بسم الله الرحمن الرحيم

Sudan University of Science &Technology

College of Graduate Studies

عملية ملء وتفريغ خزانات النفط الخام باستخدام نظام التحكم المبرمج الموزع في حقول النفط

Process of Crude Oil Tanks Filling and Discharging Using Distributed Control System (DCS) at Oil Fields

A Thesis Submitted as a Partial Fulfillment of the requirements for the degree of master in Mechatronic Engineering

By

AMIR ABD ELRAHMAN ABD ELSAMAD

Supervisor

Dr. ZAKARIA ANWAR ZAKARIA

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الآية

قال تعالى :

(وَعِندَهُ مَفَاتِحُ الْغَيْبِ لاَ يَعْلَمُهَا إِلاَّ هُوَ وَيَعْلَمُ مَا فِي الْبَرِّ وَالْبَحْرِ وَمَا تَسْقُطُ مِن وَرَقَةٍ إِلاَّ يَعْلَمُهَا وَلاَ حَبَّةٍ فِي ظُلُمَاتِ الأَرْضِ وَلاَ رَطْبٍ وَلاَ يَابِسٍ إِلاَّ فِي كِتَابٍ مُّبِينٍ)

صدق الله العظيم

ســـورة الأنعام (الآية 59)

Dedication

To my father& mother, they taught me to persevere and prepared me to face challenges with faith and humility. They were a constant source of inspiration to my life. They give me strength and support I always thanks them that used to urge me to strive to achieve my goals in life.

Acknowledgement

So many people have encouraged and supported me throughout the writing of this research. I would like to acknowledge their contribution. My thanks and gratitude to Dr. Zakaria Anwar Zakaria for all supports and guidance.

Special thanks to my best friends without specification for their advice, support and endless patience.

Thanks are extended to my colleagues for their great effort and encouragement work without them would not have been possible

Abstract

A distributed control system (DCS) is a modern control system used to automate electromechanical processes, is frequently used when DCS implementing automated control, which is an important part of many modern industries.

This research is based on monitoring Level, Pressure and flow of crude oil in the crude oil storage tank by using ABB Program. Automatic control of crude oil in vessel can work continuously and can provide accurate quantity of crude in less time. In such process there is no need of labor so there is no human error. Without human error, the quality of product is better and the cost of production would definitely decrease.

The purpose of the research is to replace the manual system being used in the industry, compare the time, and manpower requirement for both the existing system with the proposed automated system. Using of DCS turns to a higher performance, great efficiency, minimize hardware and maintenance costs. So the automatic control system is better than manual control system

المستخلص

نظام التحكم المبرمج الموزع عبارة عن نظام متكامل يستخدم للتحكم في العمليات الكهروميكانيكية، يستخدم نظام التحكم المبرمج الموزع في تصميم التحكم الأوتوماتيكي وهذا يشكل دور مهم في جزء كبير من الصناعات الحديثة.

هذا البحث مبني علي مراقبة المستوي والضغط و التدفق للنفط الخام الموجود في وعاء او خزان باستخدام نظام التحكم المبرمج الموزع من شركة أي بي بي . التحكم الاتوماتيكي في النفط الخام الموجود في خزان يمكن ان يحدث باستمرار ويمكن ان نحصل علي كمية دقيقة من البترول في أقل زمن. في هذه العمليات لا توجد الحاجة للعمال ولهذا لا يوجد خطأ بشري. مع عدم وجود الخطأ البشري جودة المنتجات سوف تكون جيدة وتكلفة هذه المنتجات بكل تأكيد سوف تقل.

الغرض من هذا البحث استبدال النظام اليدوي الذي يستخدم في المصانع بالمقارنة مع النظام الاتوماتيكي من حيث الزمن والحاجة إلى الأيدي العاملة.مما ذكر تعتبر اتمتة التحكم باستخدام نظام التحكم المبرمج الموزع من احد الحلول الاكثر فعالية لتحسين الموثوقية وزيادة الكفاءة وتوفير التكاليف بالمقارنة مع النظام اليدوى.

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List of Symbols and Abbreviations

AC	:	Advance Controller.
A/D	:	Analog to Digital Converter
AI	:	Analog Input
AO	:	Analog Output
API	:	American Petroleum Institute
bar	:	barometer unit of atmospheric pressure measurement
Bps	:	Bits per second
CAN	:	Control Area Network or Control and Automation Network
CIP	:	Common Industrial Protocol
CPU	:	Central Processing Unit
CS	:	Configuration Server
DCS	:	Distributed Control System
D/A	:	Digital to Analog Converter
DC or dc	:	Direct current
DCP	:	Data Collection Platform
DI	:	Digital Input
DO	:	Digital Output
DP	:	Distributed I/O
ESDV	:	Emergency Shutdown Valve
FBD	:	Function Block Diagram
GS	:	Gateway Station
HMI	:	Human Machine Interface
IEC	:	International Electrotechnical Commission
IEEE	:	Institute of Electrical and Electronic Engineers (US)
IDF	:	Individual Drive Function
FBD	:	Function Block Diagram
IL	:	Instruction List
IP	:	Internet Protocol
ISO	:	International Organization for Standardization
IT	:	Information Technology (as in IT manager or IT department)
KPa	:	kilo-Pascal
LAD	:	Ladder Diagram
LED	:	Light Emitting Diode

mA / ma	:	Milliamperes
MB	:	mega-Byte
Mbs, mbps	:	Mega Bits per Second
MMI	:	Man-Machine Interface
MOV	:	Motor Operated Valve
MSB	:	Most Significant Bit
MV	:	Manipulated variable
NIR	:	Near Infrared
PC	:	Personal Computer
PID	:	Proportional Integral and Derivative
PL	:	Program list
PLC	:	Programmable Logic Controller
PS	:	Power Supply
PS	:	Process Station
psi or PSI	:	Pounds Per square Inch
PTC	:	Positive Temperature Coefficient
PV	:	Process variable
OPC	:	Open Platform Communications
OS	:	Operator Station
OWD	:	On-Line Water Determination
RAM	:	Random access memory
RED	:	Redundant
ROM	:	Read only memory
RTD	:	Resistance temperature device
SCADA	:	Supervisory Control And Data Acquisition
SFC	:	Sequential Function Chart
SP	:	Set Point (reference)
ST	:	Structured Text
TCP/IP	:	Transmission control Protocol / Internet Protocol
TON	:	Timer On Delay
UTP	:	Unshielded Twisted Pair
HART	:	Highway Addressable Remote Transducer Program
CO	:	Carbon monoxide
URV	:	Upper Range Value
FCU	:	Field Control Unit
I/P	:	Current to pressure Converter

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CHAPTER ONE

Introduction

1.1 Control System Overview

A control system is a device or set of structures designed to manage, command, direct, or regulate the behavior of other devices or systems. The entire control system can be viewed as a multivariable process that has a number of inputs and outputs that can affect the behavior of the process. Section is intended as a brief introduction to control system

Automatic control system is extensively used in industry and enables mass production of continuous processes such as oil refining, paper manufacturing, chemicals, power plants and many other industries. The main advantages of automatic control system are:[15]

- Replacing human operators in tasks that involve hard physical
- Replacing humans in tasks had done in dangerous environments (i.e. fire, space, volcanoes, nuclear facilities, underwater, etc.)
- Performing tasks that are beyond human capabilities of size, weight, speed, endurance, etc.
- Economy improvement. Automation may improve in economy of enterprises, society or most of humanity, with which a small staff of operating personnel can operate a complex process from a central control room. Distributed control system (DCS) is the most modern control platform. It stands as the infrastructure not only for all advanced control strategies but also for the lowliest control system.

The idea of control infrastructure is old. Automation Components are:

- Field Instruments

- Control Hardware
- Control Software

1.2 Historical Background

The two major purposes of instrumentation are measurement and control. More than 2000 years ago, measurement devices were already in use to measure water flow in order to regulate material transfer and to account for consumption of water for irrigation.

In the early part of the twentieth century, simple measurement devices such as pressure and temperature gages were mounted directly on the process pipes or vessels. Control was achieved by the operator walking about the plant monitoring the plant conditions and then making manual adjustments on valves, dampers and levers to control the process.

This was a true distributed control system, with the operators and instrumentation distributed at different points throughout the process. Early control mechanisms or regulators were mechanical by the movement of a diaphragm, bourdon tube, or bimetallic element operated the stem of a control valve. These mechanisms helped to automate the work and made it possible for Operators to handle larger plants.

In the 1920's and 1930's, pneumatic transmission of measurement signals was developed, making it possible to put indicators, recorders, controllers, and other equipment in a centralized area, these instruments were installed on large panels located at the process unit or in a centralized control room. Disadvantage of these pneumatic systems was that as the distance between the process and the control device grew, a significant delay, or dead time, which was detrimental to the quality of the control, was introduced into the control system.

The development of electronic analog signal transmission in the 1960's helped alleviate this problem. The use of electronic transmission signals was hindered in some applications because of the danger of electrical energy in explosive and flammable environments.

The application of digital computers to process control began in the late 1950’s.The computers in this era were large, expensive, and not reliable. It was not until the middle 1970’s that the use of computers became widespread in the process control industry. The early computers were used only for supervisory purposes because of their unreliability communicating with the panel-mounted controllers by setting valve positions and set points, the computers allowed for more complex control strategies. Use of computers also allowed changing the control system structure while the plant was still on-line. The advent of microprocessors and large scale integrated electronic circuits has made the development of distributed control systems possible.

The first distributed Control system (DCS) was introduced in 1976. These control systems distribute the functions of the control system among a number of processors so that a single failure does not affect the entire system and shut down the entire process. By distributing the functions and intelligence of the system, it is also possible to locate the analog/digital interface close to the process. This greatly reduces the amount of cabling required because the signals can be multiplexed and brought back to the computer over a single communication cable.

1.3 Problem Statement

The purpose of this research is to study process of crude oil tanks filling and discharging using distributed control system (DCS), at oil fields. Also to study the hard ware and software of distributed control system (DCS) which is consists of control builder F and DigiVis.

1.4 Objectives

The study had been conducted to accomplish the following goals and objectives:-

- Control for tank filling and discharging process.
- Execute Special Programmed Logic
- Monitor Inputs and outputs of the system

1.5 Methodology

The system configured and controlled by using personal computer (PC) , hard ware and Software of ABB DCS. This soft ware includes Control Builder F which is used for the editing and developing of the program, logic or graphics part. And the DigiVis software is used for visualizing and operating the plant in real time.

1.6 Outlines of The Thesis

This study consists of five chapters, chapter one has presented an introduction of automatic control and background, importance, methodology, objectives and overview of the thesis, chapter two presents a literature review of the contains distributed control system (DCS) components and functions in details. Chapter three presents system hardware, chapter four presents software.

Finally chapter five presents a conclusion and recommendations.

CHAPTER TWO

Literature Review

2.1 The Importance of Process Control

Refining, combining, handling, and otherwise manipulating fluids to profitably produce end products can be a precise, demanding, and potentially hazardous process. Small changes in a process can have a large impact on the end result. Variations in proportions, temperature, flow, turbulence, and many other factors must be carefully and consistently controlled to produce the desired end product with a minimum of raw materials and energy. Process control technology is the tool that enables manufacturers to keep their operations running within specified limits and to set more precise limits to maximize profitability, ensure quality and safety [7].

2.2 Purpose of Automatic Control

The purpose of automatic control is to provide a means by which any process operating condition within a production system can be maintained in a stable and consistent manner. This requires that there is some means of measuring the condition of the process and that some method of adjusting the operating condition is provided. The effect of automatic control is an adjustment to the process which corrects a deviation from the preset operating condition. It follows that four main components are required for any automatic control loop [13]:-

- Process,
- Measuring unit
- Controlling unit
- Correcting unit

The four items may include many variations in equipment. Operating process equipment may range from a relatively simple pipeline with several valves to high speed centrifugal compressors. Measuring units can use equipment ranging from simple float devices to electronic transducers. The controlling unit can be a self-acting device mounted directly onto process equipment, a remote mounted device mounted in a control room or a computer in a remote location. Correcting units can be simply classified as variations of control valves fitted with some form of motor element.

Once an automatic control system has been installed and commissioned, it should be able to maintain a preset operating condition over an extended period of time without any operator involvement. A whole section of process equipment may operate in a fully automatic mode, provided automatic control loops are installed to maintain the process conditions required, without the intervention of an operator.

The main components of an automatic control loop comprise a process, measuring unit, controlling unit and correcting unit. These units can be shown in block diagram form as in the accompanying illustration.

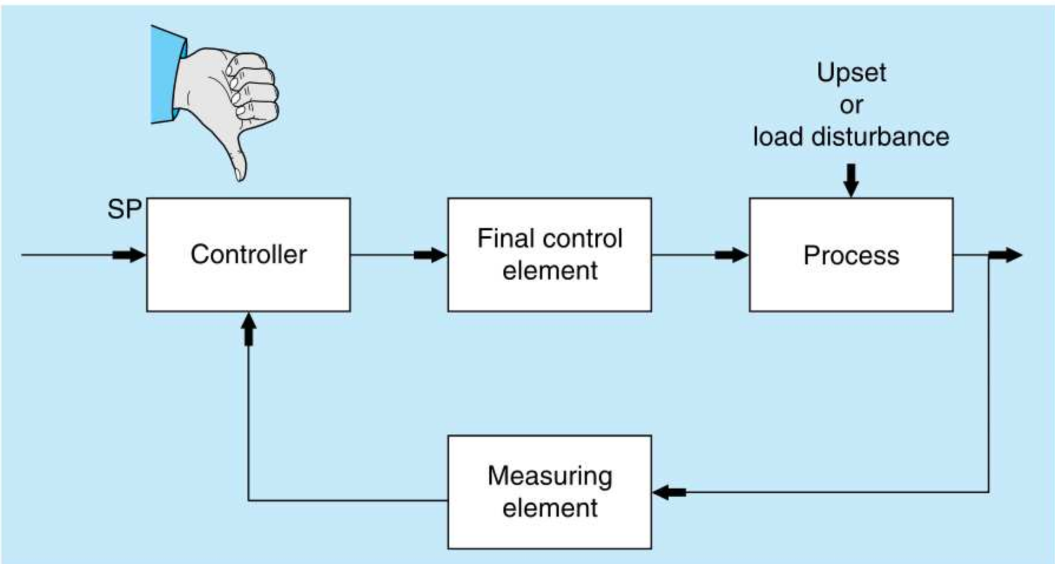


Figure (2.1): Block diagram of automatic control system components

2.2.1 Process

The production rate and product quality of most operation processes need to be controlled. The condition of the process at any instant in time needs to be known with a certain degree of accuracy. The conditions which need to be measured are usually related to flow, level, temperature, pressure or quality. If these process variables can be measured and conditions in the process adjusted to maintain a set value, then automatic control is achievable. Although each unit in the block diagram may be treated individually, the final performance of the controlling unit will depend upon the combined effect of all the components in the loop.

