9th International Interdisciplinary Congress on Renewable Energies, Industrial Maintenance, Mechatronics and Informatics

*Booklets*

RENIECYT
Registro Nacional de Instituciones y Empresas Científicas y Tecnológicas
1702902 CONAHCYT

RENIECYT - LATINDEX - Research Gate - DULCINEA - CLASE - Sudoc - HISPANA - SHERPA UNIVERSIA - Google Scholar DOI - REDIB - Mendeley - DIALNET - ROAD - ORCID - V|LEX

# Title: Implementation of a system ANDON for the utilities department in a plastic injection plant

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**Editorial label ECORFAN:** 607-8695
**BCIERMMI Control Number:** 2024-01
**BCIERMMI Classification (2024):** 241024-0001
**RNA:** 03-2010-032610115700-14
**Pages:** 12

**CONAHCYT classification:**
**Area:** Engineering
**Field:** Engineering
**Discipline:** Electronic Engineering
**Subdiscipline:** Automation and Control

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# PRESENTATION CONTENT

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# Introduction

ANDON is a visual and auditory communication system used in industry that informs operators which activities they need to perform to resolve problems in the production line as soon as they occur, to increase quality, production, and reduce costs. These systems generally display the error or failure signal after the issue has occurred, necessitating corrective maintenance and process recovery to resume production, resulting in production downtime.

This project was developed for an automotive parts company. Air compression, chiller water condensation, and cooling tower operations are essential services required for the proper operation of the injection and blow molding process.

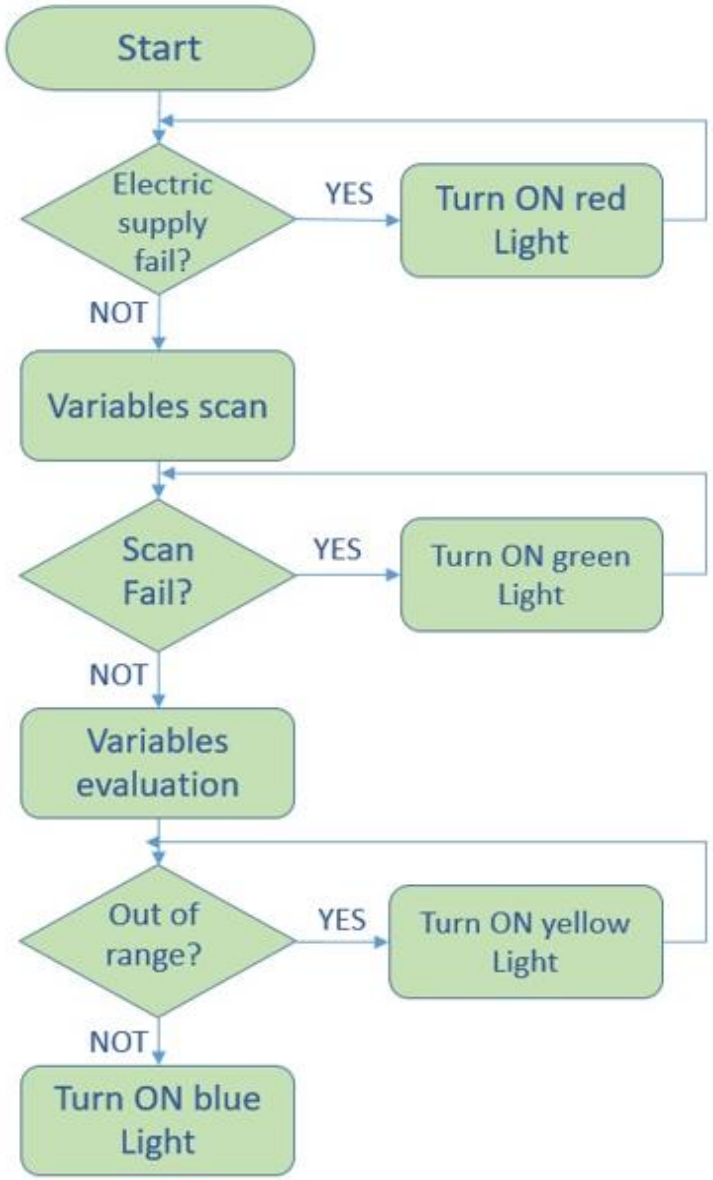
# Methodology

The first step is identifying the problem.

The need presented by the company is to achieve real-time monitoring of the pressure and temperature services necessary for the injection process.

