of a small PCB were evaluated. Accelaration, deflection and strain were measured and natural frequencies were measured.

Acknowledgment

This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2018R1D1A1A09083672).

References

[1] J. Handy et al.,"SNIA Webcast: All about M.2 SSDs" SNIA, 2015. D.A. Shnawah, M.F.M. Sabri, and I.A. Badruddin, “A review on thermal cycling and drop impact reliability of SAC solder joint in portable electronic products”, Microelectronics reliability, (2012)
[2] T.M. Kang et al., “A study on the correlation between experiment and simulation board level drop test for SSD”, 18th International Conference on Thermal, Mechanical and Multi-Physics Simulation and Experiments in Microelectronics and Microsystems, (2017)
[3] L.B. Freund, “Dynamic fracture mechanics”, Cambridge University Press, Cambridge, (1990)
[4] D.S. Steinberg, “Vibration analysis for electronic equipment”, John Wiley & Sons, Inc, New York, 19880
[5] D. K. Shin et al., “Development of multi stack package with high drop reliability by experimental and numerical methods”, Proc 56th ECTC Conf., San Diego, (2006)
[6] E. Suhir, "Could shock test adeqeately mimic drop test conditions," Proc 52th ECTC Conf., (2002)
[7] JEDEC Standard JESD22-B104C, Mechanical shock
[8] JEDEC Standard JESD22-B111, Board level drop test method of components for handheld electronic products