2.2.2 Measuring Unit

The measuring unit usually comprises two elements, the detecting element and the measuring element. The detecting element is usually in close contact with the process such as, a thermocouple in a thermo well detecting the process temperature. The measuring element receives an input from the detecting element and responds to it to produce a measured value of the process condition. In this case, the instrument is a transducer, receiving the input from the thermocouple (emf) and outputting a current signal proportional to the process temperature.

2.2.3 Controlling Unit

The controlling unit comprises those elements which provide a control signal for transmission to the correcting unit in relation to any deviation. The controller determines this by comparison of the Measured Value (MV) signal from the measuring element with a signal representing the Set Point (SP) value of the process condition. Any deviation between the MV and SP signals is countered by an error signal output from the controlling unit. Thus the controlling unit comprises a comparator, to compare the MV and SP signals, and an error signal generator. The set point signal value may be fixed or may be varied by an external agent. The magnitude of the error signal generated for any given value of deviation depends upon the sensitivity of the controller.

2.2.4 Correcting Unit

The correcting unit consists of a correcting element and a motor element. It adjusts the physical quantity on which the value of the process condition depends in response to a signal from the controlling unit. The correcting element, usually a valve, directly affects the process condition. The motor element adjusts the correcting element in response to the controller output signal as illustrated in the below figure.

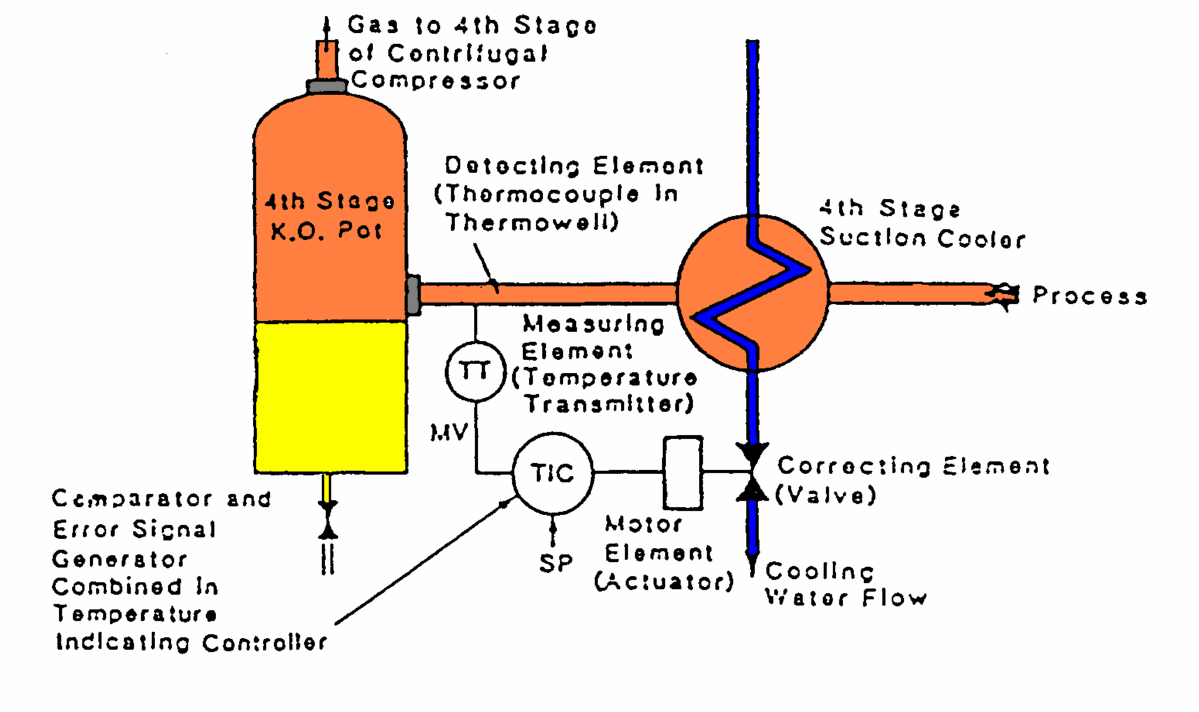


Figure (2.2): Example of control loop

2.3 Process Control Terms

As in any field, process control has its own set of common terms that you should be familiar with and that you will use when talking about control technology.[17]

2.3.1 Process Variables

A process variable is a condition of the process fluid (a liquid or gas) that can change the manufacturing process in some way.

Common process variables include:

- Pressure
- Flow
- Level
- Temperature
- Density
- Ph (acidity or alkalinity)
- Liquid interface (the relative amounts of different liquids that are combined in a vessel)
- Mass
- Conductivity

a. Set point

The set point is a value for a process variable that is desired to be maintained. For example, if a process temperature needs to kept within 5 °C of 100 °C, then the set point is 100 °C. A temperature sensor can be used to help maintain the temperature at set point. The sensor is inserted into the process, and a controller compares the temperature reading from the sensor to the set point. If the temperature reading is 110 °C, then the controller determines that the process is above set point and signals the fuel valve of the burner to close slightly until the process cools to

100 °C. Set points can also be maximum or minimum values. For example, level in tank cannot exceed 20 feet.

b. Measured Variables, Process Variables, and Manipulated Variables

In the temperature control loop example, the measured variable is temperature, which must be held close to 100 °C. In this example and in most instances, the measured variable is also the process variable. The measured variable is the condition of the process fluid that must be kept at the designated set point. Sometimes the measured variable is not the same as the process variable.

For example, a manufacturer may measure flow into and out of a storage tank to determine tank level. In this scenario, flow is the measured variable, and the process fluid level is the process variable.

The factor that is changed to keep the measured variable at set point is called the manipulated variable.

c. Error

Error is the difference between the measured variable and the set point and can be either positive or negative. In the temperature control loop example, the error is the difference between the 110°C measured variable and the 100 °C set point—that is, the error is +10°C.The objective of any control scheme is to minimize or eliminate error. Therefore, it is imperative that error be well understood.

2.4 Types of Control System

A closed control loop (automatic control system) exists where a process variable is measured, compared to a set point, and action is taken to correct any deviation from set point. An open control loop(Manual control system) exists where the process variable is not compared, and action is taken not in response to feedback on the condition of the process variable, but it is instead taken without regard to process variable conditions. For example, a water valve may be opened to add cooling water to a process to prevent the process fluid from getting too hot, based on a pre-set time interval, regardless of the actual temperature of the process fluid.[11]

2.4.1 Closed Loop Control System

In a closed loop control system the output of the measuring element is fed into the loop controller where it is compared with the set point. An error signal is generated when the measured value is not equal to the set point. Subsequently, the controller adjusts the position of the control valve until the measured value fed into the controller is equal to the set point.

The Measured Value (MV) signal is fed back to the controller after adjustment of the control valve (correcting element) by the controller. The controller continuously compares this feedback (MV) signal with the Set Point (SP) and readjusts the control valve to maintain MV = SP. Thus closed loop control is often referred to as feedback control.

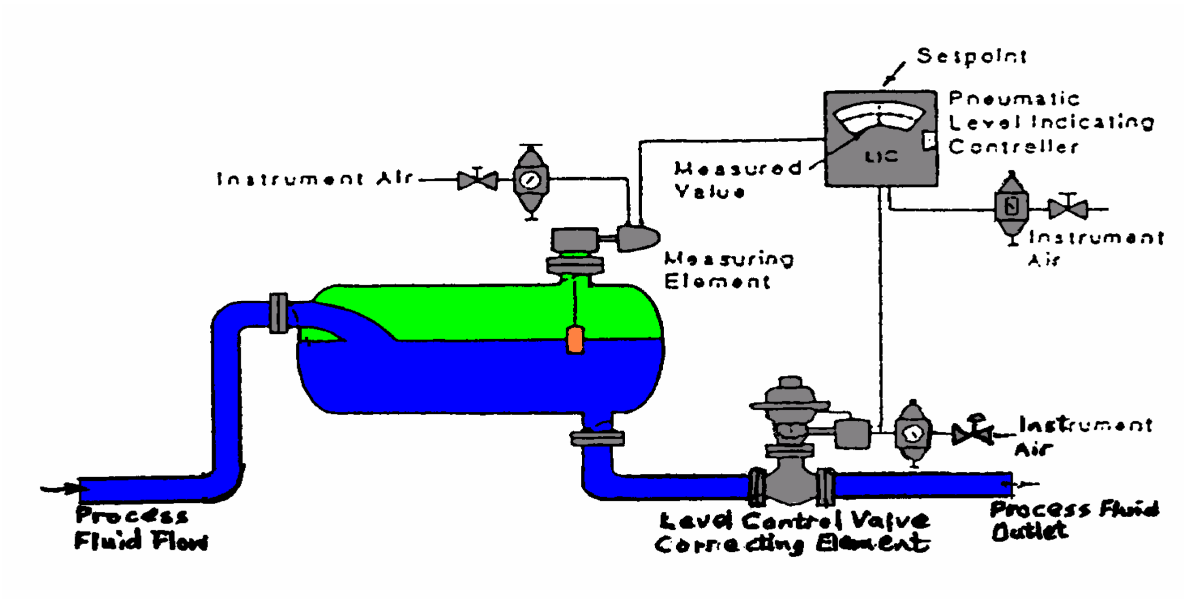


Figure (2.3): A closed control system

The Figure (2.3) shows a practical representation of a pneumatic closed loop control system where the process level is measured by a displacer level transmitter which transits the level measured value (process variable) to the loop controller. In the controller the measured value is compared with the manually adjusted set point (desired value). If the set point is not equal to the measured value, then a deviation exists. Depending upon the magnitude and direction of the deviation, the controller will make the necessary adjustment to its output in order to move the control valve position.

If the vessel level is above set point, the control valve must be moved towards the open position, so that the vessel discharges faster. The level will begin to drop, provided the flow of fluid into the vessel remains constant. The measured value will now fall towards the set point and the control loop will attempt to stabilize.

The response of the process, the speed at which stable conditions can be achieved and the amount of deviation between the measured value and set point are important conditions which affect the performance of any process. It is these constraints which must be acknowledged when considering automatic control.

2.4.2 Open Loop system

Process control system may be considered in two distinct modes, namely, open loop system and closed loop system. Typical applications are shown in the accompanying in Figures (2.3) and (2.4)

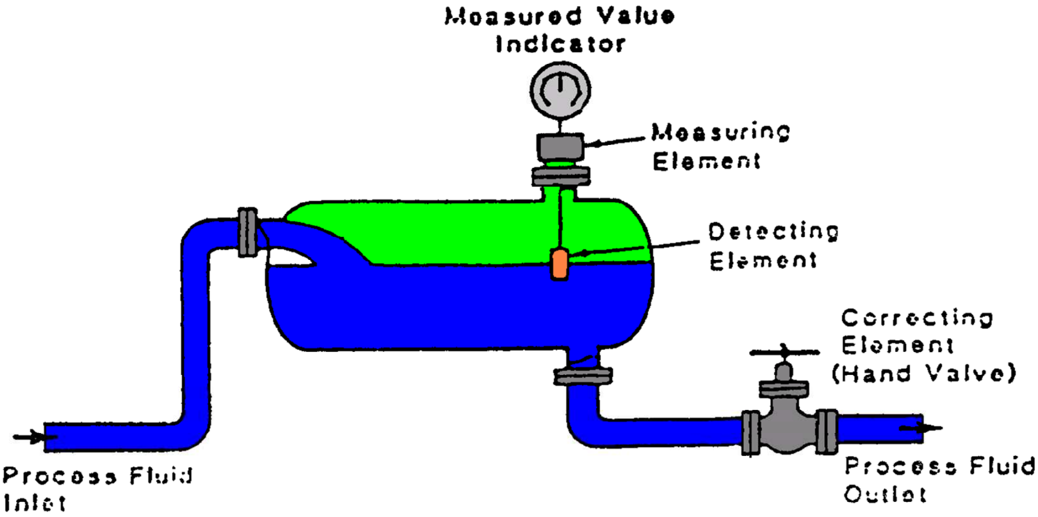


Figure (2.4): Open control loop

In open loop control, the process condition is measured and continuously indicated. The output of the measuring element does not play a direct part in actuating the valve; its only function is to provide information. The reading from the measuring element is taken periodically and the hand valve on the process fluid output adjusted accordingly. These operations are carried out by an operator.

A similar situation arises when a closed loop controller is put into manual.

If an adjustment to the process is necessary, the operator either increases or decreases the controller output signal, using the manual output adjustment on the controller. The control loop is therefore said to be in manual mode, (or open loop). An example of this would be if disturbances to the process could not be handled by the controller, especially during start-up.

To summarize, in a control system in open loop or manual mode the correcting element needs to be adjusted manually by hand. Linking the controller output to the motor element reverts the automatic control loop to closed loop system.

2.5 Components of Control system

This section describes the instruments, technologies, and equipment used to develop and maintain process control loops.

The previous section described the basic elements of control as measurement, comparison, and adjustment. In practice, there are instruments and strategies to accomplish each of these essential
tasks. In some cases, a single process control instrument, such as a modern pressure transmitter, may perform more than one of the basic control functions. Other technologies have been developed so that communication can occur among the components that measure, compare, and adjust.[9]

2.5.1 Primary Elements/Sensors

In all cases, some kind of instrument is measuring changes in the process and reporting a process variable measurement. Some of the greatest ingenuity in the process control field is apparent in sensing devices. Because sensing devices are the first element in the control system to measure the process variable, they are also called *primary elements*. Examples of primary elements include:

- Pressure sensing diaphragms, strain gauges, capacitance cells
- Resistance temperature detectors (RTDs)
- Thermocouples
- Orifice plates
- Pitot tubes
- Venturi tubes
- Magnetic flow tubes
- Coriolis flow tubes

- Radar emitters and receivers
- Ultrasonic emitters and receivers
- Annubar flow elements
- Vortex sheddar

Primary elements are devices that cause some change in their property with changes in process fluid conditions that can then be measured. For example, when a conductive fluid passes through the magnetic field in a magnetic flow tube, the fluid generates a voltage that is directly proportional to the velocity of the process fluid. The primary element (magnetic flow tube) outputs a voltage that can be measured and used to calculate the fluid's flow rate. With an RTD, as the temperature of a process fluid surrounding the RTD rises or falls, the electrical resistance of the RTD increases or decreases a proportional amount. The resistance is measured, and from this measurement, temperature is determined.

2.5.2 Transducers and Converters

A *transducer* is a device that translates a physical value into an electrical signal. For example, inside a capacitance pressure device, a transducer converts changes in pressure into a proportional change in capacitance.

