Optimized battery vibration tests

As electric and hybrid vehicles grow in popularity, the new systems they implement require new test techniques

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In the automotive industry, electric vehicles (EV) and hybrid electric vehicles (HEV) are becoming more prevalent. This has created the demand for new parts, new suppliers and new test requirements. HEV battery systems are not solid single cells like laptop batteries, but are assembled from many components, including electronic controller units, sensors, air flow ducts, cabling, cell mounting fixtures, cells, trays, covers and attachment brackets. This increasing use of electronics and battery systems in vehicles has driven rapid change in environmental test specifications.

The development of new test specifications has placed increased demands on vibration test systems. High-acceleration shock test equipment can be required and long durability tests in sine and random conducted. In particular '100g, 11ms' as described in GMW 3172-2008 is a target that many electrical components are required to pass for shock testing.

To reach the high level of demands required from an ED shaker system, there have been few options, including moving to a larger (often water-cooled) test system or using two systems (one large, one small) to cover the test requirements. However shaker systems are expensive with the potential need for further outlay on cooling systems and high maintenance costs.

ABOVE: IMV's ECO-shaker; the Intelligent Shaker Management System provides real-time feedback on CO_2 emissions and electrical usage to minimize running costs

Another way to increase the system test specification is by using a transformer-coupled system to achieve high velocity. For these systems, active DC control of the armature is not possible, which in turn demands that the shaker have a larger displacement specification, and makes shock tests harder to control. Moreover, the transformer is large and expensive for low-frequency shock testing (100ms = 5Hz).

IMV's unique ECO-shaker with automatic energy-saving operation has the added capability of full field control to deliver high-level system specification for the vibration testing of HEV batteries.

There are several key factors in an ED vibration test system that can be considered. For example: armature voltage (e) = field density (B) x

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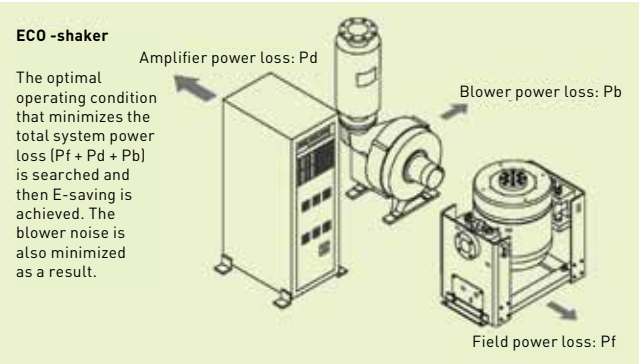
armature coil length (l) x velocity (v) and armature force (F) = field density (B) x armature current (i) armature coil length (l).

The maximum amplifier armature voltage normally determines the maximum velocity of a shaker. The maximum amplifier armature current normally determines the maximum force of a shaker. Force x velocity ∝ e x i = constant (for a given amplifier).

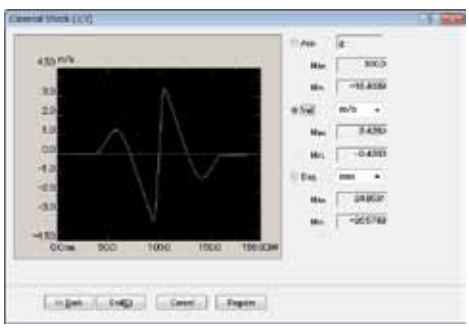
Therefore within a given 'e' and 'i' (amplifier rating), we can adjust force and velocity to suit a particular test requirement. The parameter to achieve this variation is 'B', the field density is proportional to the field supply voltage. By varying this voltage, it is possible to vary the field density. The vibration controller calculates each parameter of a test (force, acceleration, velocity, displacement) and therefore has the ability to optimize the performance of the vibration test system by setting 'B' to meet the test requirements. This automatic process in IMV's ECO-shaker systems requires no user input.

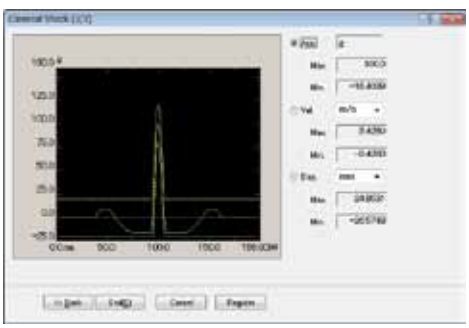
But what about the potential for energy-saving operation of an air-cooled ED shaker system? It is necessary for the ED shaker system that the field coil and the drive coil are continuously cooled during normal operation. In the conventional air-cooled ED shaker system, the blower is always driven at the nominal speed and the field current level is set to the nominal value to ensure that the system is always ready to provide the maximum possible excitation force if this is required by the test specification.



LEFT: Illustration showing how optimal energy saving is achieved with the ECO-shaker

BELOW: The optimized field current setting is calculated by the K2 controller and automatically passed to the vibration system





The ECO-shaker system solves this problem through the Energy Manager (EM). The EM software observes the drive current (armature current) and uses this observation as a constraint within the optimization routines. The EM software determines the optimum operating values for the blower speed and field current by calculating the minimum energy required by the ED shaker system to achieve the current test operating conditions. This real-time calculation is carried out by the automatic E-saving operation mode of the ECO-shaker.

The vibration test system specification is entered into IMV's K2 controller, including the low-field/high-shock capability. The required shock test specification is then entered and the controller compares the shock specification with the system specification and optimizes the field setting. This optimization is performed against the two equations discussed. The optimized field current setting is automatically passed to the vibration system.

IMV's shock-optimization software and energy-saving software is also available in semi-automatic mode for use with any vibration controller to achieve the same results. This technology can also be applied to existing shakers, achieving a substantial system specification upgrade and significant energy savings. ❮