

SOFTWARE FOR CALCULATION OF PARAMETERS OF EQUIVALENT ELECTRIC SCHEME OF PHOTOVOLTAIC CELLS

Abstract. The elements of the structure and user interface of a specialized application for processing experimental data and calculating the parameters of photovoltaic solar cells, based on the concept of using different software packages and media most effective at each step, are presented. The application provides such service functions as data entry using the Excel spreadsheet program; calculations in the mathematical package "Mathcad"; test examples of the use of computational algorithms and the provision of the necessary textual information from internal sources and the Internet.

Keywords: photovoltaic cell, equivalent electrical scheme, software application, calculation of parameters, algorithm

Introduction

Processing the experimental data in order to obtain information about the objects under study, in particular, obtaining information about their physical and technical parameters, is an integral part of any scientific research or engineering development.

This fully applies to the methods of solving the problem of increasing the efficiency and reliability of photovoltaic systems of solar batteries, based on improving circuit design means of protection against electrical overloads of their elements - photovoltaic cells [1]. Determination of the effective circuit design in this case significantly depends on such parameters of a particular type of solar cells as the value of series and parallel resistances, parameters of the internal diode.

It should be noted that the solution of this problem is associated with a number of difficulties related to the accuracy of calculations, the presence of their alternative algorithms, etc.

In this connection, it seems reasonable to computerize such works in terms of developing a specialized application of a software application that allows solving the specified data processing task framework of the concept using different software packages and environments that are most effective at each step [2].

Problem statement

This paper presents the elements of the structure and user interface of a specialized application designed to process the experimental light-current-voltage characteristics of photovoltaic cells of solar cells and calculate the parameters of their equivalent electrical circuit.

Main part

1. Structure diagram of the application

The application is designed to manage the library of application software modules, which are documents of the well-known mathematical package Mathcad. The general structure and the list of modules is shown in fig. 1.

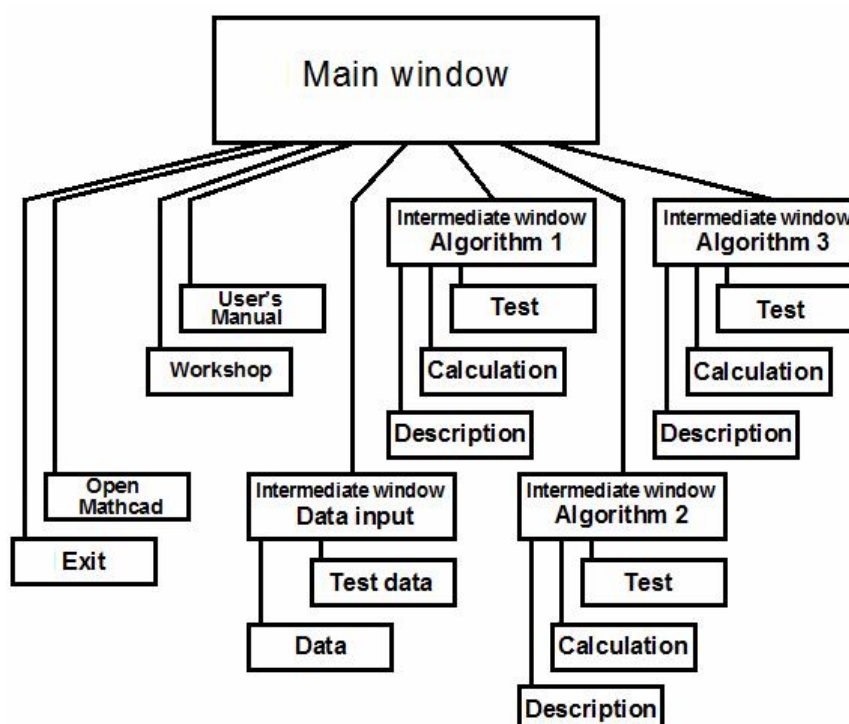


Figure 1 – Block diagram of an application for calculating the parameters of photovoltaic solar cells

As can be seen, the library consists of three sections, which contain three subsections each corresponding to solving the problem of finding the parameters of the equivalent electrical circuit of photovoltaic cells of solar cells using one of the three methods used here.