The compressor, chiller and cooling towers are located in a different area than the production line.
It is important to monitor these variables to guarantee production with good quality.

# Methodology




Next, the control flow design.

Considering the needs of the plant, it is required to monitor a failure in the electrical supply. Measure the values of temperature and pressure variables in real time, identifying that they remain within the desired range for production.

Interaction with the user occurs through the lighting of lamps indicating the status of the process.

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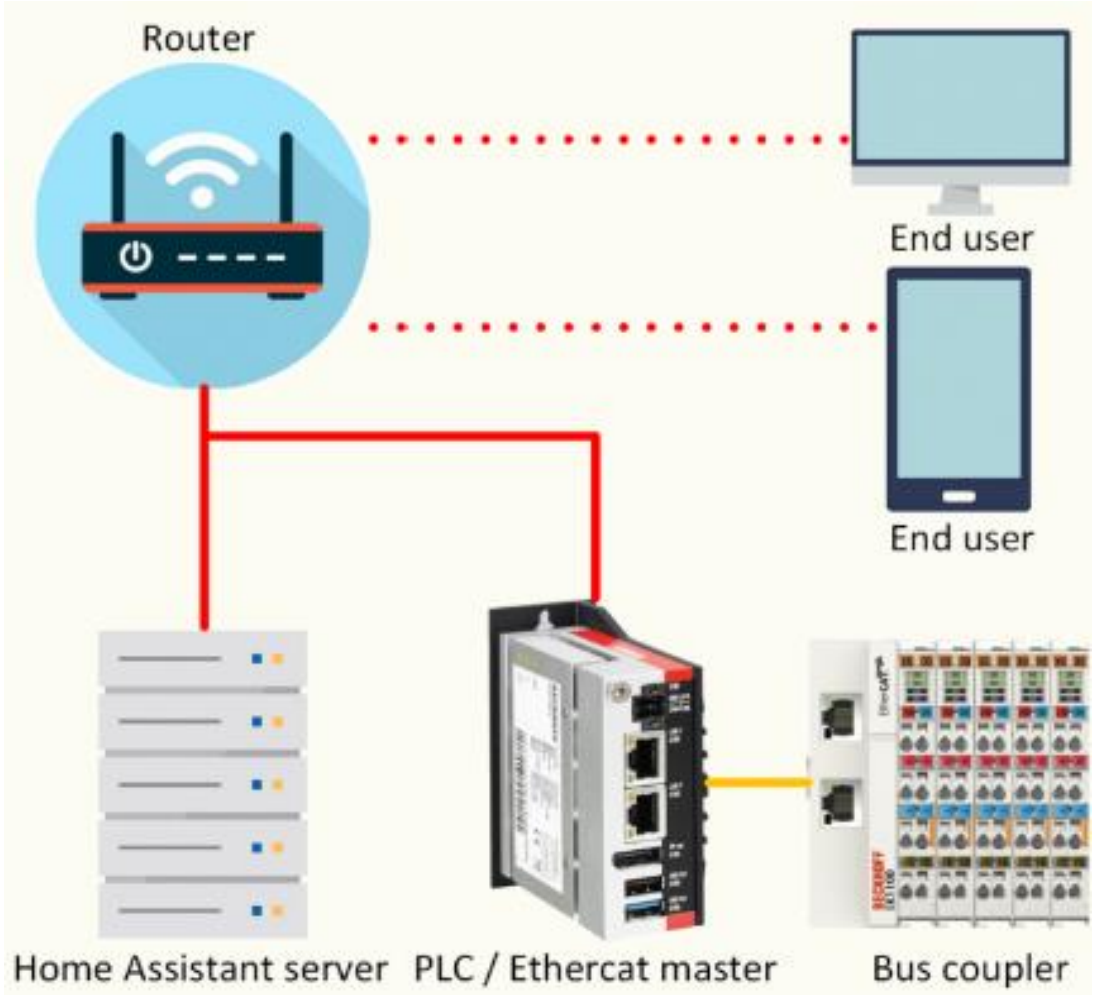
# Methodology

The supervisory system will be a computer responsible for collecting process data and sending instructions via the command line. For this project, the computer can be online with the system and perform supervisory functions; however, the system can operate independently of the computer.

The PLC, or programmable logic controller, will host the control program and act as the field device receiving the signals from the field sensors, properly formatting these signals, and displaying the data on a visualization panel.