A *converter* is a device that converts one type of signal into another type of signal. For example, a converter may convert current into voltage or an analog signal into a digital signal. In process control, a converter used to convert a 4–20 mA current signal into a 3–15 psig pneumatic signal (commonly used by valve actuators) is called a *current-to-pressure converter.*

2.5.3 Transmitters

A *transmitter* is a device that converts a reading from a sensor or transducer into a standard signal and transmits that signal to a monitor or controller. Transmitter types include:

- Pressure transmitters

- Flow transmitters
- Temperature transmitters
- Level transmitters
- Analytic O_2 [oxygen],CO [carbon monoxide], and PH transmitters

2.5.4 Signals

There are three kinds of signals that exist for the process industry to transmit the process variable measurement from the instrument to a centralized control system.

a. Pneumatic signal

b. Analog signal

c. Digital signal

2.5.4a Pneumatic Signals

Pneumatic signals are signals produced by changing the air pressure in a signal pipe in proportion to the measured change in a process variable. The common industry standard pneumatic signal range is 3–15 psig. The 3 corresponds to the lower range value (LRV) and the 15 corresponds to the upper range value (URV). Pneumatic signaling is still common. However, since the advent of electronic instruments in the 1960s, the lower costs involved in running electrical signal wire through a plant as opposed to running pressurized air tubes has made pneumatic signal technology less attractive.

2.5.4b Analog Signals

The most common standard electrical signal is the 4–20 mA current signals. With this signal, a transmitter sends a small current through a set of wires. The current signal is a kind of gauge in which 4mA represents the lowest possible measurement, or zero, and 20 mA represents the highest possible measurement. For example, imagine a process that must be maintained at 100°C. An RTD temperature sensor and transmitter are installed in the process vessel, and the transmitter is set to produce a 4 mA signal when the process temperature is at 95 °C and a 20mA signal when the process temperature is at 105 °C. The transmitter will transmit a 12mA signal when the temperature is at the 100 °C set point. As the sensor's resistance property changes in response to changes in temperature, the transmitter outputs a 4–20 mA signal that is proportionate to the temperature changes. This signal can be converted to a temperature reading or an input to a control device, such as a burner fuel valve. Other common standard electrical signals include the 1–5 V (volts) signal and the pulse output.

2.5.4c Digital Signals

Digital signals are the most recent addition to process control signal technology. Digital signals are discrete levels or values that are combined in specific ways to represent process variables and also carry other information, such as diagnostic information. The methodology used to combine the digital signals is referred to as protocol. Manufacturers may use either an open or a proprietary digital protocol. Open protocols are those that anyone who is developing a control device can use. Proprietary protocols are owned by specific companies and may be used only with their permission. Open digital protocols include the HART® (highway addressable remote transducer) protocol, FOUNDATION™ Field bus, Profibus, Device Net, and the Modbus® protocol.

2.5.5 Indicators

While most instruments are connected to a control system, operators sometimes need to check a measurement on the factory floor at the measurement point. An indicator makes this reading possible. An indicator is a human-readable device that displays information about the process. Indicators may be as simple as a pressure or temperature gauge or more complex, such as a digital read-out device. Some indicators simply display the measured variable, while others have control buttons that enable operators to change settings in the field.

2.5.6 Recorders

A recorder is a device that records the output of measurement devices. Many process manufacturers are required by law to provide a process history to regulatory agencies, and manufacturers use recorders to help meet these regulatory requirements. In addition, manufacturers often use recorders to gather data for trend analyses.

By recording the readings of critical measurement points and comparing those readings over time with the results of the process, the process can be improved. Different recorders display the data they collect differently. Some recorders list a set of readings and the times the readings were taken; others create a chart or graph of the readings. Recorders that create charts or graphs are called chart recorders.

2.5.7 Controllers

A controller is a device that receives data from a measurement instrument, compares that data to a programmed set point, and, if necessary, signals a control element to take corrective action.

Local controllers are usually one of the three types: pneumatic, electronic or programmable. Controllers also commonly reside in a digital control system.

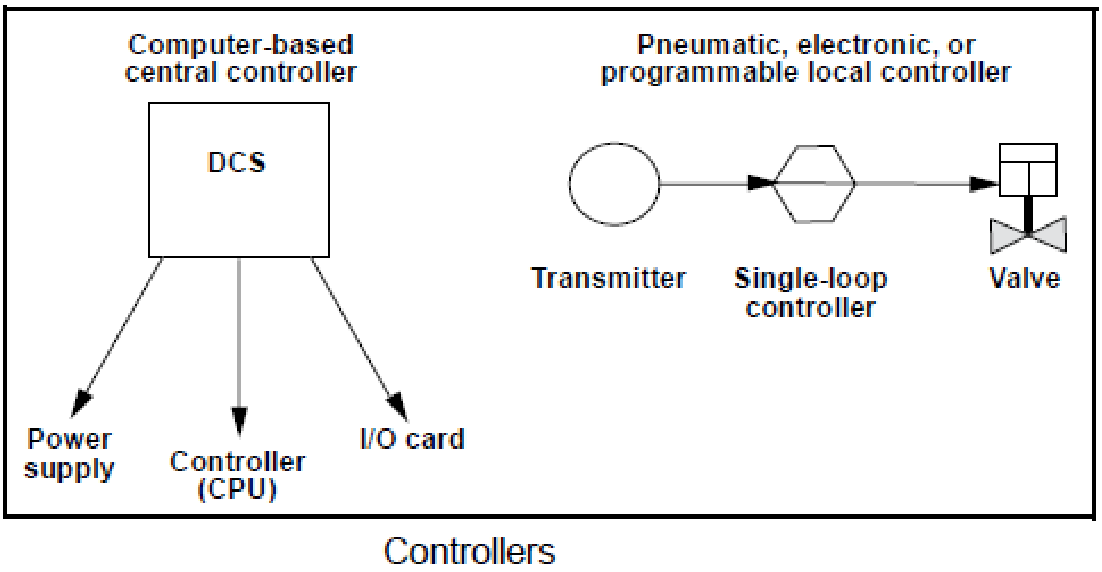


Figure (2.5): Controllers

Controllers may perform complex mathematical functions to compare a set of data to set point or they may perform simple addition or subtraction functions to make comparisons. Controllers always have an ability to receive input, to perform a mathematical function with the input, and to produce an output signal. Common examples of controllers include:

Programmable logic controllers (PLCs) — PLCs are usually computers connected to a set of input/output (I/O) devices. The computers are programmed to respond to inputs by sending outputs to maintain all processes at set point.

Distributed control systems (DCSs)—DCSs are controllers that, in addition to performing control functions provide readings of the status of the process, maintain databases and advanced man-machine-interface.

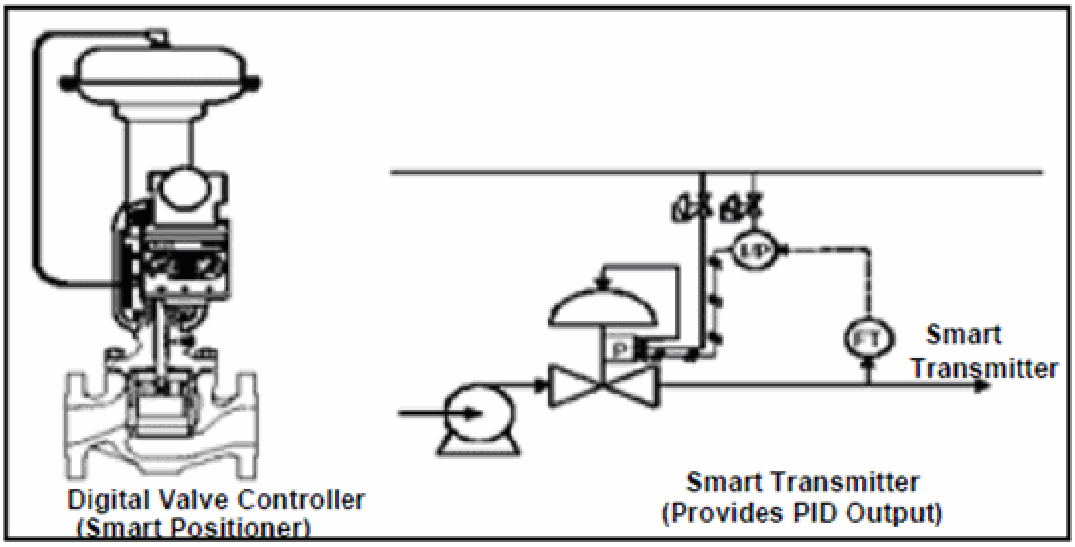


Figure (2.6): Types of process controllers

2.5.8 Correcting Elements/Final Control Elements

The correcting or final control element is the part of the control system that acts to physically change the manipulated variable. In most cases, the final control element is a valve used to restrict or cut off fluid flow, but pump motors, louvers (typically used to regulate air flow), solenoids, and other devices can also be final control elements. Final control elements are typically used to increase or decrease fluid flow. For example, a final control element may regulate the flow of fuel to a burner to control temperature, the flow of a catalyst into a reactor to control a chemical reaction, or the flow of air into a boiler to control boiler combustion. In any control loop, the speed with which a final control element reacts to correct a variable that is out of set point is very important. Many of the technological improvements in final control elements are related to improving their response time.

2.5.9 Actuators

An actuator is the part of a final control device that causes a physical change in the final control device when signaled to do so. The most common example of an actuator is a valve actuator, which opens or closes a valve in response to control signals from a controller. Actuators are often powered pneumatically, hydraulically, or electrically. Diaphragms, bellows, springs, gears, hydraulic pilot valves, pistons, or electric motors are often parts of an actuator system.

Industries like the oil and gas industries, automobile industries, power sector like the paper mill, coal fired boilers, power boilers, and water treatment plants, etc uses the DCS (Distributed Control System) to control the process. The use of DCS, increases the quality of production by several times compared to the traditional methods.

DCS operation is very safe and economical as it has various features including the redundancy. Any kind of logic may be realized in DCS like the combustion control, drum level control, downstream and upstream process, refinery process, water treatment process etc.

There are many DCS companies including ABB, YOKOGOWA, HONEYWELL, and FOXBORA (INVENSYS). Of these ABB DCS is selected in this project.

ABB is having different types of DCS like Freelance AC 800F, 800M, 800C, 800xA. Freelance AC800F V9.1 is used in this project. For developing the program and graphics we are using Control Builder F. For operation purpose DigiVis is used. Freelance AC800F V9.1 is the latest of the AC800F series.

In this project the design of logic, graphics and program for various processes are discussed. All the processes may be operated in auto or manual mode according to the requirement. And each process is guided by start and trip interlocks.

2.6 System Connection Overview

The DCS consists of redundant, high-reliability microprocessor control units (Called Field Control Units or FCU's) distributed across the plant. Each FCU is connected to an I/O rack; the rack contains eight slots for multi-channel I/O modules or serial communication modules and is equipped with redundant power supply units.

The I/O modules are connected to the Interface Terminal Boards in the Marshaling Panels via multi-pin plug type System Cables. The FCUs are connected to each other, and to the operator interface stations (called Human Interface Stations or HIS) by using the redundant DCS control network V-net or Ethernet. The HISs provides the operators with windows based graphics and displays for operation and monitoring of the plant.

2.7 System Description

A DCS typically uses computers (usually custom designed processors) as controllers and use both proprietary interconnections and protocols for communication. Input & 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 (aka field) and output modules transmit instructions to the output instruments in the field. Computer buses or electrical buses connect the processor and modules through multiplexers/de-multiplexers. Buses also connect the distributed controllers with the central controller and finally to the Human-Machine Interface (HMI) or control consoles

DCSs are connected to sensors and actuators and use set point control to control the flow of material through the plant. The most common example is a set point control loop consisting of a pressure sensor, controller, and control valve. Pressure or flow measurements are transmitted to the controller, usually through the aid of a signal conditioning Input/output (I/O) device. When the measured variable reaches a certain point, the controller instructs a valve or actuation device to open or close until the fluidic flow process reaches the desired set point. Large oil refineries have many thousands of I/O points and employ very large DCSs. Processes are not limited to fluidic flow through pipes, however, and can also include things like paper machines and their associated variable speed drives and motor control centers, cement kilns, mining operations, ore processing facilities, and many others.[12]

Basically DCS system receives input signals from other devices, these signals will be processed and analyzed by DCS CPU and based on the result an action will be taken.

There are many sensors and transducers inside the plant converts physical quantities such as pressure, temperature to an electrical quantity, this device called Transmitters they transmit the electrical signals represents physical quantities to DCS System

There could be thousands of transmitters in a factory sending signals to DCS. The electrical signals could be either analog or digital, for analog signals they could be in one of the following cases4 to 20mA, 1 to 5V DC and for digital they would be either 0 or logic 1.

An analog field device that transmits a signal to the controller through I/O Module modulates the current running through the current loop, with the current proportional to the sensed process variable. On the other hand, an analog field device that performs an action under control of the control room is controlled by the magnitude of the current through the loop, which is modulated by the I/O port of the process I/O system, which in turn is controlled by the controller.

When FCS receives the analog signals from different transmitters it will convert it to digital via input module then passed to CPU for processing, the CPU will compare the process measured value (PV) with value sited by the operator (SV). If the both values are not matched then DCS will generate an output called Manipulated value (MV) to the field via output modules in order to adjust the physical quantity by operating a valve for example.

Figure (2-7) shows an example of simple control mechanism. The water in the tank is required to be controlled, the level transmitter will measure the water level and send PV signal (4-20mA) to DCS. Input module in the FCS will receive this signal and pass it to CPU after

converting it to digital signal. The PV data can be monitored on operator station screen in small window called Faceplate.

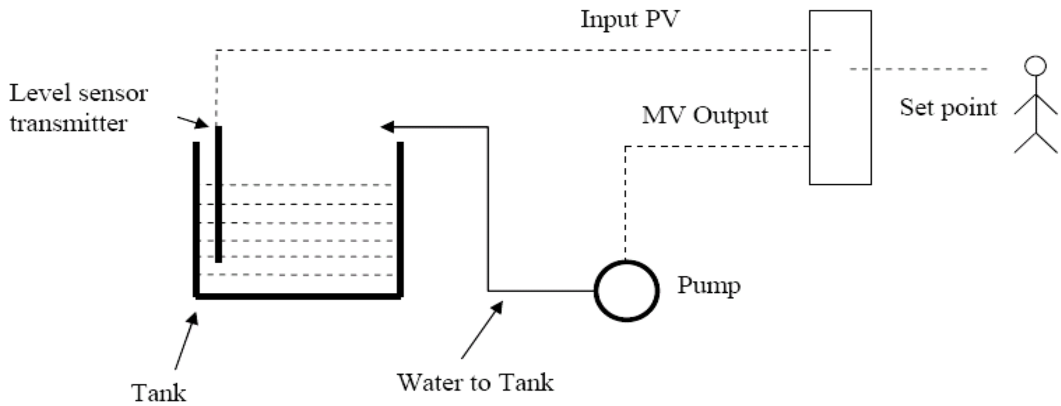


Figure (2.7): Simple control mechanism

Figure (2-8) shows an example of faceplate. On the faceplate the operator can see the three parameters reading SV, PV & MV at the top also the faceplate shows the status of this control process Normal or Alarm.[2]

The SV can be set to the required level by moving the yellow pointer. DCS system will operate the pump by sending MV Signal via output module to fill the tank and continue as long as PV signal received from the transmitter is less then SV, once the water level reached to required level that means PV= SV the DCS will stop the pump and this happen if faceplate mode is Auto, however in Manual mode, the operator can control MV directly and SV pointer will be disabled. So the faceplate shows the status of this control process Normal or Alarm, the alarm Also status will be initiated if there is any problem in which PV is not able to equalize with SV.

