10. ANALYSIS AND SOLUTIONS

This section is remarkably shorter than the corresponding one in the vibration analysis. The reason is the lack of specific information appeared, with most of the literature covering only thermal shock.

10.1 DESIRED DISPLACEMENT AND RESONANT FREQUENCY

The same process which was followed in RESTRICTION IN MAXIMUM DISPLACEMENT / DESIRED RESONANT FREQUENCY can be used here.

According to [1], when less than a few thousand shock stress cycles are expected and the ductility is high enough fatigue is no longer a concern. Then the follwing equation can be used as a limit on the PCB displacement

$$Z = \frac{0.00534\ B}{C\ h\ r\sqrt{L}} \tag{10-1}$$

Using (9-4) the desired value for resonance can be calculated as

$$f = \left(\frac{C\ h\ r\ A\ a_{max,input}\sqrt{L}}{0.02136\ B} \right)^{\frac{1}{2}} \tag{10-2}$$

10.2 SHOCK ISOLATORS

The choice of isolators for shock conditions relies on the octave rule as a way to minimize the effect of shock. The idea is actually to achieve the lower resonant frequency possible in the isolator, while maximizing the resonant frequency of the PCB. The low frequency of the isolator will imply both low R and amplification. A high frequency in the PCB will avoid further amplifications of potential low frequency excitations. The philosophy of the process is therefore similar to the vibration isolation, so both effects can be achieved with the same set of isolators.

Unless other considerations are important, the main restriction to the resonant frequency of the isolation will be given by (9-4). As with vibration isolators, the displacement tends to infinite when the frequency does to zero, so it is necessary to apply a restriction of the form

$$|z| \le \Delta \tag{10-3}$$

The limit should respond to reliability requirements, but it must also be logical for the usually small isolators that are used in electronic equipment.

It is important to mention that some companies require rigid mounting for certain applications. The reason is that ringing effects can occur in old isolators, substantially altering the dynamic properties of the system. It is therefore prefered that the reliability of the tool is assured for conditions which will not change over time. It might be intereting to follow this approach in critical applications whose working life is expected be long.

10.3 DROP TEST AND SHOCK PULSE

Drop is one of the most frequent sources of shock excitations, and it is especially dangerous since it can affect tools which are not designed for shock enviroments. Also, several shock conditions are usually simulated through drop test, and vice versa. It is therefore important to study the similarities between both processes.

Drop conditions can be easily compared with shock pulses through the increase in velocity. In the case of a drop test it can be estimated by equalling the potential energy lost in the fall with the kinetic energy gained. This leads to

$$\Delta v = \sqrt{2\,g\,h} \qquad (10\text{-}4)$$

The equation is valid in the case of a single fall, without rebound. If it is to be consired, the equation turns into

$$\Delta v = C\sqrt{2\,g\,h} \qquad (10\text{-}5)$$

where C is the coefficient of rebound, which is 1.0 for no rebound and 2.0 for full rebound.

When using a free-fall drop instead of a shock pulse the main point is to determine the height of the fall. It is done by imposing that the velocity increase is the same for the theoretical pulse and the drop, which gives

$$h = \frac{\left(\displaystyle\int_{t=t_0}^{t=t_f} a(t)\,dt\right)^2}{2\,C^2\,g} \qquad (10\text{-}6)$$

A more detailed analysis can be found in [14].