STRUCTURAL DESIGN OF ELECTRONIC PACKAGE FOR AN AIR BORNE VEHICLE AGAINST RANDOM VIBRATION ENVIRONMENT

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ABSTRACT: **Electronic packages play vital role in any air borne vehicle. During their course of application these packages will be subjected to harsh environments like vibration against which their safe functioning needs to be ensured which otherwise results into catastrophic failure of the air borne vehicle. A typical electronic package consists of a Mechanical housing in which set of Printed Circuit Boards (PCBs) will be mounted. Critical electronic components like ICs will be in turn mounted on these PCBs. These components will be sensitive against vibration. During qualification testing of one such electronic package in random vibration environment failure of electronic components is noticed.The primary objective of this paper is to design a new packaging configuration which results in to vibration levels lesser than the allowable limits of the electronic components. In the paper mechanical housing is first designed and then the inter connecting scheme for housing and PCBs is designed. Random vibration response analysis is carried out using Finite Element Method (FEM) with the help of commercial software package i.e. NX IDEAS. Design is fine tuned in order to ascertain that with the designed packaging configuration, vibration levels are within the acceptable limits**.

Key words: PCB, Random vibrations, Gravity frequencies

I.INTRODUCTION

Supporting structures will be used as an interface for mounting subsystems in aerospace vehicles. Dynamic loads like vibration originated from the external sources like aerodynamic pressure will first act on the aerospace vehicle. This will transmit to the subsystem through the interface supporting structure. Subsystems are supposed to deliver the intended functions safely without getting influenced by vibration. If the influence of vibration on subsystems is high there are three ways to reduce the effect of vibration. First one is reducing the vibration at the source which is practically not possible. Second one is attempting on the subsystem which is also not possible as the design of the subsystem will be frozen. Only possible way is to modify the path i.e. interface supporting structure. The structural design of the supporting structure is to be fine tuned such a way that the amplification in vibration between the supporting structure and the subsystem is to be minimized. For doing so first the vibration response for the present configuration will be estimated using Finite Element Method (FEM). From the response spectrum we will come to know how much response has come against specified input near critical component on Printed Circuit Board (PCB). 30 G is the qualification limit for most of Electronic component on PCB. If the vibration response level near critical component is more than 30 G limits then its electronic component can malfunction and mechanically lead pin can also break so in order to ensure proper functionality of the component and package we have to reduce the vibration level below 30 G. One package of an aerospace vehicle is taken up in this project. The above said approach will be adopted for reducing the vibration in the supporting structure. Commercial FEM software package IDEAS will be used for executing this project

II.CONFIGURATIONDETAILS ELECTRONIC PACKAGE

Supporting structure is nothing but a rectangular plate of size..Supporting structure is made of aluminium. Supporting structure is having eight holes of diameter 5 mm with which it will be fitted to the aerospace vehicle. Subsystem which is mounted on the plate as shown in diagram. Weight of the subsystem is considered to be 3 Kg. Supporting structure with subsystem mounted on it is shown in Figure 2.0.

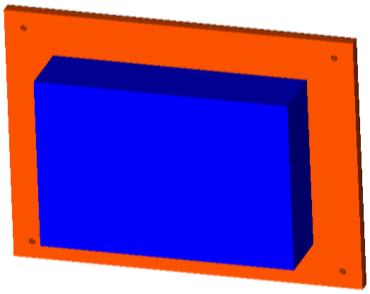
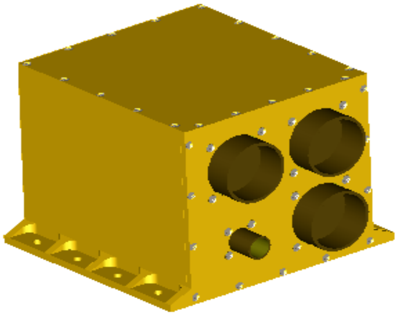


Figure 1. supporting structure with mounted subsystem.



III. ANALYSIS OF ELECTRONIC PACKAGE-PRE ANALYZED CONFIGURATION

Random vibration response analysis is carried out using Finite Element Method (FEM).

A) FE Molding

For building a mathematical model of the package, all the subsystems are modeled separately and then assembled. All the subsystems are discredited using linear 4-nodded quadrilateral shell elements having six DOF per node, except DC-DC unit and EMI/EMC filters which are modeled as lumped mass elements. The thicknesses of individual plate like members of the structure are keyed in as physical properties to the FE model. FE model of chassis and properties of aluminum which has been considered for chassis

After meshing each part of CAD model final assembly is made of all meshed Part and all connection between Printed Circuit Board (PCB) to Printed Circuit Board (PCB) and PCB to chassis is given by Beam Element. FE model of the package is shown in fig.

