

# Technical Brief No. 14

All Technical Briefs are based on past projects at RH Lyon Division

Automotive  
Quality Control  
Vibration

## ***Reverberant Test Fixtures*** Window Lift Motor Testing

### ***Testing for Product Noise Compliance***

Automotive component manufacturers are often required by the customer to assure that their products will meet a noise and vibration standard when installed in a target vehicle. In such cases, the product is tested for compliance before leaving the manufacturer's production line.

Generally, it is easier to make a valid vibration measurement than an acoustical measurement on the production line because it is much easier to eliminate vibrational background than surrounding acoustical noise. When the component can be tested unloaded, only a simple isolating pad of rubber or foam is required. The component is placed on the pad and the test is run. An accelerometer or other sensor reads out the vibration at one or more predetermined locations and the signal is analyzed.

### ***"Obvious" Designs for Test Fixtures Have Problems***

When testing a component that must be operated under load, more care must be taken in isolating it. For the purpose of locating the window lift motor during a test, or to apply a load to the motor, it is necessary to place the motor and gear assembly in a fixture that will restrain it. It seems "obvious" that this restraint should be as "strong" as practical, making the fixture both heavy and stiff. In addition, if there is to be more than one of these fixtures in use, they must be made as identical as possible to produce consistent results.

Unfortunately, QA fixtures designed with these "obvious" guidelines have been found to have problems. Manufacturers have discovered that fixtures, made according to the same blueprints, do not give consistent results; products that pass when tested on one fixture will fail on another, and vice versa. Considering the cost and care that goes into such devices, this is not only a great disappointment but also a puzzle. However, there is an explanation and a solution.

### ***Why There Are Problems***

Anyone with experience in acoustics would not trust a measurement of sound from a product placed in a small cavity – an environment with only a few modes of resonance. This is particularly true if the source of the sound has strong tonal components, as does a window lift motor. The exact match-up between the emitted tones and the few cavity resonances can have a sizeable effect on the measured noise output of the motor. By direct analogy, a very "strong" fixture will have few vibrational modes of resonance. Again, coupling of these modes with the vibration of the motor will affect the measured signal. If the motor under test changes slightly, or if one copy of the test fixture has different material properties from the next, then the measured vibration of the motor when mounted in the fixture will vary, and inconsistent QA decisions will result.

***QA vibration test fixtures can be designed for accurate, repeatable measurements. These fixtures can be lighter, less expensive and easier to manufacture than commonly thought. They perform better too!***

### ***"Reverberant" Designs for Test Fixtures Do The Job***

A QA test fixture does not need to simulate the environment of the product. It need not be heavy and stiff. Instead, it needs to have many modes of response. Then, when a small speed change occurs, there is

another coincident mode that is present in the fixture to receive the exciting energy. With this design knowledge, the cost of fixtures can be reduced because precise, heavy construction can be avoided.

Additional precision can be obtained by taking the average of the vibration level at several different points. To do this, the product under test is mounted in the fixture in the usual manner, and several vibration pickups are used. The sum of these vibration signals is used to make a pass/fail decision. Employing these techniques, test results will be extremely consistent.