

# **AUTOMATIC MEASURING SYSTEM FOR RESEARCH LEAD/ACID CELLS**

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## **ABSTRACT**

An automated data capture system comprising an electronic measuring board and charge and discharge power source connected to a computer was developed for laboratory cycling of battery cells. Development, checkout and the improvement of the measuring software is showed in this paper. Newly designed and developed measuring apparatus leads to establishment of modern, precise, prompt, reliable, user-friendly and graphically-object-oriented measuring program which removes deficiencies of the contemporary measuring workplace and which greatly expands possibilities of existing measurements. Measuring program was developed under MS Windows XP platform by the usage of the program VEE Pro 8.0. Data will be automatically saved to tables and graph directly presented with help of charts in the spreadsheet of program MS Excel.

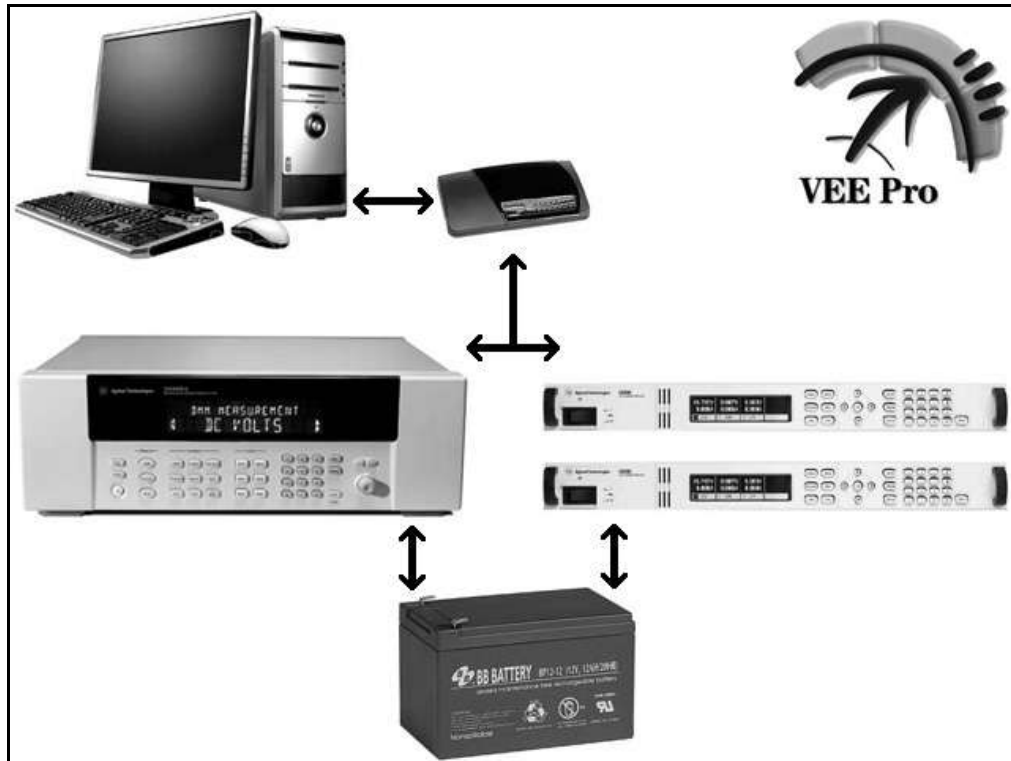
## **1. INTRODUCTION**

New measuring system will replace the contemporary measuring apparatus which is 15 years old and was using operating system MS-DOS and programming software Turbo Pascal 5.0[1]. This equipment enabled to execute the automatic measurement of the contact resistance and the resistance of active mass and further automatic cycling of monitored cells together with the cell voltage and cell current data recording. However the evaluation part was problematic, because of the data was necessary to computerize on another computer and there was no possibility to watch the progression in the graphic form during a measurement. On the top of that the multimeter and computer failed as well. All of this was brought about the deceleration of evaluation and it was not possible to flexible respond to the problems generated in the course of the whole experiment process. Used measuring software was not possible to use in combination with new high-speed computers. This complicated exchanges of defective and serving out parts of the measuring PC.

## **2. MEASURING APPARATUS**

The measuring system design for automatic laboratory cells cycling can be seen on Fig. 1.

