

**DESIGN OF CONTROL UNIT/ DATA PATH FOR PRODUCTION  
MONITORING SYSTEM USING FPGA BASED ON OVERALL EQUIPMENT  
EFFECTIVENESS (OEE)**

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Tajuk Projek : **DEISGN OF CONTROL UNIT/ DATA PATH FOR  
PRODUCTION MONITORING SYSTEM USING FPGA  
BASED ON OVERALL EQUIPMENT  
EFFECTIVENESS (OEE)**

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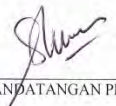
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To my beloved father and mother

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## ABSTRACT

A Production Monitoring System (PMS) is a set of equipment placed on a production line to monitor the status of a process or manufacturing line. It collects, process, stores and displays production information. Nowadays, with the rapid grow of technologies, the conventional PMS is not suggested to be used in industries. This method is not efficient because it's time consuming and the collected data are not reliable and inaccuracies due to human errors and intervention. Hence, an automated PMS project is proposed. The automated PMS is fully automated in data collection, processing and recording. Basically, the aims of this project is to design a Control Unit /data path by translating the Overall Equipment Effectiveness (OEE) concept into a set of logic units that described using Very High speed integrated circuit Hardware Description Language (VHDL) and to be implemented in a programmable digital logic chip called Field Programmable Gate Array (FPGA). Normally, the performance and efficiency of a machine are measured by using OEE. It's a concept of determining the performance indicators of a production line, which involves arithmetic and logic operations for data processing. In conclusion, the project is efficient because it's useful and fully automated yet the price is reasonable, portable and applicable to many industries.

## ABSTRAK

Sistem Pemantauan Pengeluaran (PMS) adalah satu set peralatan yang diletakkan pada barisan pengeluaran untuk memantau status sesuatu proses atau pembuatan talian. Ia mengumpul, memproses, menyimpan dan memaparkan maklumat pengeluaran. Pada masa kini, dengan kepesatan teknologi, PMS konvensional tidak dicadangkan untuk digunakan dalam industri. Kaedah ini tidak berkesan sebab ia memakan masa dan data yang dikumpul tidak boleh dipercayai dan tidak tepat kerana kesilapan manusia. Oleh itu, projek PMS automatik dicadangkan. PMS automatik adalah automatik sepenuhnya dalam pengumpulan data, pemprosesan dan rakaman. Pada asasnya, matlamat projek ini adalah untuk mereka bentuk laluan Unit Kawalan / Data Jalan dengan menterjemahkan Keberkesanan Peralatan Keseluruhan konsep (OEE) ke dalam satu set unit logik yang diterangkan menggunakan kelajuan tinggi Sangat litar bersepadu Perkakasan Penerangan Bahasa (VHDL) dan akan dilaksanakan dalam cip logik digital diprogramkan dipanggil *Field Programmable Gate Array* (FPGA). Biasanya, prestasi dan kecekapan mesin diukur dengan menggunakan OEE. Ia adalah satu konsep menentukan petunjuk prestasi garis pengeluaran yang melibatkan aritmetik dan logik operasi untuk pemprosesan data. Kesimpulannya, projek ini adalah berkesan kerana ia berfungsi dan automatik sepenuhnya lagi dengan harga yang berpatutan, mudah alih dan boleh digunakan dalam pelbagai industri.



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## LIST OF ABBREVIATION

ALU	–	Arithmetic Logic Unit
FSM	–	Finite State Machine
FPGA	–	Field Programmable Gate Array
GUI	–	Graphical User Interface
IC	–	Integrated Circuit
IR	–	Infrared
LCD	–	Liquid Crystal Display
LED	–	Light Emitting Diode
OEE	–	Overall Equipment Effectiveness
PC	–	Personal Computer
PCB	–	Printed Circuit Board
PMS	–	Production Monitoring System
PPC	–	Production Planning and Control
TQM	–	Total Quality Management
VHDL	–	Very High speed integrated circuit Hardware Description Language

## **CHAPTER 1**

### **INTRODUCTION**

This chapter will discuss about the overview of process that involved in design the control unit and data path. It discuss about the introduction, problem statement, objectives and scope of the project. The end of this chapter will list the thesis outline.

