The Production Performance Monitoring System

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Abstract: - To ensure efficient running of production line a production performance monitoring system (PMS) is necessary. Such a system could relay data to monitoring office where decisions can be made to improve production. The data should be true and it should be relayed without human intervention. Such unadulterated data would be interpreted and analyzed to spur actions from the management. A production line is normally operated in a combination of automation or semi automation machineries using programmable logic controller (PLC), sensors and display panel. All this builds the entire networking of the PMS. With the help of this monitoring system the management will be able to monitor both the workers and machine performance. This performance will directly reflect towards the production output. To ensure the performance is always sustainable a real time PMS is required to capture the information's from the production lines and distributes them into understandable production data. The data available should be interpreted accurately in order to identify the various faults at production level and to immediately rectify them to improve efficiency. An accurate data management and monitoring system is equally important in improving production. Faults due to improper monitoring are a down turn to the management whereby it will result in less productivity. Devices designed should be capable of working as individual units or working together with multiple terminal links such as automated machineries, robotic systems and manual process line. This system can be used in any production line to monitor the line performance and helps to improve line efficiency. By implementing such a system will result towards a better line efficiency and this will help the company to generate higher revenue.

Key-Words: - Production lines, production monitoring system, programmable logic controller, display panels,sensors, semi automated machines, robotics systems, manual process lines

1 Introduction to Production Monitoring System

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 [1, 2]. Apart from that PMS is useful for displaying the production line targets, acts as a calling unit and able to inform the management on production line problems. PMS is made up of a very simple combination of the state of the art electronics devices.

The block diagram of the system is as shown in fig.1.

2 Components in PMS

2.1 Primary control unit

The primary control unit (PCU) makes the PMS as an intelligent unit. The super relay (SR) as shown in fig. 2. is integrated to accomplish a real time base control system for the PMS.

SR is an intelligent control [3], which uses function blocks for programming. Function blocks enable the control functions of a PLC to be achieved without the need for large number of instructions and complicated programming. When several function blocks are linked together in a specific way, relatively complicated control functions can be implemented. The PMS real time control program is as shown in fig. 3. Programming can be implemented using a The SR enables the user to write and edit the program design using a removable liquid crystal display panel or by using a computer.

