IJIREEICE

ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 4, Issue 4, April 2016

Closed Loop Control of Different Processes Using DCS

K. Vijaya Shanthi[1], K. Swathy[2], R. Ramya[3], T. Devashena[4]

Student, Department of ICE, Saranathan College of Engineering, Trichy, Tamilnadu, India[1, 2, 3]

Assistant Professor, Department of ICE, Saranathan College of Engineering, Trichy, Tamilnadu, India[4]

Abstract: The paper is about the control of different processes. Here the control action is distributed and monitoring can be done in a system which means monitoring is centralized. Real time data acquisition and control can be done using the ABB distributed control system. We can take level, pressure, temperature processes where the control action is distributed. AC800M microcontroller in the Field control unit (FCS) acquire the real time data of the process and those process variables are communicated to the monitoring system which has been installed with compact control builder AC800M software through the Ethernet cable. The set point has given in the system and depending upon the error between the process variable and Set point, the control action has done. The field instrumentation and control system have to be integrated properly and must function optimally to achieve such a goal.

Keywords: Level process, ABB Distributed control system.

I. INTRODUCTION

Process plant automation has evolved from pneumatics to electronics' to Distributed control system [1].

A distributed control system (DCS) refers to a control system usually of a manufacturing system, process or any kind of dynamic system, in which the controller elements are not central in location (like the brain) but are distributed throughout the system with each component sub-system controlled by one or more controllers. The entire system of controllers is connected by networks for communication and monitoring.DCS is a very broad term used in a variety of industries, to monitor and control distributed equipment [5].

A DCS typically uses custom designed processors as controllers and uses both proprietary interconnections and communication protocol for communication. Input and output modules form component parts of the DCS. The processor receives information from input modules and sends information to output modules. The input modules receive information from input instruments in the process (or field) and transmit instructions to the output instruments in the field.

In process control applications, input instrument such as transmitter transmits the real time process variables to the input module.[2],[3] The controller output to manipulate the output instrument which is the final control element of a process[4]. It might be easy to monitor a single process or a very few process. But in Process industries where multiple process has to be taken for consideration, even a little deviation of process variable from the desired point in a single process will affect the whole major process of industry. In such case, Distributed control system and centralized monitoring will help the industry personnel to track the process in a better way.

In this project, we have controlled level process in the field with the help of DCS. Similarly, we can follow the same procedure to control other processes.

II. ABB AC800M MICROCONROLLER

AC 800M is a hardware platform comprising individual hardware units, which can be configured and programmed to perform multiple functions. Once configured and programmed, the AC 800M effectively becomes the AC 800M controller [7]. The hardware units that form the AC 800M Controllers are:

- Processor units (including base plate) (PM851/ PM851A/PM856/PM856A/PM860/PM860A/PM861/ PM861A/PM864/PM864A/PM865/PM866/PM891)
- High Integrity Processor Unit(consists of PM865 and SM810/SM811 with corresponding base plates)
- Communication interfaces for different protocols (including base plates)
- CEX-Bus Interconnection Unit(BC810)
- Power supply units, providing various power output levelsSD831/SD832/SD833/SD834/SS823/SS832)
- Battery back-up unit (SB821/SB822).The SB821 is not supported with PM891.

When equipped with the specified Control Software, the AC 800M Controller acts as a stand-alone interconnected controllers, operator stations and servers.

Various I/O systems can be connected to the AC 800M Controller, either directly (S800 I/O) or via PROFIBUS DP or FOUNDATION Field bus. The AC 800M is delivered without Control Software. To provide the controller with Control Software, first load the firmware and then create the application separately using the Control Builder M engineering tool.

The AC800M Controller consists of a selection of units mounted on horizontal DIN-rails, which can be housed within an enclosure. The majority of units consist of a base mounting plate and removable cover attached with screws. The base plate, which is always mounted onto the DIN-rail, carries the majority of the connections to processor, power supplies and communication interfaces, as well as the connections to the external buses and systems. The AC

IJIREEICE
ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526
INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 4, Issue 4, April 2016

800M Controller provides a cost-effective, low-maintenance solution for applications ranging from small Programmable Logic Controller (PLC) to advanced Distributed Control Systems (DCS) control applications and combined DCS, and High Integrity systems control applications.