The apparatus centre is a computer which is connected with the LAN ( UTP category 5 ) cable to switch and peripheries. For measuring is there Agilent 34980A Multifunction Switch/Measure Unit and for power supply are there two Agilent N6700B Unit [2].



**Fig. 1:** The measuring apparatus for the automatic laboratory cells cycling.

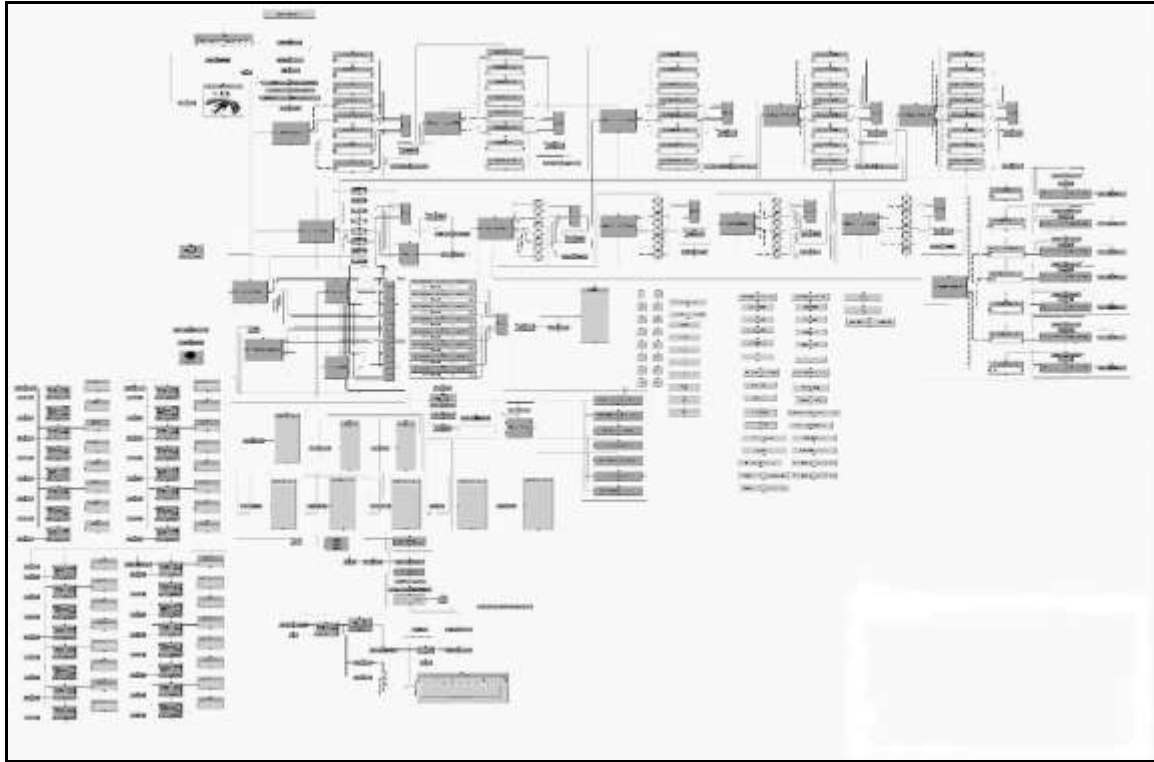
The measuring software controls all of these devices. Voltage proportional to the cell internal resistance and the total cell voltage are brought to the multiplexer on Agilent 34980A. Switching of the discharging / standing / charging of laboratory cells runs in the switch-board on Agilent 34980A. The current is directly read from the power source.



**Fig. 2:** The measuring apparatus for the automatic laboratory cells cycling.

## 2.1. SOFTWARE

Measuring software VEE Pro 8.0 is based on the object programming - the programmer defines the input and output data flow of the individual template program modules. The basic instructions which control the peripheral equipment are inserted in the various control modules. The final software is formed by the efficient connection of these functional modules. There is possible to see simplified schematic diagram of measuring program which is assembled from the few basic modules on the Fig. 3.

