WHERE TO LOCATE THE CONTROL ACCELEROMETER

By Wayne Tustin and Steve Brenner

One of the most critical decisions in developing sine or random vibration tests also is the most neglected.

The location of the control accelerometer is one of the most critical decisions when developing random vibration tests. As proven in numerous experiments, the position of the accelerometer can greatly affect the results of a test.

But surprisingly many test standards, specifications, and test-plan documents ignore this vital topic. Even MIL-STD-810 Test Method Standard for Environmental Engineering Considerations and Laboratory Tests does not give the user a good method of determining the location.

Traditionally, the control accelerometer has been located in one of three areas: on the shaker table, on the fixture, or on the DUT. Most lab personnel mount the control accelerometer at some location on the DUT side of the fixture.

Figure 1 shows a typical electrodynamic shaker system that is performing a sine or random vibration test on a DUT. The vibration levels are based on an intensity feedback signal generated by the control accelerometer.

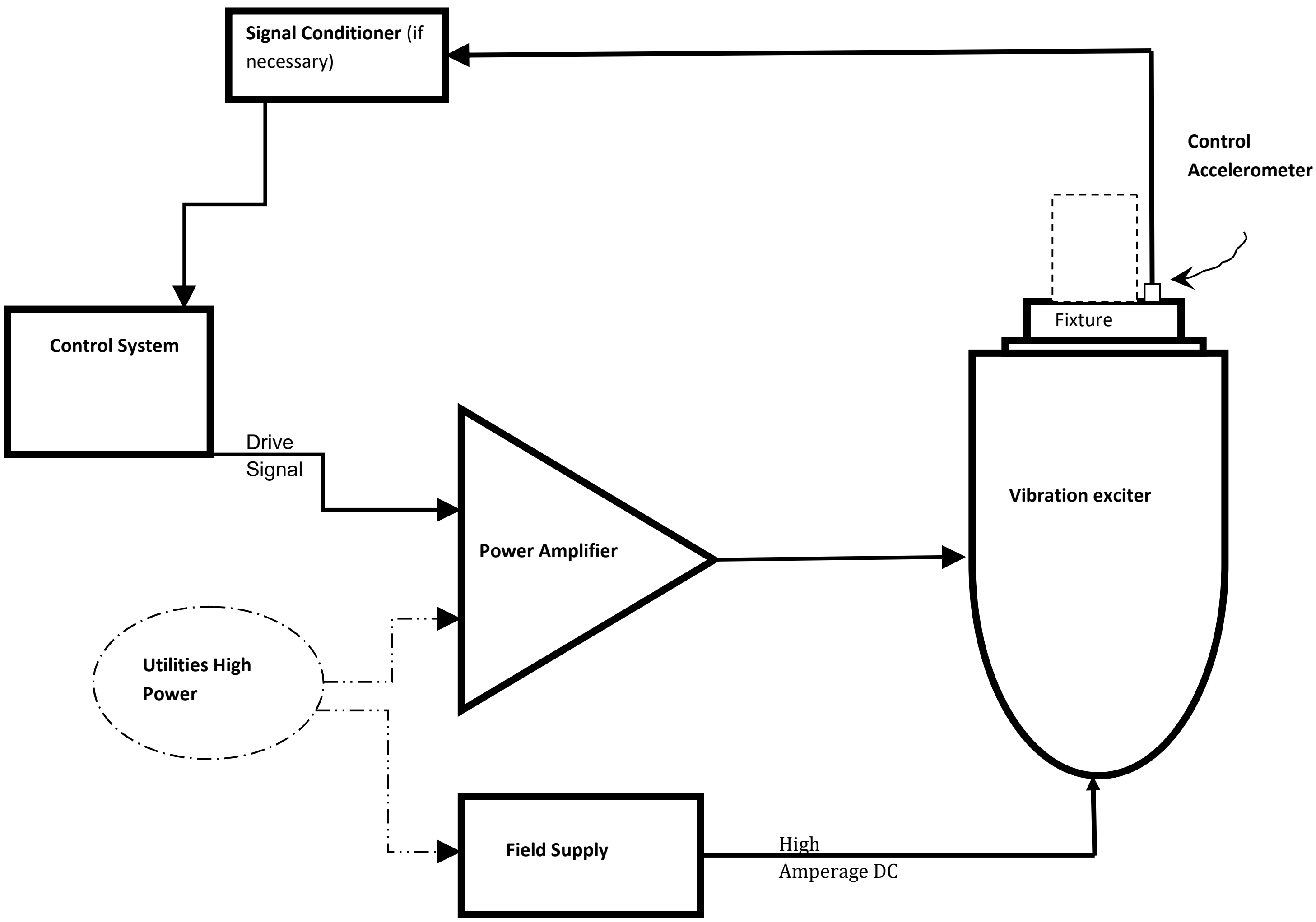

Figure 1. Block Diagram of a Vibration Test System

An Example

To illustrate how various monitoring points on a fixture can vary widely, let us look at a real-world application: a prototype black box scheduled to receive a 2g swept-sine vibration test.

