INTEGRATED AUTOMATION OF SYSTEMS WITH AN INCLUDED ELECTRIC MOTOR

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Rezumat. *Automatizările integrate cuprind o serie de echipamente şi procese cu rolul de a eficientiza toate liniile de producţie. Cu alte cuvinte, ceea ce făceau în trecut operatorii umani, actualmente poate fi realizat fără probleme de echipamentele automatizate. Oferind un avantaj clar, automatizările au câştigat teren în aproape toate subramurile industriei, dar nu numai. Automatizarea integrată este considerată şi constituie o necesitate pentru existenţa, supravieţuirea şi dezvoltarea oricărei companii ce oferă produse de o calitate superioară.*

Abstract. *Integrated automation contains equipment and a series of processes designed to make more efficient production lines. In other words, what was done in the past by human operators, now can be done with automated equipment without problems. Offering a clear advantage, automation gained ground in almost all sub-branches of industry, but not only. Integrated automation is seen and considered as a necessity for existence, survival and development of any company that provides products of superior quality.*

Keywords: integrated automation, PLC, electric motor, monitoring.

1. Introduction

Industrial automation includes a range of equipment and processes designed to make all production lines more efficient. In other words, what was done in the past by human operators, now it can be done easily by automated equipment. Offering a clear advantage, automation has gained ground in almost all sub-branches of industry and not only. Industrial automation is seen and considered as a necessity for the existence, survival and development of any company which has a high productivity [1]. Representing a vast field, automation is a complex branch of technique, without which large and small producers cannot continue to work.

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The main objective of this paper is to develop new solutions for the automation of an integrated system and a study of the active control of the parameters of the drive which belongs to a machine tool.

Siemens Starter software helps connect the rectifier to a PC, and the engine sensors can measure, by data acquisition, various parameters such as speed, torque, voltage, amperage, frequency and power consumption. With the help of Siemens Starter the trend of the motor torque can be determined by knowing the ramp up time of the motor.

2. Structure of the automation solution

Due to the high memory capacity of the autonomous console, off-line programming solution typically uses complex programming software which has multiple programming possibilities due to a complex graphic user interface. Simulation facilitates the possibility of testing the created programme. One such programme is the Siemens software called TIA Portal.

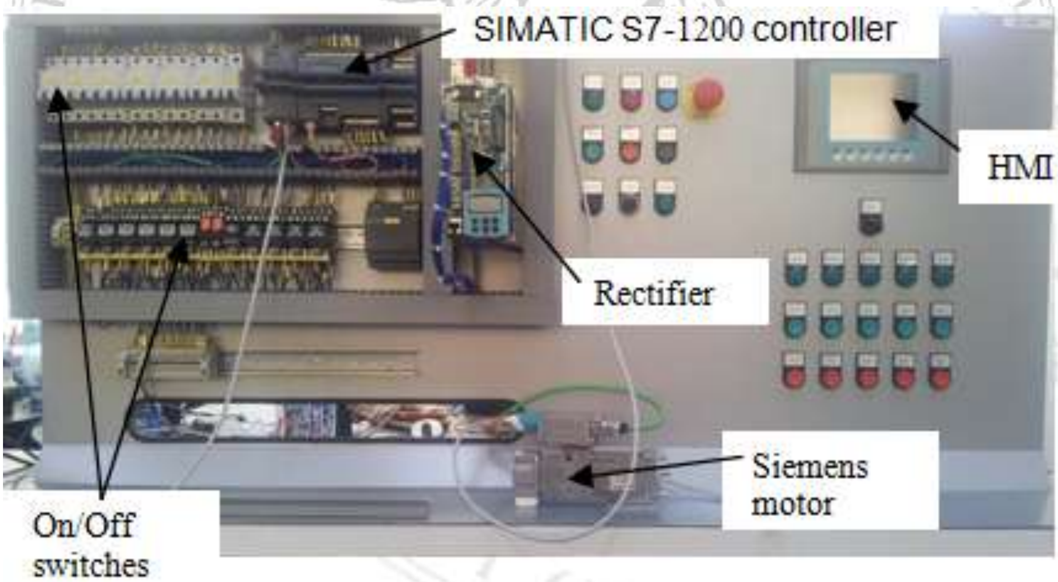

Fig. 1. Automation stand (Siemens).

