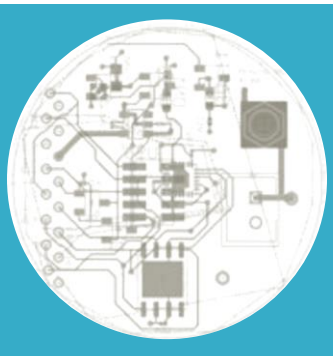
Orbital Test Services, LLC
Specializing in Extreme Testing Environments

Angela M. Lisy

Tony Opperman

Orbital Test Services White Paper



High-G Testing Overview for Sensor & Actuator Designers

High-G Testing Overview for Sensor and Actuator Designers

Current and Future munitions are requiring an increase in hit-probability, while reductions in fratricide, collateral damage and CEP. To meet these performance requirements, many sensor and actuator designers are developing guidance systems with complex packages in order to protect the sensors/actuators and corresponding hardware from the harsh environment of gun-launch. Gun-launched munitions are subjected to very high accelerations when fired. In fact, these munitions may experience upwards of 80,000g's when launched from the weapon platform (Figure 1). The high g forces from gun-launch have the potential to damage or degrade packaging, electronics (connections, printed circuit boards, discrete IC's, etc.) and sensor and actuator performance. To increase the confidence level that the guidance technologies will survive gun-launch, designers are turning towards *High-G Mechanical Shock Testing.* Mechanical Shock Testing is fast becoming an acceptable testing method used to evaluate guidance technologies for use in high-g, gun-launch environment.

Figure 1*: High-g shock testing can be used to accelerate the development of tactical grade electronics designed for the gun-launch environment.*

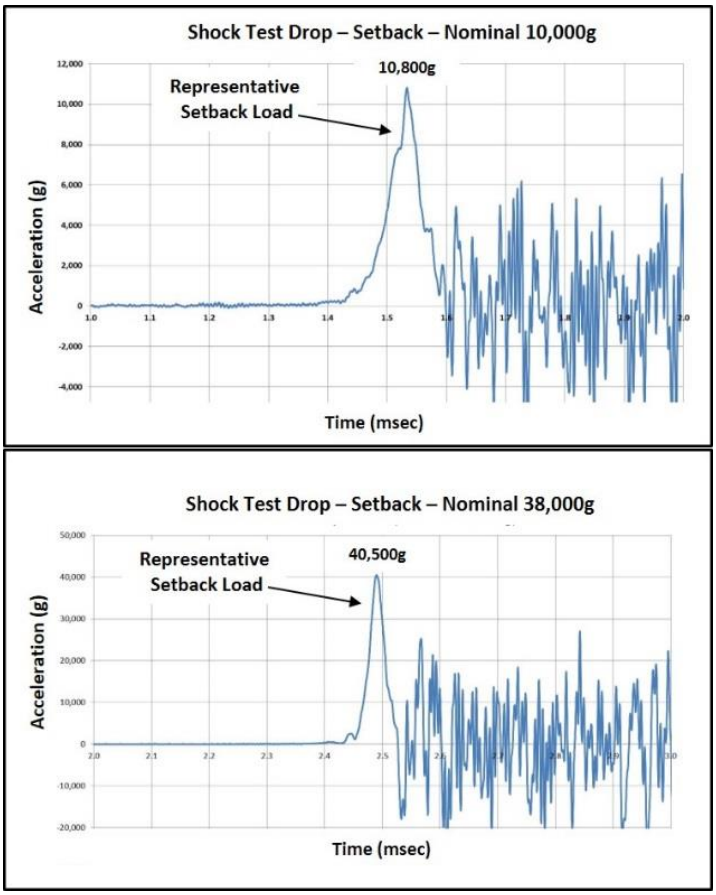


Figure 2*: Test shock profiles (acceleration vs time) representing a Setback load of an anticipated gun-launch event.*

High-g mechanical shock testing exposes a test article (prototype packaged device) to sudden and extreme changes in acceleration. Outputs of high-g mechanical testing include the acceleration as a function of frequency and the total energy of the applied shock pulse. This applied shock pulse is called *a half-sine shock pulse* and is typically characterized graphically as acceleration vs time curves. To estimate and predict survivability, test articles are subjected to representative set-forward and setback loads of the anticipated gun-launch event (Figure 2). For example, Setback Loads for: ***a)*** tank round test articles are between 35k-65k g's, ***b)*** medium caliber cannon artillery test articles are between 30k-100k g's, and ***c)*** artillery and mortar test articles are between 5k and 20k g's. When test articles survive these laboratory-based shock tests, the designer's level of confidence increases with respect to live-fire test survivability. If the test article fails, the designer can investigate the failure mechanisms which ultimately reduces the risk of failure when providing components for system-level demonstrations.

