LTT Transient Recorder: Qualifications Test of a Satellite's Components

Application Report from TU München, KRP-Mechatec

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The Chair of Light Weight Structures (LLB) at the Technical University in Munich Germany is responsible not only for the daily teaching duties but also for many research projects. Most projects are funded by companies from the airplane and space industries, e.g. EADS and KRP-Mechatec, who want to use TU's expertise, flexibility and access to its equipment.

KRP-Mechatec is a strong partner for Test and Development of mechanical components. It has strong ties to the space technologies and is atune to the latest technical developments and also can perform various measurements and development test using its close partnerships with many research institutes.

1.The Measurement Assignment

In December 2002 the company EADS-Astrium contracted KRP-Mechatec to test a component of a satellite called a "Low Shock Release Unit" (LSRU) which it had developed and built. For the tests KRP-Mechatec used the equipment provided by LLB. EADS-Astrium desired a detailed report about the quality and characteristics of the apparatus including proposals for any possible improvements.

Fig.1: Low Shock Release Unit

The component used a newly developed method for holding and releasing a satellite's folded solar panels. The Low Shock Release Units press the folded panels (each 3.9m x 2.1m in size) together through the flight to the satellite. The panels when folded out to form 2 solar generators are up to 23m x 2.1m in area

As solar generators extend, a spindle is pulled in a an extreme low friction holder that is integrated in the LSRU. The unfolding of the solar panels occurs via a motor and a cable connected separately to each panel.

Till now the unfolding of a panel was accomplished using pyrotechnics which cause a great deal of shock to the satellite. The sharp impulse, and very high mechanical vibrations due to the explosion could cause defects in electonic boards, sensors, and intruments or even the complete failure of a sattelite. The enormous costs for a satellite, up to 200 Mio €, do not justify such a risk.

Three test were perform using the LTT Transient Recorder.

I.Measurement: Electrical Measurement

Four LSRU's were tested each having 2 electromagnetic actuators. This test was to characterize the release mechanism. The control pulse having 21V to 35V lasting 40ms, a “glitch“ pulse 21V - 35 V lasting 10us and the pulse's rise time of 150ns were controlled. The current and back EMF of the magnets were measured and analyzed. The current was measured using a clamp meter and recording was performed using LTT-184 sampling up to 20MHz.

II.Measurement: Sine / Random Vibrations Test

Three LSR units were mounted on a large electrodynamic Shaker and shook with up to 80kN.

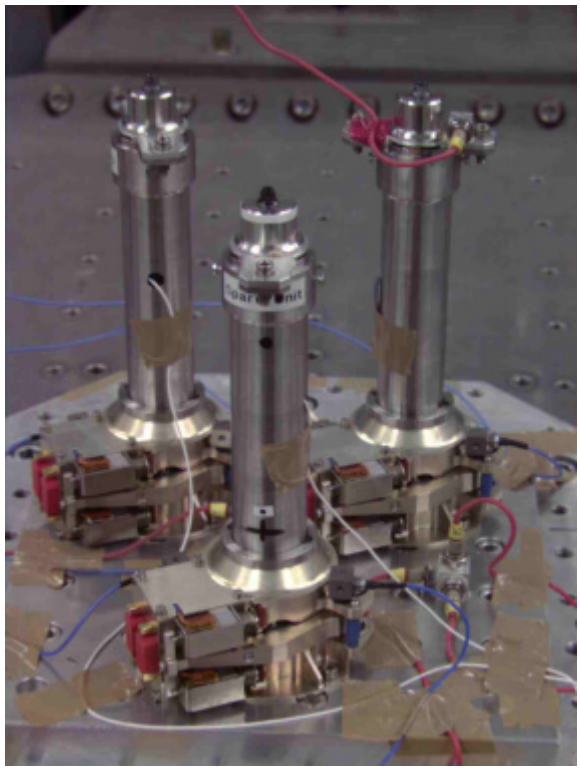

Fig.2: Vibrationstest

The test consisted of either a sine or random load test. Before and after each test a resonance characterization was performed to determine if any defects had occured. The resonance characterization meant ramping the vibration frequency from 5 to 2000Hz with a small amplitude of 0.5 G. The sine test was done from 5 to 100Hz with a maximum amplitude of 18G, and the random test was perfomed from 5 to 2000Hz with a maximum rms accelleration of 16.
Each test were perfomed along the 3 axis which meant a total of 15 tests.

A total of 21 channels were measured during each of the tests, of which 18 came accellerations sensors, a pilot signal or control signal from the shake table and 2 strain gauges. The sampling rate per channel was 20kHz or for a total sampling rate of 420kS per second.

Upon successful completion of the vibration test a LSRU could survive the start of rocket and successfully hold the solar panel in place.

III. Measurement: Shock Measurement and Analysis

Purpose of the measurement was to characterize the mechanical shock caused by the LSRU when it releases. The LSRU was monted to a hanging aluminium sandwich plate. The acceleration was measured using four 3 axis accelerometers +/- 500 G for a total of 12 channels having 400kHz per channel.

A Shock Response Spectrum was made and justified the high sampling rate. It was shown that the LSRU produced a very small shock and therefor other satellite components would only be lightly infuenced by it.