#### **1.1 Production Monitoring System (PMS)**

A production line is a set of sequential operations established on a factory shop floor whereby materials are put through a refining process to produce an end product that is suitable for onward consumption or components are assembled to make finished goods (Siva, 2009). A set of equipment called Production Monitoring System (PMS) is necessary to place on production line to monitor the current status of manufacturing line. A Production Monitoring System (PMS) consists of a real time display for monitoring production line problems and a systematic and accurate online data collecting system for production lines. Besides that, PMS is a useful data collection tool and reporting system which able to collect, process, and displaying the p

roduction line targets concurrently acts as a calling unit to inform respective personnel at the right time on production line problems.

From research, a number of production floors are utilizing manual methods of data collection for producing reports. Manual data compilation leaves room for both inconsistencies and inaccuracies. When manual data collection is practiced, it always involves manual data compiling. This is mostly accomplished by entering in the information into spreadsheets for recording. Whenever the human intervention occurs on the recording or collection of data, the truthfulness of the collected data is no longer reliable. Factors affect the collected data may not be truthful are due to the improper monitoring system, the inaccuracy of the monitoring device and human intervention.

Therefore, this study is conducted to explain the usefulness of an automated data collection tool and display system for production lines. Develop an automated real time PMS to replace human supervision on production lines is extremely needed due to information obtained from production lines is essential for the management to enhance the production yield in all stages. Capturing and interpreting this production data without human intervention is a major challenge for the management.

## **1.2 Problem Statement**

A production line is a very efficient way of manufacturing and assembling a product. The inefficiencies of production line will be the main factor that caused a company to achieve less yield and hence less profit. A Production Monitoring System (PMS) such a data collection tool and reporting system is required to be placed on a production line to monitor the status of a process or manufacturing line. The system enables to monitor and evaluate the real time performance and process improvement towards achieving a targeted production yield.

Nowadays, there are various types of monitoring systems practiced in the industries. Monitoring system involve manual approach such as charting on a white board or tracking sheets. A person in-charged is responsible on keeping tracks of the line status and records the operation performance, such as the amount of good or reject products on a white board. This method is not efficient because it is time consuming and there is a possibility that the collected data are not reliable and less accurate due to human errors and intervention.

In year 2009, a real time PMS was developed by Siva Kumar. This system is used in real time to record production line problems. It is built by using programmable logic controller and sensor to collect data from production lines. However the processing and recording parts were still done manually. It is not practical to process and record a big set of information manually due to possibilities of human errors and workers lack of good work ethic. A line supervisor or operator might forget to record or simply miscount the number of goods, caused the management team, maintenance and engineering personnel misinterpret the status of production line. In addition, in some circumstances, faults and mistakes which occur on the process line can be overwritten and fabricated. Thus, an automated production monitoring system is needed in data collection, processing and recording to improve the data accuracy and reliability.

### **1.3 Objectives**

The aim of this study is to develop a control unit program based on Overall Equipment Effectiveness (OEE) concept. A Control Unit or data path is designed by translating the OEE concept into a set of logic units and the logic units are described using Very High-speed-integrated-circuit Hardware Description Language (VHDL). Next is to compare the simulation results with mathematical calculations based on OEE. This is to verify the workable and efficient of the VHDL program.

## 1.4 Scope of Project

This study is conducted to further enhance the existing production monitoring system (PMS). The system should be able to perform automated data collection, processing and recording. The automated data inputs are three important information that need to be monitored by a production monitoring system (PMS) from the production line. They are total amount of production over a certain period of time, total amount of rejects and total downtime or breakdown time. Through the data processing done by an FPGA chip, the system displays the output on a text Liquid Crystal Display (LCD) display module. Figure 1.1 illustrates the suggested system to be designed.

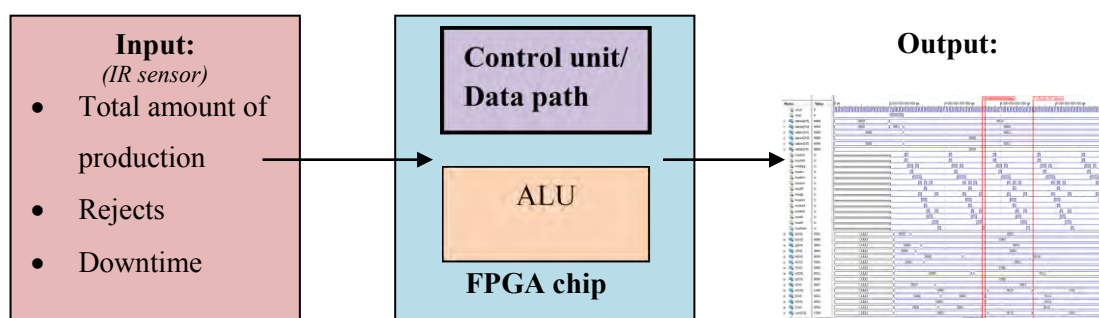


Figure 1.1: Block diagram of control unit/data path for production monitoring system.