Orbital Test Services' high-g shock testing system provides a quick and cost-effective assessment of device survivability through exposure to representative pulses of shock in one direction and in a single axis. Please note, the high-g shock testing system does not simulate the exact environmental conditions associated with an actual gun-launch because a typical gun shock pulse has a much longer duration (Figure 3). Gun-launch pulse durations are typically between 4 and 20 msec, compared to a mechanical shock test pulse duration of 0.1-1.0 msec. Nonetheless, Mechanical Shock Testing may be a harsher test when considering the *jerk* (slope of acceleration) when comparing similar acceleration levels as gun-launch. With OTS's shock testing system, functional tests can be performed before, during, and after the shock event for hardware, mechanisms, and electronic evaluation. In summary, devices that survive high-g mechanical shock testing will most likely survive live-fire demonstrations.

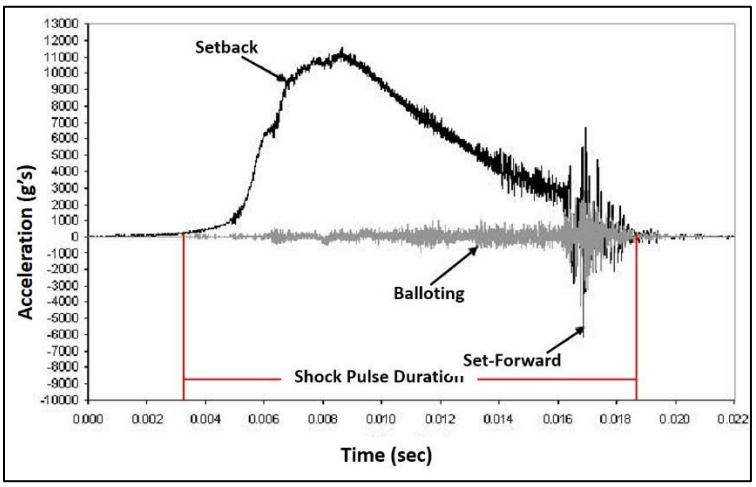


***Figure 3**: Typical live-fire gun-launch environment with a 16 msec pulse duration.*
https://www.researchgate.net/publication/260708765_Statistical_Comparison_Between_Component_Level_and_System_Level_Testing_for_the_Excalibur_Projectile [accessed Dec. 2 2018]

***Figure 4:** High-G Mechanical Shock Test Set-up. Shock system mounting table with test article (top left), Dual Mass Shock Amplifier (DMSA) with test article (bottom left) and mechanical shock system with a 16 ft tower (right).*

Orbital Test Services (OTS) provides High-g Shock Testing services using an accelerated drop test. The shock table is accelerated to a sudden stop using elastic bands. For high-g exposure, the System (Figure 4) is equipped with a DMSA (Dual Mass Shock Amplifier). OTS' data acquisition system is designed to capture and analyze shock data including peak acceleration, duration and velocity change. The shock testing system can provide a broad range of test condition compliant with MIL-STD-810G, Method 516.6 and MIL-STD-883J, Method 2002.5. Shock loads are recorded during testing using a high-speed shock accelerometer mounted in line with the test article. The Shock Table is utilized to perform structural experiments on various electro-mechanical components designed to simulate the high g environment. This laboratory based high-g test system allows engineering teams to evaluate prototype hardware and software after being subjected to representative high g events.

CONTACT US TODAY ABOUT YOUR PROJECT

OTS, LLC
4415 Euclid Avenue, Suite 510
Cleveland, OH 44103

Phone: 216.649.0378
Web: www.OTSshocktesting.com
Email: OTS@orbitalresearch.com