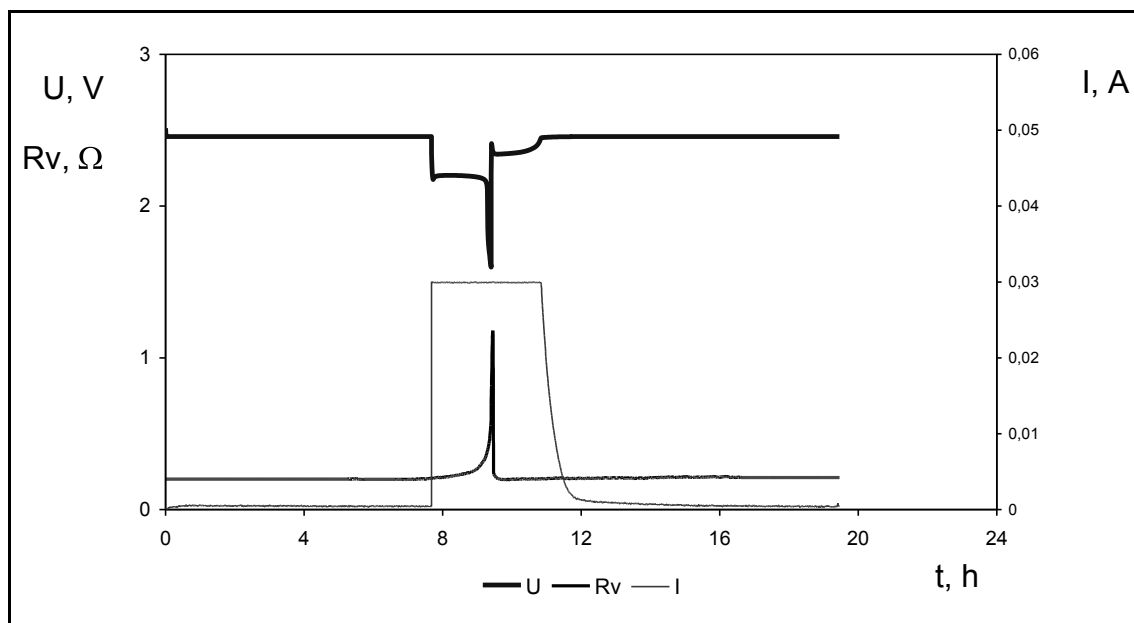


**Fig. 3:** Simplified schematic diagram of measuring program.

After pushing the button "Start" it comes to the data loading (number of cycle and cell capacity before, previous settings, etc.). Then user can select function, what he want to do with laboratory cells (Charging and cycling with measuring, Discharging and cycling with measuring, Standing and measuring, Charging with measuring, Discharging with measuring, Cell formation. Also program can discharge with PSOC mode. All of these function can run separately and independent on other cells. Function are executed with cycling in never ending loop that can be interrupted both by the operator (the button 'Switch off') and the any peripherals equipment error (measuring unit, source unit, outage electric flow). Measured magnitudes (Voltage, Current, Internal Resistance, potential of the positive and negative electrode, vapour tension, thrust or temperature) are measured after the given intervals and simultaneously recorded to the MS Excel tables and instantly graphically displayed - see Fig 4.

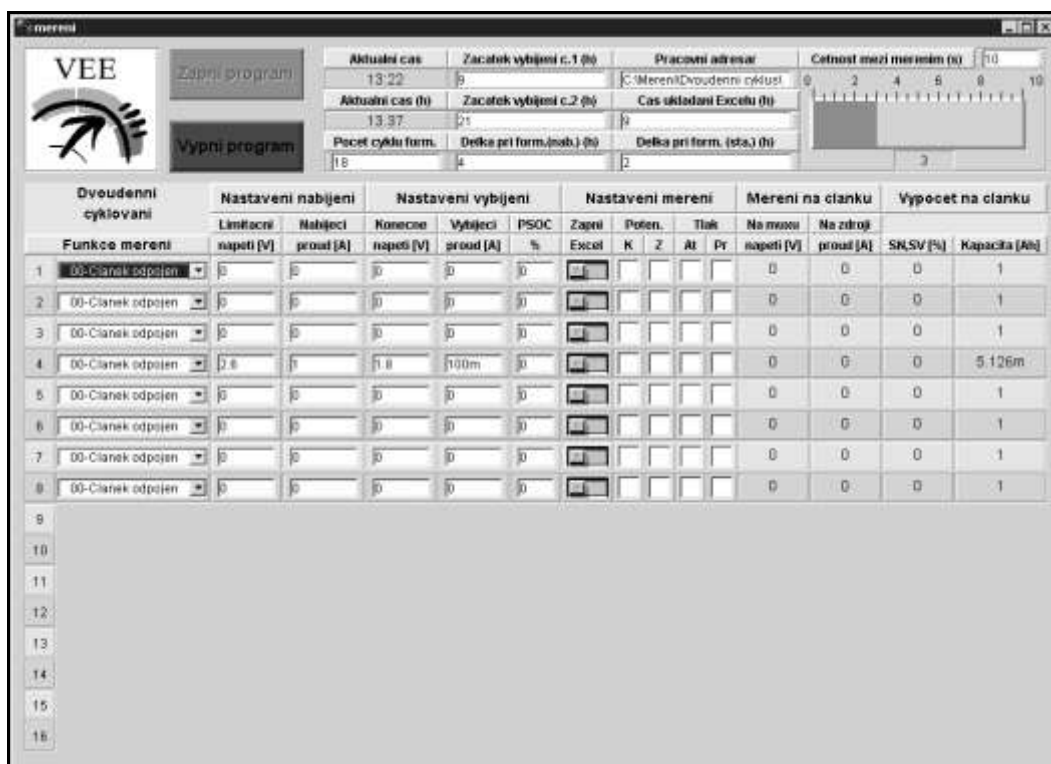
At the end of each measuring cycle the important data (date, number of cycle, cell capacity, etc.) is saved to the file (the module 'Save data to file').

