Software programs used in designing of low voltage electrical distribution panels

Programe software utilizate în proiectarea tablourilor electrice de distribuție de joasă tensiune

Cristina Gabriela Sărăcin[1], Diana Paraipan[1]

[1]Universitatea Polithnica din București
Splaiul Independenței Nr.313
E-mail: cristina.saracin@upb.ro, dianaparaipan98@gmail.com

Abstract.– *This paper presents the ABB Doc and Schrack Design programs used in the design of voltage electrical distribution panels. The consumers' power supply depends on the correct choice of the protection and switching equipment and the correct size of the distribution panel. Therefore, the paper exemplifies and compares these software applications used successfully in the size of distribution cabinets. Therefore, the paper exemplifies and compares these software applications used successfully in the size of distribution cabinets. Dimensions of the switchboard are obtained by choosing and correctly positioning the electrical equipment in the switchboard. Schrack Design program allows the manufacturing of electrical panels without calculating the necessary parameters choices of protection and switching equipment. The choice of electrical equipment and electrical distribution panels is made exclusively by the user. It can make component selections from the manufacturer's database or add electrical equipment from other companies to this database. Once the options have been selected, the program generates the single-wire or multi-wire circuit diagram. The validation of the chosen solutions involves the thermal calculation of the electrical distribution panels which is done with the help of the Schrack Design program.*

Keywords: electrical distribution panels, ABB Doc program, Schrack Design program

1. Introduction

The electrical distribution panel has the role of powering the electrical receivers offering protection against overloads and short circuits. The panel is a component of the distribution system that branches the power supply on circuits that are safeguarded by protection and switching equipment [1].

When manufacturing and designing electrical distribution panels, each company specialized in the field of low and medium voltage electrical installations, must comply with the following rules:
- the electrical distribution panel must be mounted in such a way that the distance to the floor is not higher than 2,2 m;
- the electrical distribution panel must be provided with switches that allow the power supply to be stopped in case of breakdowns;

- the temperature of the room, where the panel it is supposed to be mounted, must be within the range of 0-40°C;
- the installation of circuit breakers must allow to stop all phases simultaneously in the event of fault in the supply circuits;
- fuses must not be mounted on the work/protection nulls;
- for currents higher than 100 A, the connections in the panel must be made with distribution bars;
- the colour code must be observed as follows: null (white, light blue, gray), protective conductors (green-yellow), phases (dark blue, black).

The electrical distribution panels are subject to operational risks and, for this reason, their constant maintenance is necessary. Software programs dedicated to the design and sizing of electrical equipment are used to create electrical distribution panels. In this paper, we will present two programs, ABB Doc and Schrack Design used to design low voltage electrical distribution panel.

2. The ABB Doc software used in designing of electrical distribution panel

The ABB Doc is a program used in the design of electrical diagrams and calculates the necessary protection and switching elements electrical distribution panels. ABB Doc has numerous key features such as [2]:
- drawing the single-line electric diagram;
- drawing the key diagram of the auxiliary circuits;
- calculation of line current and voltage drops;
- calculation of short-circuit currents;
- dimensioning low- and medium-voltage cables;
- dimensioning switching- and protection devices;
- switchboard configuration;
- setting and coordination of protection devices;
- verifying cable protection;
- printing the single-line diagram and project documentation.

To make a project with the help of the ABB DOC program, four power supply options can be chosen, one medium voltage (MV) and three low voltage (LV) power supplies. In the case of power supplies on low voltage, we can have three possibilities, namely: "LV distribution", "Trafo MV-LV" and "Generator".

In the case of power supply - "LV distribution", Icc is defined as the short-circuit current calculated according to the following parameters:
- apparent short-circuit power;
- short-circuit impedance of the supply line;
- power factor in case of short circuit;
- the ratio between the short-circuit current per phase and line current.

In the second case of power supply through a transformer - "Trafo MV-LV", the followings must be configured:
- apparent power of the transformer;
- transformer short circuit voltage.

Finally, the third case of power supply through generator - "Generator", it involves only the supply voltage parameter.