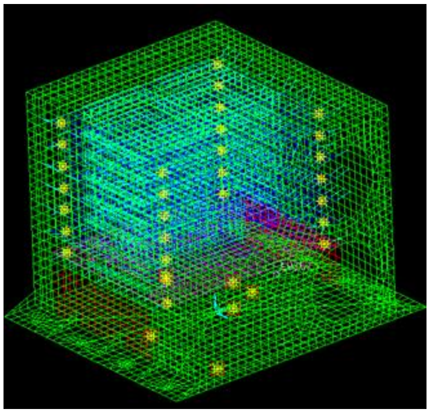


Figure 2 FE model of the package

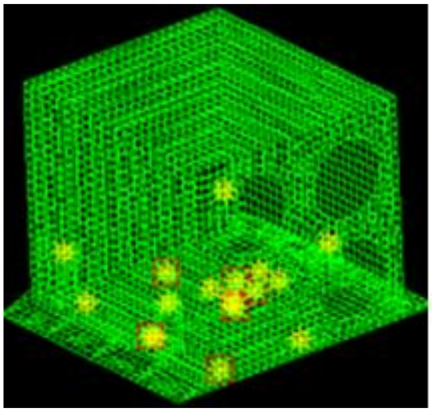


Figure 3 FE model of the package

B) Random vibration response analysis

The objective of random vibration response analysis is to obtain the acceleration response of the package. Against a specified random vibration input. The input spectrum is applied as base excitation in a direction normal to the base plate.

Maximum response obtained near BMC on top PCB in axial direction (Normal to the base plate) along with input is shown in Figure 3. Response location is also shown below.

Maximum Response near BMC on top PCB: 45grms

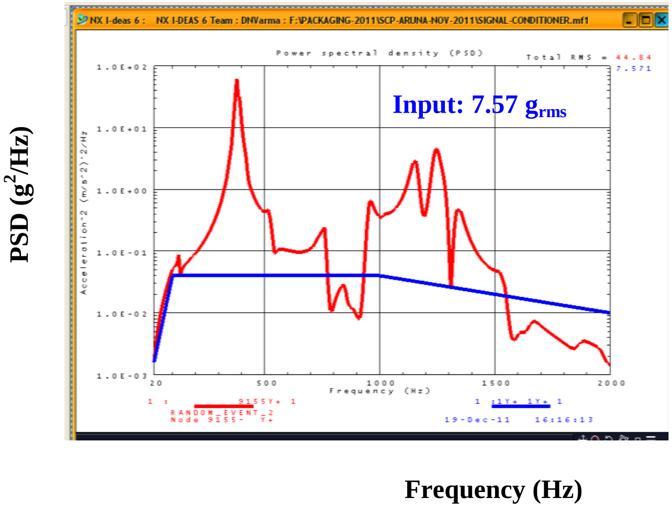


Figure 4 Input and response spectrum (Top PCB) – Axial direction

Maximum response obtained near BMC on top PCB in lateral direction along with input is shown in Figure 4. Response location is also shown below.

Maximum Response near BMC on top PCB: 60 g_{rms}

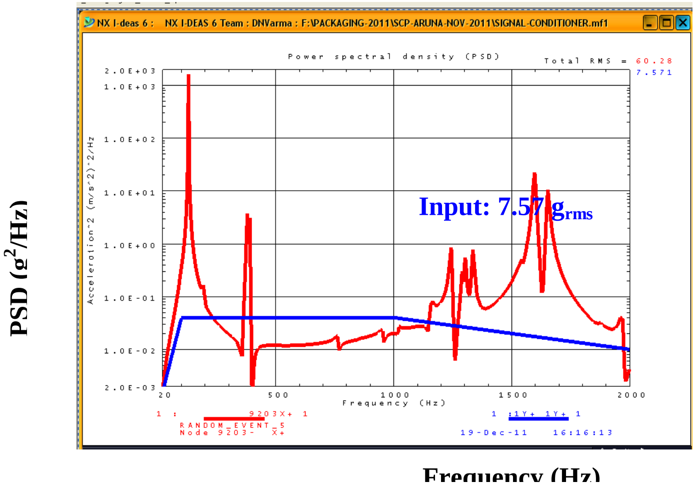


Figure 5 Input and response spectrum (Top PCB) – Lateral direction.s

OBSERVATIONS

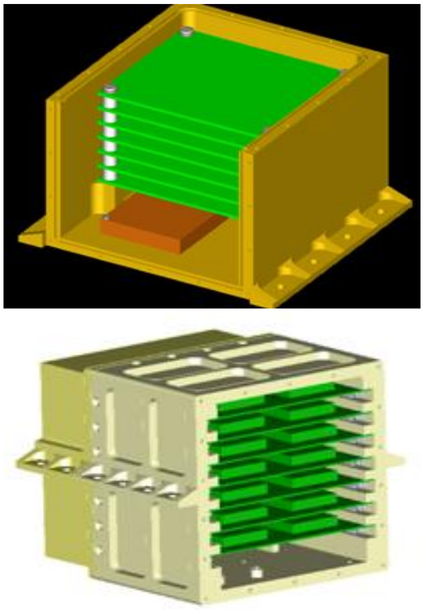
- The maximum vibration response obtained near BMC on top PCB in axial direction is 45 g_{rms}.
- Whereas maximum vibration response observed near BMC on top PCB in lateral direction is 60 g_{rms}.