A communication network is necessary to link the PLC with the computer, HMI, and other devices within the plant network. This project uses the EtherCAT (Ethernet for Control Automation Technology) protocol, an Ethernet-based fieldbus developed by Beckhoff Automation.



# Results


The final design of the ANDON system visualization, operating and running online, is shown in Figure. This graphic can be accessed by any internet-connected device for remote monitoring and operation. Access to this graphic is available from any point in the production plant via screens that display graphs and numerical indicators showing real-time values of process variables.

# Results

**andon.programa.control**

| Expression | Type | Value | Address |
|---|---|---|---|
| presion | INT | 9475 | %I* |
| chiller | INT | 629 | %I* |
| torre | INT | 488 | %I* |
| ambiente | INT | 482 | %I* |
| lamp_verde | BOOL | TRUE | %Q* |
| lamp_ambar | BOOL | FALSE | %Q* |
| lamp_roja | BOOL | FALSE | %Q* |
| compresor_apagado | BOOL | TRUE | %I* |
| inicio | BOOL | FALSE | %M* |
| paro | BOOL | FALSE | %M* |
| presion_escalada | REAL | 5.78325748 | %M* |
| chiller_escalada | REAL | 10.5633583 | %M* |
| torre_escalada | REAL | 21.9647751 | %M* |
| ambiente_escalada | REAL | 23.8292141 | %M* |

During the execution of the ANDON system, the variables are assigned a name, type, value, and memory address. The user interaction indicators of the ANDON system are configured according to the values required by the process. .

# Results

After installing the system in the service area of the injection plant, tests were conducted to compare the values provided by the ANDON system with those obtained from calibrated measurement instruments, yielding results as shown in Table .

| Hora | Presión Compresor | | Temperatura Chiller | | Temperatura Torre | | Temperatura Ambiente | |
|---|---|---|---|---|---|---|---|---|
| | ANDON | Real | ANDON | Real | ANDON | Real | ANDON | Real |
| 8:00 | 6.2 Bar | 6.2 Bar | 8.1 °C | 8.4 °C | 15.5 °C | 15.7 °C | 18.5 °C | 18.7 °C |
| 9:00 | 6.1 Bar | 6.0 Bar | 8.5 °C | 8.9 °C | 17.2 °C | 17.5 °C | 29.2 °C | 29.5 °C |
| 10:00 | 6.0 Bar | 5.9 Bar | 9.1 °C | 9.3 °C | 18.9 °C | 19.1 °C | 20.4 °C | 20.9 °C |
| 11:00 | 5.9 Bar | 5.7 Bar | 9.7 °C | 10.0 °C | 20.6 °C | 20.9 °C | 21.6 °C | 22.0 °C |
| 12:00 | 5.8 Bar | 5.6 Bar | 10.5 °C | 10.8 °C | 21.9 °C | 22.3 °C | 23.9 °C | 24.2 °C |
| 13:00 | 5.8 Bar | 5.7 Bar | 11.0 °C | 11.4 °C | 22.2 °C | 22.6 °C | 25.3 °C | 25.6 °C |
| 14:00 | 5.9 Bar | 5.8 Bar | 12.3 °C | 12.8 °C | 23.3 °C | 23.8 °C | 27.1 °C | 27.4 °C |
| 15:00 | 6.0 Bar | 5.8 Bar | 12.9 °C | 13.5 °C | 24.2 °C | 24.6 °C | 29.7 °C | 30.3 °C |

$$er = \frac{\sum_0^n \left| \frac{Xi - Xv}{Xv} \right|}{n}$$

Where:
n = total number of data points
Xi = value acquired in each iteration.
Xv = expected value.

The relative error for each variable was 0.0304 for pressure, 0.0330 for chiller temperature, 0.01595 for cooling tower temperature, and 0.01564 for ambient temperature. This demonstrates that the proposed system has a sampling accuracy between 96% and 98%.

# Conclusions

This article demonstrates the implementation of an automatic ANDON system for monitoring process variables. The data acquisition system is implemented in a PLC controller with a bus coupler to receive pressure and temperature data. Information is transmitted over an Ethernet network and displayed on screens to the end user for the prevention of failures and downtime.

By utilizing the EtherCAT protocol, the system benefits from high transmission speed and low latency. Additionally, the system can integrate a database for information storage and historical data retrieval.

The system was verified by calculating the relative error between the obtained values and the expected values, demonstrating a sampling accuracy between 96% and 98%. It is validated that the system can be applied to other areas of the plant with different process variables.

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