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New dimensions in battery testing

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Abstract

Flexible battery test systems with a high level of sophistication are available today thanks to advances in computer hardware/software and new microelectronics. Test systems are becoming more affordable with rapidly advancing features. These hardware advancements together with sophisticated software features for data acquisition and database management are expanding the roles of research engineers and laboratory personnel. Battery product performance and expansion of applications are no longer constrained by the limitations of testing equipment.

Introduction

The needs for battery testing cover a wide range of battery technology, performance standards and specific-application requirements. Battery testing equipment has advanced considerably from the manual and early computerized systems that have been available during the past few years.

Not only can difficult testing procedures now be carried out more effectively, but also the need for junior test personnel to take data and oversee the tests has declined considerably. The emphasis is now on research and development engineers to define tests that accurately examine battery performance under critical charge/discharge conditions without personnel limitations. Data acquisition is now completely automated. Performance data, that only a short time ago were difficult to obtain, are now routine. Only the required data need be recorded. This may be based on the rate of change of battery parameters or specified value changes. In any case, only relevant data are recorded.

With significant relaxation of the personnel restriction relating to data taking, opportunities exist for expanded research and process control development, as well as for quality-control testing. Expanding a battery database with performance data for new applications can also lead to new markets that would otherwise be missed. Some of the modern computer-controlled test systems include alarm and abort limits that allow tests to operate safely whether laboratory personnel are present or not.

The above advancements in testing capabilities have resulted in a laboratory environment in which it is possible to perform virtually any battery test necessary for any battery technology. Battery databases can now unmask all the potential uses for battery products.

Recent advancements in hardware technology

Hardware advancements have occurred in two major areas: data-acquisition circuitry and power components.

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The need for increased data acquisition has inspired development of new hardware approaches with emphasis on reducing the cost of these features while providing the accuracy required. Advancement of data-acquisition features have been helped by the following:

(1) programmable logic-reducing discreet components;
(2) higher accuracy A/D converters;
(3) higher density memory ICs;
(4) lower cost cell-scanning techniques;
(5) increased capabilities of computer hardware.

Another hardware advancement that has reduced cost and functionality is the use of power MOSFET transistors. Until recently, the cost of these devices limited their application. The use of MOSFET transistors can reduce the cost of power circuitry when it is necessary to discharge batteries to near zero potential.

While hardware advancements now allow many new, more affordable features, it is only with the concurrent development of system software and computer hardware that these new dimensions in battery testing are possible.

Data management is one of the most important functions of the system software. Orderly creation and retrieval of data files are vital to database management.

Testing capabilities now possible

Battery testing covers an extensive range of requirements from simple automotive battery performance tests to complex discharge profiles for nickel/cadmium batteries used with electronic equipment.

Although automotive battery tests are straightforward in comparison with other battery applications, lead/acid technology often requires advanced testing capabilities, especially with sealed lead/acid designs.

Performance testing may include charge/discharge cycling with ampere-hour, power or voltage limits. Tests are mostly defined by the intended application of the battery. There are, however, many standard tests for specific battery types with well-defined end-uses. These tests tend to be uncomplicated with limited data-acquisition requirements.

Complex battery testing requirements are most often necessary with advanced battery technologies. These will usually include sodium/sulfur, nickel/hydrogen and other battery technologies with a wide range of dynamic characteristics during charge and discharge. For these battery types, it is normal to have tests that must measure the change in voltage during charging, cell temperature, and cell voltages. Limit and abort conditions are almost always required to prevent runaway conditions. It may also be necessary for the test system to switch out cells when determining capacity limitations for multiple cells.

As previously mentioned, an important capability of a test system that is required to perform complex tests is the recording of data only when required. This will limit the size of the data files. Thus, the criteria for data logging must be selectable for each step in the test program.

Features available

An almost unlimited number of test features are now available. Most test systems, are designed, however, with a number of standard features to perform industry standard

tests. Cost becomes a concern when test requirements call for high-speed data acquisition or involve a large number of data inputs.

Standard features

The following is a list of the usual standard features.

(i) Display of all important test-circuit conditions as a total battery. These include date/time, circuit number, test-step function, time into test, elapsed time of step, remaining step time, cycle number, voltage, current, ampere-hours, watt-hours and temperature.

(ii) Back-up screens to show data-file number, program number and battery type. The data file should include a notebook provision to enter additional information about the battery, test purpose, and audit trail to related test on the battery under examination.

(iii) Other screen displays provide listings of data files by user-generated identification codes. A helpful feature is a search function to locate specific data based on multiple criteria.

(iv) A data-analysis package to provide graphic display or plotting of tabulated data. Advanced systems will allow multiple data plots and zoom capabilities on specific data.

(v) Data-file output in ASCII formats for transfer to Lotus or other data-analysis packages.

(vi) Automatic and manual backup of data files for data protection and to prevent overflow of data storage.

(vii) System parameters for defining operator access, system safety checks and alarm levels.

(viii) Test program listing that allows detailed display of program flow and test variables.

(ix) A multitasking environment so that test programs can be created or data files analyzed while data acquisition takes place in the background.

(x) Test programs that allow up to 50 steps with looping and branching capability. Test steps allow entry of multiple variables to regulate or terminate a step. Data registration may be specified as a function of multiple variables.

Optional features

(i) Cell scanning with settable termination or alarm criteria.
(ii) Scanning of multiple temperature inputs.
(iii) Cell cut-out for capacity testing of multiple cells.
(iv) Standard deviation analysis of cell data.
(v) High-speed data acquisition.
(vi) Data analysis for cell efficiency.
(vii) Special hardware packaging of mixed test circuit ratings within a single cabinet.
(viii) Networked work stations for initializing or stopping tests and data analysis.

Concerns in specifying test systems

A test system must perform the required tests at a price that is acceptable. In this regard, it is important to define fully the immediate test requirements, as well as potential future requirements. Features to provide the latter need not be purchased ahead of time, but the possibility of expansion should be investigated.

The following items should be considered before making a purchase commitment.

(i) Is it system user-friendly? Does it advise the user of input errors and protect against accidental loss of data?

(ii) Does the system provide a multitasking type of environment, e.g., spooling of data to printers or plotters so that other system functions are not inhibited.

(iii) Is the system expandable to accommodate optional features in the future?

(iv) Can existing test systems be retrofitted to work together with equipment that will be purchased?

(v) Are all the defined functions truly required at this time? If not, can they be added in the future?

Future expectations in battery test equipment

The availability of lower cost, high-density memory and higher speed analog-to-digital converters could have a significant impact towards reducing the cost of advanced testing capabilities. Computer software developed for operating systems that are not memory limited will provide faster data acquisition and analysis.

Almost certainly, the features of future testing equipment will surpass testing requirements.