1. This project is part of a bigger system. The project is only concern about the design of control unit/ data path for production monitoring system (PMS) but not involve the ALU part.
2. The FPGA chip is programmed to work as a processing unit, it capable to control more data inputs from production lines.
3. The Overall Equipment Effectiveness (OEE) concept is used in this project to measure the performance and efficiency of production line.
4. The OEE concept is translated into a set of logic units which are described using Very high speed integrated circuit Hardware Description Language (VHDL).
5. For the processor, the received data inputs perform data processing to determine Overall Equipment Effectiveness (OEE) indicator and its parameters (Availability, Performance, Quality and OEE).

6. This project used Xilinx ISE Design Suite 11 for design entry, design analysis and synthesis. ISim simulator is used for design simulation.
7. Finally, comparison between the simulation results and mathematical calculations is required to verify the VHDL program is validate.

## 1.5 Outline of Thesis

In this thesis, there are involve of five chapter to describe the project of Design of control unit/ data path for Production Monitoring System by using FPGA based on overall equipment effectiveness which is starting with Introduction, Literature Review, Methodology, Result and Discussion and Conclusion and Recommendation.

Chapter 1: Introduction of the project that discussed the background of the study, problem statement, scopes and objectives of developing this project.

Chapter 2: Literature Review consist the background study and research before developing this project. The content of the background studies such as the information about the Production Monitoring System, VHDL, OEE concept and etc.

Chapter 3: Methodology described about the methods or approaches used in solving the project. In this chapter, it contains a block diagram and flow chart to explain the procedures of designing the project. The circuit design is discussed as well.

Chapter 4: Concentrates on the result and discussion of this project. This chapter consists of the simulation, results and analysis of the product performance.

Chapter 5: Conclusion consists of the summary of the project. After the project is done, recommendations are made for the betterment of the project or upgrades that might be done in the future.

## **CHAPTER 2**

### **LITERITURE REVIEW**

This chapter contains the literature review on theoretical concepts applied in this project. It contains the information that the project required in order to develop and complete the entire project.

#### **2.1 Production Line**

Refer to Cambridge dictionaries, production line is a set of machines and worker in a manufacturing plant that a product flows along while it is being made or produced. Every machine or worker must be complete performs specific job before the product proceeds to the next station in production line.

Production lines were operated by workers before the initiation of computer control and robots. Each person executes a limited number of tasks and the product would be passed to the next person continually until the product was completely assembled. Currently, the production lines of worldwide manufactory can be classified into three types, which are manual production lines, semi-automated production lines and automated production lines.

Accuracy and efficiency on the production lines allow an improved production and application of usable resources within industries (Siva, et. al., 2009). The better line efficiency will be able to assist companies or industries to generate higher yield and revenue. Hence, a Production Monitoring System (PMS) is essential to install at manufacturing line to help collect and distribute line information to everyone in the shop floor as production are happening. The task of the production tool is to aid the manufacturing team to perform their best within the usable resources. Moreover, improve quality matters and reducing overheads.

Generally, the Overall Equipment Effectiveness (OEE) as an ultimate efficiency tool for machineries and equipment in manufactory. It is concept of determining the performance indicators of a production line, which involves arithmetic and logic operations for data processing.

## **2.2 Types of Production Lines**

The type of a production line is depending on the complexity of the manufacturing parts, production volume, restricted or dangerous manufacturing process, the sensitivity of the product and price (Siva, 2009). Based on specific production requirements shows how the administration in industries going to design and plan their production layout. The combination of machineries and mans would be the ordinary source of manufacturing resources which is practice in worldwide to perform this task. The practice of both machines and mans is various types of production lines are demonstrated as in Figure. 2.1.