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Artículos Científicos

Propuesta de tablero de entrenamiento para automatización y control

Training Board Proposal for Automation and Control

Proposta do conselho de treinamento para automação e controle

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Resumen

Este documento tiene como intención proponer un diseño de tablero didáctico basado en un controlador lógico programable (PLC) S7-1200, lo más parecido a un tablero de control en la industria. Con este diseño, se busca considerar el involucramiento de los estudiantes en las múltiples formas de automatización existentes, apegándose a un plan de estudio de 70 % práctica y 30 % teoría, donde el alumno realizará programaciones de control mediante el lenguaje de escalera en Step 7, llevando a cabo conexiones directas al tablero; y realizará también las prácticas necesarias para elevar su nivel de aprendizaje. Este tablero está pensado para ser utilizado en asignaturas referentes a los temas de automatización y control. Como parte del proyecto se realiza una guía básica de prácticas, que van desde el principio de funcionamiento del relevador hasta la

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programación de un PLC, incluyendo ejercicios donde el alumno diseña diagramas eléctricos a partir de casos propuestos, para después comprobar su funcionamiento. La presente metodología es sencilla de seguir para la construcción de un tablero didáctico o la réplica del mismo.

Palabras clave: automatización, PLC, S7-1200, tablero de entrenamiento.

Abstract

The purpose of this document is to propose a training board design, which will be based on programming logical controller (PLC) S7-1200, this will look like an industrial control panel. With this design, we are looking to engage the students on the knowledge of multiple automation ways that exist, according to a study plan of 70% practice and 30% theory, where the student will do control programming through the Ladder language on Step 7, doing direct connections to the board, reaching understanding of ladder language, as well as doing the necessary practices to increase their knowledge. This training board is intended for use in subjects related to automation and control. As part of the project, a basic training manual is carried out, which ranges from the working principle of relay to the programming of a PLC, and includes exercises where the student designs electric diagrams from proposed cases, and later check their operation. The presented methodology is simple to be followed for the construction of a didactic board or the replica of it.

Keywords: automation, PLC, S7-1200, training board.

Resumo

Este documento pretende propor um projeto de placa didática baseado em um controlador lógico programável (PLC) S7-1200, o mais próximo de uma placa de controle na indústria. Com este desenho, busca-se considerar o envolvimento dos alunos nas múltiplas formas de automação existentes, aderindo a um plano de estudo teórico de 70% prático e 30%, onde o aluno realizará programação de controle utilizando a linguagem ladder no Passo 7. , fazendo conexões diretas ao quadro; e também realizará as práticas necessárias para elevar seu nível de aprendizado. Esta placa foi projetada para ser usada em assuntos relacionados a problemas de automação e controle. Como parte do projeto, é realizado um guia básico de práticas, que vão desde o princípio de operação do relé até a programação de um PLC, incluindo exercícios em que o aluno projeta diagramas elétricos a partir dos casos propostos e, então, verifica seu funcionamento. A presente metodologia é simples de seguir para a construção de um quadro didático ou a réplica dele.

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Palavras-chave: automação, PLC, S7-1200, quadro de treinamento.

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Introduction

The technological universities have a teaching model where their "educational system comprises 30% theory and 70% applied or practical knowledge" (Secretaría de Educación Pública [SEP], 2008). So it is of special importance to have equipment for appropriate practices and in sufficient quantities. However, although this board is primarily intended as an inexpensive option for a practical team for this type of university, it is a valid alternative for any training center, since it is a team that helps to forge the specific competencies that are sought in programs of training. training of human capital in the areas of automation and control.

The development of this work arises as an idea of designing a board that meets the expectations of knowing the programming by software of a programmable logic controller (PLC), as well as obtaining dexterity to make connections of input / output devices in the case of the hardware Dexterity that is often underestimated in modules or pre-wired boards where only quick connections are used.

The PLC is used in different industry roles for automation; for example, in programming inputs and / or outputs to control different equipment such as motors, lamps, pneumatic actuators, etc. These activities are relevant in the industry because "in current production systems it is necessary to maintain a high competitive level to respond to market demands effectively" (Magos, Lara, Rodríguez, Loyo and López, 2016).