The components of the subsections of the library (Mathcad documents) are presented in two versions test and open for making changes by the user, and also contain a file describing the corresponding method.

As additional services, the scheme provides opportunities for entering experimental data, calling a mathematical package of Mathcad and exiting the applica-

tion, as well as getting acquainted with the user manual and accessing the Internet to obtain additional literature data.

All sections are interconnected by the main menu of the package, Mathcad documents are located in the corresponding sections.

2. Design of the user interface window

Environment for the operation of the described software product is the Windows operating system. Navigation between sections is done using buttons and menus of various levels (main, intermediate and work menus) [3].

The application uses the Package Monitor, which is written using the C # language and the Windows Forms Application project type of Visual Studio.Net platform. The applied program modules of the computational algorithms library, as already indicated, are documents of the well-known mathematical package Mathcad (version 13). In addition, the application uses universal tools for working with files with extensions such as .xls, docx and .pdf.

A general view of the user interface windows of the application is presented in Fig. 2.

The main elements of the main window are buttons with labels indicating their purpose. Pressing the “Input data” button brings up an intermediate menu that indicates the layout of the input information and provides an opportunity to go to the Excel window, which contains data for testing (“Test”) or into which experimental data intended for processing should be entered (“Data ”).

The “Algorithm...” buttons are intended for switching to intermediate windows of the same name. Each such window contains a brief description of the algorithm and a menu of the three following items, initializing actions in accordance with the block diagram of Fig. 1:

“Test” - call the Mathcad package window with a test example (which does not allow any changes);

“Calculation” - call the Mathcad package window with a similar file used for processing the experimental data loaded for processing;

“Description” - opens a .pdf file with a detailed description of the selected method.

