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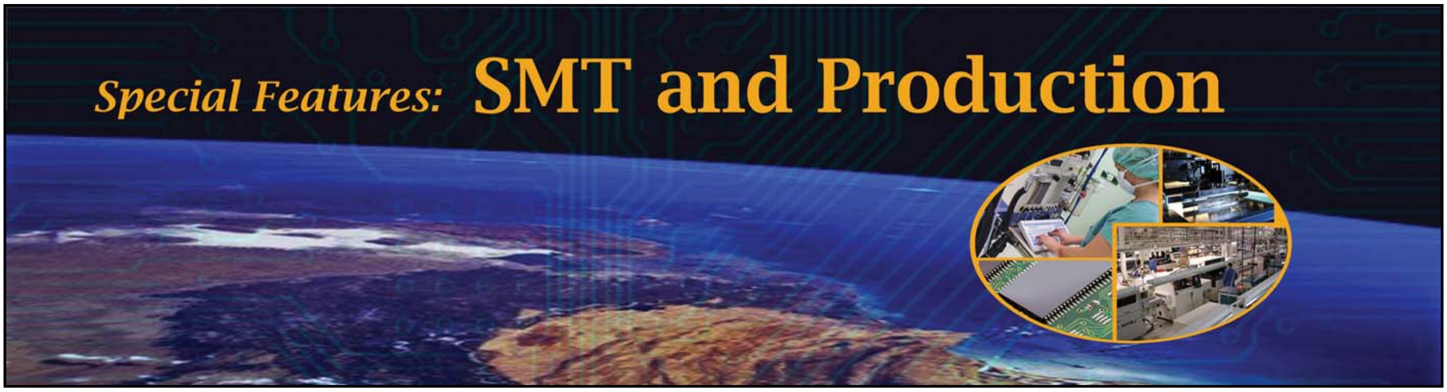

The Future of Electric Vehicle (EV) Battery Testing

By David Sigillo, Vice President, Seica, Inc.

With the expansion of electric vehicles around the globe, there is a growing interest in the entire battery lifecycle, from chemistries and manufacturing to recycling. One needs only to log into any social media portal to find advertisements for not only electric cars and buses, but also electronic drones capable of carrying packages and even people.

Aircraft manufacturers have also been prototyping experimental aircraft that run entirely on battery power, as they await the next technological leap in long-duration battery power life.

With the increased focus on and need for batteries, it is up to the OEMs to determine the best solution for their needs. For example, lithium-cobalt-oxide batteries are most commonly used for the consumer market. However, these have been judged unsuitable for automotive and transportation applications due to safety concerns.

The most commonly used battery chemistries in the transportation market are: lithium-nickel-cobalt-aluminum (NCA); lithium-nickel-manganese-cobalt (NMC); lithium-manganese spinel (LMO); lithium-titanium (LTO); and lithium-iron-phosphate (LFP). OEMs must weigh the tradeoffs of the six key components for battery selection in any given application — specific energy, specific power, lifespan, performance, cost, and safety.

Seica's Pilot BT battery test system can test nearly 2,400 battery cells per minute.

Most OEMs have decided to buy. They purchase batteries from known producers. On the other hand, some larger firms have partnered with battery manufacturers, and as a result, have played a role in the globalization of battery production.

With this globalization, a key component has emerged, which at times, takes a backseat to the topics of chemistries and long life. That is production, and more specifically, battery testing.

Battery Production and Testing

The production and testing of batteries usually can be accomplished in two ways. First, the battery OEM forms a partnership with an integrator that has mechanical assembly experience; or second, they actually design and develop specialized capital equipment themselves. Ten or more years ago, you could walk a production floor and see custom-designed solutions along with integrated test and inspection work cells.

These work cells were typically rudimentary at best, but they existed at a time when the market was still in its infancy, and they could keep up with production demands. The problem with these highly customized solutions was that they were generally slow, testing only a few cells at a time using older mechanical technology, such as stepper motors. From a software standpoint, they lacked the sophistication to manage data, and they simply could not easily generate test programs for a variety of different battery cells or battery pack configurations, which are much more common today.

