# INCREASING RELIABILITY AND IMPROVING THE PROCESS OF ACCUMULATOR CHARGING BASED ON THE DEVELOPMENT OF PCGRAPH APPLICATION

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*Abstract: The article presents the software written in Builder C++ that monitors the process of processor impulse charger. Protocol, interface, components used and the future research are presented..*

*Keywords: PCGraph, developing software, charging process, C++ Builder*

*ACM Classification Keywords: C.3 Special-Purpose and Application-based Systems*

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## Introduction

The article presents the software written in Builder C++ language that monitors the process of charging through COM port. Pulsar is impulse charger made by Elprog. It is a professional fast impulse charger to charge all kinds of cells available on the market. The product won the prestigious prize "Polish Market" in 2004. Among its qualities are:

1. the speed of charging
2. the reliability of the charger process
3. the regeneration of old cells
4. the monitoring of charging process.

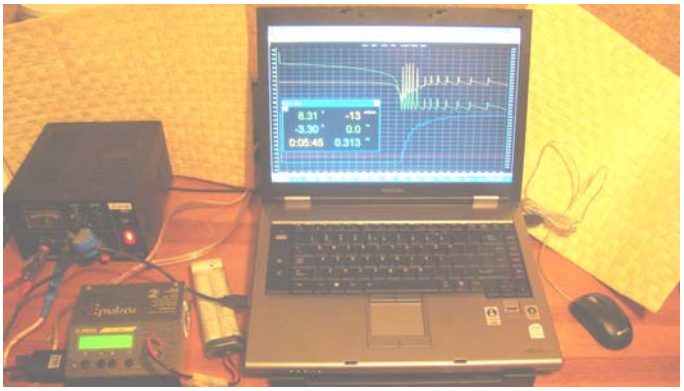


Fig. 1. The charger system during work

Computer program that read the data directly from charger is a useful tool to analyze the quality of aku pack.

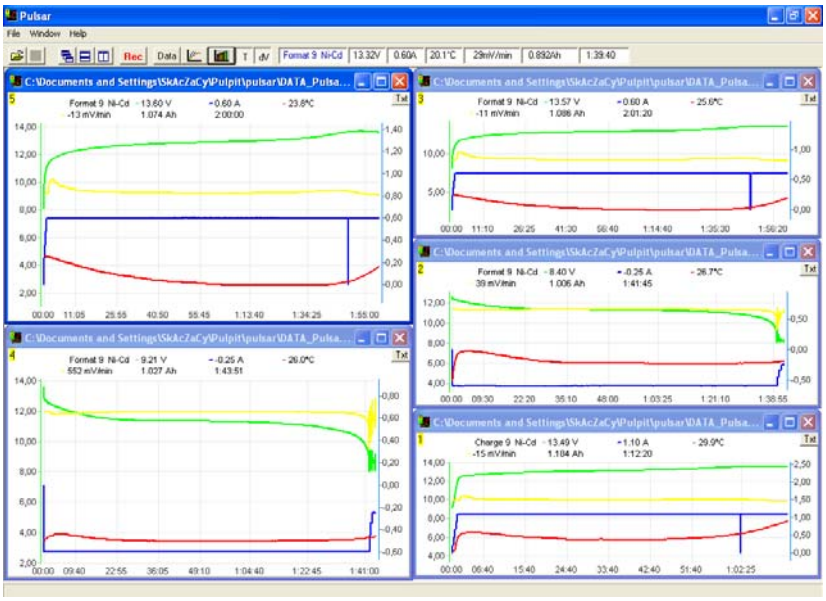



Fig. 2 The graphical interface of PCGraph program
(the colors determine: blue – amperes, red – temperature, green – volts, yellow – dV/dt)

The charger system and the graphical interface of PCGraph program is shown in Fig. 1. and Fig. 2.

The system is used especially when high reliability is required. The systems work for example in European Space Agency and Polish Polar Station (Spitsbergen).

The program is written in Builder C++ as an MDI application. Components used are presented in Figure 3.