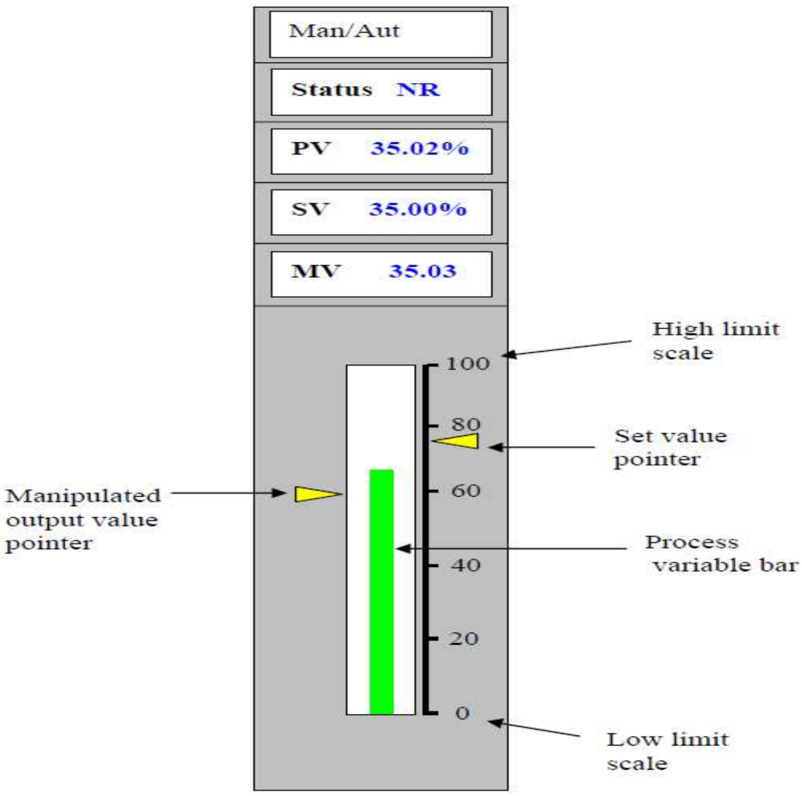


Figure (2.8): Example of simple phase plate

2.8 Technological Architecture

DCS architecture of each manufacturing company may have different structures according to the design of each manufacturer's production company, but DCS all companies have to share equipment in the DCS of a functional and operational responsibilities are Engine unit (module) always consists of the DCS Although each manufacturer has a different name, but must consist of DCS units are similar tools.

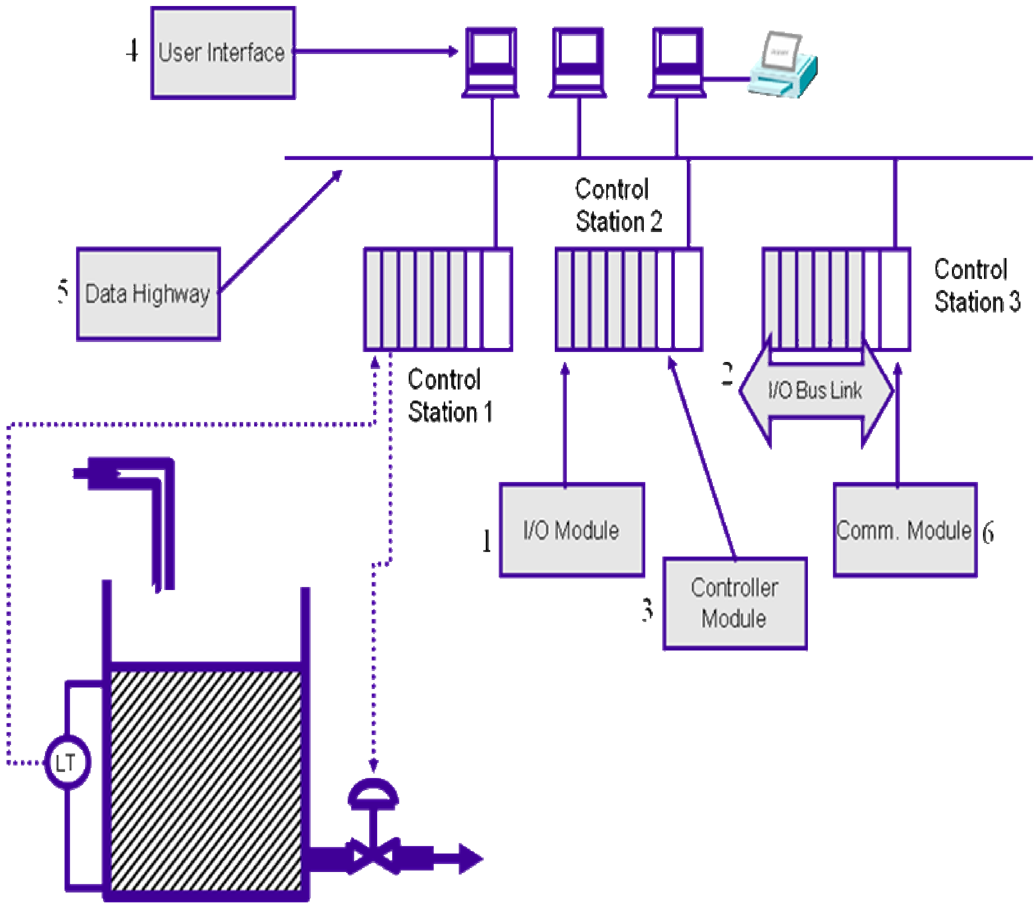


Figure (2.9): Technological Architecture

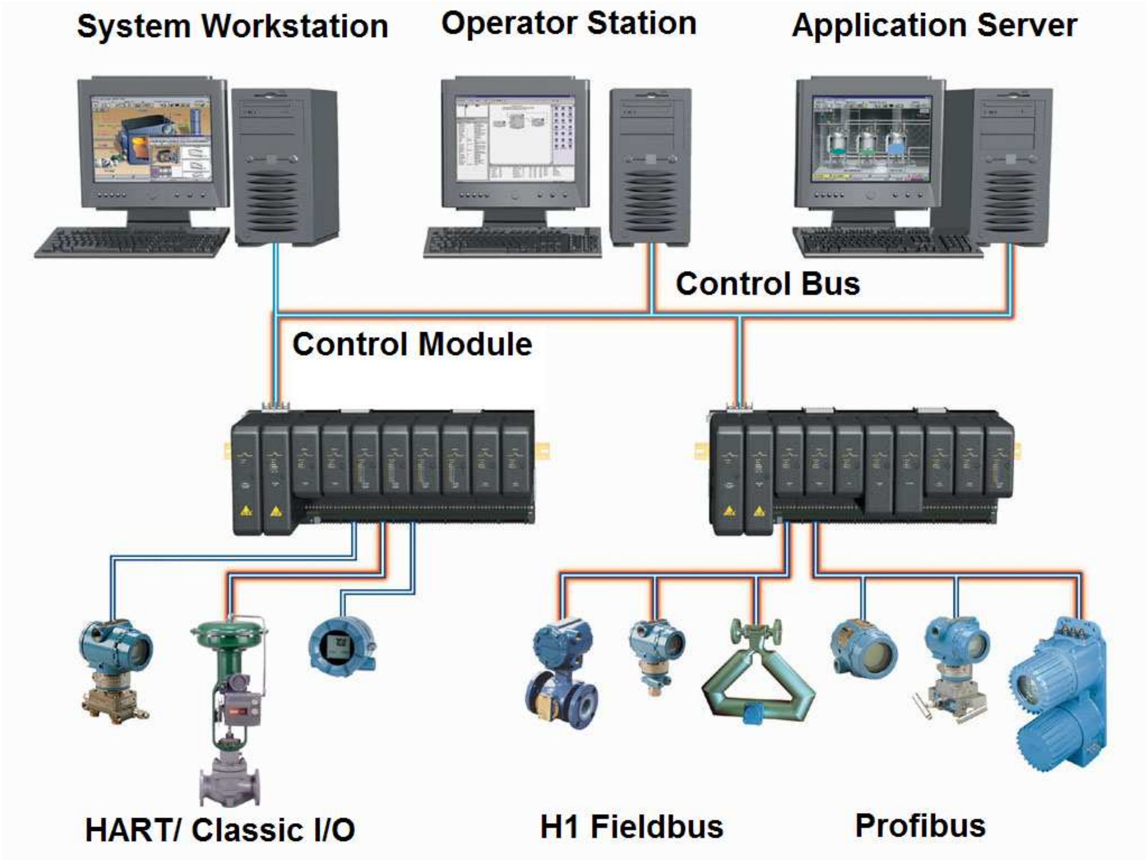


Figure (2.10): Elements of a Modern DCS

2.9 Main Features

i Logic and sequence control to perform complex loops and machine operation.

ii Regulatory control, including self-tuning and adaptive control

iii Batch process control.

iv Calculations and process optimization.

v Recording of alarms and events.

vi Logging of measured and calculated values.

vii Process interfacing through local or distributed I/O.

viii Management information systems.

ix Simulation and modeling.

x Lower maintenance cost.

2.10 Basic Functions

The DCS performs:-

- Control/Automate Plant Units

  i Implement the low and the complex level control loops.

  ii Co-ordinate plant sequences and setup.

- Alarm/Fault Detection.

  i Monitor inputs, outputs and status variables. Interrogate alarm monitor variables.

  ii Action alarm situations.

- Quality Monitoring/Control.

  i Trend and monitor quality variables.

  ii Log and report quality values.

- Communications.

  i Communication between process units.

  ii Communicate to external business network.

- Human Interfaces.

  i Repeat the process state to human operators.

  ii Accept input from human operation

- Report and Management Functions

  Report generating functions are also available. Examples of typical operating reports that a DCS can produce include shift, daily, monthly, maintenance, and emissions reports. The reports can use data from the history package or real time data.

- Data History and Collection

The history subsystem is responsible for gathering data for long term storage. A mass storage device is always associated with this node. The historical data can be called to the operator's display screen in graphic and sometimes tabular format and can be used for control applications, optimization routines, and reporting functions. Depending upon the DCS manufacturer, the functions of the history subsystem can be on a dedicated processor or on a processor that has a number of other functions.

Interface to Other Instruments or Instrument Systems

DCS manufacturers also provide interfaces to other instruments, such as intelligent analyzers or temperature scanning devices. Interfaces are also available to many of the programmable logic controllers, smaller instrument systems, such as single loop controllers, and first generation instrumentation systems. These interfaces are also often referred to as gateways.

2.11 DCS Components

2.11.1 Hardware modules

Hardware modules of DCS consist of:

2.11.1a Input/output modules

There are four signal types connected to I/O modules:-

- Analogue inputs (AI's). .
- Analogue outputs (AO's).
- Digital inputs (DI's).
- Digital outputs (DO's).

I/O modules may have separate, individual circuits, or they may share components such as analog to digital and digital to analog converters and multiplexers.

2.11.1b Local I/O Bus

The local I/O bus provides a bridge between the I/O and controller modules. Communication rates can range from 9,600 to 250,000 to 1 million bits per second. The manner in which they provide communications can also vary, from polling or scanning of the I/O

2.11.1c Controller Modules

Microcomputers Controller modules Fig.(2.11) continuously read and update field data and perform loop control calculations and complex logic needed to produce the controller output signals .The digital computer used in DCS systems is a regular microcomputer with the simplified components shown in Fig.(2.11) It includes the arithmetic unit, which carry out arithmetic and logic commands. The control unit is the part of the computer responsible for reading program statements from memory, interpreting them, and causing the appropriate action to take place .The memory unit is used for storing data and programs. Typical computers have Random-Access-Memory (RAM) and Read-Only-Memory (ROM). The final unit is the input/output interface. The I/O interface is necessary for the computer to communicate with the external world. This interface is the most important in the control implementation. The process information is fed to the computer through the I/O interface and the commands made by the computer are sent to the final control element through the I/O interface. The controller modules perform [17]:-

i. Alarming I/O modules.
ii. Control logic.
iii. Control interlocks.
iv. Sequencing.
v. Batch control.
vi. Passing on of trending information.

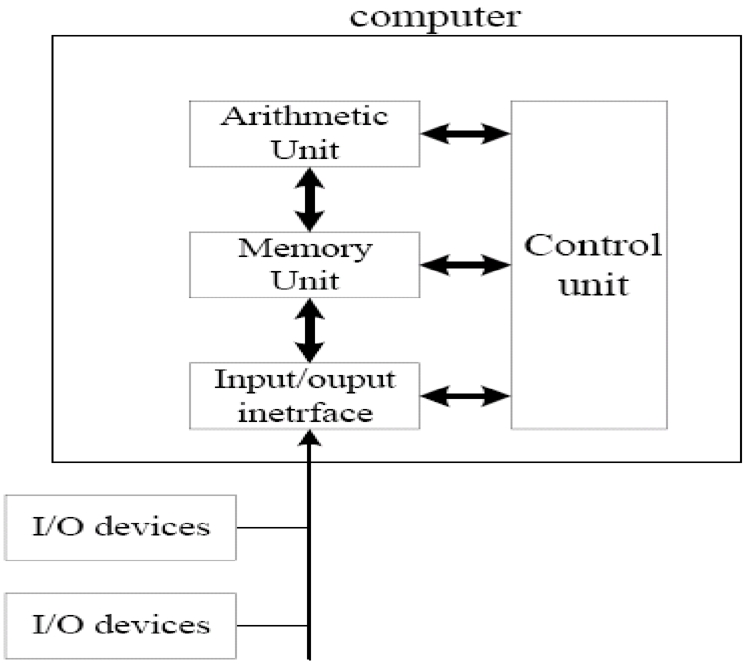


Figure (2.11): General purpose digital computer

2.11.1d Communication Modules and Real-time Data Highway

Manage the flow of information between the data highway and controller modules, user interfaces, and gateways to host computers and PLC.

2.11.1e Data Highway

If controller modules are the brains of a DCS, then the data highway is its back bone, data Highway 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.

2.11.1f Host Computer Interface

This is between different (other) computer systems communication Interfaces or gateways to other computer systems are sometimes required to allow communications with an advanced control system or a monitoring

2.11.1g Power Distribution Module

The power unit (power supply module) is equipped with the power to all devices of the power of the DCS equipment. Served eliminate noise and adjust the power off to suit various devices of DCS and store energy reserves for DCS system. Input voltages from 115 ... 230 V AC

2.11.1h Communications Module

Unit connected to the network. (Communication module) device is a device for connecting all parts of the DCS network communication. Unit connected to the network initially will link DCS process control equipment with equipment and laboratory staff to contact.

