Shock and Vibration Testing

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Abstract

Simple mechanisms and procedures for shock and vibration testing suitable for the AXIOM camera.

Contents

1 Mechanisms

1.1 Vibration

A simple but efficient way to create various low frequency vibration scenarios is by mounting the camera on a platform which itself rests on a number of springs and is agitated by one or more eccentric rotating mass vibration motors (ERMs).

Both, springs and ERMs are readily available and can be easily adjusted to various scenarios providing a cost efficient solution for realistic testing.

High frequency low amplitude testing can be accomplished by utilising a large speaker to agitate the platform.

1.2 Acceleration

A mechanism to apply acceleration forces to a device under test (DUT) can be efficiently built by locking a platform mounted on a number of springs in compressed state and then suddenly releasing the lock.

The lock can be a simple mechanical or a solenoid which is electrically released.

Note that continuous acceleration beyond the expected gravitational forces is not to be expected in real world scenarios and thus does not need to be tested in the lab.

1.3 Shock

In contrast to the typical acceleration scenarios, shock usually is caused when the DUT in motion hits another object or a moving object hits the DUT causing a shock wave propagating through the device..

An efficient mechanism to simulate this event is to extend the mechanism for acceleration testing by limiting the movement at a specific point, for example by blocking the way with a stopper.

2 Instrumentation

2.1 Measuring acceleration

Thanks to the advances in micro-electro-mechanical systems (MEMS) and the fact that inertial measurement unit (IMUs) have become commodity over the past decade, rather cheap and small devices are available to record 3D acceleration of the DUT in all of the described test mechanism scenarios.

2.2 Measuring the Effect on the DUT

Besides the obvious case where the DUT suddenly stops working a continuous but easily verifiable test loop needs to be designed and implemented and the resulting data recorded and evaluated.

Care needs to be taken to design the test loop in a way which resembles normal operation to avoid testing unrealistic scenarios.

2.3 Calibration

Obviously all involved measurement devices need to be tested and calibrated before they are attached to the DUT, otherwise the results would be inconclusive.

IMUs can be calibrated with the help of gravitation while the test loop typically will produce some kind of error rate which only needs to be specified.

3 Procedures

3.1 Short Burst Tests

Acceleration and shock testing typically makes a lot of sense when applied in short bursts with detailed analysis about the effect on the DUT, varying the strength or type of test as well as the DUT configuration to identify potential problems within reasonable limits.

3.2 Long Term Testing

Exposure to long term vibrations of periodic or random nature can help finding mechanical design flaws and characterise the durability of the camera design, both mechanical and electrical.

3.3 Typical and Expected Stress

Recording data from existing cameras equipped with IMUs is an excellent way to identify typical vibration, acceleration and shock scenarios which need to be expected in the field and thus tested for.

As this information is only of statistical value, a reasonable safety margin should be added to all testing, so that the typical stress will be well within the tested scenarios.

Note that there are test conditions where the DUT is expected to survive, but is allowed to stop working correctly and there are less extreme test conditions where the DUT is expected to continue working without any problems.

References

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[2] Allan Piersol and Thomas Paez *Harris' Shock and Vibration Handbook* 6th Edition

[3] Wayne Tustin *Random Vibration & Shock Testing, Measurement, Analysis & Calibration*