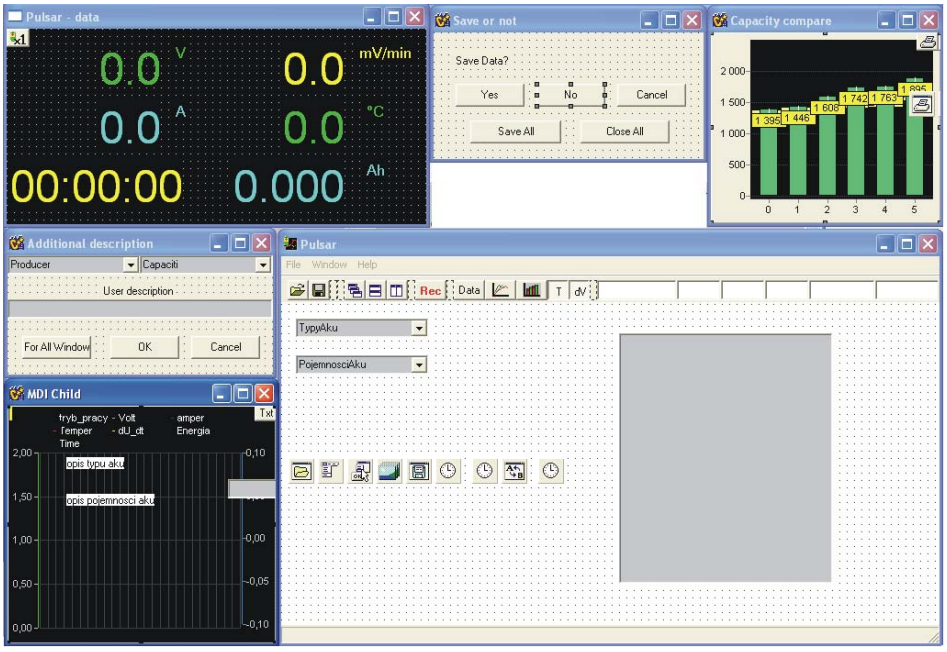



Fig. 3. The view of chosen forms with components used.

The data flows diagram between the most important components are presented in Figure 4.

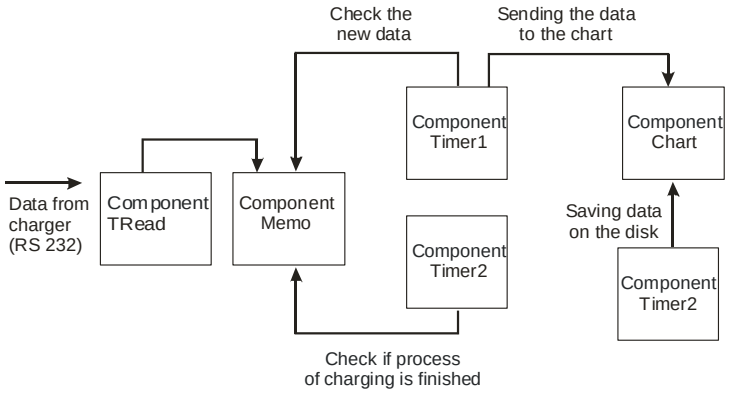



Fig. 4. Data flow diagram of applications.

A serial port is used for communication. The format of protocol (32 bytes long) is presented on Figure 5.

| #C | 3 | 5 | D | 00035, | 12029, | +0199, | 000, | 00001 |
|---|---|---|---|---|---|---|---|---|
| Begin frame | Number of cells | Cell type | Char. Type | Time[s] | Volts[mV] | Curent[mV] | Temperature[°C] | Energy [mAh] |

Fig. 5. The charger communications protocol data format

The type of calls determined the kind of process charging (Table 1)

The charge mode is described with letters – for their meaning see Table 2. The plus and minus sign before the ampere's value means charging and discharging.

*Table 1*

| Type of calls | Kind of accumulator |
|---|---|
| 1 | Ni-Cd |
| 2 | Ni-MH |
| 3 | Pb-bat |
| 4 | RAM |
| 5 | Li-Ion |
| 6 | Li-Pol |
| 7 | Li-TA |
| 8 | Li-S |

*Table 2.*

| Charge/ Discharge mode | Charge mode |
|---|---|
| D | Discharge |
| S | CH. Simple |
| R | CH. Reflex |
| P | CH. Pb-bat |
| L | CH. Lith |
| C | Regen. |
| C | Charge |
| D | Disch |
| F | Format |