2.11.1j Human machine Interface (HMI)

The operator interface is generally a terminal upon which the operator can communicate with the system. Such terminals usually permit displaying graphical information. Often these display consoles are color terminals for better visibility and recognition of key variables. The operator will use the keyboard portion of the terminal to perform specific tasks. For example, the operator can type in requests for information or displaying trends, changing controller parameters or set points, adding new control loop, and so on.

2.11.1k Engineering Workstation

The system can be configured from one of the operator consoles or from a dedicated engineer workstation. The engineer workstation can be a personal computer or a console identical to the operator’s but dedicated to engineering functions. A dedicated engineer’s workstation is recommended for large systems. From the engineer’s workstation the engineer must perform system, database, display, history, and report configuration. Standard engineering utilities provide “fill-in-the-blank” forms to configure the database. Typically, a higher level computer language is provided to perform more advanced applications. The node responsible for engineering configuration will have access to a mass storage medium. The engineering and configuration functions are typically found on the system processor node.

The nodes can all be located in a central location (such as a control room) or they can be physically distributed throughout the facility. There are often economic advantages to locate the node responsible for control and input and output (I/O) in the field, because then it is not necessary to wire each individual instrument to the control room. The instruments are wired to a panel in the field and then a single cable is run from the field panel to the control room.

The engineering workstation is used principally to:-

❖ Update and decompile the database.

❖ Implement application software.

❖ Configure the database and console

2.11.2 DCS Software Modules

The software Functions are:

- Active in real time.
- To gather and analyze process information.
- To execute control algorithms including sequence and continuous control, and to interface with operator interactions.

The software for DCS systems is often non-standard and in general includes the main software:

❖ Operating systems.

❖ System support software.

❖ Applications software.

❖ Communications software

The DCS which is highly computer based, must be programmed with process information, control algorithms, and the operator interface instructions that are necessary for proper operation.

Computer based control systems come with standard fill-in-the blank software for data acquisition, process control, alarming, and operator displays.

2.11.2a Operating Systems Software (Server Software)

The operating systems software is the executive software for the computing system. Typical examples are RTOS, OS-9, Real-IX, UNIX, Windows NT and WIN CC. Functions of programs that supervise the actual operation of the system while it is running are: -

- Scheduling and starting the execution of system application programs.
- Allocating main memory and loading programs into main memory forms like: bulk memory such as CD and floppy disks.
- Supervising I/O operations.

2.11.2b System Support Software

Consist of programs that help the user in the development of application programs. Sometimes these are called System Utility Programs since they include Editors and Loading programs and so on.

2.11.2c Applications Software.

Packages specifically related to configuring, a DCS Contain routines for simple operations reading analog or digital inputs into memory to more complicated calculations like a PID algorithm and may extend to complex sequencing. Optimization routines or expert system facilities.

2.11.2d Communications Software

Allow the exchange of information between process control and information devices. Standard provides for connection between one communication system and another using a standard

2.12 Advantages of DCS

Distributed processing is useful in process control for the major advantages [17]

- High reliability each function of the DCS has its own processor with the data sent along buses. Each processor has a redundant processor doing exactly the same so it can take over in the event of a failure. This makes the DCS more reliable than PLC.
- Increase Efficiency

Some processes need to be maintained at a specific point to maximize efficiency. For example, a control point might be the temperature at which a chemical reaction takes place. Accurate control of temperature ensures process efficiency. Manufacturers save money by minimizing the resources required to produce the end product.

- Ensure Safety

A run-away process, such as an out-of-control nuclear or chemical reaction, may result if manufacturers do not maintain precise control of all of the process variables. The consequences of a run-away process can be catastrophic.

Precise process control may also be required to ensure safety. For example, maintaining proper boiler pressure by controlling the inflow of air used in combustion and the outflow of exhaust gases is crucial in preventing boiler implosions that can clearly threaten the safety of workers.

- flexibility in system design,
- Expansion is easy (the instrument panel does not require modification).
- Control logic can be easily changed while the facility is operating.
- The cost per loop for large systems is low.
- All database items are tag addressable
- Ease of maintenance.
- Reduced cabling cost (i.e., field wiring and installation)
- It also reduces risk by distributing the control function throughout number of small modules rather than concentrating it in one large module.

2.13 Disadvantages of DCS

- The initial software cost is higher.
- Software maintenance personnel are required.
- Increase software development cost
- Distributed control is costly for systems with a small I/O count (1 to 100).
- If I/O and control is not redundant, control of multiple loops will be lost if the hardware fail
- Dependence on communication technology.

2.14 Differences between DCS and PLC

The differences between DCS and PLC are [6]:-

- DCS (Distributed Control System) is a control system that works using several controllers and coordinates the work of all these controllers. Each controller is handling a separate plant. This controller is referred to the PLC. The PLC (Programmable Logic Controller) is controller which can be re-program back, if the PLC is only a stand-alone and not combined with other PLCs. It means PLC is a sub system of a large system called DCS.

- A PLC can be used effectively for "simple" batch applications, while DCS is typically better suited for "complex" batch manufacturing facilities that require a high level of flexibility and recipe management. Again, the requirements of the batch application determine whether it is "simple" or "complex:"
- If the value of each independent product being manufactured is relatively low, and/or downtime results in lost production, but with little additional cost or damage to the process, the PLC is the likely choice. If the value of a batch is high, either in raw material cost or market value, and downtime not only results in lost production but potentially dangerous and damaging conditions, the selection should be DCS.
- The speed of logic execution is a key differentiator. The PLC has been designed to meet the demands of high-speed applications that require scan rates of 10 milliseconds or less, including operations involving motion control, high-speed interlocking, or control of motors and drives. Fast scan rates are necessary to be able to effectively control these devices. The DCS doesn't have to be that quick – most of the time. The regulatory control loops normally scan in the 100 to 500 millisecond range. In some cases, it could be detrimental to have control logic execute any faster – possibly causing excessive wear on final control elements such as valves, resulting in premature maintenance and process issues.
- The extra cost for redundancy, an insurance policy of sorts, may be well worth it in the case of the typical DCS system, where high availability is mission critical. However, it is often not cost-justified to make a PLC system fully redundant[16].

CHAPTER THREE

DCS Hardware

3.1 DCS hardwares

In a typical industrial plant, a distributed control system (DCS) is used to control many of the industrial processes performed at the plant. Typically, the plant has a centralized control room as in figure (3.1) Control room includes (HMI) computers (operator station and engineering station).

Control room is coupled to process station (AC800F controller) via Ethernet or Vnet or any bus which is typically a proprietary digital communications network or an open digital communication network employing a proprietary protocol.

Controller receives various commands from control room (HMI) and provides data to control room (HMI), the field bus connects the control unit to the I/O module (S800I/O). It is used to transmit the input/output values from the controller to the I/O modules (S800I/O) and from I/O module to AC800F controller.

The I/O module S800I/O includes a plurality of I/O ports which are connected to various field devices throughout the plant. Field devices include instrument element like flow transmitters, pressure transmitters and temperature transmitters and final element like on/off switches, actuators or control valve.[7]

Traditionally, analog field devices (level transmitters, pressure transmitters and temperature transmitters) have been connected to the JB by two-wire twisted pair current loops as in figure (3.2) field devices are coupled to I/O module S800I/O each device connected to an individual channel of I/O unit by a single pair of wires. Analog field devices are capable of responding to or transmitting an electrical signal within a specified range.

When the analog signals (4-20 milliamps) send from different transmitters it will convert it to digital via input module I/O S800 (DI module) then passed to CPU for processing.

AC800F Controllers automatically compare the value of the PV to the SP to determine if an error exists. If there is an error, the controller adjusts its output according to the parameters that have been set in the controller. The AC800F controller will generate an output called Manipulated value (MV) to the field via output modules S800I/O (AO module) to control valve. A "current to pressure" converter (I/P) converts an analog signal (4 to 20 mA) to a proportional linear pneumatic output (3 to 15 psig). Its purpose is to translate the analog output from a control system into a precise, repeatable pressure value to control pneumatic actuators and then control valve. Regarding to motor the controller start and stop command according to set point .the controller digital signal input (RUN, STOP, and TRIP) and digital output signal are (START, STOP).

Controllers have the option of selecting either automatic or manual control. Means the controller responds to differences between set point and actual conditions. Manual control means that the operator selects the controller output; the controller does not respond on its own to the process. Manual control is necessary, for example, when the control loop transmitter is being repaired or calibrated.

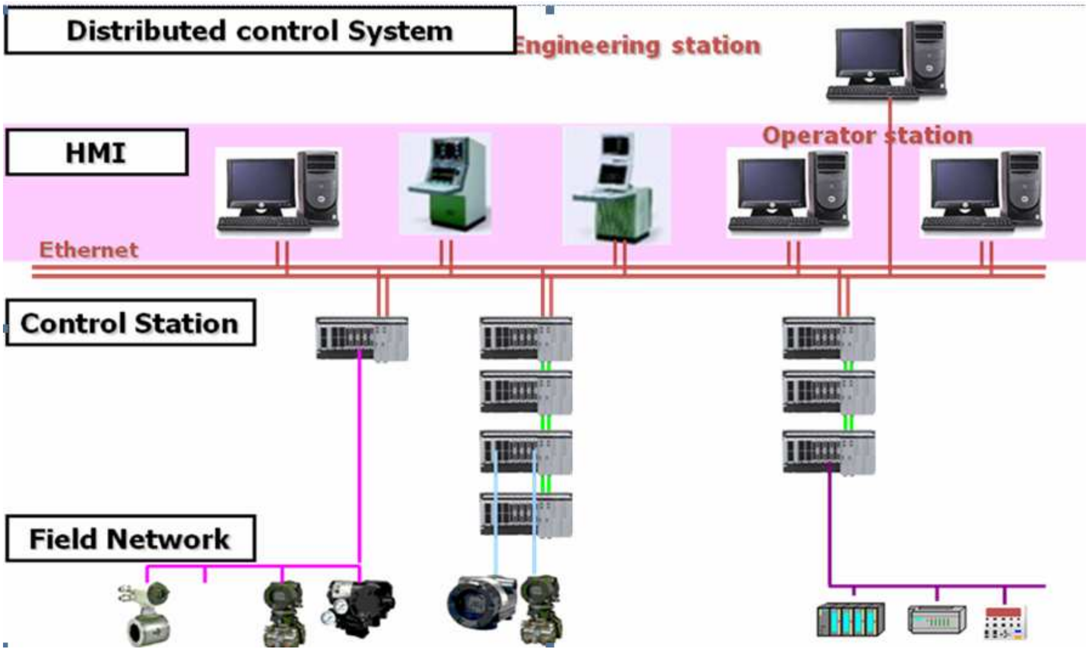


Figure (3.1): Distributed Control System

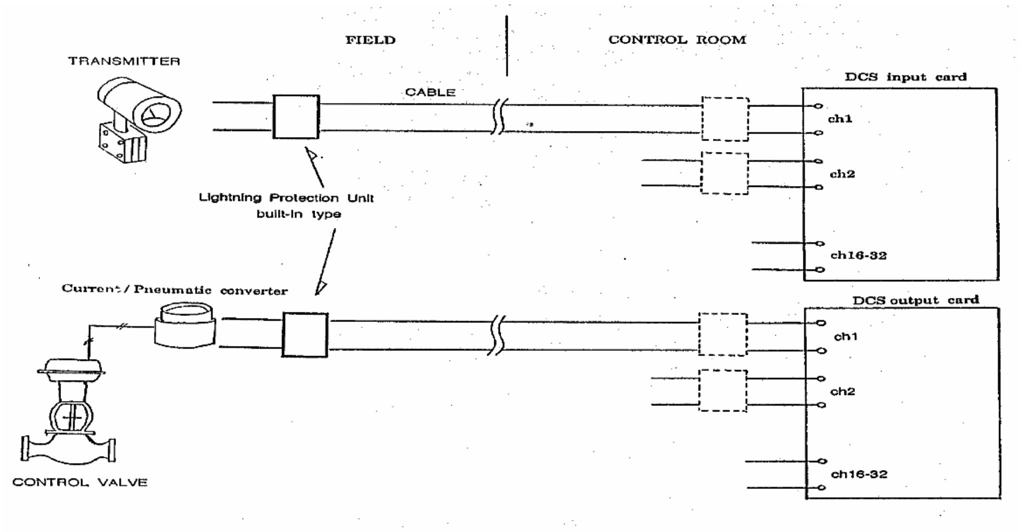


Figure (3.2): Typical installation drawing

3.1.1 Controllers AC800F (process station)

Controller modules AC800F shown in Figure (3.3) are continuously read and update field data and perform loop control calculations and complex logic needed to produce the controller output signals.

The AC 800F consists of:

- The housing with CPU board and module slots
- The power supply module
- At least one Ethernet module,
- A maximum of four Field bus modules

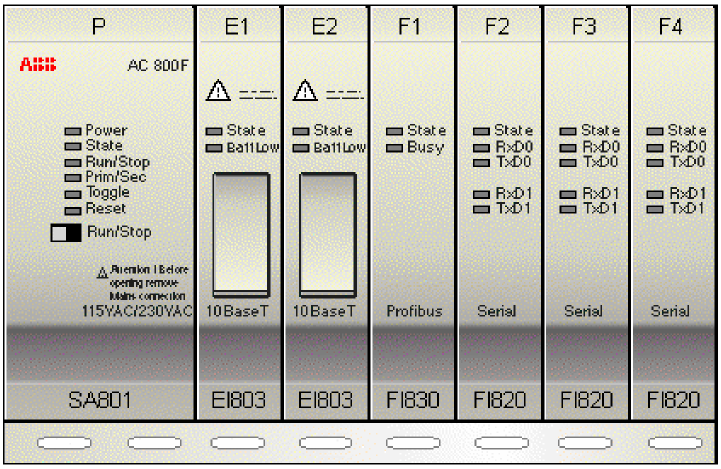


Figure (3.3): AC800F Controller

- **Power Supply Module**

 Input voltages from 115 ... 230 V AC

The front panel of the power supply module as in figure (3.4) carries the indicators and operating elements for the CPU board

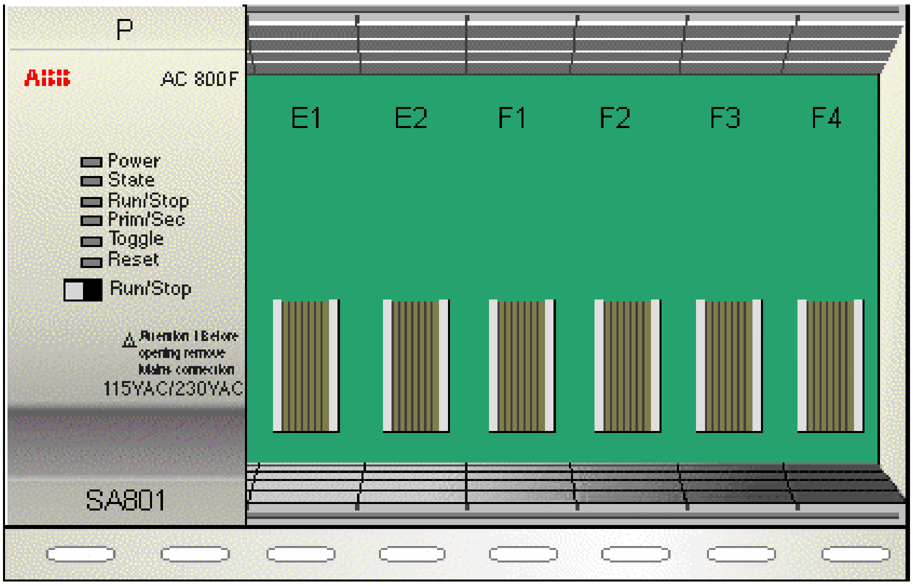


Figure (3.4): SA 801F: Power supply module

- **Ethernet Module**

The system bus (Ethernet) links the individual stations with each other shown figure (3.5). It transmits data between the AC 800F controllers, the operator stations, the engineering station and the process stations via coaxial or fiber-optic cables.