There is possible to see the panel settings on the Fig. 5. Is necessary to be, because is very important for operative person. The input values of variables can be set there (charging voltage limitation and current, discharging voltage, current and percents of PSOC). Also user can turn on many measurement input and modules.



**Fig. 4:** Graphical dependences of measured values without potential of the positive and negative electrode, vapour tension, thrust and temperature.

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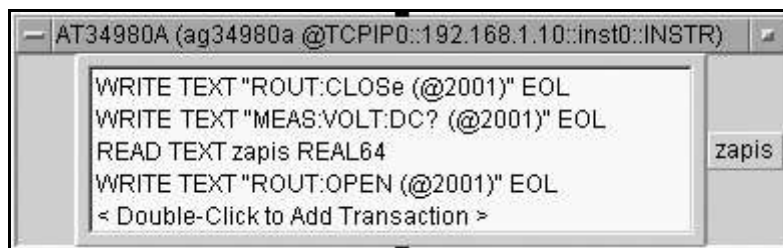


**Fig. 5:** Panel settings for controlling all measurement process.

At the beginning the module 'charge' program switches off the discharge contacts (the module 'Discharge off'), sets the power source in agreement with input values of variables

(the module 'Source adjust') and at last switches on the charging contacts (the module 'Charge on'). After that the important parameters of experimental cells both on the source – voltage, current (the module 'source measurement') and on the multiplexer card – voltage, internal resistance, potential of the positive and negative electrode, vapour tension, thrust and temperature (the module 'Module measurement') are measured after the given intervals.

There is possible to see the example of command sequence for the voltage of experimental laboratory cell in the multiplexer card on the Fig. 6.



```
AT34980A (ag34980a @TCPIP0::192.168.1.10::inst0::INSTR)
WRITE TEXT "ROUT:CLOSE (@2001)" EOL
WRITE TEXT "MEAS:VOLT:DC? (@2001)" EOL
READ TEXT zapis REAL64
WRITE TEXT "ROUT:OPEN (@2001)" EOL
< Double-Click to Add Transaction >
```

**Fig. 5:** Module voltage measurement on port @2001.

On the first line there is the command which closing port for measuring. Second line sends the instruction for the data reading on the port @2001 (the cell voltage is connected to the port @2001). Subsequently the value of voltage is read and written to the variable 'zapis'. Then port must be open.

### 3. CONCLUSION

The automatic measuring system allows the large-scale long-term experiments making without presence of operator. This is made possible by the automatic start of runtime version of measuring software in MS Windows platform even after the computer reboot. This new measuring system helps our laboratory to get new measured values and more accurately. User friendly graphic environment allows monitoring the measured data in the course of experiment. It makes possible to operator to respond on critical situations which could happen in time. In graphic-oriented object programming there is possible to modify the program according to needs and up-to date requirements.

### ACKNOWLEDGEMENT

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### REFERENCES

- [1] Křivák, P.: Study of the impact of compression upon the properties of positive electrodes of the lead-acid accumulator, thesis, Brno 2001
- [2] Lábus, R.: Automatic laboratory cells cycling and measuring system, thesis, Brno 2006