In addition, the choosing of voltage but also the power supply, the ABB DOC software offers the possibility to configure the following parameters [3]:
- distributed phases (three-phase with neutral conductor LLLN, three-phase without neutral conductor LLL and single-phase L2L3, L1L3, L1L2, L1N, L2N, L3N);
- distribution systems (TN-S, TN-C, TT, TI);
- parameters regarding the calculation methods;
- parameters for sizing conductive elements according to standards (IEC 60092[4], IEC 60364 [5], UNE 20460-7-740 [6], DIN VDE 298 [7]);
- the parameters regarding the ambient temperature and the working temperature of the installation.

For example, it is proposed the designing of a low voltage industrial electrical panel that must supply the following groups of receivers:
a) 3 single-phase resistive electrical receivers with nominal power $P_n = 5kW$, $\cos\phi_n = 0,9$;
b) 4 three-phase resistive electrical receivers with nominal power $P_n = 5kW$, $\cos\phi_n = 0,9$;
c) 3 three-phase electric motors having $P_n = 5,5kW$, $\cos\phi_n = 0,88$, $\eta = 0,88$, $I_p/I_n=7$.

The first step consists in making the single line diagram (figure 1). To start, we choose "Generic Load" corresponding to the resistive load type from the Objects menu and then complete V_n, P_n and $\cos\phi_n$ and evenly distribute the receivers in group (a) on the three phases (L1N, L2N, L3N). We make the same choice regarding the type of load for the three-phase resistive receivers from group (b) but, the circuit is three-phase (LLLN). The third group (c) of receivers is the motor from the "Objects" menu; select "Motor" and then fill in the parameters V_n, P_n, $\cos\phi_n$, η.

In the second stage, the cables necessary to power the receivers are dimensioned. In order for the conductive element to be calculated by the program, the fields circuit length, cable laying mode and maximum permissible voltage drop across the circuit are completed. The criteria on the basis of which the cables are determined are the followings:
- the criterion of the maximum admissible heating of the conductors;
- the criterion of the maximum allowable voltage drop in the network;
- the criterion of short-term thermal stability when starting the engines.

The third step aims to choose the switching and protection equipment. From the Object menu of the ABB-DOC program, we choose "Circuit-breaker with overload and short circuit protection + RCB". The IEC 60364-4-43 standard "Electrical installation of buildings - Protection against overload current" specifies the coordination between the conductive elements and the protective equipment. The relationships, used by the program, comply with IEC 60898 [8] based on formulas $I_b \leq I_n \leq I_z$ și $I_2 \leq 1,45 \cdot I_z$

