A Brief Review of Automotive Vibration Requirements

Provided By:
Mike Gardner, Sasha Babenko
Molex

Supporters

Why the interest in Vibration:

- Vibration is mainly defined for mechanical impact with regard to contact interface reliability.
- Interests are expanding into the electrical domain.

Note:

It should be noted that a great deal of work has been done on this topic by industry.

Reference:

A Practical and Reliable Method for Detection of Nanosecond Intermittency.

(*By: Steven Dunwoody & Edward Bock of AMP Incorporated and John Sofia of Anatech Corporation)*
http://www.te.com/documentation/whitepapers/pdf/5jot_8.pdf

Effect of Nanosecond Electrical Discontinuities in High-Speed Digital Applications Practical

(S. B. Smith, V. Balasubramanian, D. Nardone, and S. S. Agili)

http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=4694922&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D4694922

What Standards are currently available?

- USCAR-2 *(US Auto Makers Connector Test Specification)*
- LV 214 *(German Auto Makers Connector Test Specification)*
- OEM Specific
  - Specific requirements may vary by each OEM primarily in the area of vibration profiles.

Vibration as stated in USCAR-2

- USCAR-2 *(Section 5.1.9.4)*
  - Continuous monitoring during vibration test
  - Acceptance Criteria
    - No loss of electrical continuity for more than 1 microsecond
    - If one or more terminal pairs are monitored, rather than the series resistor, there must be no instance in which the resistance of any terminal pair exceeds 7.0 Ω for more than 1 microsecond.

Vibration as stated in USCAR-2

- USCAR-2 *(Section 5.1.9.4)*

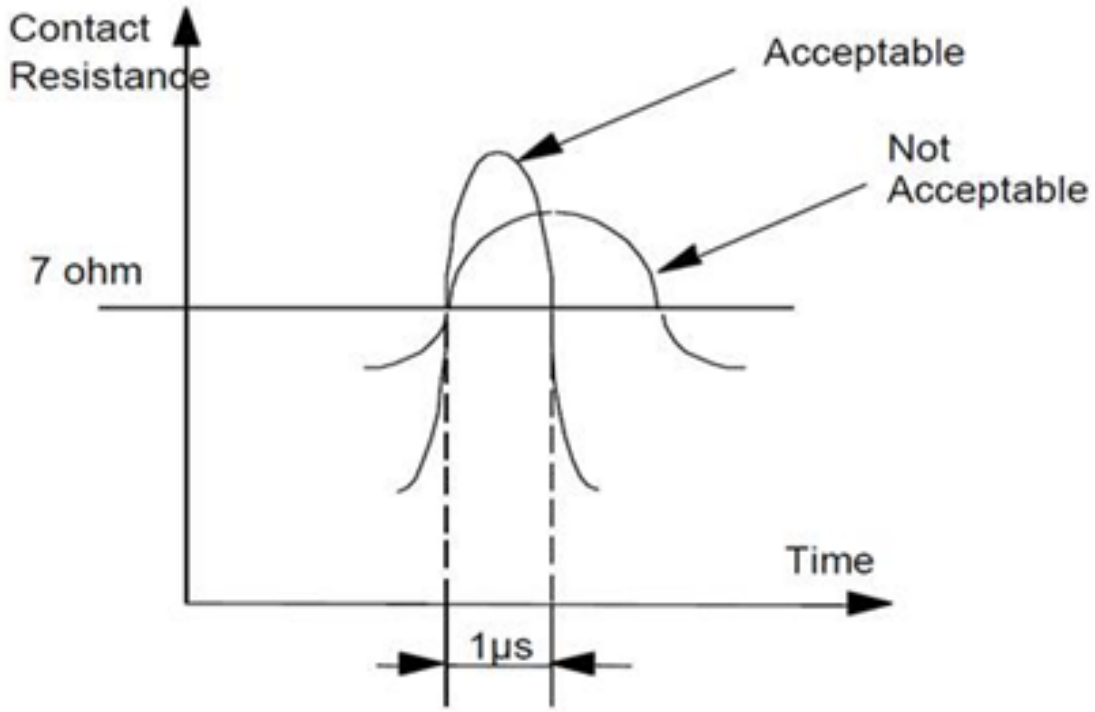


Figure 5.1.9.4 Intermittency Measurement

Monitoring for Failed Event

- Equipment Capability
  - The equipment defines a discontinuity as being greater than 7 Ohms for 1 microsecond or longer. It records the number of events that happen during the course of the test.
    - Records the event, but not the value… like a go/no go gauge.
    - If it is above 7Ω and greater than 1 µsec, it's an event.

