MULTIPLE CONSTANT POWER DISCHARGE TESTER

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1. Introduction

The range of battery applications is increasing year by year. Despite the fact that new battery concepts have been developed and are being marketed, the lead–acid battery is still the first consideration in any new application for secondary batteries. This paper is therefore primarily directed to the problems of this system, but it would appear that all secondary systems are beset with similar difficulties which must be overcome.

It is evident that new applications are more sophisticated than established ones and require more sophisticated battery designs and consequently more sophisticated test procedures. Let us consider, as an example, the frequency control facilities under construction at the Berlin electric power utilities (BEWAG) where modern design lead–acid batteries will act as energy buffers. The batteries will supply additional power to the mains as demand increases, and will be recharged as demand is reduced. As this situation will only exist for the time necessary to adjust the power plants to the new demands the load will change rapidly, within seconds or minutes. No decision on such a multimillion mark project would have been taken in advance of tests involving the whole system and including the suitability of the batteries.

The tests for new applications should include at least performance data, service life of all the components, and behaviour under different specific loads. To undertake all these tests manually would be almost impossible taking into consideration all the necessary man power and time. To obtain a complete and reliable set of data the modern trend is to use a computerized, fully automatic, controlled system.

2. The battery test system BTS 200

2.1. Hardware

The hardware involved in an automatically controlled battery test system normally consists of:

the process computer;
the video terminal;
the printer;
the plotter;
the test units.

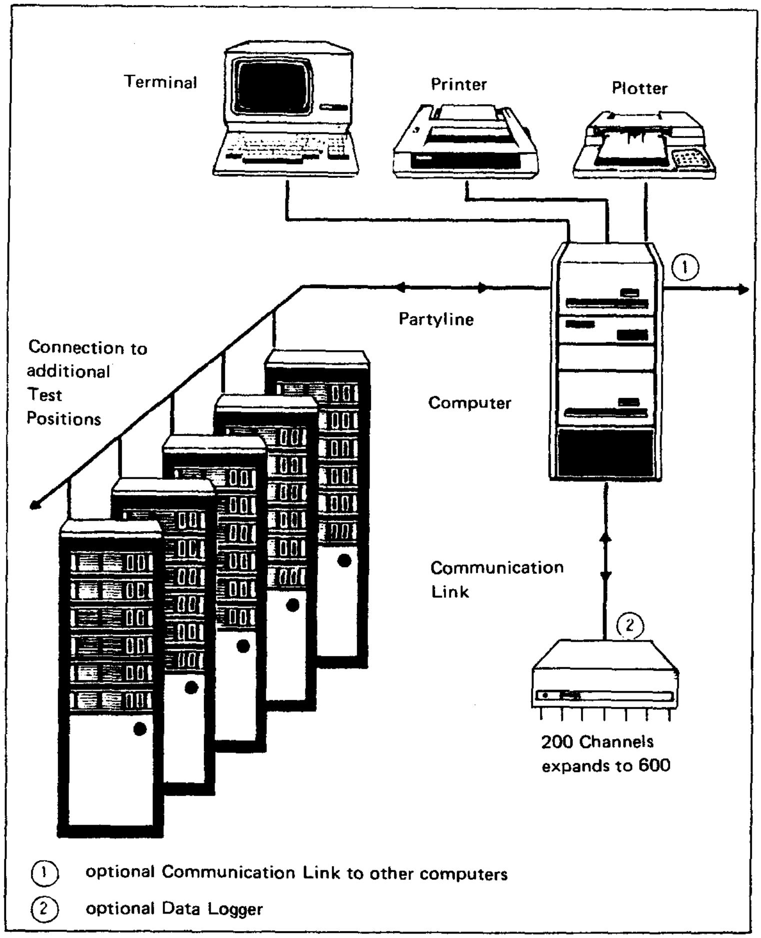

Fig. 1. BTS 200 system configuration.