Therefore, students can not ignore this knowledge and must have fundamental bases that allow them to interact with these devices at the time they require it. This didactic board presents all the necessary elements to perform and / or simulate industrial processes.

Overall objective

Design a didactic board for the teaching and learning of control boards Siemens PLC 1200, which allows to outdo the student with respect to automation and start it in the industry, and thereby achieve a level of proficiency to compete with graduates of other institutions.

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Problem Statement

The study plans of the model of technological universities are based on the principle that the student receives more practical than theoretical training. Consequently, the teaching-learning process of subjects that make use of PLCs requires great attention in order to provide the necessary tools for their correct performance.

The high cost of acquiring a didactic board flagship shore to find practical solutions, so it seeks to solve the problem of insufficient and sometimes unavailable boards to practice, a problem that, as said, can be found in a higher education institution.

Methodology

Background

The training of professionals in fields of automation and control obeys to the tendencies of the industry with respect to the need to count on trained manpower, with which they can make use of internal services and not depend on outsourced services. Candia, Galindo, Carmona and González (2016) affirm that "the continuous implementation of processes based on the Lean Manufacturing philosophy in the business sector (regardless of the type of industry) forces the planning, production and maintenance departments to have professionals dedicated to PLC control. " The raison d'être and objectives of industrial automation are those of "being able to improve their productivity and perform all their tasks or provide their services in a more accurate manner and reducing production losses to a minimum" (Cañar, 2015).

The didactic modules, didactic boards or trainers of PLC of the recognized brands Siemens and Festo, among others, bet for the handling of banana terminals (see figure 1), which is an advantage when learning about the programming of this type of controllers, since there are no complications when making connections (see figure 2). However, if you want to achieve the acquisition of skills in the detection of faults and wiring of input / output devices, an open architecture is the best option for the design of a board. According to Candia et al. (2016), the best way to learn about fault detection is through the process of wiring the control panels, since it requires a vivid experience and sustained in the repetition.

Figura 1. Cable banana

Fuente: Electrónica I+D (2019)

Figura 2. Entrenador de PLC

Fuente: Festo Didactic (2019)

Although the words didactic board, didactic module and trainer are sometimes used indiscriminately to refer to any type of practical equipment, here, based on observation and experience, the main characteristics of each of these concepts are defined and described. (see table 1).

Tabla 1. Características principales de los tableros, módulos y entrenadores

Tablero didáctico	**Módulo didáctico**	**Entrenador**
Gran similitud con los elementos que se encuentran en la industria.	Los repuestos y suplementos deben ser compatibles con la marca.	Su principal ventaja es que sea pequeño y portátil.
Normalmente permite agregar accesorios sin necesidad de interfaces específicas.	Prácticas variadas con opción de agregar aditamentos de la marca para un mayor repertorio.	Prácticas limitadas.
Componentes a la vista, cableado oculto pero terminales de conexión a la vista.	Componentes visibles con conexiones tipo Poka Yoke para evitar daños al equipo y al usuario.	Componentes que normalmente no son visibles, por lo que se colocan símbolos o imágenes alusivas al elemento.
Uso de cableado común y cables tipo banana.	Uso de cables tipo banana.	Uso selectores o cables tipo banana.

Fuente: Elaboración propia

From the previous table the following definitions can be formulated.

Definition of didactic board

Equipment designed for the development of practices that has elements and connections of great similarity to the equipment found in the industry.

Definition of teaching module

Equipment designed for the development of practices that has elements similar to those found in the industry; The difference lies in the types of connections, which are error-proof, with the aim of avoiding damage to equipment and users.

Definition of coach

Equipment designed for the development of practices that has the elements equivalent to what is found in the industry, with pre-assembled connections, which limits the amount of practices that can be performed on it; however, that is why it is a safe equipment to operate due to its protections against damage to its own elements and to the user. This type of equipment is usually of small dimensions and portable type.