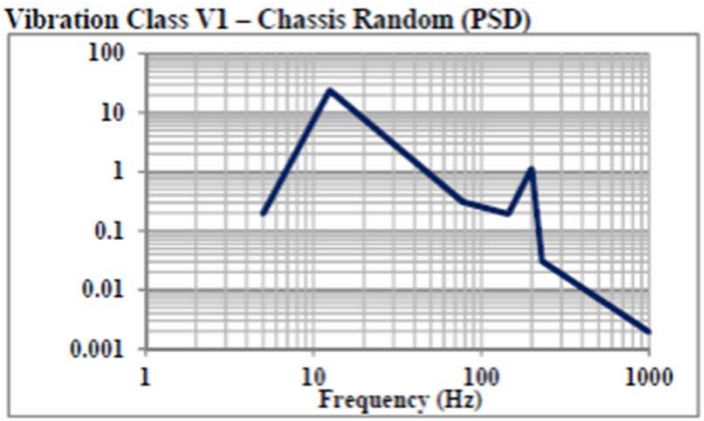
	Above 7 ohms	**Below 7 ohms**
> 1 µs	Registered Event	Good
< 1 µs	Good	Good

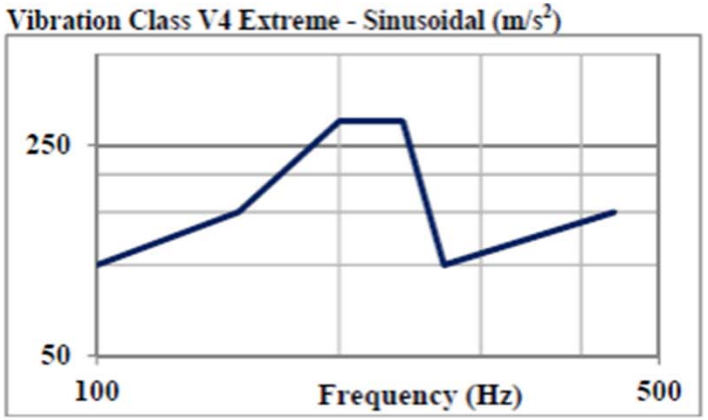
Vibration/Mechanical Shock USCAR 5.4.6

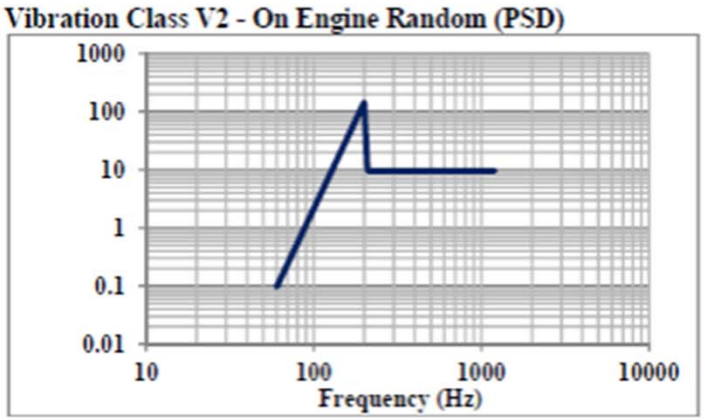
- 5.4.6.1 Purpose
- This test subjects a connector system to vibration, simulating accelerated exposure to actual vehicle conditions.
- Since unsealed connectors are not suitable for use outside the passenger and luggage compartments, they would normally be tested only to the non-engine/transmission profile (V1).
- Sealed connectors may be used in applications requiring direct attachment to the engine/transmission, so they should normally be qualified to the harsher vibration profiles (V2 through V5).”

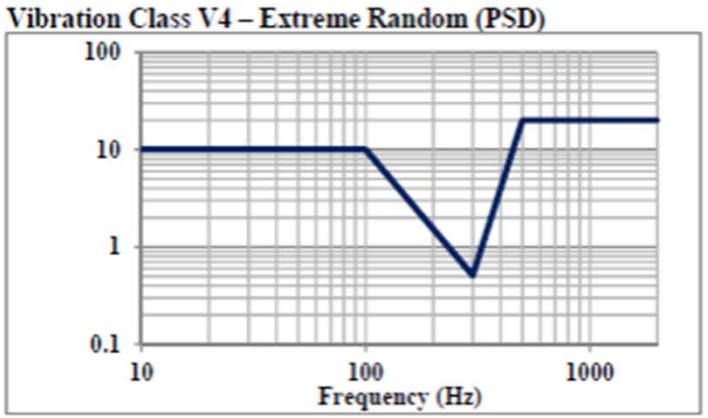
Vibration/Mechanical Shock USCAR 5.4.6

- Vibration Profiles (Example USCAR)