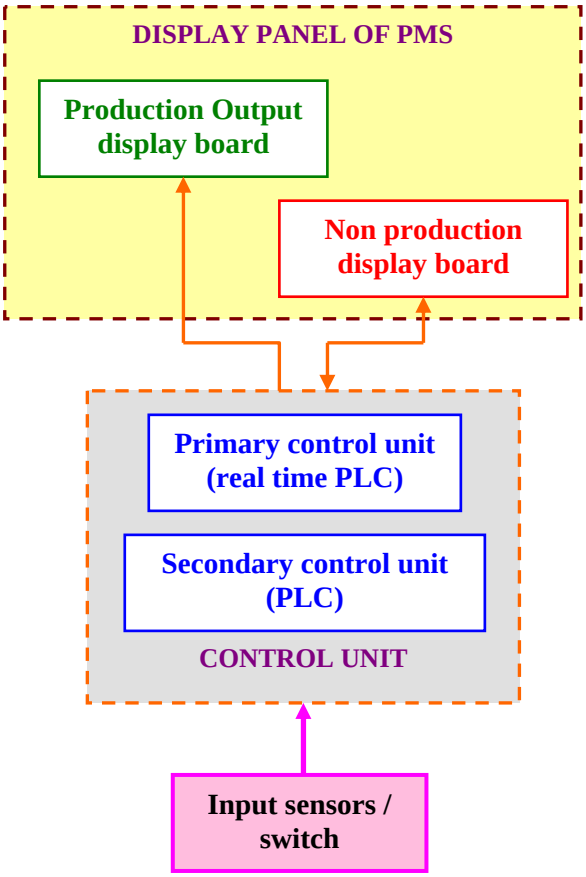


Fig.1: Block diagram of system

Fig.2: Super relay model SR-22MRDC

The SR is a reliable control unit with the capability to control extensive range of electronic applications. Such a control unit will be the perfect match to the secondary control unit (SCU). The main role of a SR is to operate on specific timing as programmed. SR can be programmed for every year / every month / every week / every day / day [3]. The relevance of this function is to program SR to work in real time where it is capable of determining the date and day. Such a system is capable of operating base on the programmed schedule according to days on a week including off days without the assistance of humans. The SR enables the system to automatically stop and resume during meal breaks, small breaks and shift change over. Most of the industries have multiple production schedules for them to operate. By having the schedule programmed in PCU the process is made easy for real time switching of SCU. Automation system without human assist can be established by integrating the SR with the PMS at all times.

2.2 Secondary control unit

The SCU is designed to match with the PCU for the real time communication. The OMRON CQM1H-CPU21 PLC is a compact programmable controller (PC) that supports communication and other advanced functions [4]. The picture of the SCU is as shown in fig. 3. A flexible system configuration is enhanced by serial communications with a protocol macro function, user installed boards called Inner Boards, network communications, a wide range of monitoring and setting methods, higher speed, and larger capacity.

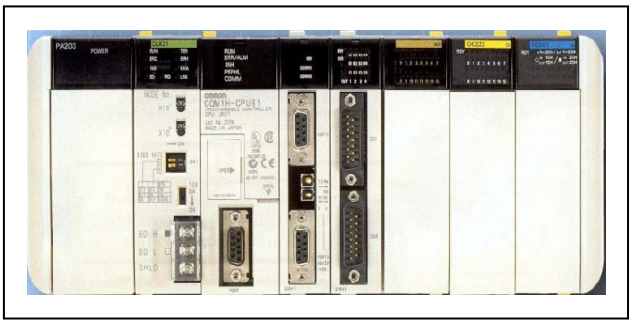


Fig. 3: The OMRON CQM1H-CPU21 PLC

Sensors and switches will be linked to the SCU as an input and the circuitry is connected as the output. The detection of the sensors will generate signals to SCU and this will be then be displayed accordingly. The sensors are connected thru the SCU to the circuit to minimize the debounce effect and

this ensures the display board reacts accurately as the signal sent.

2.3 I/O sensors

The input signals are generated by sensors attached to machineries. Any types of sensors could be used with the PMS to generate signals to the SCU. Commonly sensors are used in detecting completed process, machine breakdown, quality problems and material shortage for the production. Sensors are located base on the requirements of the production and also the machines, robots and workbench used. Without sensors automation system can't be established.

Switches are equally important as the sensors in the PMS. Switches are used to address the departments involved in the production process. At the event of faults are detected, the switches on the system will be pressed for further assistance. Apart from the above task the other switches in the system are used to activate the planned stop display.

The other switching elements in the system are key selectors. This key selector switches are designed for the authorized personnel only on specific events on the production process. The first key selector is to turn power on the entire system and the second key selector switch is used to reset the system manual when ever is necessary.