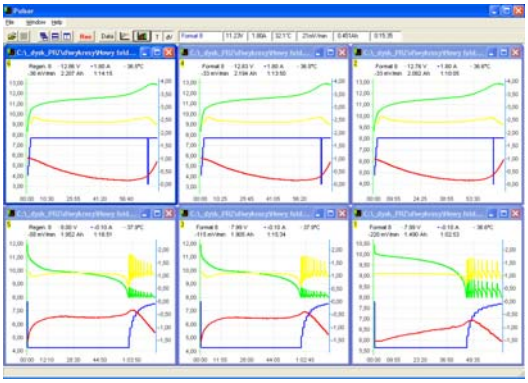
The reading and correct interpretation of charging and discharging process characteristics that are obtained enables us to determine the actual quality of accumulator. However, some experience in reading the characteristics obtained is required. A demonstration of characteristic received with one weaker cell is shown in Figure 6.

*a) the characteristic of charging process in which after 22 minutes and 30 seconds there was a volt decrease. This situation means there is one weaker cell in the package*

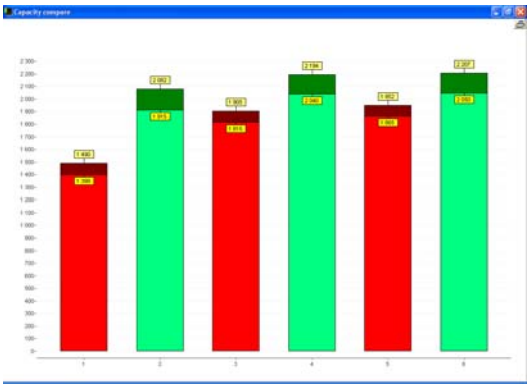
*b) the example of charging a cell that was completely discharged*

Fig. 6. The examples of packages of accumulators' defects characteristic

The program presented enables the recording of several discharging/recharging cycles and to present the data in graph form. The possibility of such analysis is valuable during the package's regeneration as well as during the determination of its consumption in time (see Figure 7).



*a) the graph of separate cycles*



*b) the graph comparing capacity*

Fig. 7. A three-cycle discharging/recharging process in which the capacity of an accumulator package was raised from 1400mAh to 1900 mAh

The monitoring program that collects data and presents them in the form of graphs is therefore extremely useful to all that increases the functionality of the charger. The reading and proper interpretation of graphs is possible only after gaining some essential skill by the user which often requires some time and effort.

## The Current Research

Research on the process of creation the expert system that would make reading graphs not essential for the user is being conducted. Initial analyses using the artificial neural network were satisfactory. The network (for the scheme see Figure 8) was prepared as an expert system stating whether the discharging process of an accumulator package finished successfully.

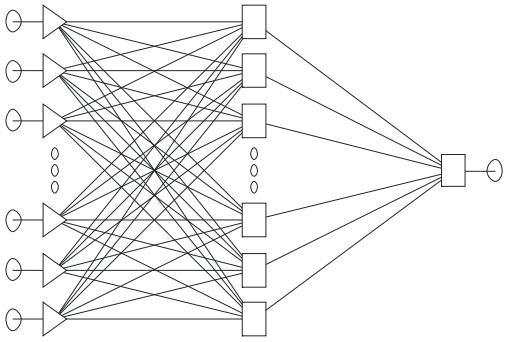


Fig. 8. The scheme of neural network used to identify the fault of accumulator packages.

The data received during the charging process was normalized in table of volting level $[U_1,U_2,..,U_n]$. The output vector consisted of two elements (the correct package and the wrong package). Coincidence of the network's learning process was observed during the experiment. The modeling of neural network was made in STATISTICA NEURAL NETWORKS system. At this stage collecting more actual data including information about the charging process is crucial. In order to achieve these purposes the current program version includes the record of extra information about the package.

## The Future

It is probable that the next program version would enable sending the collected characteristics directly to the network server that contains a database. Building an internet server including the expert system is another aim that should be possible to achieve. It would be attainable for the user to check whether their package is correct using the current knowledge of server's expert system and the data could increase sources available. Several possible scenarios of development are shown in Figure 9.

