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VALIDATION AND COMPARISON OF TIME AND SRS SHOCK DATA

An opportunity for OEM's to recognize different solutions for data analysis in linear shock testing

ABSTRACT

Often a customer, OEM or contract testing house inquires as to "How can I use SRS and what analysis system is best to use?" As a marketer and producer of shock testing equipment, but not data analysis software, we are at somewhat of disadvantage in providing them with the best solution.

This effort will help LAB, its potential and existing customers seek an answer to this question.

SCOPE

Over the last several years OEM's have been persistent in developing shock specifications that address concerns regarding the performance of their products during manufacturing, the distribution cycles and product use.

Dell Computer Corp. Austin, TX has been the most visible by employing the *OEM/Third Party Lab Certification Procedure*. This procedure addresses vibration and shock. At this time, LAB will only address the Linear Shock requirements and more specifically the *Shock Specification Test* for different components and systems.

In an effort to create a "baseline" of data for analysis and at the same time apply the above procedure to an existing requirement, several different of hardware systems, software and externally generated sources of data needed to be employed.

The shock system consisted of an LAB ASII™-24x32 Shock system, an LAB SD10 shock system and a non-LAB shock system. The software systems used to capture and analyze data were the GHI's Wincat™ with SRS, Lansmont's TP3™ and MathCAD® by Mathsoft®. The external data was gathered from existing Dell Corp. Lab certification reports.

The External scope of this project involved capturing data, validating compliance with the above specification, analyzing different methods of Time domain and SRS presentation, analyzing the difference within the industry known data capture systems and developing a bias as to what data system is the most sound technically for customer compliance requirements. The results will hopefully be presented in a concise manner below.

The Internal scope of this project involved defining performance limitations of LAB's existing test systems, defining the optimum programmer modules and developing a set of engineering objectives that would define the future performance and capabilities of LAB"s shock product offering. This information will be held as confidential.

SECTION I

Technical Issues of discussion Regarding SRS parameters and analysis

The "Composite" debate: Lansmont has created a term that only they use to describe the collection of all the data in a TD test. The term "composite" is used to describe the collection of all of the input data points in the time window, or the combination of the primary and residual SRS type. GHI uses a combination of primary and residual SRS types in its SRS test, but does not

- **SRS Types**: Primary and Residual SRS types are valid types, terms used in the industry standard algorithm (Smallwood Algorithm). Primary SRS is a collection of all data in the time window during the application of the event, starting at time zero and ending at the right integration limit. Residual SRS is all data in the time window that occurs after the completion of the event, starting at the right integration limit and ending at time max.

- **Smallwood Algorithm**: Dr. David Smallwood's Ramp Invariant Recursive Digital Filter algorithm, known as the Smallwood algorithm, is the leading algorithm used in the packaging industry. There is no standard related to SRS testing, although there probably should be. Through rigorous testing and simulation, industry experts, such as Bill Kipp, and independent testing firms, such as Innovative Engineering Solutions (IES), agree that the Smallwood algorithm is the most accurate algorithm for use in SRS testing.

- **Use of the Smallwood Algorithm**: After testing both GHI and TP3 data with our MATLAB application, which utilizes the MATLAB Shock toolbox supplied by Smallwood himself and based on the Smallwood algorithm, our conclusion is that Lansmont and GHI both use the Smallwood algorithm in their SRS analysis. To test this hypothesis, data from GHI was exported to a tab delimited text file, run through the MATLAB application, and the results of which overlaid onto the original GHI WinSRS test results for comparison. The same method was used to verify that Lansmont uses the Smallwood algorithm in its SRS test. Results of the comparison confirmed that both applications (GHI & TP3) use the Smallwood algorithm correctly.

- **Proper (Smallwood algorithm) SRS testing**: There are many schools of thought, as well as various algorithms, available to facilitate SRS testing. With the Smallwood algorithm, there is much discussion on the topic of conducting accurate SRS testing. One of the validations for the Smallwood algorithm is unfiltering the TD data prior to SRS analysis. To ensure that this process occurs, WinCAT/WinSRS requires users to unfilter data prior to SRS analysis. A message box appears when the user tries to run an SRS analysis on TD data while the data is filtered. In order to proceed, the user must unfilter the data. During the course of our research for this project, specifically during the process of verifying each application's [proper] use of the Smallwood algorithm, we formed the hypothesis that Lansmont does not use the Smallwood analysis correctly when users analyze filtered data with the Smallwood SRS algorithm. To test our hypothesis, we opened TP3 data and exported in two forms: unfiltered and 5K filtered. We then analyzed the data with our MATLAB application, and compared the results to the original TP3 SRS results. We found that our results matched TP3 Composite results from an SRS analysis 5K filtered data.