The arrangement of the components is depicted in Fig. 1. Detailed information and specifications relating to the components and optional extensions are available on request. As an adjunct to the above, only two main features need be mentioned.

The connection between the process computer and the test units consists of a screened, two-wire party line only, which may be several hundred meters long, so test and control sites need not be too close, and the installation of several multi-wire cables can be avoided.

The test units are, in most cases, charge or discharge circuits or combinations thereof, and include an intelligent interface (PSE). The core of this interface is a microprocessor coordinating the data transfer with the central unit and internally controlling the circuit. So the main functions are:

(i) switching of the operation mode (charge, discharge, pause);
(ii) setting the nominal values for current and/or voltage;
(iii) control of actual current and/or voltage;

(iv) pick-up of actual data;
(v) transmission of data to the central unit;
(vi) reception of control data from the central unit.

The design of the interface allows, in most cases, its installation into already existing circuits.

In testing industrial batteries, charge–discharge units are available according to the user's specifications in respect of nominal voltage and current. The construction of the units, in most cases, is based on a thyristor technique.

2.2. Software

The design of the system allows for a flexible definition of the test methods which might be entered by the user through the video terminal in dialogue. In this way running programs will not be interrupted. The test results need not be read individually and transferred to Tables, but are automatically registered and normalised to provide clear reports printed out on request. This might be done via the printer or — in diagrams — via the plotter. All relevant data might also be stored and transferred to mass data storage from time to time.

Special emphasis was laid on ease of operation. One need not be an expert on EDP since all entries for battery and test identification, as well as for the relevant test parameters for the test procedure and for the number of cycles, are provided by a menu technique and assisted by masks (Fig. 2). All entries are made in simple words in the English or the German language. Explanatory texts can be retrieved during the dialogue by selecting the INFO function.

The menu system is not only used to define new test procedures but also for:

advising and cancelling of batteries,
calling and altering of procedures,
combining battery, procedure and test unit for test,
entry of data from other tests,
setting of the system's data,
output and clearing of the test results,

and other functions. By using passwords, access to the system could be limited to a different level for different people.

Standardized test procedures, such as those defined by the IEC, in most cases use simple criteria such as constant current load, and are terminated by, *e.g.*, reaching a certain terminal voltage. Such tests are very useful for standardization but are not always suitable for practical battery application. Consequently, a UPS system requires constant power supply instead of constant current, and termination of operation is determined by the maximum current. For electric vehicles, heavy load alterations are more typical than average loads.

To meet these demands the system allows for the use of secondary data such as the discharge power of a single or of a defined set of identical test circuits which are operated simultaneously as test loading parameters. Also

