Test Stand for Prospective Mobile Power-Supply Sources

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Abstract **– This article describes a method for the long-term testing of storage batteries and high-capacity ion sources, implemented using National Instruments technologies.**

A test stand was developed using DAQ NI USB-6001. A brief description of the program implemented in NI LabVIEW is given. The part of the program code is opened - the block diagram of correction of temperature coefficients. The interface of a virtual device for monitoring charge and discharge is shown.

In the course of the test, on the test bed, the degradation of the capacity of the charge was proved. The test results showed that the ionistor capacitance dropped from 50 kF to 3.3 kF for two weeks of testing and continued to decrease with each charge and discharge cycle.

Keywords – NI USB-6001, LabVIEW, supercapacitors, battery testing.

I. Introduction

As known, lithium-ion batteries have a limited quantity of charge and discharge cycles for the declared capacity. Moreover, the quantity of cycles strongly depends on a manufacturer of these batteries. That is why it is actual for some tasks to determine more accurate parameters of their operating characteristics.

As a result of this work, a stand for analysis and study of the time evolution of battery characteristics was designed.

Batteries with the following characteristics were taken as the basis:

- capacity: 5000 F
- discharge current: to 10 A;
- quantity of charge and discharge cycles: 25000

that corresponds to about 10 years of continuous operation without capacity deterioration.

II. Task

It was required to create a stand for long-time battery testing. Batteries shall operate in the charge and discharge mode. In the course of work, it was also decided to use a delay timer during batteries transfer from one mode to the other one. So the operation modes maximally approach to the real operation conditions.

III. Tool Base

The control program was realized with the help of the NI LabVIEW 2015 software, NIDAQ and NI ELVIS drivers were additionally installed to control the measurement accuracy.

A device made by the National Instruments USB-6001 company, which has main functional capacities for data acquisition and measurements for scientific and laboratory experiments, was selected for data control and acquisition. The NI USB-6001 unit is programmed due to the National Instruments LabVIEW software. Integrated Express tools allow easy unit adjustment for real-time operation. The NI USB-6001 unit has 8 analog inputs (14-bit, 20 kS/s) and 2 analog outputs (14-bit, 5 kS/s/channel); 13 digital lines and counter digit capacity to 32 bit.

The stand body is made of a fireproof material because, during long-time tests, the fire safety is an extremely important parameter. Metal-coated spring contacts are applied for convenient and quick replacement of batteries to be tested.

Since the quantity of control channels is limited, it was decided to multiplex them due to the integration of relay switches into the system.

Fig.1 shows the structural connection diagram of test stand. A personal computer with an installed LabVIEW 2015 package and data control and acquisition program is the main component. The USB-6001 control unit is responsible for channel switching and parameter recording. The channel switching board changes the mode at batteries from charge to discharge in the opposite mode, and the first battery is charged, the second one is discharged. A laboratory power-supply source with the output current to 10 A, and voltage to 30 V is used for charging. The load consists of parallel-connected high-power light bulbs. The stand is designed for parallel tests of two batteries, but it also has the connection mode of one tested battery.

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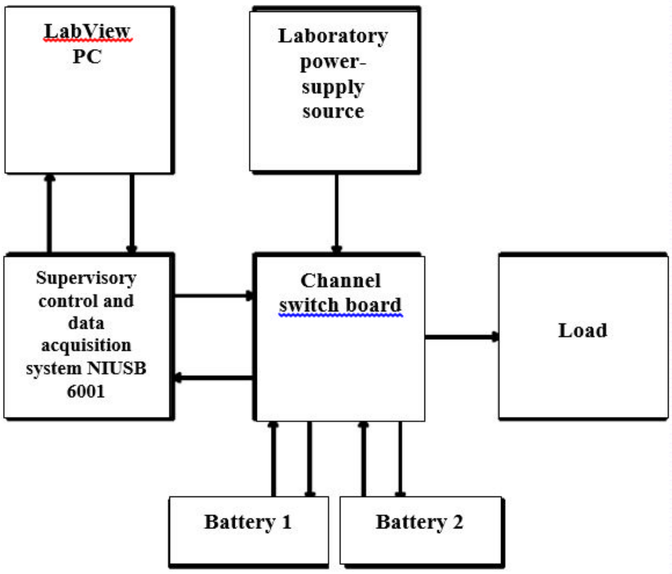

Fig. 1. Test stand flow chart

IV. Program and Control Algorithm Realization

The batteries have different charge and discharge times, so the adjacent channel waiting algorithm on the basis of the RS-trigger behavior was integrated into the program. Then additional virtual tools were integrated.