The test lab had procured a fixture for attaching the DUT to the shaker. As often happens lab personnel were unable to get engineering to designate where to place the control accelerometer.

Two days before the customer was due to witness the swept-sine vibration test, the lab drilled and tapped a 10-32 hole close to each of the DUT's six mounting points and mounted six accelerometers. The following day, engineering brought the black box down to the lab for a private pre-test. An engineer decided which of the six accelerometers the lab would use as control. He chose #3.

Both the pre-test and the more formal customer test went well. As a part of the test, the lab prepared a graph similar to **Figure 2.** It showed only the one heavy trace that indicated how well the controller maintained the desired acceleration at location #3.

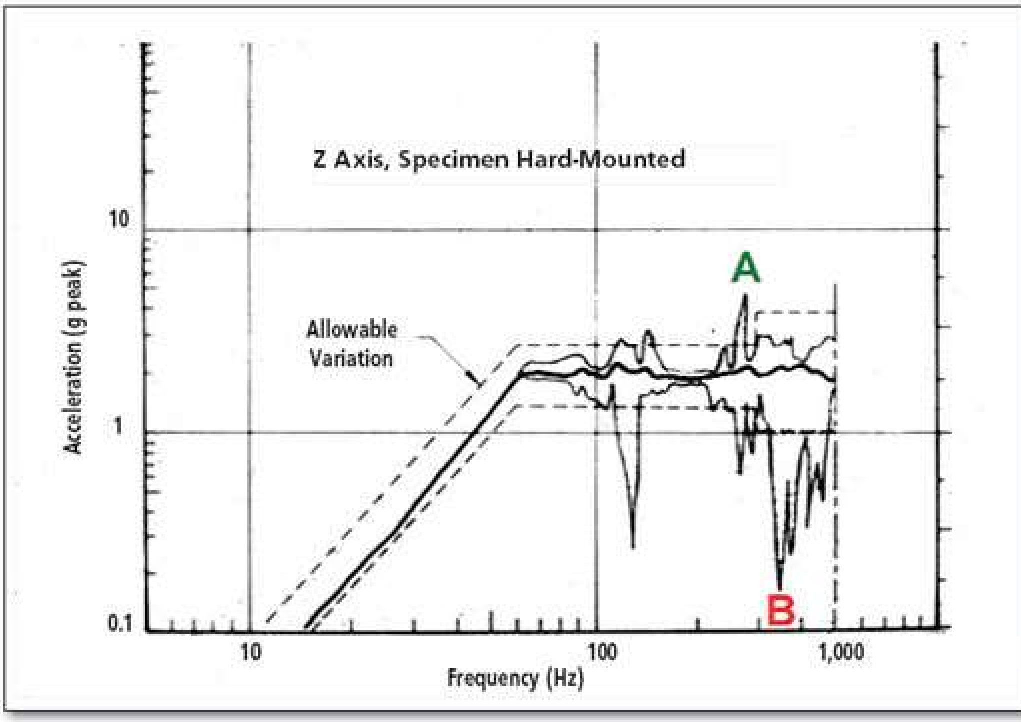

Figure 2. Wide Difference in Dynamic Inputs

After the official test concluded, the lab continued a more thorough testing of the DUT. The outputs of all six accelerometers were recorded. From that graph, the lab extracted and plotted points representing the most severe and the least severe outputs of the six accelerometers, represented by the upper and lower graphs, respectively, in Figure 2.

The Effect of Controlling Elsewhere

Suppose instead of accelerometer #3 controlling the vibration levels as the test approached frequency A that accelerometer #1 was in control. To maintain 2g at location #1, shaker intensity would have been reduced by about 50%. If A had been a critical frequency, a fail could have been converted to a pass.

Instead of accelerometer #3 controlling the test as it approached frequency B, suppose that accelerometer #5 was regulating the vibration output. To maintain 2g at location #5, shaker intensity would have been increased about 10 times. If this had been a critical frequency, a pass could be converted to a fail.

Recommendations
Don’t attach several accelerometers to the fixture and then command the controller to regulate some form of average. If the lab in this example had done that, half of the accelerometers would have experienced undertesting, and half would have experienced overtesting.

Don’t attach several accelerometers to the fixture and then command the controller to jump around, always selecting the largest accelerometer signal. If the lab had done that, all but one of the accelerometers would have experienced undertesting.

To avoid further confusion and possible errors, establish rules for locating the control accelerometer as part of the procedures for experimental evaluation of new vibration test fixtures. Perhaps a future revision to MIL-STD-810 will institute the needed specifications.

About the Authors
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October 2006 revised November 2020

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