IV.ANALYSIS OF PACKAGE – WITH SUGGESTED MODIFICATIONS

As the maximum vibration responses observed in pre analyzed configuration are higher, the following modifications are carried out in the design of Signal Conditioning Package with a view to reduce the responses.

Package is mounted on to the airframe through lugs provided in the C.G. plane rather than in the base plane (As it is in pre analyzed configuration).

PCBs are mounted in the chassis using wedge guides rather than mounting in stacked configuration (As it is in pre analyzed configuration).



Pre Analyzed Configuration in Figure 6.

Random vibration response analysis is carried out for the package by considering these modifications. The maximum response obtained near BMC on top PCB in axial direction is compared with that of pre analyzed configuration in Figure.

Maximum Response near BMC on Top PCB: 45grms axial

Maximum Response near BMC on top PCB: 29 g_{rms}

(With suggested modification)

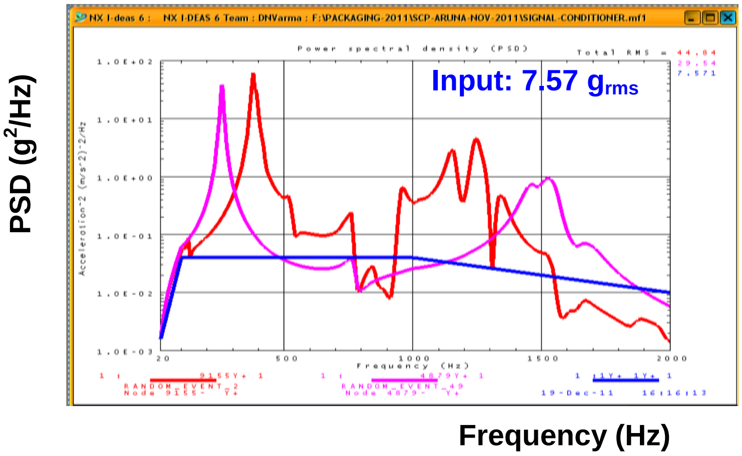


Figure 7 Comparison of response spectra (TOP PCB) – Axial direction

Random vibration response analysis is carried out for the package by considering these modifications. The maximum response obtained near BMC on top PCB in lateral direction is compared with that of pre analyzed configuration in Figure.

Maximum Response near BMC on top PCB: 60 g_{rm} lateral

Maximum Response near BMC on top PCB: 7.6 g_{rms}

(With suggested modification)

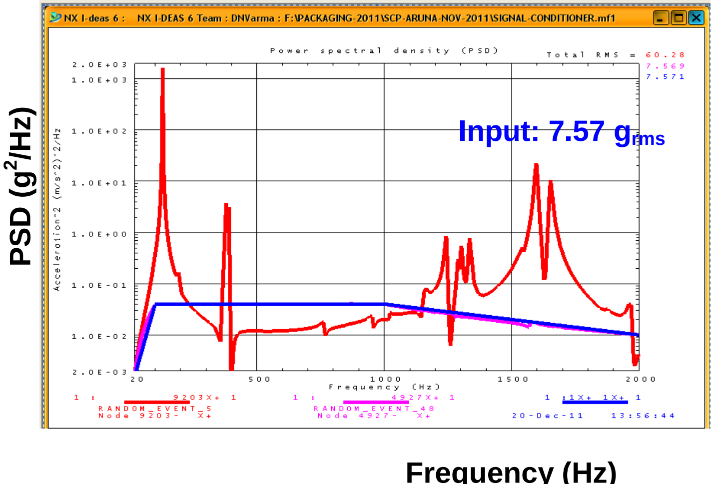


Figure 8 Comparison of response spectra (TOP PCB) – Lateral direction

OBSERVATIONS:

By implementing the modifications the maximum vibration response near BMC on top PCB got reduced from 45 g_{rms} to 29 g_{rms} in axial direction.

Whereas the maximum vibration response near BMC on top PCB got reduced from 60 g_{rms} to 7.6 g_{rms} in lateral direction.

V.RESULTS AND DISCUSSION:

The results obtained for various configurations near BMC on top PCB are compared.

DIRECTION	**VIBRATION RESPONSE**	
	PRE ANALYSED CONFIGUR-ATION	**WITH SUGGESTED MODIFICATI-ONS**
LATERAL	**60$_{grms}$**	**7.6$_{grms}$**
AXIAL	**45$_{grms}$**	**29$_{grms}$**

The vibration response level obtained using FEM and random vibration test are in good agreement.

Configuration with out stiffeners resulted in reducing the contribution of high frequency response.

VI.CONCLUSIONS

To mount the package in the airframe by providing lugs in the C.G. plane rather than in the base plane.

To adopt wedge guide configuration for mounting the PCBs in the chassis instead of stacked configuration.

With implementing above said modifications maximum vibration response near BMC on top PCB gets reduced from 45 g_{rms} to 29 g_{rms} in axial direction and from 60 g_{rms} to 7.6 g_{rms} in lateral direction.

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