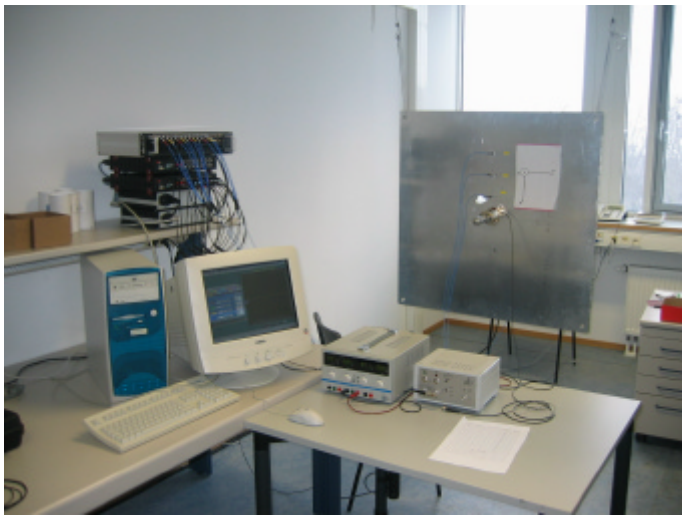

Fig.3: Shock Experimental Setup

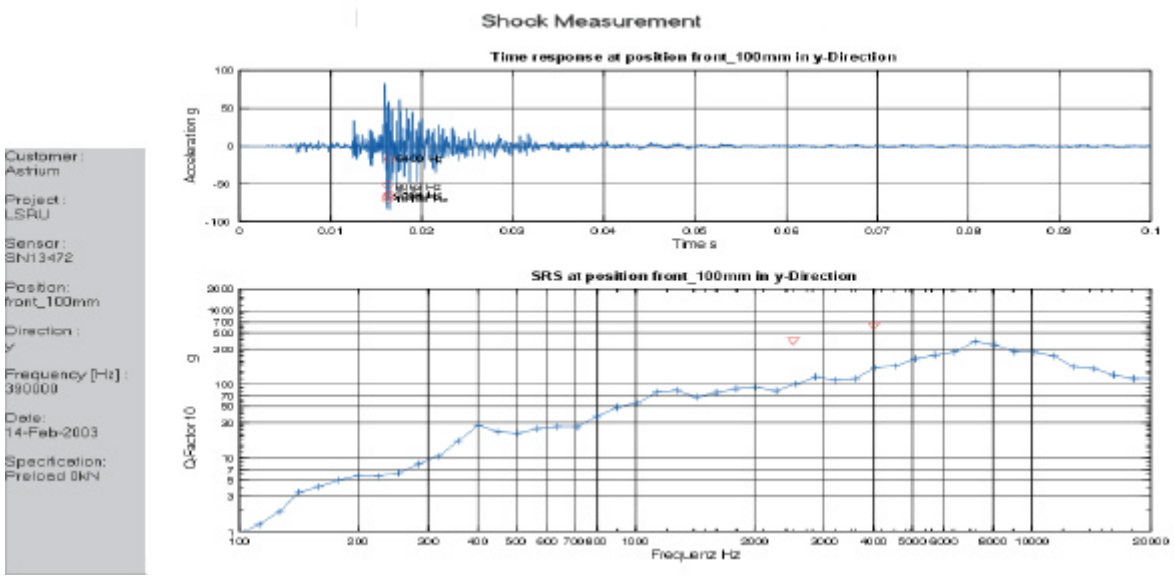

Fig. 4: Measurement Analysis

2.Reasons for the Transient Recorder from LTT

The demands required on the current measuring equipment were too high. A solution was desired that allowed for 21 channels measured synchronously and a maximum sampling rate of 20MHz. The signals to be measured were current and voltage. Because control of the actuators required a rise time of 150ns, fast sampling was required. Also the calculation of the shock response spectrum required a high time resolution of the acceleration.

After careful study of possible solutions the Chair decided on a transient recorder system from LTT GmbH (www.tasler.de) consisting of two cascaded recorders with a total of 24 channels. The system will also be used in future projects, such as the develoment of active and passive shock absorbing systems, as well as acoustic measurements.

The software LTTview allows for saving the data in various common data formats. Since software FAMOS is used extensively at the center, all data from LTTview was saved in the FAMOS format. It was very helpful and easy using LTTview to select online and interesting section of data from a rather large data set (1GB) and directly export to FAMOS.

For certain measurements, KRP-Mechatec had cooperated with the Max Planck Institute in Garching. Parallel measurements were taken using the equipment at Max Planck and it was shown that the LTT recorders are extremely precise. If one considers the price difference between the equipment at Max Planck and the LTT recorder one would not expect such a results.

3.Results

The contractor was very satisfied with the results presented by KRP-Mechatec and TU Munich. LTT transient recorders complied with all requests and requirements.

Also the engineers of KRP-Mechatec praised LTT for the userfriendly transient recorders. A more intimate contact between LTT and the engineers supported a fluid order of events and a fast problem resolution. The installation of the systems at TU Munich required some software adaptations, which were made by LTT very quickly and free of charge.

Many experiences during operation of the systems have been documented. Aside from the precision of the systems and the qualitiy of the measurement data, the head engineers commended the intuitive interface LTT view.

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