where: I_b is the current required by the circuit;
I_z - the maximum allowed current of the conductive element;
I_n - rated current of the protective equipment;
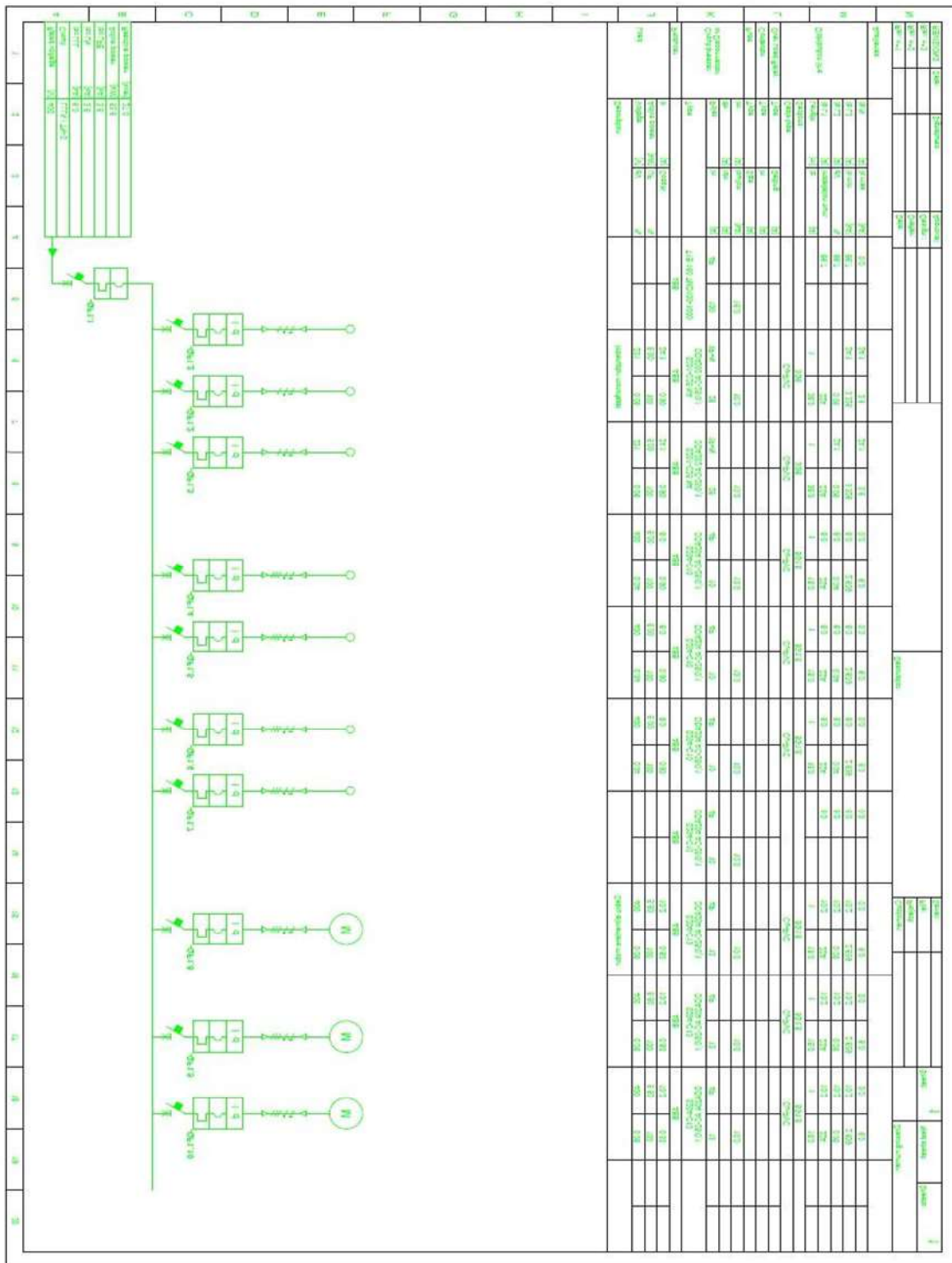I_2 - operating current of the protection device.

Fig. 1. Single-wire diagram of the electrical distribution panel

Based on the single line diagram, the ABB Doc program proposed the electrical distribution panel from fig. 2 (front and top view).
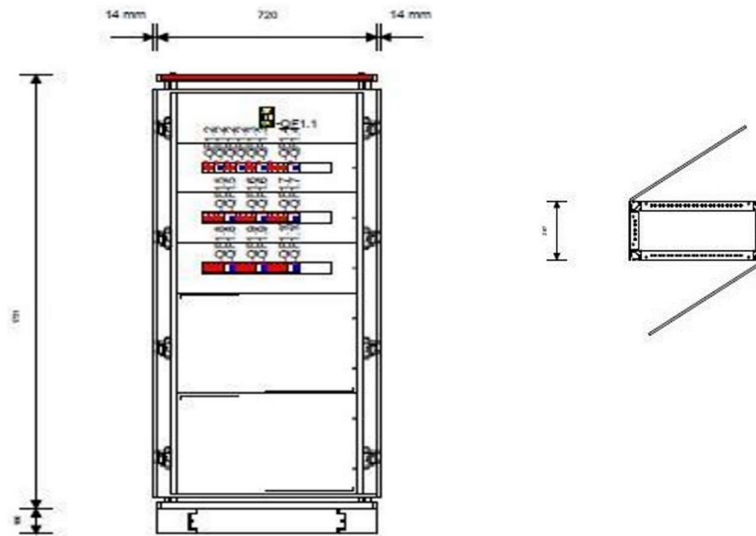
Fig. 2. Diagram of the electrical distribution panel

3. The Schrack Design software used in designing of electrical distribution panel

The Schrack Design program is a software offered free of charge by Schrack Technik to their customers. With the help of this program it is possible to design the distribution boards using components made by Schrack Technik or other manufacturers. The new created equipment can also be saved in the database of the Schrack Design program. The design of electrical panels is performed according to the EN 61439 [9] and IEC 60890 [10] standards.