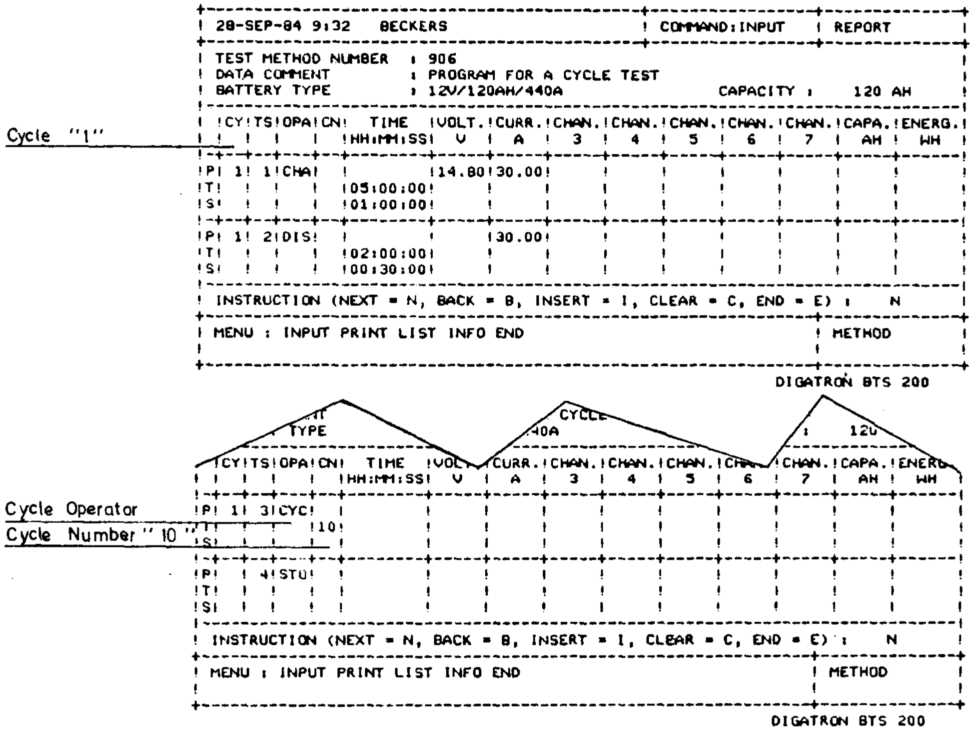

Fig. 2. Program for a cycle test.

during charge, power could be used for this and, together with a limiting voltage, a constant power–constant voltage charge might be obtained instead of an *IU*-charge according to DIN.

The switch or terminating condition could be either a test time, a voltage or a (maximum) current. In this way, by defining several operational steps in sequence, a test procedure for any complicated structure can be developed.

3. Applications

3.1. Battery sizing

Battery sizing is a typical problem in stationary battery application. In many cases the load is well known or, at least, has been calculated. The optimum size of the battery must be determined. This can be done in a straightforward manner provided that a constant current load is requested. As soon as more complicated conditions such as different consecutive constant current loads or, even more complicated, different constant power loads are required the applications engineer must make use of more or less generally accepted assumptions to arrive at a solution. This solution might be verified using the BTS system. A more accurate and reliable recalculation of the battery size is then possible.

By repeating the tests with older batteries, the effect of longer service life can also be demonstrated. Temperature correction effects can be expected to be revealed more clearly.

Finally, the acceptance test will be reassuring to the test engineer. It is possible to run the whole load fully automatically without any manual switching and the result can be printed out ready for signing. This not only saves manpower, but also increases the reliability and accuracy of the tests.

3.2. Cycle life tests

The cycle life of a traction battery can be determined according to standards such as DIN which will provide comparable but not practical data. A typical example is an electric vehicle battery. The load profile for this application is fairly well known, but up to now, to the author's knowledge, it has never been used for life determination. This is due to the frequent change of the (constant power) load which is made more complicated by deceleration energy feed-back into the battery during braking periods.

Heat generation due to ohmic losses within a battery is proportional to the square of the load current. It will be higher when using the correct profile, therefore, than it is when applying the average profile. Since temperature affects service life, this might be one reason for the difference between laboratory and practical results.

Without listing all the unsolved problems, an additional investigation could be made into the different performance data arising from the exchange of single cells in a large battery after a particular length of time, a procedure which in most cases is not recommended by the manufacturer.

3.3. Investigation of design parameters

The investigation of design parameters is essential for R&D purposes. Here, also, it is interesting not only to undertake tests according to general standards but also using parameters characterizing future applications. In this case, the use of parallel-operated, low voltage charge–discharge units should be advantageous. A nominal 12 V unit comprises 6 lead–acid cells, a number which allows limited application of statistical laws or at least majority decisions in case of freak values. On the other hand, different design parameters might be checked in parallel under identical conditions.

Examples of such parameters might be:

intercell connectors,

separators, tubes, S.G. of acid and other components,

current distribution by varying the length and width of the plates while keeping the area constant,

use of monoblocs with welding through the partition wall instead of single cells.

Design engineers are never lacking in ideas, but additional to the preparation of samples the bottleneck often occurs as a result of the test and evaluation capacity of the laboratories, especially when more complicated test conditions are requested.