Choice of type of training equipment

In this stage, we seek to determine the scope and type of structure with which we will work. Based on the definitions presented in the section on background, opts for the development of a design of a didactic board, which should be easy to integrate external elements and do not use banana cables. As a complement, a basic guide of practices that can be performed on the didactic board will be developed.

Choice of materials

In the first instance, considering that the PLC already exists, in this case the S7-1200, it was thought of a project that did not have such a high cost, so it started by determining which materials would be ideal to consider in the module. The above was done by requesting quotation of the materials from local suppliers, to choose the components based on price-utility. Since, although there are good components to add to the module, they are not necessarily used in any automation application, an end that is sought with this board. Thus, general-purpose components were searched for in an automated system, such as keypads and light indicators, connection terminals, among others.

The following list of necessary components was determined on the board, as shown in table 2. It should be remembered that in this case it is being considered that there is already a PLC.

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Tabla 2. Lista de materiales para desarrollar el tablero de entrenamiento

Cantidad	Unidad	Descripción
50	Pieza	Clema para cable
8	Pieza	Relevador de control (bobina 24 V DC)
8	Pieza	Base Socket para relevador
2	Pieza	Canaleta ranurada
3	Metro	Riel DIN
8	Pieza	Botón pulsador
4	Pieza	Contacto para botón N.O.
4	Pieza	Contacto para botón N.C.
8	Pieza	Lámpara piloto 24 V DC
1	Pieza	Gabinete de control

Fuente: Elaboración propia

Board design

Once I know that the information was available, we proceeded to design CAD software to represent the module. In this regard, AutoCAD software proves to be a good option because of its wide dissemination and because it offers free licenses for students and teachers; This software also has a special module for electrical components.

Based on the industry, a control cabinet is considered as the base where the PLC will be assembled with its attachments; the measures designed for the cabinet are those shown in figure 3. The board is proposed to be mounted on any wall of the automation workshop where it will be located. This to prevent falls and damage to the outside of the cabinet.