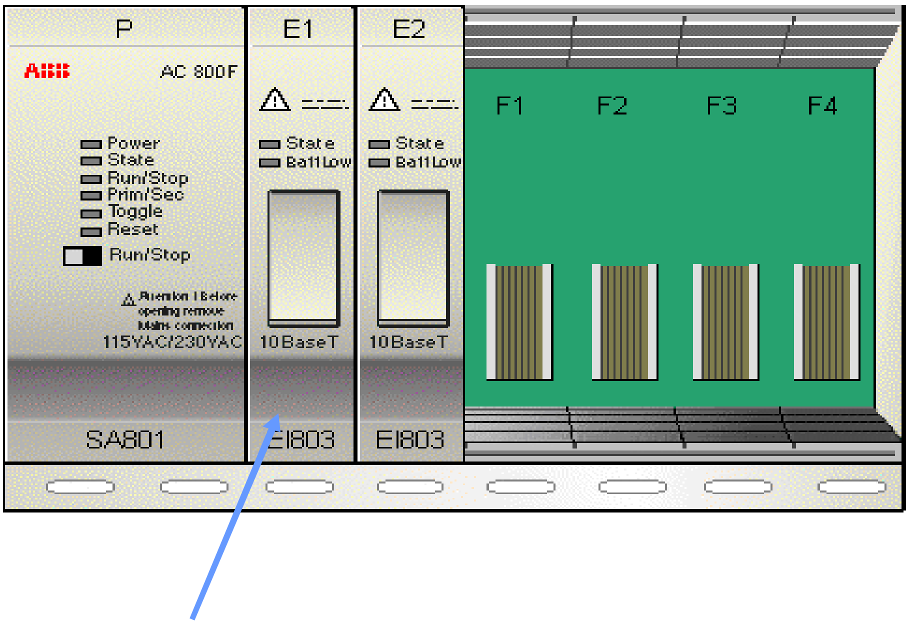


Figure (3.5): EI 80310BaseT module

- **Fieldbus Module**

  i Profibus- DP

Is optimized for high speed and simple connection of devices This Profibus version as in figure (3.6) is specially designed for communication between programmable controllers and a distributed I/O level.

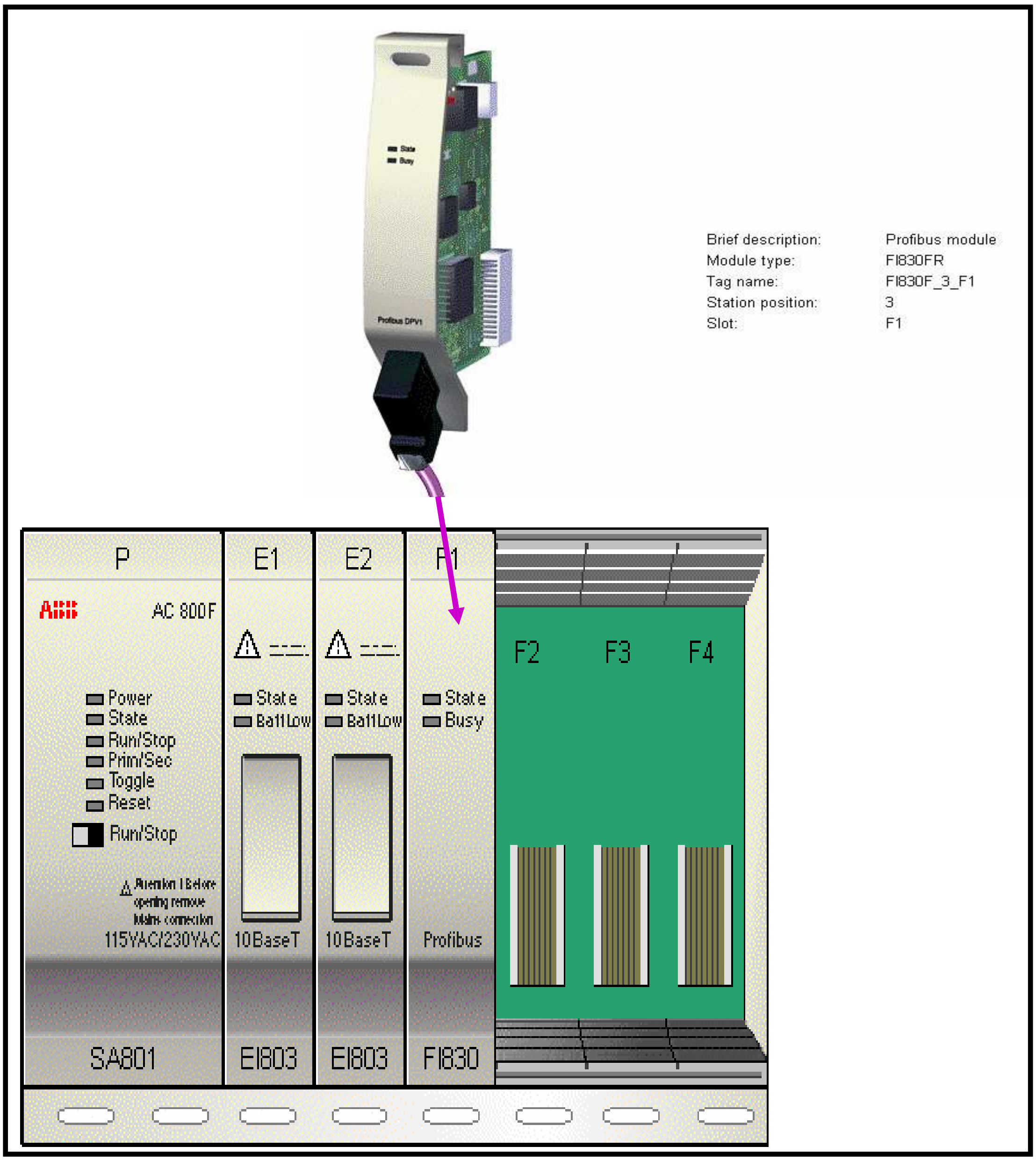


Figure (3.6): FI 830F Profibus-DP

i. Modbus Module

Modbus connects subsystems to the system, preferably via the RS485 interface. The serial fieldbus module FI 820F as in figure (3.7) provides two channels to the AC 800F to enable work with Modbus using the Modbus protocol, process data can be exchanged with other systems via the serial interfaces - FI820F. This protocol allows data to be transmitted in either master or slave mode.

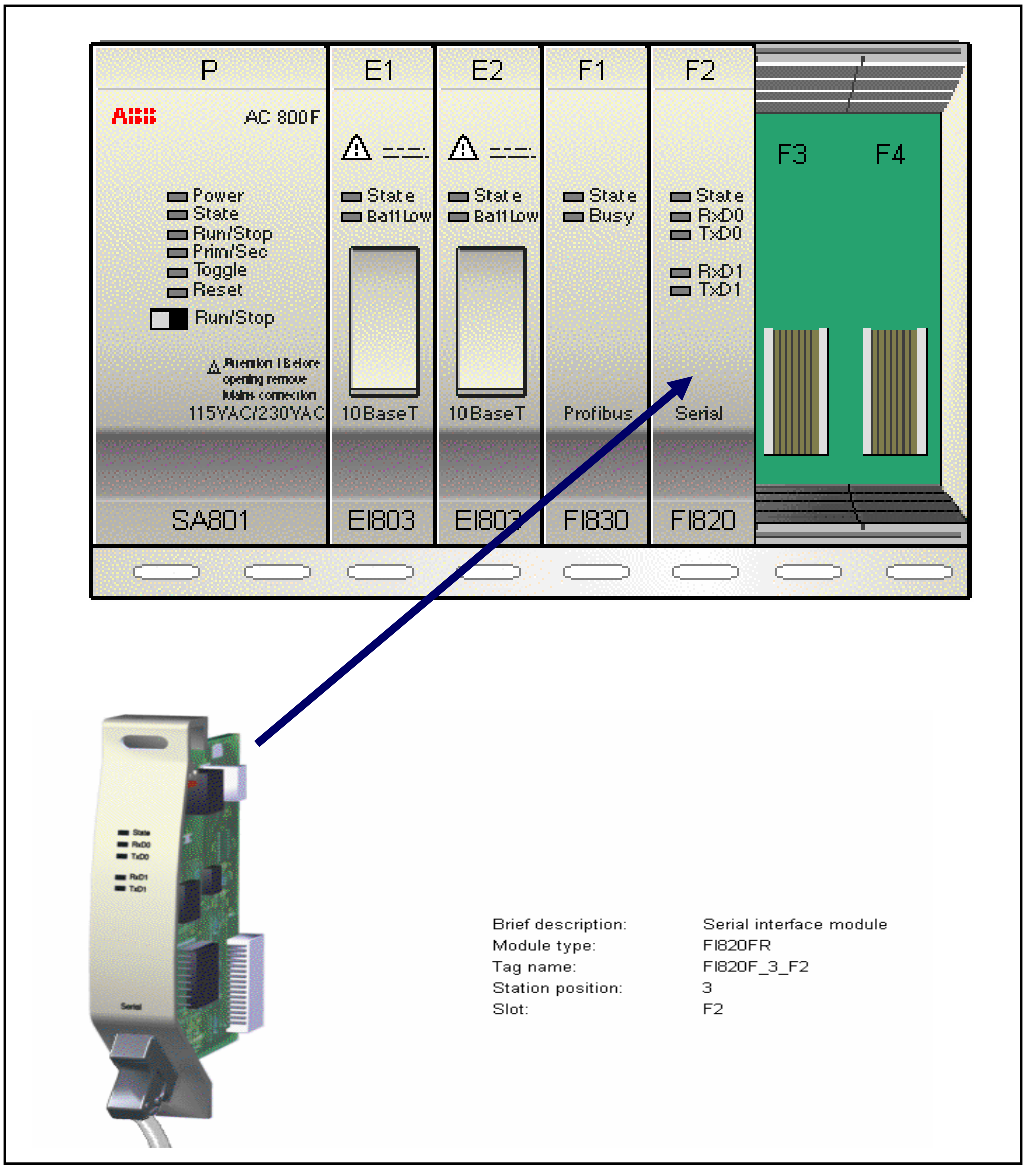


Figure (3.7): FI 820F Modbus Module

ii CAN bus Module

The CAN bus Module as in figure (3.8) connects the central unit to the I/O units. It is used to transmit the input/output values from the AC 800F to the I/O modules. For this purpose, the AC 800F is equipped with CAN module FI 810F.

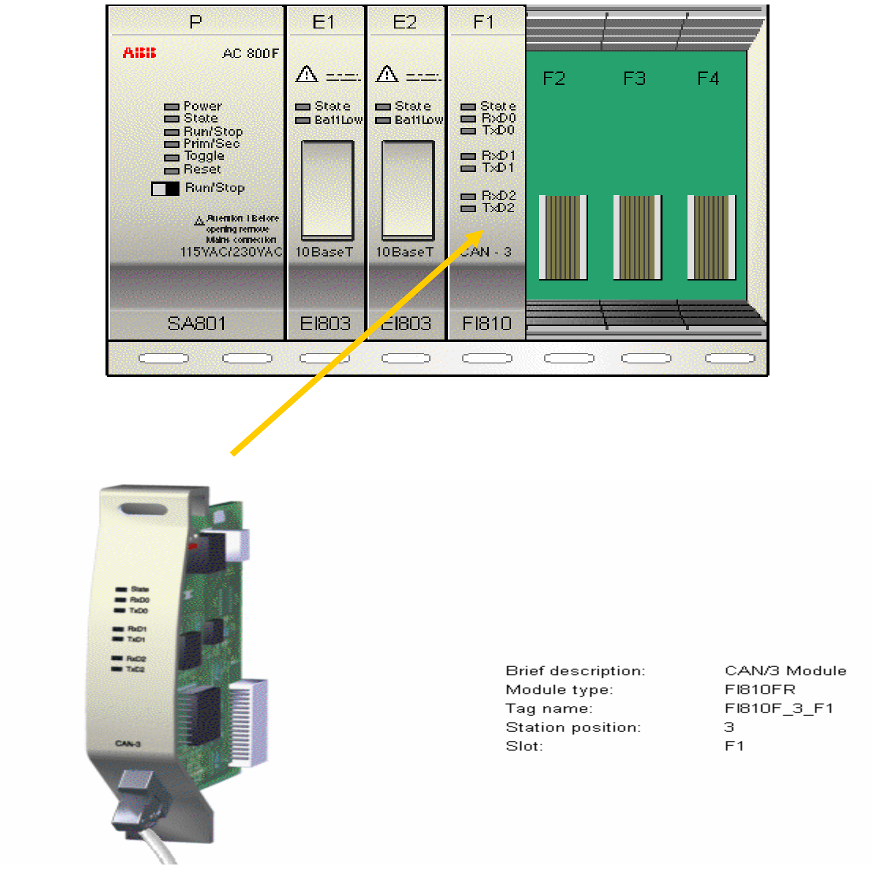


Figure (3.8): FI810 CAN bus Module

3.1.2 I/O Module -S800 I/O

S800 I/O is a comprehensive, distributed and modular process I/O system that communicates with parent controllers over industry-standard field buses.

By permitting installation in the field, close to sensors and actuators, S800 I/O reduces the installation cost by reducing the cost of cabling.

S800 I/O features include Comprehensive coverage, Flexible configuration and installation, Ease of setup and Reliability and accuracy.