This is complex programming software which tests and simulates different variants of PLC connections. By contrast, the on-line version uses minimal software, with reduced programming, usually limited to the introduction of words in a command line environment, without having a graphic user interface [2].

The system includes a Siemens motor 1FK7022-5AK21-1DG0. The motor has 6000 RPM, 1.8 kg, 0.37 kW rating power and an input voltage of 230 V. A programme will be created in TIA Portal in order to create a safety measure for a drilling machine. The research will be made on the equipment presented in Fig. 2.

2.1 Components of the stand

In order to have a valid example that can be compared to new and advanced systems, a Siemens automation was chosen. The stand that was used for the study contains the latest models of automation components that have the best firmware available in order to function at the maximum potential. The SIMATIC S7-1200 compact controller is the modular, space-saving controller for small automation systems that require either simple or advanced functionality for logic, HMI and networking. The SIMATIC S7-1200 controller panels can be programmed with the TIA Portal engineering software. The ability to programme both devices using the same engineering software significantly reduces development costs. The TIA Portal includes STEP7 for S7-1200 programming and WinCC for designing Basic panel projects. The S7-1200 can be extended up to 11 modules and it uses PROFINET or PROFIBUS communication protocols that are specific protocols used in the automation industry because smaller information packets are transmitted with a higher speed. These protocols have a lower response time than the TCP / IP protocol. It contains a card that loads the programme to be run and it is a compact product containing a CPU and more inputs and outputs, which are analogue or digital. On the left side of the S7-1200 communication modules are available and on the right there are signalling modules (inputs / outputs).
SINAMICS S120 is a modular drive system with servo and Vector Control. The SINAMICS S120 AC Drives especially supplement the DC/AC units with a central power in feed and a DC link in types Booksize and Chassis for multi-axis applications [3].

1FK7 motors are permanent magnet excited synchronous motors. The self-cooled motors are characterized by superior overload capability, ruggedness and compactness. The connection via rotatable connectors and preassembled cables ensures a flexible, fast and safe connection to the converter [4].

3. Siemens Starter

Siemens STARTER software helps the parameterization, commissioning, troubleshooting and when needed, service or maintenance. This software imports data from the rectifier and provides the opportunity to realize a quicker process parameterization, avoiding possible invalid entries and thus reducing production costs [5]. Setpoint and actual values can be tracked in real time. The starter also offers a graphical user interface for configuration [6]. This provides a better overview and a simpler handling. Once a programme is created, in order to make it more efficient, some parameters from the rectifier can be modified using the Starter software. The Siemens Starter recognizes the rectifier’s type through the Ethernet cable and a virtual model can be downloaded on the PC, already having initial settings on the drive. Default settings can be saved as a project and they can be modified in offline mode.

3.1 Data acquisition

The Siemens Starter has a data acquisition module which is found in the menu "Commissioning" -> "Device trace". Within the data acquisition module, the user can choose many parameters that can be recorded.

Using data acquisition, more engine parameters can be followed in real time, such as values of speed, torque, power consumption, frequency and engine temperature. There is little difference between the set speed and actual speed of the motor. Through its settings, the rectifier is trying to keep the engine speed as close as possible to the one that was set.

Fig. 2. The menu where the parameters are chosen in order to be followed during the acquisition

4. Determining the trend of the torque

Measurements were made for several weights varying the ramp up of the motor. This means that for each weight the time in which the motor reaches 3000 RPM was modified. Ten measurements were made with the ramp up from 0.1 s to 1 s for the following weights: 0g (with no weight), 28g, 82g, 97g. After the speed is stabilized at 3000 RPM, there is no big difference between the values of the torque. The difference appears in the interval between 0 and 300 RPM.