III.DISTRIBUTED CONTROL SYSTEM

III. A. Specifications of DCS hardware:

The control panel has an input and output module. The input module is divided into two sections: Analog input and Digital input

The **Analog input** section has 16 ports for connecting 16 real time analog current values in the range of 4-20mA which can be obtained from the transmitters as an output. From each port, constant 24V supply is obtained. This constant voltage is obtained by using a Step- down Transformer for reducing 230V into 24V. The direct supply of 230V is converted into 24V because all the transmitters will work with this voltage range. If a transmitter is connected to the analog input section, it utilizes the 24V from the port as its input and gives output in the range of 4-20mA current.

The **Digital input** section also has 16 ports but it has 16 toggle switches for giving binary inputs (0 or 1) to the Digital type of Program. We can give the binary inputs either by manually changing the switch conditions in the DCS kit or by changing the value in the program.

Fig 1 Local Control Unit (LCU)

The output module has also two sections namely Analog output and Digital output sections.

The **Analog output** section has 16 ports from where we can get the corresponding output from any of the port for the given input. Say if we are giving analog input in port 1 we can get its corresponding output from the port which is mentioned in the Software while doing configuration. But in the LCU that we are using, the analog output port is not working. So the challenge is that we have to take Digital output and convert it into the analog form

The **Digital output** section has also 16 ports from which we can get the corresponding output. This section has 16 LEDs to display the binary output. As said in the analog output part here also we can configure any output port for an input port. The internal portion of the control panel consists of PLC (Programmable Logic Controller), AC 800M Microcontrollers and hardware units.

III. B. Description of the elements in the DCS:

Local Control Unit (LCU): This is denoted as local computer. This unit can handle 8 to 16 individual PID loops, with 16 to 32 analog input lines, 8 to 16 analog output signals and some a limited number of digital inputs and outputs.[5],[6]

Data Acquisition Unit: This unit may contain 2 to 16 times as many analog input/output channels as the LCU. Digital (discrete) and analog I/O can be handled. Typically, no control functions are available.

Batch Sequencing Unit: Typically, this unit contains a number of external events, timing counters, arbitrary function generators, and internal logic.

Local Display: This device usually provides analog display stations, analog trend recorder, and sometime video display for readout.

Bulk Memory Unit: This unit is used to store and recall process data. Usually mass storage disks or magnetic tape are used.

General Purpose Computer: This unit is programmed by a customer or third Party to **Central Operator Display:** This unit typically will contain one or more consoles for operator communication with the system, and multiple video color graphics display units.

Data Highway: A serial digital data transmission link connecting all other components in the system may consist of coaxial cable. Most commercial DCS allow for redundant data highway to reduce the risk of data loss.

Local area Network (LAN): Many manufacturers supply a port device to allow connection to remote devices through a standard local area network

IV. CLOSED LOOP CONTROL OF LEVEL PROCESS USING DCS

Level process has done in Multi trainer kit. The setup is designed to understand the advanced control methods used for complex processes in the industries.[8] It consists of water supply tank, pump, level transmitter, transparent level tank, and orifice meters with differential pressure transmitters, rotameters, pneumatic control valve, I/P converter and serial based dual loop controller.

IJIREEICE
ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526
INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 4, Issue 4, April 2016

Fig 2. Level process in Multi trainer kit

Product	Multi process trainer
Product code	326A
Control unit	ADAM-4022T Serial based dual loop PID controller; Analog input 4, Analog output 2, Digital input 2, Digital output 2. With RS485 communication.
Communication	USB port using RS485-USB converter
Differential pressure Txr	Type Capacitance,2 wire, Range 0–200 mm, Output 4–20 mA (2 Nos)
Level transmitter	Type Electronic, two wire, Range 0–250 mm, Output 4–20mA
I/P converter	Input 4-20mA, Output 3-15 psig
Control valve	Type: Pneumatic; Size: 1/4", Input: 3–15 psig, Air to close, Characteristics: linear
Rotameter	10-100 LPH(3 nos)
Pump	Fractional horse power, type submersible
Process tank	Transparent, Acrylic, with 0-100% graduated scale

Table1. Description of Multi process trainer kit

IV.A. REAL TIME CONTROL OF LEVEL PROCESS:
To control the process in real time, the current variation for the level changes in the linear tank has measured.