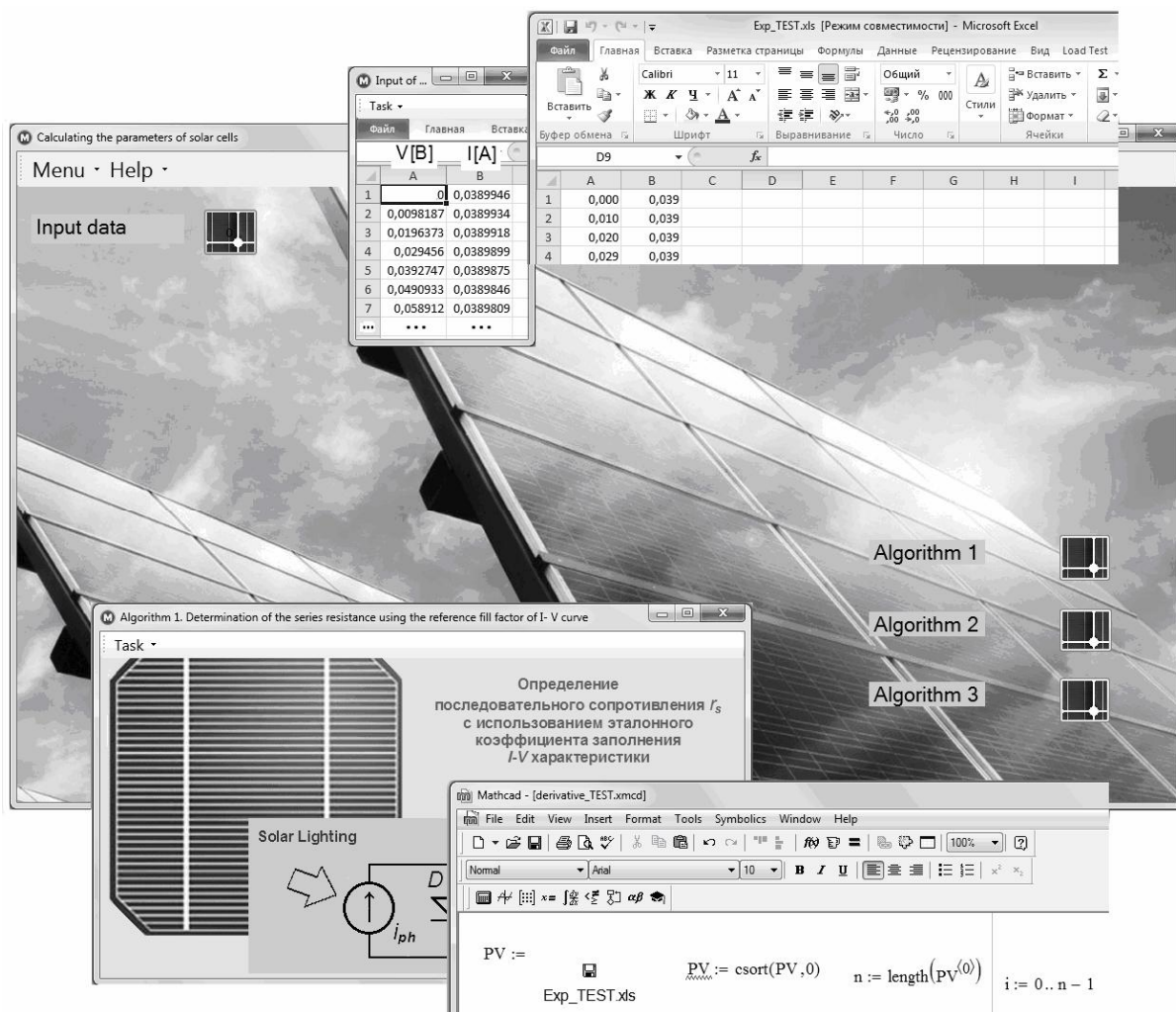


Figure 2 - The main application windows

The main window also contains a toolbar with two buttons “Menu” and “Help”. The “Menu” button contains two items. When you select the first of them, the “Open Mathcad” item will launch Mathcad or a window will appear asking you to select the Mathcad startup file yourself. If you select the second “Exit” item, the application will be closed. The “Help” button also contains a menu of two items. The item “User's Manual” opens a document with user instructions. Item “Workshop” launches a browser to access the Internet.

It should be noted that before using the described software product on a specific computer, it must be installed with the standard math package Mathcad, Excel, the browser, and the means for reading files with the extension .pdf. Setting up the product presented here is reduced to prescribing using the Visual Studio environment the corresponding file addresses in its monitor, which contain specific software implementations of the computational algorithms from its library.

3. Algorithms of calculation

The application uses the following algorithms for calculating the parameters of photoelectric converters from its light-current-voltage characteristic:

- determination of the series resistance using the reference fill coefficient of the current-voltage characteristic (Algorithm 1) [4];
- determination of parameters using the angles of the current-voltage characteristic relative to the coordinate axes (Algorithm 2) [5];
- determination of parameters using separate areas for the current-voltage characteristic (Algorithm 3) [1].

Before direct calculations, the introduced experimental light-current-voltage characteristics of the photoelectric converter undergo smoothing procedures to eliminate random errors and interpolate to obtain their analytical form, which is required to implement the calculation algorithms.

Conclusions

A version of a specialized application for calculating the parameters of the equivalent electrical circuit of photovoltaic cells of solar cells based on the integrated use of heterogeneous software products is presented. The application provides the following service functions:

- data entry using the Excel spreadsheet program;
- calculations in the mathematical package "Mathcad" of the specified parameters by three methods;
- providing the necessary textual information about the used calculation algorithms and test examples of their use;
- Internet access, if necessary, to obtain additional information.

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