2.4 Production performance display board

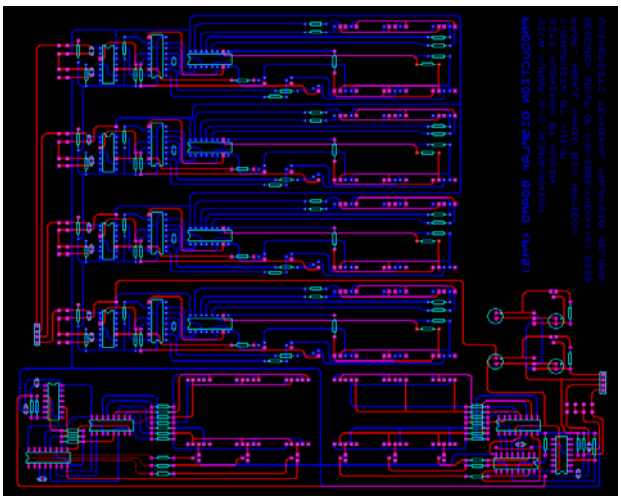


Fig.4: The production status display board design of the PMS

The display unit is made up of electronics up counter circuits whereby modification is done base on the requirements of the system. The multiplexed display LED is driven by the up counter circuits. These circuits are designed on a double sided printed circuit board (PCB) using Proteus Aries as the design tool. The design layout of the production status display board is as shown in fig.4 and the design layout of the production interruption display board is as shown in fig 5.

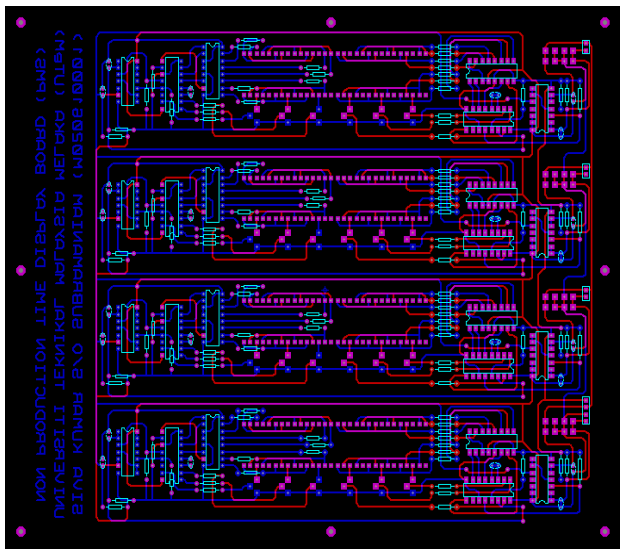
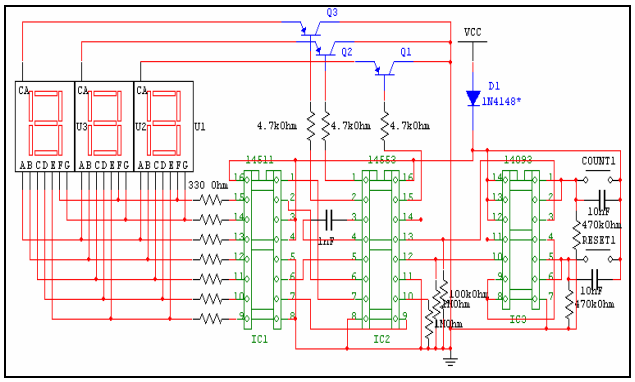


Fig.5: The production interruption display board design of the PMS



Schematic 1: The 3 digit multiplexed up counter circuit

The three digit counters can be designed using a single 74C92 x 4 digit counter chip or by using a 4026 cmos. Some of the designs are analyzed from [5, 6, 7]. Problems with the existing design are cost, while the latter require too many IC's and thus take much PCB space. The circuit used here as shown in schematic 1 is a compromise between these two approaches. The circuit uses two

IC's for the up counter operation. The 14553 is a 3 digit binary coded decimal (BCD) counter. Inside the chip, each counter drives a 4 bit latch which quad 3 input multiplexer. The chip has carry, reset, an input clock and latch enable. The four outputs (Q0 to Q3) are fed into the 14511 cmos 7 segment decoder driver. The outputs of this driver then drives the 3 digit multiplexed display unit. Each digit is turned on at the correct time via the display control output at pins2, 1 and 25 of the 14553. They are active low outputs. Each drives a BC557 PNP transistor via a 4K7 resistor.

