

Investigating the use of PLCs for Data logging applications in an Industrial Environment



LLOYD DAVIES - 1707513 University of Wales Trinity Saint David

1707513@student.uwtsd.ac.uk



ABSTRACT

The purpose of this project is to research, design and build, a datalogger for use in a highly controlled industrial environment. Are PLCs effective dataloggers and how do they compare to what is already on the market? A medical equipment manufacturers factory floor is in need of a data logger. The factory produces two products, hypodermic needles and bio sensors used in pulsometers. The items are manufactured industrial standard cleanrooms.

AIMS & OBJECTIVES

The Aim of the project is to analyse the performance of a PLC based Logging system and compare it to existing Loggers already on the market.

In order to achieve the here is the list of project objectives:

- Gain a better understanding of data loggers already on the market and the operation of industrial cleanrooms by carrying out a literature review.
- Select suitable sensors to measure the climate of two Zones

AREA	ZONE A	ZONE B
TEMPERATURE	18 C	18 C
HUMIDITY	40-45% rH	30-35% rH
ISO RATING	6	8

⇒ Zone A—Production of Bio Sensors

⇒ Zone B—Production of Hypodermic Needles

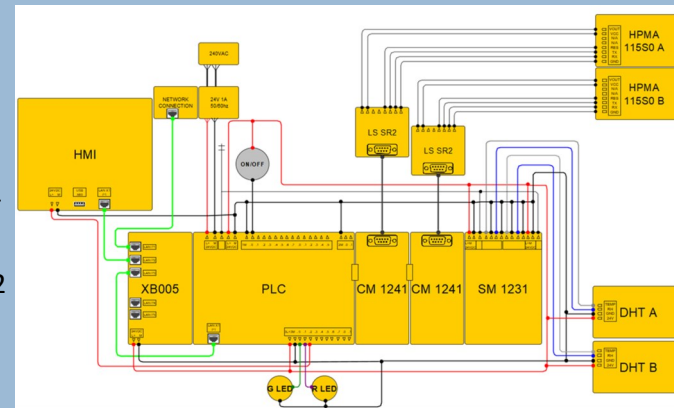
- Design and build a PLC based system to record and store data from both zones, which can also be controlled via a Human Machine Interface
- Analyse the performance and cost of the system

COMPONENT SELECTION

Particle sensor	Temp & Humidity	Switching module	Signal module	Communication module	CPU	HMI
HPMA11550-XXX	22DTH-11M	XB005	SM 1231	CM1241	S7-1200 1214C DC/DC/DC	KTP700 7" DISPLAY
UART	6 WIRE 0-10VAC	LAN x5	0-10VAC Input	RS232	14 DC 2 AC (I) 10 24VDC (O)	USB, LAN 24VDC
£210.00 [1]	£136.00[2]	£97.20	£349.00 [3]	£300 approx.[4]	£300 Approx.	£1050

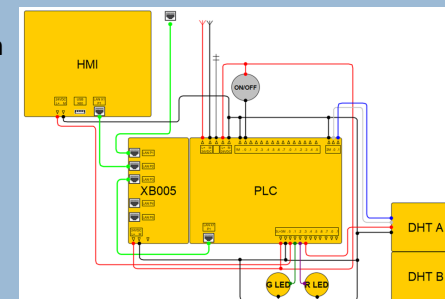
DESIGN

In order for the system to perform to the best of its ability, sensors best suited for the application have been chosen. It was discovered that Particle sensors are almost exclusively UART connection. This would be an issue as the CPU is not serial communication compatible. The UART signal is converted into an RS232 protocol which can input to the CPU Via a CM1241 RS232 module. The conversion module is manufactured by Loadstar and is called the SR2. A circuit diagram seen on the left has been produced on YED graph editor. Simple components were also used for example an on/off switch and G/R LED indicators. The expansion modules allow the PLC to take additional inputs, the CPU (standard) has 2 0-10V analogue inputs. With the SM 1231 there are 8 extra channels available. The cost of this system came in at around £3500, not expensive in the world of datalogging however, too costly for a student to find alone.