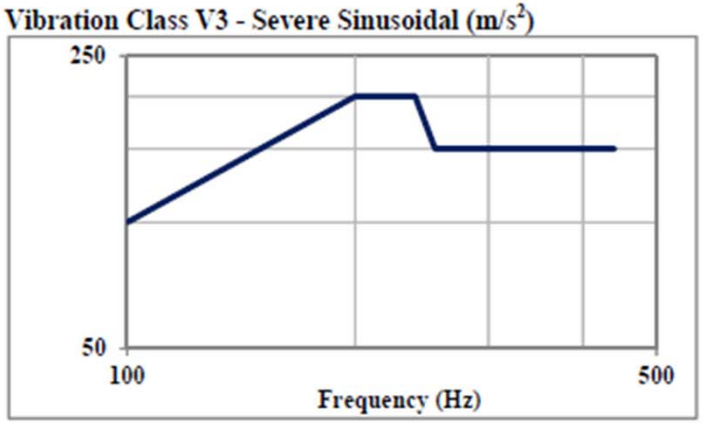


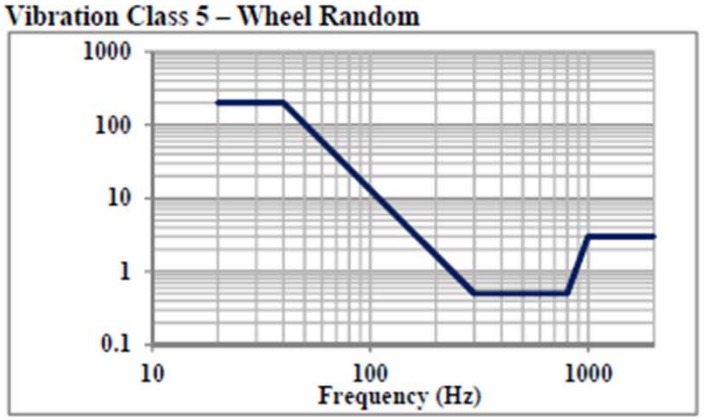


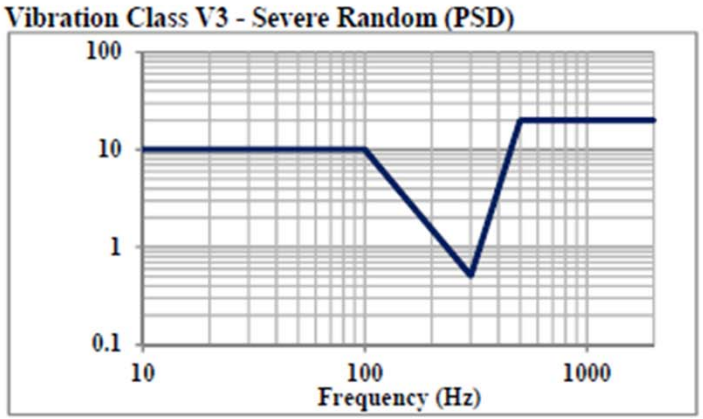


Vibration/Mechanical Shock USCAR 5.4.6

- Vibration Profiles . . . *cont.*







Closing

- The intent of this material is to simply provide a fundamental understanding of connector industry vibration testing.
- Industry (Automotive and Telecom) has debated this topic multiple times before and settled on the 1µs / 7.0 Ω measurement window method for registered event.
  - Registered Event usually represents a failed contact system not suitable for application use and suggests need for contact redesign.
- Computational study & modeling suggests it is not feasible for a contact to open long enough under vibration and still meet acceptable contact performance.
  - Reference industry work outlined on page 3 & 12 of this presentation.

Closing . . . cont.

Effect of Nanosecond Electrical Discontinuities in High-Speed Digital Applications Practical
(S. B. Smith, V. Balasubramanian, D. Nardone, and S. S. Agili)
http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=4694922&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D4694922

Effect of Nanosecond Electrical Discontinuities in High-Speed Digital Applications

S. B. Smith[1], V. Balasubramanian[2], D. Nardone[3], and S. S. Agili[4]
[1] FCI USA, Inc., 825 Old Trail Road, Etters, PA 17055, Stephen.Smith@fci.com
[2]FCI USA, Inc., 825 Old Trail Road, Etters, PA 17055, Vittal.Balasubramanian@fci.com
[3]FCI USA, Inc., 825 Old Trail Road, Etters, PA 17055, Dan.Nardone@fci.com
[4] Penn State University, 777 West Harrisburg Pike, Middletown, PA 17058, ssa10@psu.edu

***Abstract*- Nanosecond discontinuities are a concern in separable-interface connectors. Speculation about their causes includes the structural movement between perfectly clean and flat contact surfaces and/or surface irregularities and presence of surface films. Both of these scenarios are considered here in the context of high-speed transmission (i.e. greater than 1 Gbit/s) in backplane connectors. Because such connectors have gold-to-gold mating surfaces, oxide-related discontinuities such as may occur with tin, silver, or aluminum interfaces are not considered. This paper considers the propagation speed of a stress wave to show the unlikelihood of nanosecond discontinuities arising due only to macroscopic structural shock and vibration. Thus, contact physics and the presence of contact imperfections, are required to cause nanosecond-level intermittences. Assuming that a discontinuity of one or several nanoseconds does occur, the short duration of the event permits**

This paper addresses these two possible causes for intermittencies of duration on the order of a nanosecond, and determines whether they could occur in a high-speed connector with a gold interface. Assuming that nanosecond discontinuities could occur with such interfaces, their effect on a high-speed communication link is determined.

Section II of this paper discusses a mechanical analysis of a nanosecond discontinuity to determine whether a typical contact beam in a high-speed connector could react fast enough to cause such an event. In section III, a model of a communication link is studied to determine the effects of a nanosecond discontinuity on its performance. Conclusions are presented in section IV.

Thank You!