The possibility of building evaluation system that would not only find the package faults but also indicate the type of damage, e.g. damage of a single cell (or a few cells), complete discharging of one cell in the package, wrong charging method used (e.g. Ni-Cd accumulators were charged as Ni-MH), wear–out of the package etc should be examined during future research. The significance of such research is emphasized by the fact that the increase of the number of mobile devices was observed in recent years and therefore there will be more demand for

evaluating and repair of accumulator. The charger is also currently utilized by certain services such as police, fire brigades where the reliability of technical devices is of great importance. The use of data-mining for huge amount of data might result in development of routine accumulator exchange or inspection standards. The experiments indicate that the chargers delivered with the equipment often cannot make full use of the device. Also they can damage the accumulator packages even though they were destined for the concrete type of equipment as it often happens in different kinds of inexpensive mobile tools. The user exchanges the devices or accumulator packed which causes the increase of their number on garbage dumps and causes the pollution of environment. Therefore, the conduction of this research and further development of software presented seems to be appropriate.

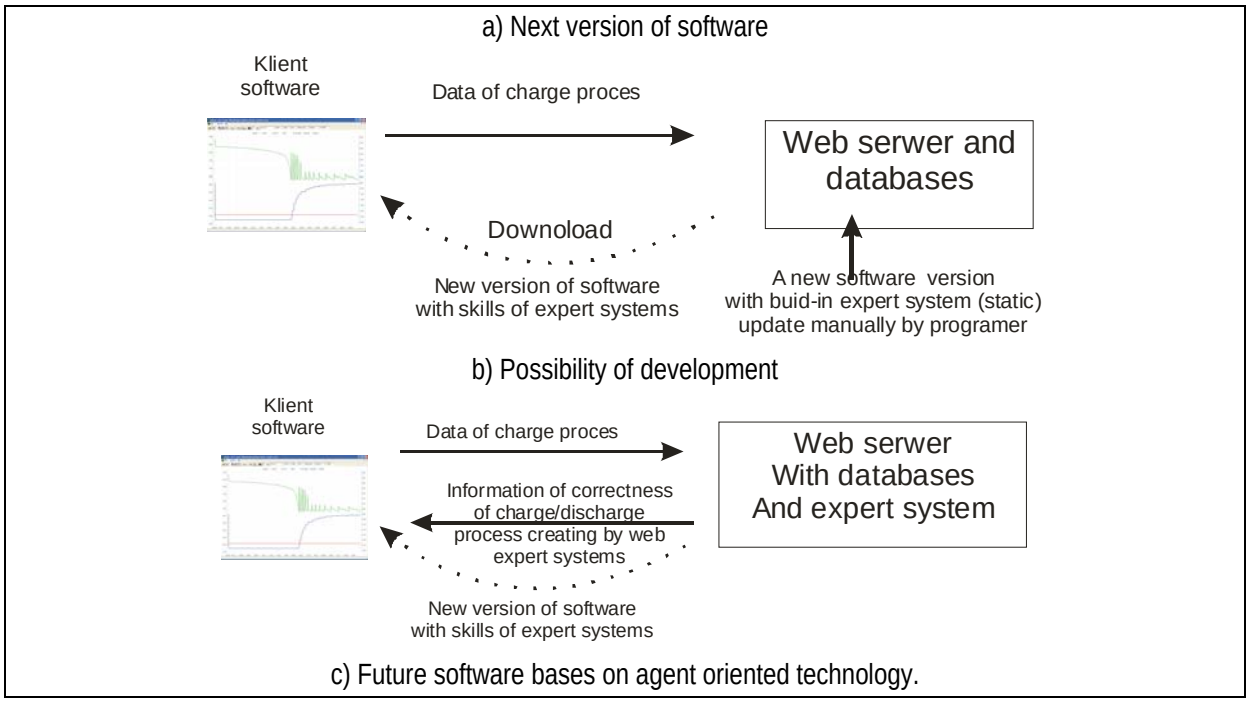



Fig. 9. The strategy of development of the software presented

## Conclusion

1. The use of application to analyze the charger mode expands the device's possibilities.
2. The analysis of characteristic obtained requires experience in their interpretation.
3. The use of expert system to analyzing chosen signals will be possible in the future.
4. The creation of databases including the characteristics' history during the usage of separate models of accumulators might make it possible to forecast the wear–out of packages. In older to do that an analysis using data-mining should be performed. The current program version includes the mechanism of accumulator description suitable for such research.

The creation of internet service collecting data from the user that might be automatically integrated with the program for expert system learning and data-mining seems appropriate.

## Author's Information

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