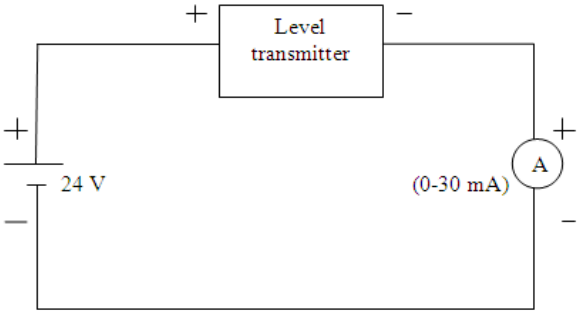

Fig3. Circuit diagram to measure current

The corresponding changes has been analyzed which has given an idea about its linear characteristics. i.e, Transmitter output (current) is linear to the change in level.

IV.B.LEVEL ACQUISITION:
The level of the linear tank has been acquired through analog input of LCU which would accept (4-20 mA) as input. 24V has taken from each and every IO module pin. So we connect analog input pin directly to the Level transmitter.

SOFTWARE:
Open compact control builder AC800M software in the system.
Step1: open new project ---> test.
Step2: Do the steps mentioned above in the hardware configuration.
Step3: Program to ON and OFF the control valve if the level reaches the set point.
Step4: The input DPT is configured with one of the analog input modules and mention the type variable as real.
Step5: If the set point has reached, one of the LEDs in the digital output module should glow. So configure the output with one of the digital output modules.
Step6: Click Download and Go Online.

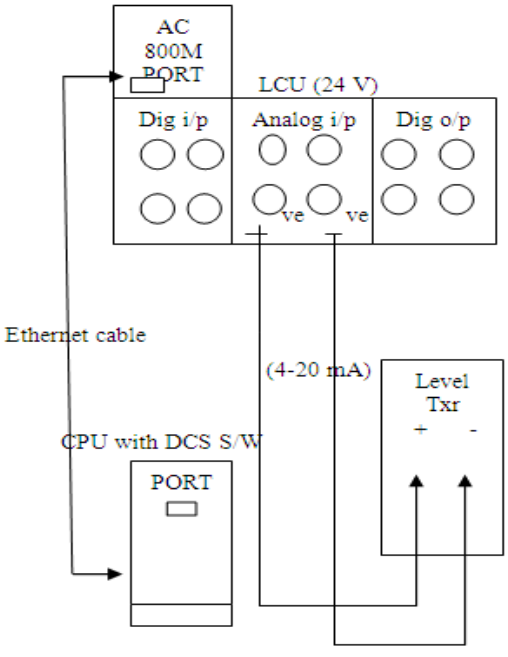

Fig 4 Connection diagram for acquisition

DOI 10.17148/IJIREEICE.2016.4414

IJIREEICE
ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526
INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 4, Issue 4, April 2016

Once the whole set up is switched ON, the DPT (analog input) in the software acquires the real time value of level in the tank. It is scaled in such a manner the current 4 - 20 mA in the loop will show 0 - 100 in the software side.

Once the condition mentioned in the program is satisfied, the LED in the digital output glows .Since the analog output in the Local control unit is not in working condition, we have to take the digital output to do the closed loop control using DCS.

IV.C.GENERATION OF VOLTAGE TO CONTROL:

Closed loop control has been achieved only by controlling the Final control element (Control valve) which would accept (3-15) psi as input in the inlet or in the outlet side .20 psi has to be given as the supply pressure to the control valve. The Final control element in the Level process control station is 'Air to close' or 'Normally open' control valve which is placed at the inlet side .It means that when the process station is switched ON, inlet valve is fully open; hence the flow is maximum at the inlet side.