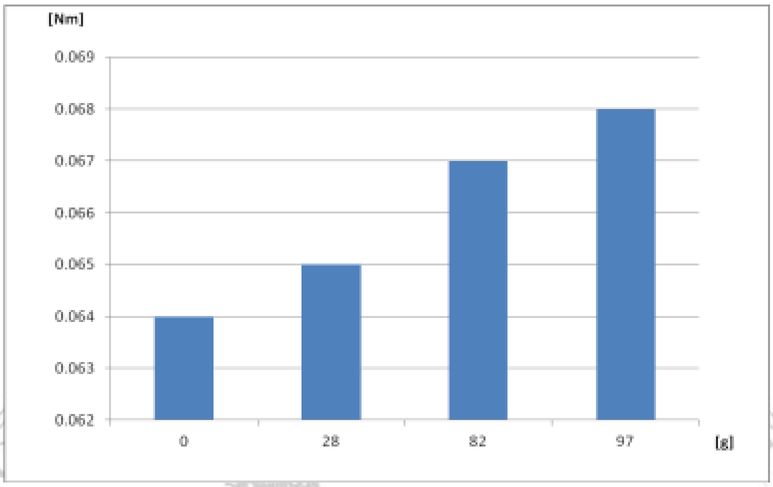

Fig. 3. Torque graph of each weight attached to the engine after stabilization at 3000 rpm

In the graph below it can be observed the difference between the ramp up of different weights. Consisting of measurements made, polynomials have been developed for each weight, so that the torque can be determined by the starting time. x [s] represents the starting time, and y represents the torque [Nm].

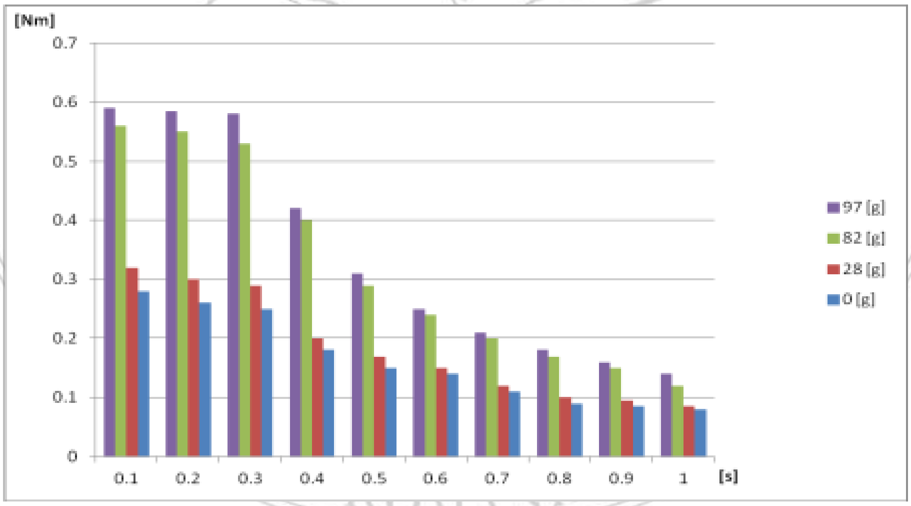

Fig. 4. Torque graph based on starting time, using different weights attached to the electric motor

The following polynomials were developed:

- for 0 g: $y = 0.0004x^3 – 0.003x^2 – 0.0162x + 0.1971$
- for 28 g : $y = 0.0003x^3 – 0.001x^2 – 0.0266x + 0.2271$
- for 82 g: $y = -0.0019x^3 + 0.0301x^2 – 0.1765x + 0.5457$
- for 97 g: $y = -0.0017x^3 + 0.028x^2 – 0.1754x + 0.5671$

5. Conclusions and future work

It is important to know the torque that is encountered by the motor when it starts. Depending on the torque and the motor's thresholds, it can be determined if the motor will start or not. Also, if the motor is not used at the maximum power, its life is prolonged.

The developed polynomials can help the user predict the torque that the motor will need. The differences between the torques are consistent considering that the differences between the ramp up times are of 0.1 s.

The prospects of this work are to find the value of the torque for a bigger value range of weights.

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R E F E R E N C E S

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