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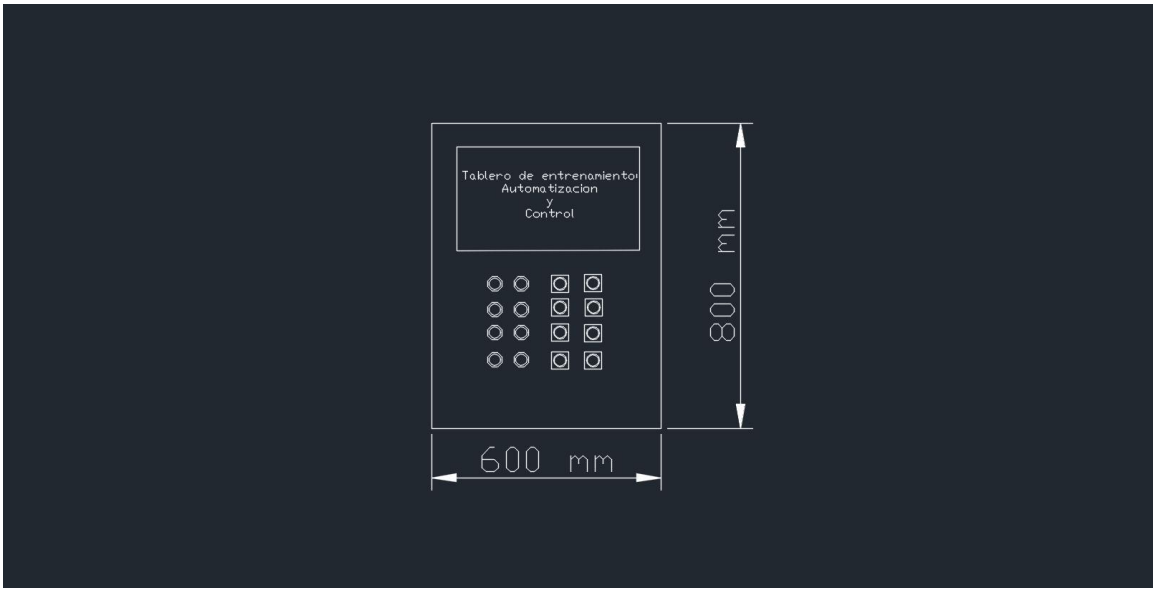
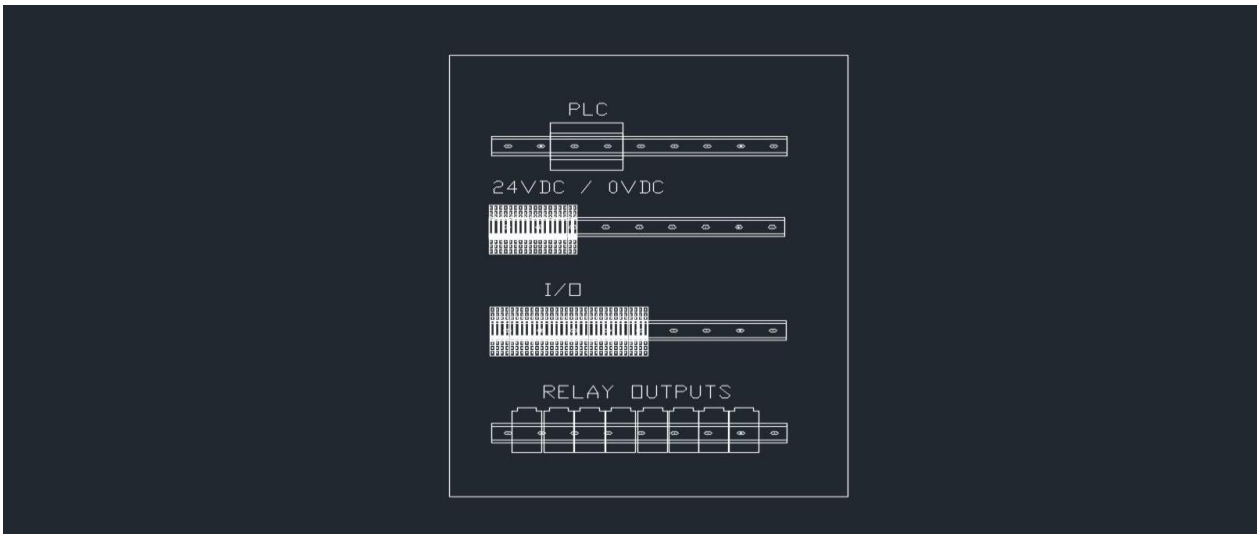
Figura 3. Vista frontal de tablero de entrenamiento



Fuente: Elaboración propia

Inside it will house connection terminals, which will serve to prevent deterioration of the PLC connection ports (due to continuous use by practices). It will also include 24V activated relays, available to connect external devices in isolation to the PLC (see figure 4).

Figura 4. Vista de parte interna de tablero



Fuente: Elaboración propia

Practice Guide

Subsequently, the formulation of guides for practices with relief, as well as PLC programming. However, being a scalable system, it can be used for practices at different levels of learning and dexterity; fault detection, creation and inspection of electrical diagrams, among other activities that can support the learning of process automation. The annexes show a guide for the realization of one of the proposed practices.

Results and Discussion

This section describes the characteristics of the different teams of practices, and demonstrates the benefits of working with a didactic board. It should be noted that this proposal serves as support when requesting the materials to develop the project at the Technological University of the North of Coahuila.

Through the use of the PLC boards, the elaboration of practices through the directed work will allow the student the understanding and understanding necessary to strengthen their knowledge in these applications of the industrial control field so important nowadays. Since in a "didactic board it is possible to carry out sequentially an unlimited reproduction of case studies, involving operation activities, wiring, fault diagnosis, programming and design of sequential actions that give solution to an automated process" (Candia et al. al., 2016, p.17).

Quotations were made with local suppliers, with which an economic price was obtained. What is assured in this project is the easy access to the acquisition of more elements, in comparison to purchasing didactic equipment from renowned companies that are generally from another country and generate "the total dependence on spare parts and maintenance of the foreigner in addition to the high acquisition cost "(Magos et al., 2016, p.39).