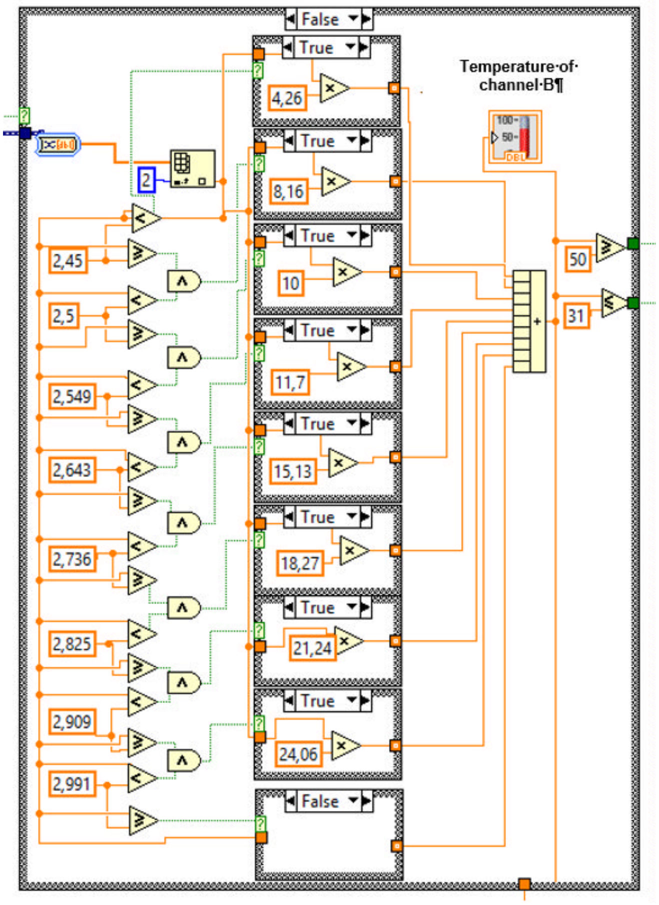

Fig. 2. Virtual tool for temperature coefficient fine adjustment

Fig.2 shows a virtual tool for temperature compensation and coefficient fine adjustment. KTY81-110 temperature sensor is made by NXP Semiconductors. The sensor has a nonlinear resistance-temperature characteristic. The coefficient fine adjustment is done in the program relative to the current value. Received data from temperature sensors are used only to prevent from battery overheating. When the preset value is exceeded, coolers are on for cooling.

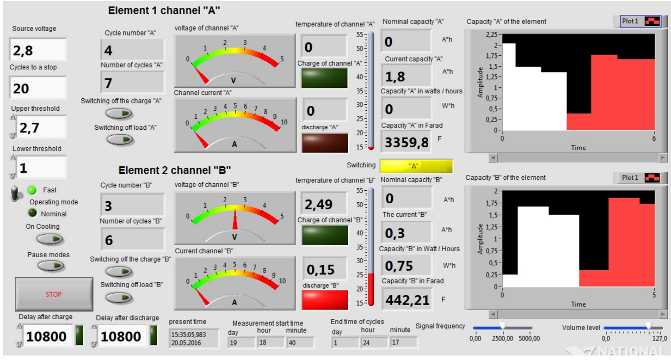

Fig. 3.Charge and discharge control program interface of two batteries

The program consists of several parts, offline modules (Fig.3.). At first, the operator shall set parameters at the laboratory unit and set load rating at this stand. Then these parameters are recorded into the program, and the quantity of charge and discharge cycles is set. The required delay after charge and discharge in seconds is set underneath. A forecast of test end time after the calculation of the first cycle time is made by a statistical calculation. In the interface middle, the pointer indicators show the valid voltage and current value, the temperature is shown by the thermometer stem. The capacity of batteries is calculated at once in several measurement means, such as ampere-hour, watt-hour and in farad.

The algorithm responsible for the capacity calculation makes voltage and current multiplication, and then sums it up with the previous value, thus accumulating the total capacity volume. The result accumulation occurs due to the integrated feedback function.

The parameter measurement accuracy directly depends on the time interval value between the selections of primary measurement values. The protection against overload and exceeding of the allowable temperature threshold is provided, which prevents from battery overheating, as well as, at limit load values, the battery temperature can reach the critical value, and it shuts the battery down. When the battery temperature exceeds 50 degrees by the Celsius scale, cooling fans are automatically on, and the PC outputs an audible signal, which volume and tone value are set in the lower part of program interface.

V. Test Results

The stand was designed for continuous testing during some months (Fig.4). A comparison of obtained data with the rating of high-quality rechargeable batteries was made to check the reliability of results. The results obtained with the help of this test stand confirmed that the charge capacity deterioration during some short time interval took place in tested batteries.

The total capacity was about 3300 farad and was reduced after each charge and discharge cycle by 7% of the previous value.

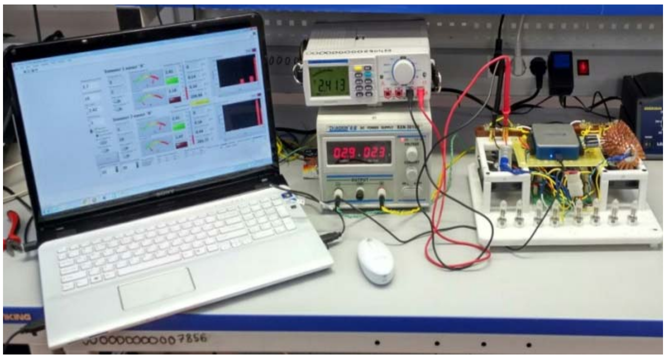

Fig. 4. Test stand appearance

VI. CONCLUSIONS

This stand allows making tests both at specialized power supply units and at different types of rechargeable batteries and supercapacitors. Quantity of cycles, charge voltage, discharge current, as well as many other parameters can be selected for different types of batteries. The program interface displays operation control elements and parameters of current values. The recording of all values on the hard drive into a table .xls log file is done during testing. A careful analysis of all processes can be made after ending of tests with the display of pictorial graphics. This stand is applicable both in single scientific laboratories, and in industrial operation.

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