I/O Module -S800 I/O consists of:-

- Digital output module
- Digital input module
- Analog input module
- Analog output module

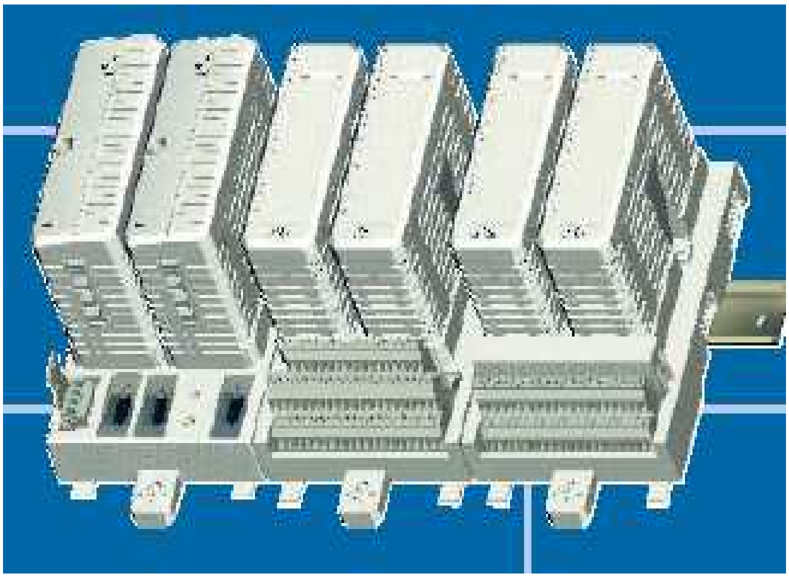


Figure (3.9): I/O Module -S800 I/O

3.2 An Engineering Station

The Engineering Station is based on a PC with the Microsoft windows 2000 Operating system and the Control Builder F Engineering Software.

It is used by the operator for the system configuration, commissioning and Documentation. After these tasks have been completed, the Engineering station can be disconnected and used for other purposes. [2]

3.3 Operator Workstation

The Operator station is based on a PC with Microsoft Windows 2000 Operating System and the Digivis Operator station Software. Main feature are:-

i. Process monitoring and operation
ii. Alarms monitoring and Acknowledgement
iii. Visualization of process parameters in the form of digital display
iv. Events and operation logs

3.4 Field Elements

3.4.1 Transmitters (level –temperature- pressure)

The sensor is the primary sensing element and exists in close proximity to the process. The sensor measures the controlled variable in the process and sends a non-standardized signal to the transmitter. The transmitter contains a transducer which converts the non-standardized signal of the sensor into a standardized form that it amplifies. The most common standardized forms are either 4-20 milliamps.[12]

Figure (3.10): Temperature Transmitter

3.4.2 Diaphragm Actuator

Diaphragm Actuators as in figure (3.11) is the part of a final control device that causes a physical change in the final control device when signaled to do so The diaphragm type usually consists of a spring which opposes the air pressure applied against the diaphragm. Spring less types of diaphragm actuators, in which controlled air pressure is applied to either side of the diaphragm

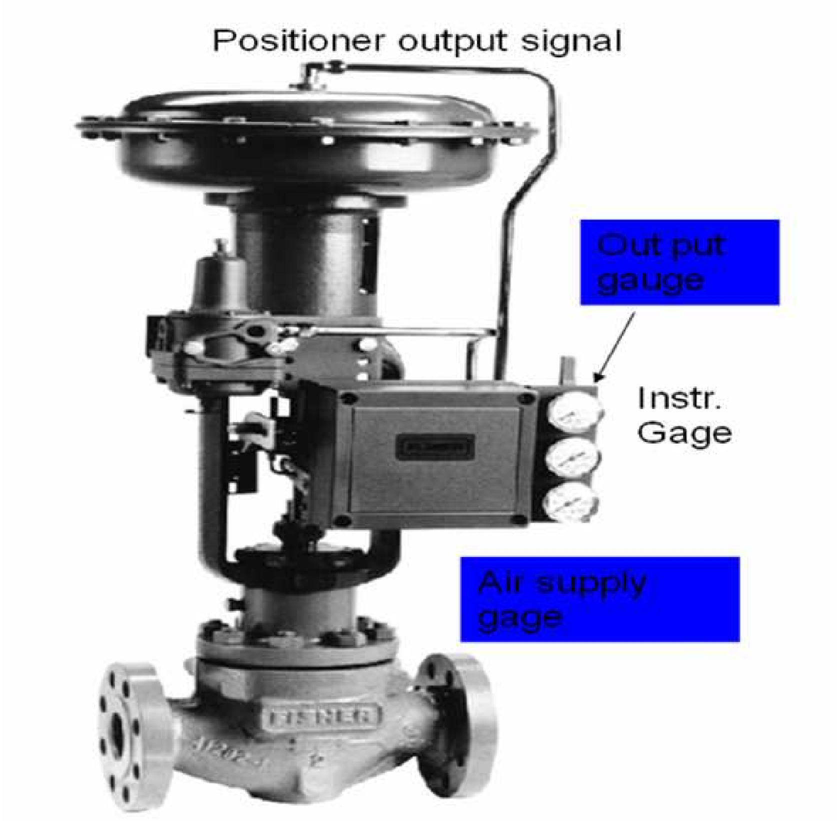


Figure (3.11): Control Valve with Diaphragm actuator

3.4.3 Motor Operated Valve (MOV)

Motor Operated valve shown in figure (3.12) is a valve where the Actuator Part of the Valve is replaced by a motor instead of pneumatic MOV are normally used for Larger Process lines where the Pneumatic pressure is not enough to provide torque or pressure for the Valves movement. Since Motors have good torque they are used to open or close the valves, these are also called as electrical Actuators.[10]

Figure (3.12): Motor Operating Valve

CHAPTER FOUR

DCS Softwares

4.1 DCS Softwares

ABB distributed control system use two software Control Builder F Engineering Software and DigiVis Operator Station Software.

4.1.1 Control Builder F Engineering Software

Control Builder F is the tool for Project configuration, commissioning and documenting the user programs and displays in a Freelance system. Control Builder F supports the following functions:-

- Configuration and commissioning of user programs
- Tree view of the programs for convenient program overview and selection.
- Graphical hardware configuration.
- Integral Fieldbus configuration for Profibus and Foundation Fieldbus
- Project-wide variables and function blocks.

4.1.2 DigiVis Operator Station Software

The Software running on the Operator Station PC in the Freelance 2000 System is known as Digivis. It offers a user-friendly graphical user interface with the MS-Windows standard. For Process Operation Digivis offers:-

- Standard display such as Overview display, group display, faceplate, trend display etc.
- Simple process operation with mouse and keyboard
- Logging

4.3 System Configuration

System configuration of Freelance 2000 system consists of the following:-

- Project Manager
- Project Tree
- Hardware Structure
- Commissioning and Documentation

4.3.1 Project Manager

From the Project Manager function you can Start and Edit the project.
Editing of Projects consists of:-

- Creating New Projects
- Open/Close Project
- Importing/Exporting of Project
- Saving/Save as Project
- Setting up Online connection (Configuration to Commissioning)
- Releasing online connection (Commissioning to Configuration)
- Exiting of Control Builder F [16]

4.3.2 Project Tree

Project Tree provides an overview of the functions in a project. The Individual elements or objects generally know as Project Objects.
The upper most objects in the project Tree is the configuration CONF, which is the sum total of all the project objects in an AC800F/Freelance system.

The first structural level below CONF is formed by the following Resources:-

- D-PS (Process Station) Resource
- D-OS (Operator Station) Resource
- D-GS (Gateway Station) Resource and
- Operate IT CS (Operate IT Configuration Server)

There is an also additional element namely the Pool of User Defined function blocks and the Global Display. Figure 4.1 show project tree user interface

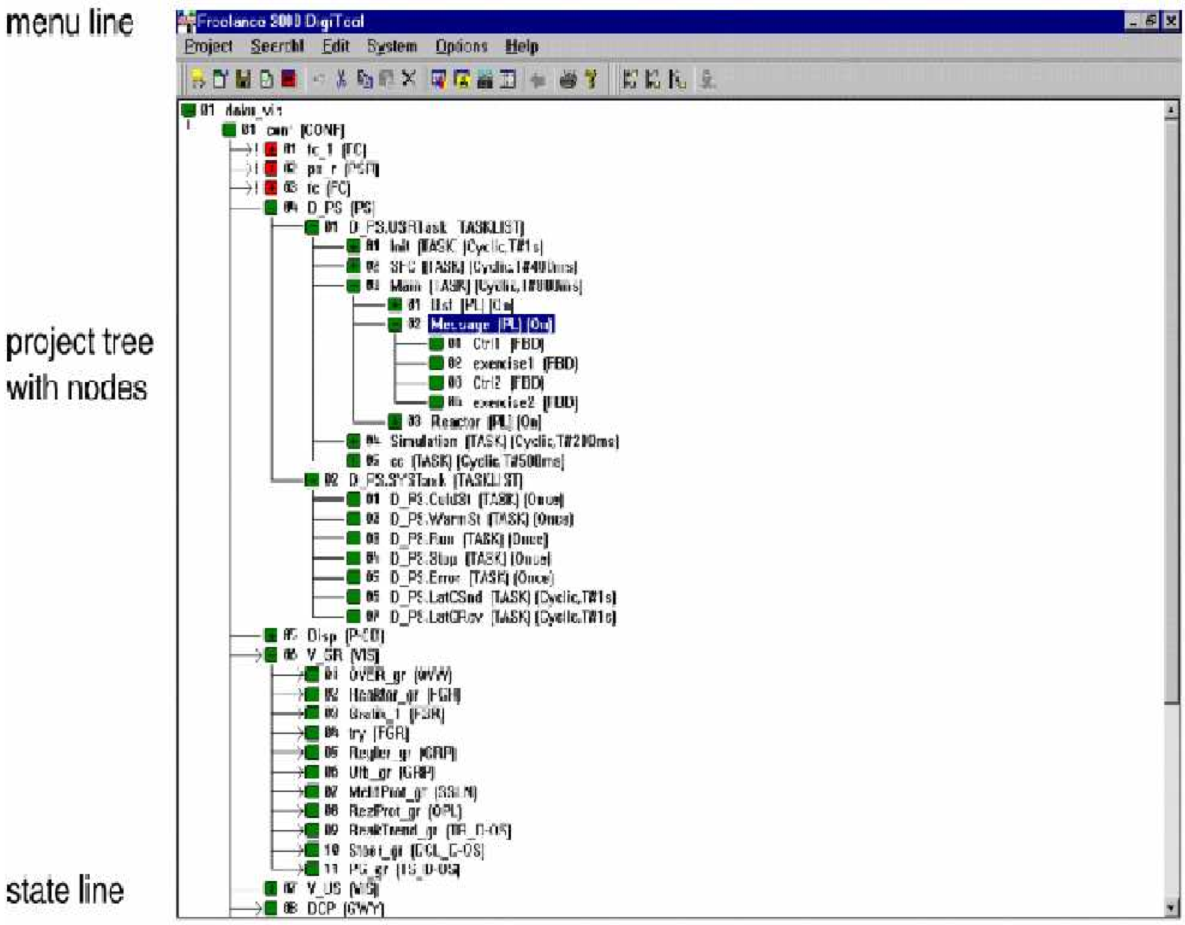


Figure (4.1): project tree user interface

• Proect Tree General Process objects

First line		The assigned project name appears here
(CONF)	Configuration	The configuration level grouping all resources and permitting data transfer
(D-PS or PS,FC, AC800F)	Process station	The process station contains the CPU module which Processes the programs configured under the resource. The type of the process station is defined in the hardware structure by allocating the resource to the hardware object. The short label D-PS indicates that a station has not yet been assigned in hardware manager to a physical station. Following assignation, the assigned station type is displayed: PS for a rack system, FC or AC800F for a Field Controller.
(D-OS or VIS)	Operator station	An operator station is a resource permitting operation and observation on a PC using the DigiVis program package. The code D-OS indicates that the station has not yet been assigned to a physical station. After it has been assigned, the station type VIS is displayed.
(D-PS/RED or PSR, AC 800 FR)	Redundant Process station	The rack system uses two type DCP 10 CPU modules. A redundant Field Controller consists of two AC 800F. The two controllers are connected by means of a redundant link and appear the same as a process station to the user. When the process station is loaded one of the two CPU modules becomes the primary CPU and the other becomes the secondary CPU. The short label D-PS/RED that a station has not yet been assigned in hardware manager to a physical station. Following assignation, the assigned station type is displayed: PSR for a rack system or AC800F for a Field Controller.
Pool		"Memory" of incorrect project objects or those no longer required for processing which you may want to return to the process.

• Resources

The first structural level below configuration is formed by the resources, which represent the various different stations in a project. For the processing of the process itself there are the D-PS (process station) resources, for operation and observation of the process there are the D-

OS (operator station) resources and Maestro CS (Maestro NT configuration server), for interfacing to external systems there are the D-GS (gateway station) resources, and for integrating data from external systems there is the OPC server resource.

Data exchange between the process stations is performed by means of cross communication. Each process station is equipped with 10 connections for data exchange with operator stations and gateway stations. If more stations are configured, then the effective communication links of all the subscribers in a Freelance system are specified in a separate parameter definition dialog.[2]

- **Process station**

Process stations are added with resource types D-PS and D-PS/Red (non-redundant and redundant stations respectively). Correlation to the physical stations is carried out in the hardware manager. Here, process stations (PS) can be selected for rack systems, and Field Controllers (FC and AC800F) can be chosen for connecting Fieldbus modules. The network addresses and resource IDs of the stations are also defined within the hardware manager, and in commissioning mode the configured program modules are loaded from the project tree into the relevant stations.

The execution of user programs within a process station is controlled by tasks. Within a task the sequence of user programs is defined either by program lists or by a structure that is configured using the sequential function chart. While the programs in a program list are run cyclically, Sequential function chart programs are run only for specified periods of time according to their structure.

The user programs in the process station, both under a program list and under a sequence flow, are created using the IEC 6113-3 programming languages function block diagram FBD, ladder diagram LD or instruction list IL.

- **Operator station D-OS**

The D-OS resource is provided for operation and observation of the process by an operator station using DigiVis software. Assignation to a physical station is indicated by the code VIS.

Standard operating facilities, e.g. faceplates, are provided for all known tags and variables on the operator stations. In addition, graphic displays, trend displays, SFC displays and logs can be configured and structured for the DigiVis operator stations.

- **Project objects of an operator station D-OS**

(TASKLIST)	Task list	Object for separating the system tasks and the user tasks.
(TASK)	Task	Object which controls the processing of the subordinate program lists and sequential controllers within theresource. A distinction is made between cyclical tasks and those which are processed only once for specific events. In addition, a default task can be configured for each resource. This task is always executed when none of the other tasks is being executed (cyclically or once only).
(TASK/RED)	Redundant task	All subsidiary program lists and sequential function charts within this task are executed redundantly. All tasks can be in redundant format. All the variables in a redundant task must be written through the process image mode.
(PL)	Program list	List of FBD, IL and LD programs which are processed according to the consecutive number in the project tree. Processing of the PLs can be switched ON or OFF.
(FBD)	FBD program	Program which was generated using the Function Block Diagram language (FBD).
(LD)	LD program	Program which was generated using the Ladder Diagram (LD) Language
(IL)	IL program	Program which was generated using the Instruction List (IL) language.
(FGR)	Graphic display	Display of freely grouped static and dynamic display objects generated by the graphics editor.