Since the materials and chemistries generally remain constant for the life of a particular battery, the requirement is *not* to test the physical materials, or "energy" stored in the battery, but to verify the manufacturing process — typically measuring and testing the connection of the cells in the battery pack to the particular positive or negative terminal plate. These connections are critical to the lifespan of the pack and could have thermal implications caused by unbalanced energy. Battery manufacturers or OEMs producing or assembling the batteries need to ensure the reliability of the connection of the individual cells to the terminal plates.

There are three crucial elements to consider when choosing a solution for battery production test: test speed, configurability and reliability. As the custom-designed test and inspection work cells used initially have become inadequate to support the growth in volumes and the rapidly evolving technology, manufacturers have had to look for other test solutions which address all three.

Flying probe test was perhaps the first standard automated solution adopted by battery manufacturers, and these systems are now being widely used to measure the electrical connections in battery packs. Originally used in an "adapted" version to verify electromechanical connections, as opposed to measuring component values and shorts or opens on a circuit card assembly, at least one vendor has chosen the more innovative approach of developing a new solution, which addresses current and future battery test requirements in terms of speed, configurability and reliability.

Three Critical Elements

High throughput is the first consideration. The new hardware architecture of the Seica Pilot BT, in the maximum configuration of four flying heads, is able to perform parallel, very precise Kelvin tests of 16 cells at once. The machine achieves production rates of nearly 2,400 battery cells per minute, more than double what was previously available.

The second crucial element, configurability — the ability to test many different types of batteries — is paramount, because not all battery cells are created alike. This means that the fixed position probe configuration of the previous flying probe testers posed some limitations in terms of production test flexibility.

The Seica solution overcomes this limitation with "flying connectors," that can be arranged from 2 to 16 channels in either an x- or y-axis orientation. If a customer is testing a certain battery configuration on first shift and then needs to run a different battery on second shift, they simply change out the flying connectors for the alternate battery configuration. Another important factor is the size variability of battery packs, so the manufacturer needs to have the possibility to change the setup of the tester to accommodate products of various dimensions, as well as weight. The Pilot BT has the capability to test battery packs up to 41.33 x 34.05 in. (1,050 x 865 mm) and weighing up to 220.5 lb (100 kg).

The third consideration is system reliability. The production of batteries and their individual cells and "packs" could almost be considered an autonomous operation. Ideally, the OEM or battery manufacturer would like to pour a little bit of lithium, a pinch of iron, a cup of "secret sauce" into the hopper in the front end, and out comes a battery cell. This is an oversimplification, but the only way to get close to this is with highly reliable production equipment, where limited operator intervention is required.

Achieving this in a test solution is problematic, since batteries have a larger buildup of tolerances than circuit card assemblies — the tolerance from the individual placement of the batteries in the pack, from the batteries to the terminal plates, from the pallet or carrier to the battery pack to be tested, and so on. In this scenario, the ability to reliably contact individual cells for testing is essential.

This signifies that the tester must have the capability to check multiple fiducials to ensure the utmost targeting accuracy, as well as the means to assess very quickly, precisely and in real time, any unusual tolerances of the packs and to make adjustments on the fly. The presence of laser scanners, high-precision cameras and dedicated software, such as those included in the Pilot BT, are fundamental to be able to eliminate guesswork and manual adjustments for tolerances, and move to a completely automated test process.

A standard, automated test solution can offer a superior alternative to the home-grown remedies that many manufacturers have used until now, with a high overall equipment effectiveness (OEE) rating and facilitated maintenance, due to robust self-test diagnostics and standard parts. By focusing on the key concepts of speed, configurability and reliability, new test solutions, such as the Pilot BT, allow OEMs and battery producers to concentrate on other facets of their own businesses, be it building cars or building batteries.

With estimates for 2020 battery market ranging from $25 to $60 billion, it is certainly prudent to keep an eye on test solutions for this market. The early adopters are the winners here. Barring any negative political climate or cost of oil, new breakthroughs in battery technology are on the horizon, though some turmoil in the EV market will still exist. Most people would agree that the EV market is here to stay.

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