The counter module consists of a debounce circuit which uses 4092 (NAND gate IC). The resistance and capacitor provide a delay period during which the noises of the switch connection will not register a count. The hatkey switches used are very noisy switches but these debounce circuits take care of the problem for as fast as manual pressing will allow. Digital inputs from other sources such as the PLC, timer circuit's etc may be routed through the board. This circuit is also designed such away to connect together two or more counters to make six or nine digit display unit. For the designed circuit there are displays with 3 and 6 digits. The up counter circuit is modified as a timer display unit for the PSM. The up counter signal is replaced with pulse generated by the SCU.

3 Real time PLC software design

3.1 Operation 1

Normal production operation of a company (OSIM TM) is designed in the first part of the program as shown in fig. 6. The first four blocks from left is for basic scheduling which is from Sunday till Saturday. The details of the operation time including meal breaks and changeover time is as shown in table 1. The system is design to generate signal according to schedule programmed to the SCU and this is done automatically with human interventions.

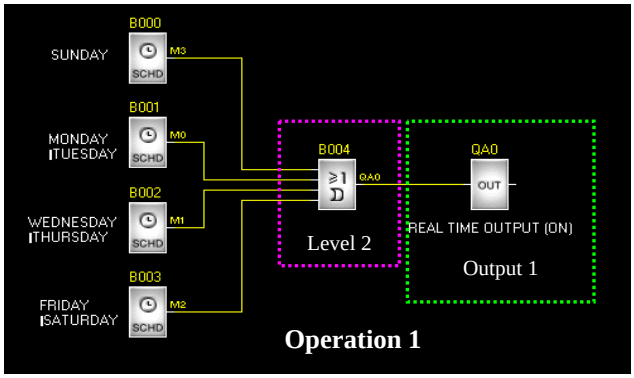


Fig. 6: Real time program for PCU (operation 1)

EVENT	Operation day		PCU status
	Mon, Tue, Wed and Thur	Fri	
Start	8.00am	8.00am	ON
Morning break	10.30am	10.30am	OFF
Production	10.45am	10.45am	ON
Lunch break	1.00pm	1.00pm	OFF
Production	1.30pm	2.20pm	ON
Evening break	3.30pm	3.30pm	OFF
Production	3.45pm	3.45pm	ON
End	5.50pm	5.50pm	OFF

Table 1: Weekly operation schedule from OSIM TM

3.2 Operation 2

The production operation on a public holiday of a company (OSIM TM) is designed in the second part of the program as shown in fig. 7. The first 2 blocks from left is the scheduled operation time which includes meals breaks and change over time. The details of the operation time are as shown in table 2. The second block from the left is used to manually switch the schedule at the event of unplanned holidays. A key selector switch will be connected to the PCU for the purposes. When this part of the program is active, the PCU will generate a signal to the SCU for the following process.

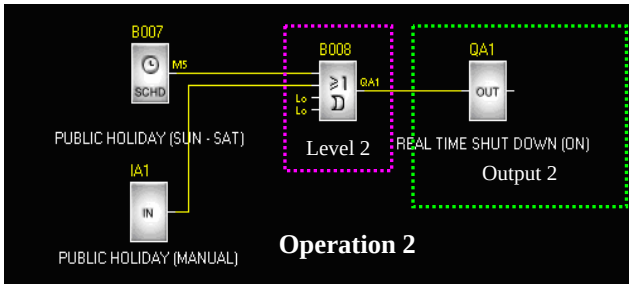


Fig. 7: Real time program for PCU (operation 2)

EVENT	Operation day		PCU status
	Sat	Sun	
Start	8.00am	8.00am	ON
Morning break	10.00am	10.00am	OFF
Production	10.15am	10.15am	ON
Lunch break	12.00pm	12.00pm	OFF
Production	12.30pm	12.30pm	ON
Evening break	3.00pm	3.00pm	OFF
Production	3.30pm	3.30pm	ON
End	5.00pm	5.00pm	OFF

Table 2: Weekend and public holiday operation schedule from OSIM TM

3.3 Operation 3

The system is capable to reset the display boards at the beginning of each shift without any human interventions. The designed program for this function is as shown in fig. 8. The system reset is done 1 minute before the shift starts as shown in table 3. Optional key selector switch is connected to these blocks to manually reset the display boards in any necessary event by authorized personnel. The output 3 will generate a signal to SCU and the changes can be viewed on the display boards.