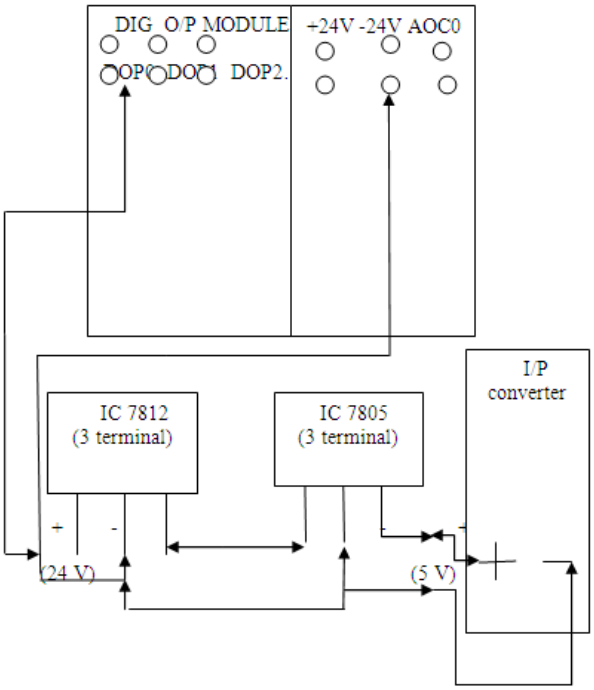

Fig 5 Connection diagram for generation

Current – pressure converter is connected to the control valve which is scalable as it converts (4 -20 mA) into (3-15 psi). When the set point is reached, the control valve has to close fully i.e, the flow is zero. Since it is in normally open condition, we have to give 15 psi to close the valve once the condition has met. To close the control valve fully, we should give 20 mA to the current – pressure converter. The current to pressure converter in the multivariable level process station has resistance internally, we can directly give Voltage (0 – 5 V) as the input which itself converts it into current (4-20 mA) and accept it as input.

Since we have to take the output from the digital output module, the initial step is to analyze the digital output module. When the digital output is '1' the voltage from the Digital output module is 22.8 V. when it is '0', the voltage is of about 0.034 V. It means when the set point is reached, the output is taken as 22.8 V. we have to reduce 22.8 V to 5V. Say, the program assigns DOP0 as the output.

V. CONCLUSION

In this project, a DCS is designed for the level process using the Multi process trainer kit. From this project we have inferred that even we can control the process using the Digital output rather than the direct Analog output. By applying suitable conversions to the Digital output we can control the entire process. The Local control unit accepts only 4-20 mA as input in analog form since it is built to accept the transmitter output of different process. By using DCS, we can monitor different processes and control them which are distributed in the field.

REFERENCES

1. "Application of Distributed Control System in automation of Process Industries" published in "International Journal of Emerging Technology and Advanced Engineering" by Megha Anand S.A. 1, Suprathik Sarkar 2 , Sree Rajendra 3 ,
2. Process Dynamics, Modeling and Control, Oxford University Press, UK, 1994 by Ogunnaike, B. and Ray, W
3. Process Dynamics and Control, Wiley & sons, New York, 1989 by Seborg, D., Edgar, T., and Mellichamp, D
4. Industrial Instruments and Controls Handbook by Conidine, D., Process.
5. "Implementation of Distributed Control System In Process Control Management Using MATLAB" published in" International Journal of Scientific & Technology Research" by Khin Nway Oo 1, Zaw Min Naing 2, Hla Myo Tun 3
6. "Design and Construction of Distributed Control System (DCS) Based Power Distribution in University Campus" published in "International Journal of Electronics and Computer Science Engineering" byYin Yin Winn 1 Hla Myo Tun 2, Su Su Yi Mon 3.
7. Compact control builder AC800M Version 5.0,Introduction and Installation
8. Temperature Level control of a Multivariable water tank process, 120th ASEE Annual Conference and Exposition.