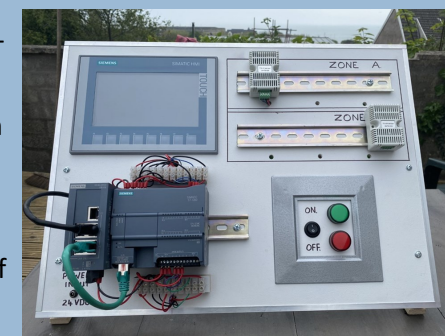
SIMULATION BOARD DESIGN & BUILD

In order to still test the PLC loggers performance, a simplified version of the system would be build in a simulation class room style Board. The components selected were chosen based on similarities to the original selection and price. Due to the components for sensing particle size and concentration costing approx. £1000 alone, the particle sensor was swapped for an Air pressure sensor. Due to unexpected circumstances, acquiring the SM1231 signal module was not possible anymore, leaving the two analogue inputs on the CPU.



The Program was set up so that Zone B mimics Zone A giving the impression there is two sensors connected. Data can be stored using two methods, access via a web-server and a hard copy via the HMIs USB Port. Having a backup data storage method on a hardcopy is a valuable feature of the system. Logs can be accessed through the webserver remotely.

The board was designed using 2D Design software, the schematic was then used to produce what is seen on the right. It is constructed out of a sheet of MDF and shelf brackets



ANALYSIS OF RESULTS

When Zone A is turned on, the log begins, each value is logged with its tag name, time and date. As you can see the data is put into a TXT file. The file is stored in the HMIs USB port (\USB_X60.1)

```
"VarName"      "TimeString"    "VarValue"      "Validity"
"relative humidity A"  "2020-04-26 12:36:25"  49      1
"SCALED PRESSURE A"    "2020-04-26 12:36:25"  0        1
"temp A celcius"       "2020-04-26 12:36:25"  23        1
"relative humidity A"  "2020-04-26 12:37:25"  49        1
"SCALED PRESSURE A"    "2020-04-26 12:37:25"  0          1
"temp A celcius"       "2020-04-26 12:37:25"  23          1
```

Data records are taken at a frequency of 1Hz. On the HMIs trend view screen, data can be seen in a graphical representation useful for looking back on previous recorded data. The primary method of data storage is very capable Including diagnostics and status updates. Unfortunately, there were some technical issues writing to the webserver from the network available since the university closed A technical comparison between the designed system and an existing data logger proved that for £1000 less, the PLC still met the system requirements and included a touch screen interface. This comparison Along with the performance of the simulation board proved the PLC is more than capable.

CONCLUSION

The environment was purposely selected to have several stringent conditions for the PLC to log. The areas used to draw a conclusion were Data acquisition/storage, compatibility, the interface and the direct cost comparison. The PLC was evenly matched with a Data-Taker DT80 logging system apart from the Sampling frequency being 10Hz as opposed to the DataTaker's 40Hz. The HMI and cost sets the system apart from the DataTaker. Overall the investigation was a success, the system meet the requirements and proved that PLCs are a viable way of logging data whilst being cost effective.

IMPROVEMENTS

The RS232 signal could be converted to LAN eliminating the requirement for the communication modules and allowing for connection via the network as opposed to wired.

A key pad could be implemented representing a restricted area.

A potentiometer could be used to help demonstrate warnings or errors, by enabling the input to be varied.

[1] Honeywell, "HPM Series Particulate Matter Sensors," 05 2019. [Online]. Available: <https://sensing.honeywell.com/honeywell-sensing-particulate-hpm-series-datasheet-32322550>. [Accessed 12 02 2020]
[2] "22DTH-11M - Duct Humidity, Temperature Sensor (L=140mm)" IACS/belimo, [Online]. Available: <https://www.i-aes.co.uk/store/index.php/22dth-11m-duct-humidity-temperature-sensor-l-140mm-dc-0-5-v-dc-0-10-v.html?UA-23404093-1&msclkid=dc01d5d1052913a3412a8b95038fd19c>. [Accessed 11 02 2020].
[3] "6ES7241-1AH32-0XB0," Siemens, [Online]. Available: <https://mall.industry.siemens.com/mall/en/WW/Catalog/Product/6ES7241-1AH32-0XB0>. [Accessed 22 03 2020].
[4] "Siemens SM 1231 PLC I/O Module - 8 Inputs, 24 V dc," RSComponents, [Online]. Available: <https://uk.rs-online.com/web/p/plc-i-o-modules/7877970/>. [Accessed 17 03 2020].