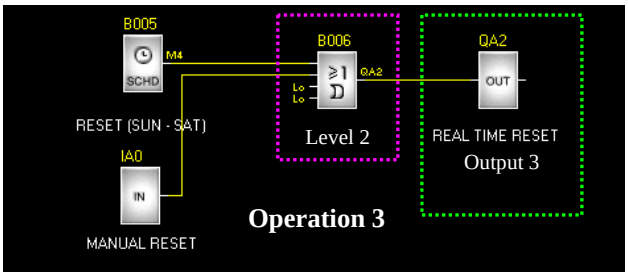


Fig. 8: Real time program for PCU (operation 3)

Event	Operation day		PCU status
	Mon - Fri	Sat - Sun	
Reset	7.59am	7.59am	ON for 2 seconds

Table 3: Reset schedule from OSIM TM

4 Connection of PMS

The entire system works by processing signals from one system to another. The PCU is linked to SCU for the switching purposes and the outcome will be displayed on the display boards of PMS. The PCU will generate 3 outputs for the SCU as shown in fig. 9 below. The PCU will generate the signal to the SCU as programmed.

The program in the SCU is designed to work according to the signal generated from the PCU. When the signal is generated for the normal operation and weekends or public holiday mode, the SCU will generate signal to the target on the production status board are programmed. Apart from that, input signals from sensors will be processed and the outcome will be displayed. The second condition has an optional input source where by if there is an unexpected public holiday the production team can switch ON the key selector switch to activate the required schedule for the shift. For the third condition the PCU will generate a signal as programmed for the automatic reset function to the SCU and the display board will be reset. The key selector is an option for the management to manually reset the entire system if required.

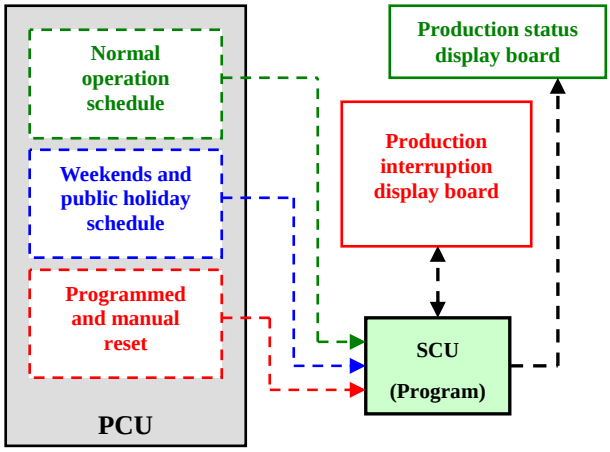


Fig. 9: Connection diagram of the PCU and the SCU of PMS

The SCU will generate a pulse every 1 second to the circuit in the production interruption display board and this will display the total length of time taken to problem solve the faults. The SCU will display the output by departments as events happen on the production lines. This system also enables the workers to manually trigger the switch located on the system to indicate problems as it occurs. The same 1 seconds pulse is also generated by the SCU to the circuits for planned stop function in the production status display board. Signals from the sensors are tapped from machineries, robots and (jig) work bench and then processed by the SCU according to the requirements set in the program.

Changes will take effect as the input signals changes. The display board will react to the signals generated by the SCU at all times.

5 Conclusion

The production display board is an essential production aid for both the management and the production team yet existing device could not comply with the needs of the modern industries. With this custom made PMS, set goals and other production faults can be rectified and display as events happen. Such a system can help industries to be more efficient and productivity in all means.

6 Acknowledgement

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