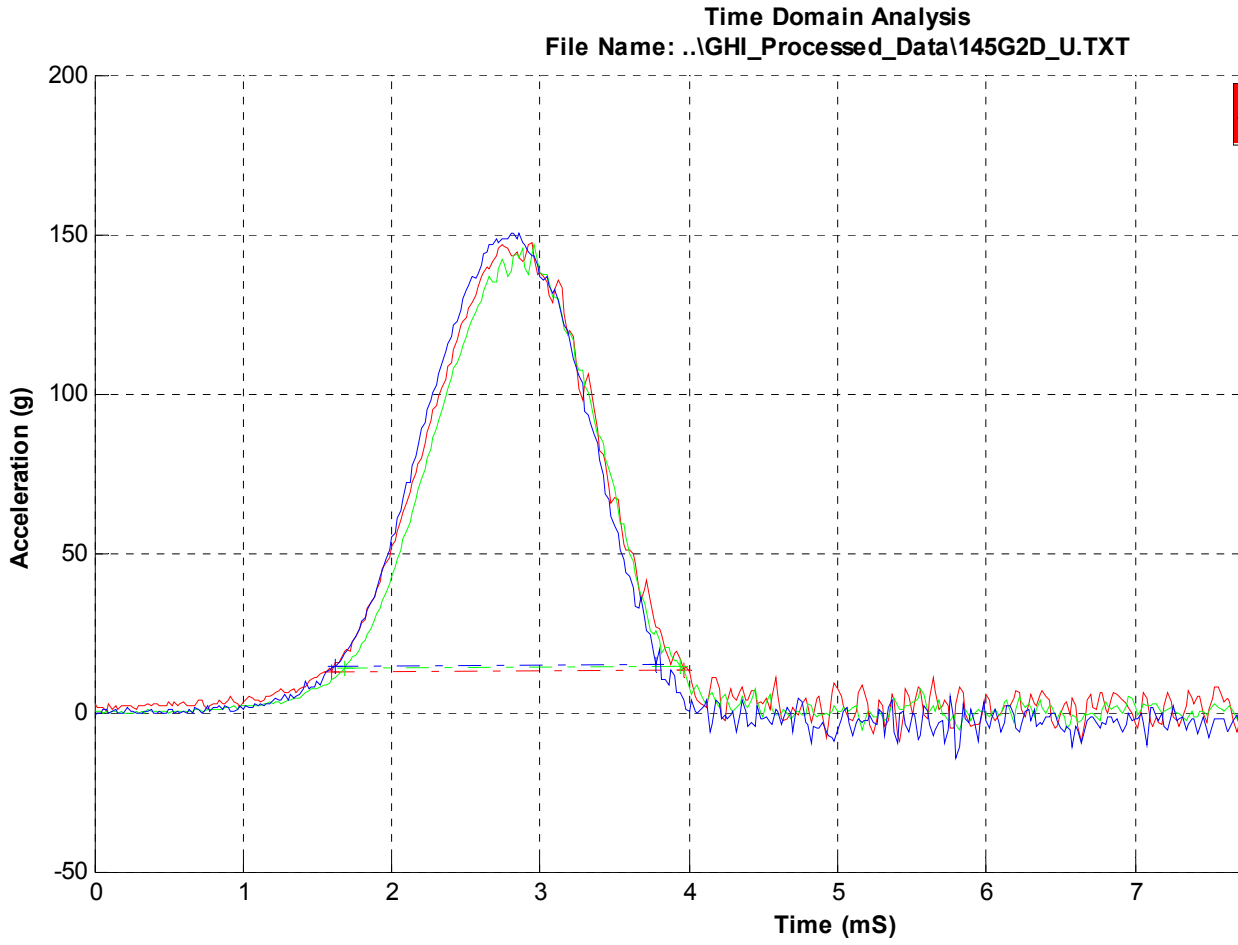
- **Collection of data**: Data for this project was collected using an LAB Equipment Auto-Shock II, 24x32 shock machine with GHI WinCAT data-acquisition software. Lansmont comparison data was collected on a competitor's shock machine of similar specs, using the TP3 data acquisition software. Our research team used both TP3 and WinCAT/WinSRS to

SECTION II

Analysis of data:

To analyze data from both GHI and TP3, we contacted Smallwood and he provided us with his MATLAB shock toolbox. This toolbox contained MATLAB files that can be used to analyze raw data in SRS. We used these files to generate an application that:

Time Domain Comparison



Channel	Amplitude(G)	Duration(mS)	Velocity(in./sec)
Nominal	145.00	2.00	71.28
CH1	147.58	2.36	75.92
CH2	146.86	2.26	71.99
CH3	150.54	2.16	74.74