The Schrack Design program has the following main functionalities [11]:
- selection of the desired switching and protection equipment;
- inserting components using the "drag and drop" function;
- adding external images to the drawing;
- adding standard symbols for consumers;
- activating the Copy/Paste function;
- marking change and simultaneous numbering for multiple products;
- the possibility to create favourite product groups;
- realization of electrical assembly schemes;
- adding links between the pages of single-wire and multi-wire schemes;
- insertion of "csv" articles;
- performing the thermal calculation;
- integration of electrical distribution panels horizontally and vertically;
- combination of two or more electrical panels in one.

The Schrack Design program allows the realization of electrical panels without calculating the parameters necessary for the choice of protection and switching equipment. Thus, this software allows to obtain single line and multi-wire schemes following the user's choice of protective equipment. In case of incorrect choice of the dimensions of the electrical distribution panel (from the Schrack database) or, of the

electrical switching and protection equipment, the program will determine that they were not chosen correctly (the panel heats up) and generate an error (fig. 3).

Fig. 3. Error generated by Schrack Designer program

Given that the allowable temperature limit is exceeded due to the small size of the electrical distribution panel (cabinet), this software also provides information on solving this design error (fig.4).
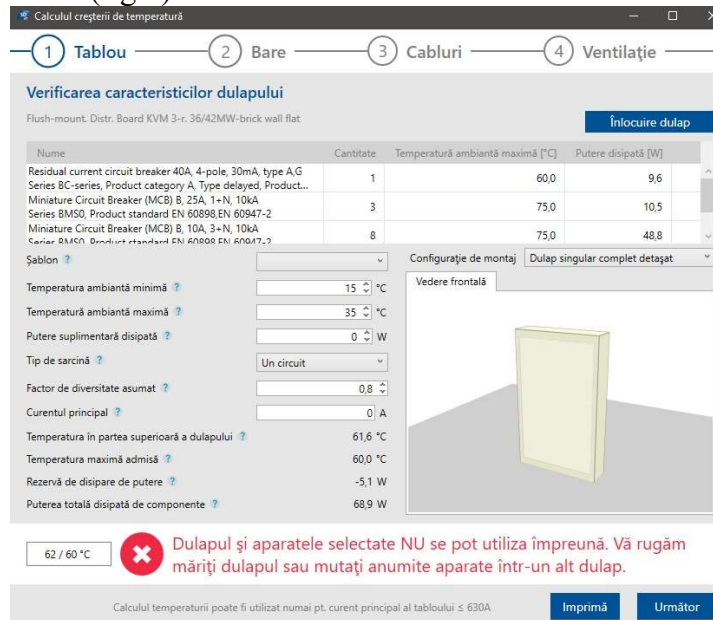

Fig. 4. Error display when choosing the electrical distribution panel

After choosing the electrical distribution panel and its components, the program allows you to read an informative guide on temperature balancing, namely:
- the application requires a check on the chosen cabinet; thus, the positions of the components in the cabinet can be changed and, if they do not lead to an improvement in temperature, it is proposed to replace the electric cabinet with a larger one;
- check the distribution bars;
- it is required to specify the cables used (including conductive material, insulation, cross section, number of conductive elements, number of circuits, length, maximum current and dissipated power);
- ventilation can be added to the chosen electric panel.

When choosing the correct size of the electrical distribution panel, the program displays the information presented in fig. 5.

Protocol de calcul al creșterii de temperatură	
Tip de dulap	IL172218AS
Dimensiuni dulap	
Lățime	590 mm
Înălțime	915 mm
Adâncime	250 mm
Temperatura ambiantă minimă	15 °C
Temperatură ambiantă maximă	35 °C
Temperatura în partea superioară a dulapului	47,2 °C
Creșterea temperaturii în partea superioară a dulapului	12,2 K
Configurație de montaj	Dulap singular complet detașat
Factor de diversitate asumat	0,800
Curentul principal	0 A
Puterea totală disipată de componente	62,8 W
Rezervă de disipare de putere	90,6 W
Putere suplimentară disipată	0,0 W
Normative	
Evaluare	
Dulapul și aparatele selectate pot fi utilizate în configurația dată conform cu IEC TR 60890	
Calculul temperaturii poate fi utilizat numai pt. curent principal al tabloului ≤ 630A	

Fig. 5. Nominal data of the electrical distribution panel

After the completion of the project, a report is presented stating whether the cabinet together with the chosen appliances can be used in the respective installation configuration according to the standards in force. Schrack Design helps to easily design electrical distribution panel and also guarantees their compliance with current standards.