Unlike the works presented by other authors, who use their board designs for practices of a specific topic, even some of them make use of connectors for banana cable, here they agree on several points discussed by Candia et al. (2016), where the importance of making the connection by means of terminals is mentioned in order to obtain better results during the learning and operation.

This board is designed to be used in subjects related to automation and control issues. In addition to the benefits that you have when using the PLC, it is suggested to use this board for the instructor to expose cases in which an automation is required without this controller, so that the student later proposes electrical diagrams and finally can check them in the board; undoubtedly the

latter will be the important features that complement this design, by not having pre-established connections and freedom to make them, the PLC can connect when required.

This type of equipment can be used for the delivery of training courses to companies, being a design similar to that found in the industry.

A basic guide of practices is carried out, ranging from the principles of relief to the programming of a PLC. Making diagrams and then checking connections will be part of the practices suggested in the equipment manual.

The cost of materials to produce this board is 11 210.81 Mexican pesos, not counting the PLC.

Conclusions and recommendations

A simple methodology has been presented to follow for the construction of a didactic board, characterized by the simplicity and accessibility of its elements, and which will serve as support for educational institutions and training centers whose purpose is the training of human resources in the automation and control specialties. Future work will consist of adapting the board to the needs of the subject, for example, electro-pneumatic circuits, electro-hydraulic circuits, instrumentation, among others.

The construction of the board, in addition to complementing the equipment of the workshops of automation of the universities, allows the student to apply the knowledge and skills acquired in various subjects of their academic training, combining them to develop structured thinking processes when the application exercises be carried out, training and strengthening the skills that will be required at the time of facing the world of work.

When presenting this didactic board proposal, an investment option is being given in which besides being economical, it has all the functional, aesthetic and robust conditions demanded by any work in the automation workshops, which offers the possibility of expanding the same, in case of requiring more devices to connect.

This design allows to practice different levels of difficulty as required by the teacher or instructor, being an equipment open to improvements.

Additionally, a 24 V DC power source could be included for the connection of devices exceeding 0.5 A.

It is encouraged that the implementation of the board is made by the students of automation subjects as part of the practices to increase their skills and knowledge in the use of electrical components.

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Anexo

Práctica

Relevadores

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Requisitos

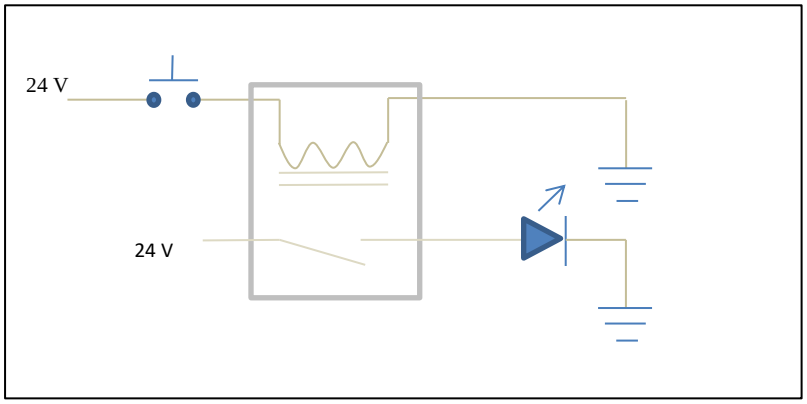
Haber llevado la clase teórica de relevadores.

Objetivo

Comprender el funcionamiento de un relevador Normalmente Abierto.

Instrucciones

Realice la conexión que a continuación se muestra:



Resultados

Una vez que se presiona el botón, el indicador luminoso enciende, cuando se suelta el botón, se apaga el indicador.

Discusión

Describa sus resultados, ¿Qué está sucediendo en el circuito al momento de presionar o soltar el botón?, ¿obtuvo un resultado diferente?

Equipo y herramientas utilizadas para la práctica

Tablero didáctico, multímetro, pinzas eléctricas, destornillador.