4. Comparison of ABB Doc versus Schrack Design software

ABB Doc allows the realization of the diagrams of primary circuits and auxiliary circuits, calculation of line current and voltage drops, calculation of short-circuit currents, sizing of cables, sizing of switching and protection devices, setting and coordination of protection devices.

Following the completion of the single line diagram, the ABB Doc program is run, which verifies the correctness of the designed single line diagram. If errors occur on the circuits they are shown in red by the program. If the scheme is correct (the single-wire representation in fig.1) the colour is green and the program calculates the nominal currents on each circuit and dimensions the elements necessary to supply and protect consumers. ABB Doc balances the consumption on the phases of the electricity network; thus, the program applies an algorithm to move single-phase tasks from one phase to another, so that consumers are evenly distributed over the three phases.

The Schrack Design software does not perform the calculations presented above, but it comes to complete the shortcomings of the ABB Doc program, namely that of the study of heating the switchboards for currents not exceeding 630A.

In addition, the Schrack database contains for each product the value of dissipated power and thus, the total active power can be observed including on the distribution bars. Also, the Schrack Design program allows the realization of the distribution board, the verification of the load on the distribution bars, the specification of the used cables and the addition of a ventilation system for the distribution board.

Schrack Design monitors the temperature in the panel in real time and displays messages if the temperature exceeds the maximum allowed limit for the chosen configuration. This real-time thermal calculation is repeated each time an equipment is selected from a database. The wrong choice of the size of the paintings can lead to the increase of temperatures above the maximum allowed limit and this aspect can be visualized in the program by messages written in red (fig. 3, fig. 4).

5. Conclusions

In this paper were presented the ABB Doc and Schrack Design software that can be used by engineers who carry out electrical installation projects. Both programs offer to the user the possibility to design medium and the low voltage electrical distribution panel according to established requirements. These programs allow the sizing of the supply circuits necessary for consumers and the realization of electrical distribution panels.

From the study we can say that, for the size of the cables and switching and protection equipment necessary for consumers, the ABB Doc program can be used successfully. However, if you want the thermal calculation of a distribution board, Schrack Design program allows us to do this in real time at the time of design.

In conclusion, for an optimal result regarding the dimensioning of the electrical distribution panels, it is recommended to use both programs, these being harmoniously complemented by scientifically covering the design stages necessary for low voltage electrical installations.

References

[1] C. G. Sărăcin, „Instalații electrice", Editura Matrix ROM, 2009.
[2] https://new.abb.com/low-voltage/solutions/selectivity/tools-support/doc
[3] https://library.e.abb.com/public/a7a540898e0685bdc1257e1a0048b3ef/DOC_UserManual_EN_SLD.pdf
[4] https://www.elandcables.com/electrical-cable-and-accessories/cables-by-standard/iec60092-cable
[5] https://webstore.iec.ch/preview/info_iec60364-1%7Bed5.0%7Den_d.pdf
[6] https://www.en-standard.eu/une-20460-7-740-2007-11m-2017-electrical-installations-of-buildings-part-7-740-requirements-for-special-installations-or-locations-temporary-electrical-installations-for-structures-amusement-devices-and-booths-at-fairgrounds-amusement-parks-and-circuses/
[7] https://www.vde-verlag.de/buecher/leseprobe/9783800746910_PROBE_01.pdf
[8] https://webstore.iec.ch/searchform&q=IEC%2060898-1
[9] https://www.hensel-electric.de/media-61439/docs/EN/leitfaden_IEC_EN61439_en.pdf
[10] https://webstore.iec.ch/publication/3820
[11] https://www.schrack.ro/tools/schrack-design-software/alte-versiuni-schrack-design
[12] P. D. Parincu, G. M. Atanasiu, „Regenerative Concepts of Design for Residential Buildings Development" Romanian Journal of Civil Engienering, nr.1/2016, volume 7.
[13] N. Postavaru „Standardization of education and strategy for 2030" Romanian Journal of Civil Engienering, nr.3/2014, volume 5.
[14]   E. Cazacu, "Instalații electrice moderne. Baze teoretice, elemente de calcul și proiectare" Editura Matrix ROM, 2015.