- **Gateway station**

  The gateway stations D-GS are used to make data from the Freelance system available to other systems. In principle, all the data from the Freelance system can be read and written via a gateway station. In addition to each gateway station in a Freelance system, the relevant server software from the add-on packages DigiDDE, DigiOPC or DigiCSO must also be installed on the network. (If, for example, a gateway station of type OPC gateway is configured in a Freelance system, then the Freelance OPC server software must be installed on a PC that is linked on the network with the Freelance process stations).

- **Task TASK and redundant task TASK/RED**

  The task object comprises all the subordinate program lists and SFC programs. The tasks determine how quickly the programs are processed on the resource. A distinction is made between user and system tasks.
  In user tasks, the programs are processed cyclically; in system tasks, certain events in the resource or commissioner actions determine whether a certain system task is executed. The programs within a task are controlled by a program list or by an SFC program.
  The number of user tasks is limited to 9 tasks per Process Station/Field Controller (Field Controller default setting: 3 tasks). A maximum of 8 cyclic tasks and one default task can be configured.
  The default task is always executed if none of the other tasks is executed (either cyclically or once only).

- **Predefined System Tasks**

  All system tasks are grouped in the project tree under *SYSTask node. The predefined Tasks let you start and stop processing sections of a user program as a reaction to system state changes. The event which triggers the task, e.g. a certain state transition of the resource, or an error in the user program, is always defined. All predefined system tasks are created in the resource after initial program loading. After the resource is initialized, the system tasks are automatically started, but do not compute until the event assigned to them occurs.

The following tasks are predefined:

* ColdSt [Task] [Once]
* WarmSt [Task] [Once]
* Run [Task] [Once]
* Stop [Task] [Once]
* Error [Task] [Once]
* LatCSnd[Task] [Cyclic,T#1s]
* LatCRcv[Task] [Cyclic,T#1s]
* RedSt [Task/Red][Once] (only for redundant process stations)

Program List

The Program List object contains all subordinate programs and controls the processing sequence of these programs. The programs are processed depending on their consecutive number in the project tree. The higher-order task determines how fast the programs are processed on the CPU module of the process station. The programs are written in the Function Block Diagram (FBD), the Ladder Diagram (LD) or Instruction List (IL) language.[2]

4.3.3 Hardware Structure

Within the hardware structure the resources defined in the project tree are allocated to the hardware actually enquired. A system essentially consists of the process, operator and Gateway stations. These stations are allocated to resources according to IEC 61131-3. The resources serve as structuring elements in the project tree for allocation of the application program parts and displays to the hardware actually required.

The D-PS resources which are configured in the project tree are assigned to the process stations in the hardware structure. A process station can have a rack-based set-up, that is, conventional with input and output modules assembled in module assembly frames for process control, or by the Field Controller through one or more field buses with intelligent field devices and/or remote I/O.

In the conventional process station, the I/O modules are mounted in modules supports (Racks). The CPU module processes all programs of this resource and is simultaneously the communication module to the system and the I/O modules. The Process station consists of the central unit and 4 I/O units max. The central unit is always the station with the CPU module.

The I/O units do not need an own CPU module: they can accept other I/O modules so that their numbers can be expanded (from 8 for the central unit) to a maximum of 44 for a process station. All units need a link module for feeding in the power supply and an identical rack for holding the modules. Depending on the Field Controller, the process station is now provided in two versions: the FC and the redundant Industrial IT Controller AC 800F. The Field Controller takes the field bus modules and makes it possible to connect various field busses.

The Field Controller basic unit consists of the case and the main board, which together form a unit which can be equipped with various modules. The module for the power supply and an Ethernet module for connection to the system bus are absolutely necessary. Both modules are available in various designs. A Field Controller can be equipped with a maximum of 4 field bus modules selected from CAN, Profibus and serial modules.

The CAN module allows the connection of a maximum of 5 I/O units and thus the connection of 45 I/O modules in the way in which they are also used in the conventional process station.

Each Profibus module allows the connection of a Profibus line, i.e. the connection of a maximum of 125 slaves. Each of these slaves can also be modular, i.e. contain a maximum of 64 modules.

The serial module has 2 interfaces which can be occupied at option with the Modbus master interface protocol, the Modbus slave interface protocol, the telecontrol interface protocol, the Protronic interface protocol or the Sartorius scale interface protocol.

The number of process and operator stations is not limited. The information given in the boot parameters of the process station determines how many operator stations or gateways will be supported by the process station.

The Operator stations are commercial PCs in which the software program DigiVis has been installed for process visualization. All displays and logs are configured with the DigiTool software program and loaded into the operator station.

D-ES resource stands for an Engineering station, i.e. the configuration tool DigiTool. It is also displayed in the hardware structure; this display is only for documentation purposes.

The hardware can be configured in two different view areas. In the tree view area the complete system can be configured in a tree structure.

In the graphic view area the hardware can be configured in several display levels:

The system view displays the complete hardware structure. In the system view the individual stations like the process station, Field Controller or operator station are activated and allocated to the project tree resources.

The station view displays the complement of a process station or a Field Controller. In the station view the modules or Field Controller modules are allocated to slots.

The detail view displays further information on the modules of a process station or the modules of the Field Controller so that they can be identified more easily. The detail view of the Profibus master displays a bus line with the slaves configured on the bus. The slaves are represented using bitmaps which are specified in the device database file. If no bitmap files are specified in the device database file of the respective vendor, standard bitmaps are displayed. However, it is possible subsequently to assign vendor-specific bitmaps. The detail view of the Profibus slave displays a device view in the form of an individual bitmap file which can be assigned in the parameter dialog of the slave. The variables which are to be linked with the process via the I/O modules are entered in the I/O editor. A number of I/O components is provided by each module or slave according to the number of channels. Via these I/O components it is possible to directly use the information in programs and graphic displays. If the I/O component is also to appear in the variable list, a variable name must be indicated. The I/O component name is composed of the object name (16 characters) and the component name (16 characters), thus making available a total of 32 characters.

Diagnosis components are available in addition to the I/O components. Through the network configuration, communication addresses, so-called resource Ids (previously station numbers), are assigned to the resources. IP addresses of the units assigned to the resources are also indicated in the network setting. When the project objects are loaded into the stations, the corresponding application program parts (as allocated in the project tree of the individual resources) are loaded into the resources. The resources or individual parts of the application program are loaded with DigiTool commissioning.

- **Hardware Structure User Interface**
- **Tree View**

The hardware structure tree view displays all hardware structure objects. Beginning with the system object, other hierarchical levels can be entered down to the device level.

The stations are entered via a position number showing the respective station in the graphic view display. Position query is made every time a station or a gateway is inserted.

Each object features object parameters such as name, short text and long text. The parameters relating to the objects are described in the Engineering manuals of the process stations. See Engineering Manual, Process station.

Individual object names are allocated automatically so the user does not need to allocate names. Names can be subsequently configured.

- **Graphic View**

The hardware structure graphic view features several views with different information within their detailed levels.

- **System View**

Figure (4.2) Rapid overview over the global structure, e.g. number of operator and process stations, number of Field Controllers, number of gateways.

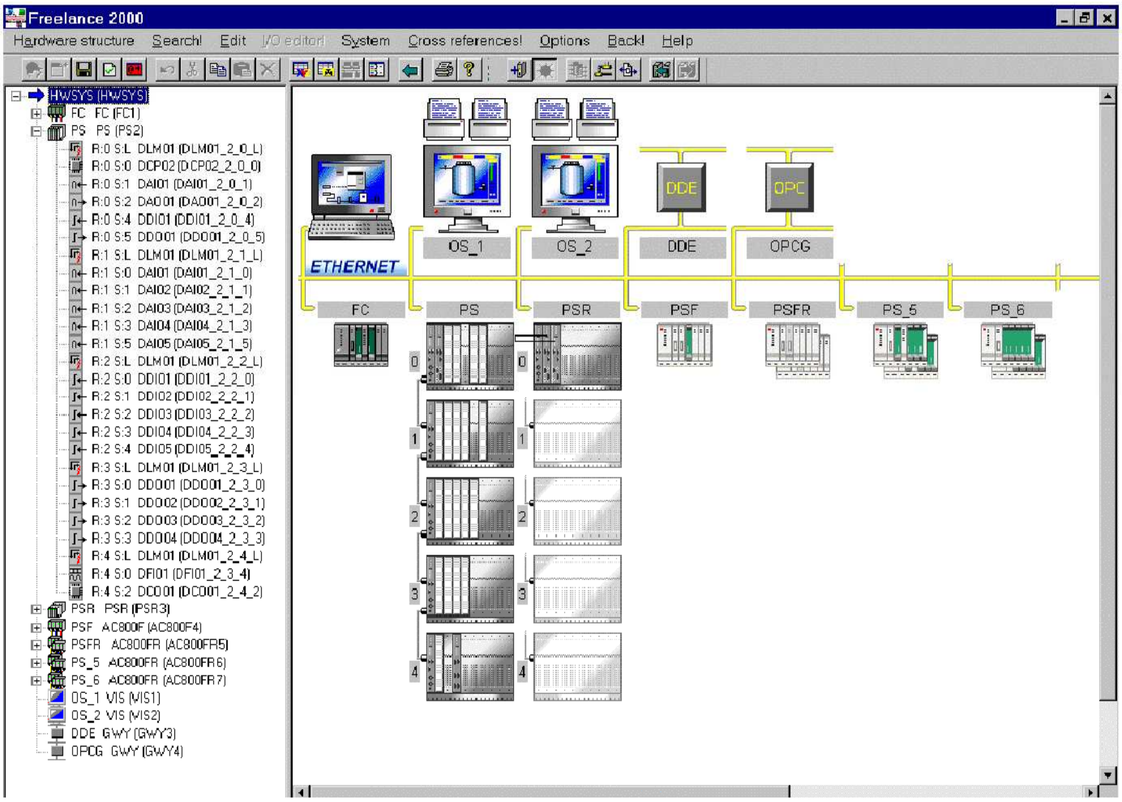


Figure (4.2): System view

• **Station View:** Figure (4.3) immediate information concerning equipped/free slots and plugged-in module types. Intuitive equipment by simple double click.

The station view of the process station shows the central unit with the CPU module and the I/O units.

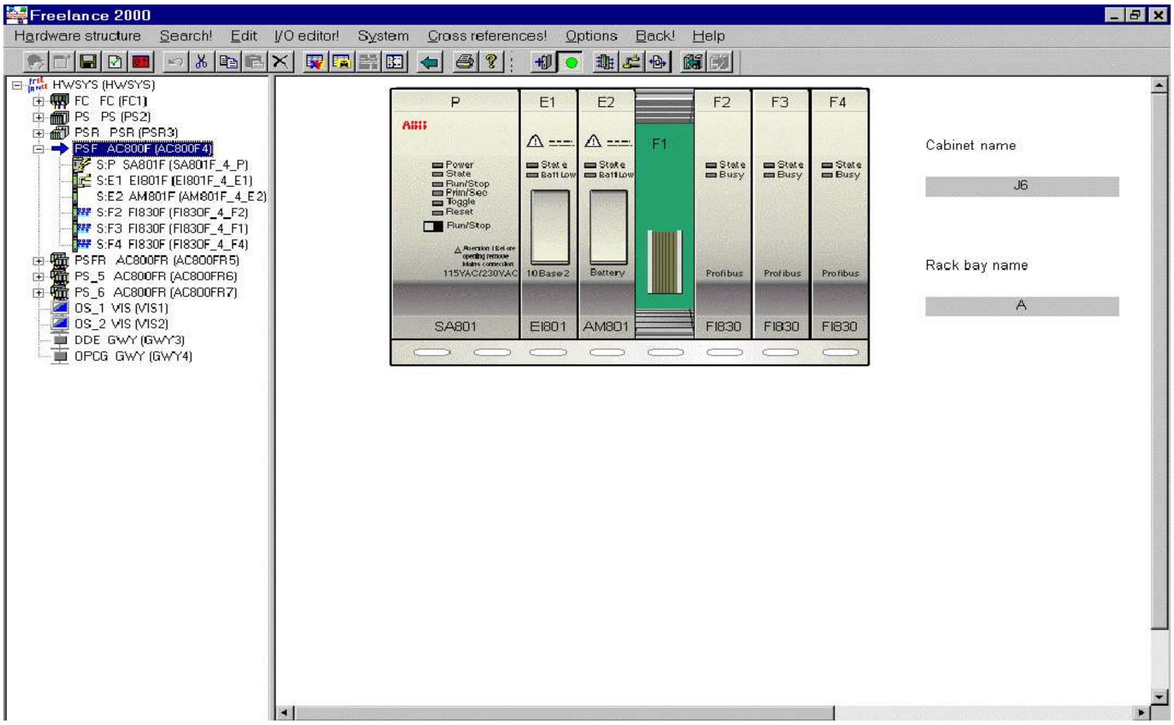


Figure (4.3) Station view

• **Detail View**

The detail view differs depending on the object selected and displays a detailed display of the object. Displayed are the module type (status information only online), the slaves connected, their vendor, model name and bus address (status information and diagnostic information only online) or only the slave connected in its device view with some information such as vendor, model name and bus address (status information and diagnostic information only online).

4.3.4 Commissioning

Commissioning is an operating mode of DigiTool which offers a range of other functions in addition to the loading of project objects. However, in contrast to the configuration operating mode, the user programs cannot be changed structurally. When the user programs have been configured and checked for plausibility, can they be loaded into the process station or the Field Controller and started as part of the commissioning process. When a project is commissioned for the first time, the complete project must be loaded into the respective station. Later, only changes need to be loaded. Changed project objects are loaded and started in accordance with selections made in the project tree. The selection of single or multiple user program objects is made in the project tree, as already described under configuration.

As well as starting, loading, stopping or initializing project objects, such as a resource, a task or a program list, it is also possible to edit individual function blocks of programs. This enables the operator to change operating modes, switch to a specified operating state and set parameters for function blocks without having to reload the modified program. There are two methods of making these changes known to the system:

- Write loads the changes without saving them in the project file.
- Correct saves the changes in the project file, as well as loading them.

After loading a project with Load whole station, additional configuration changes may be loaded incrementally. A configuration change consists of the creation of, deletion of or a change to a project object. A configuration change which affects other project elements is said to have side effects.

During loading, the existence of side effects will cause the changed project object and any objects affected by it to be stopped. For this reason, changes with side effects should be loaded during operations only with the greatest of caution. The user is made aware of the occurrence of side effects by the way the object nodes concerned are displayed in the project tree.

In FBD and LD programs, binary values are displayed directly with their logical state of 1 or 0.

The state of the binary signal is recognized by a different line type. In the IL programs, the current contents of the accumulator are displayed in their own column. Freelance 800F provides an operator level and a process level. The operator level contains the functions for operation and observation, archives and logs, and alarms. Open-loop and closed-loop control functions are processed in the controllers which communicate with actors and sensors in the field.

The whole system Figure (4.4) consists of the following components:

- Control Builder F – Engineering Tool
- DigiVis – Operator software
- AC 800F Controllers
- Configuring and commissioning hardware and software
- Fieldbus and device management
- Cross-references
- Graphics editor for DigiVis

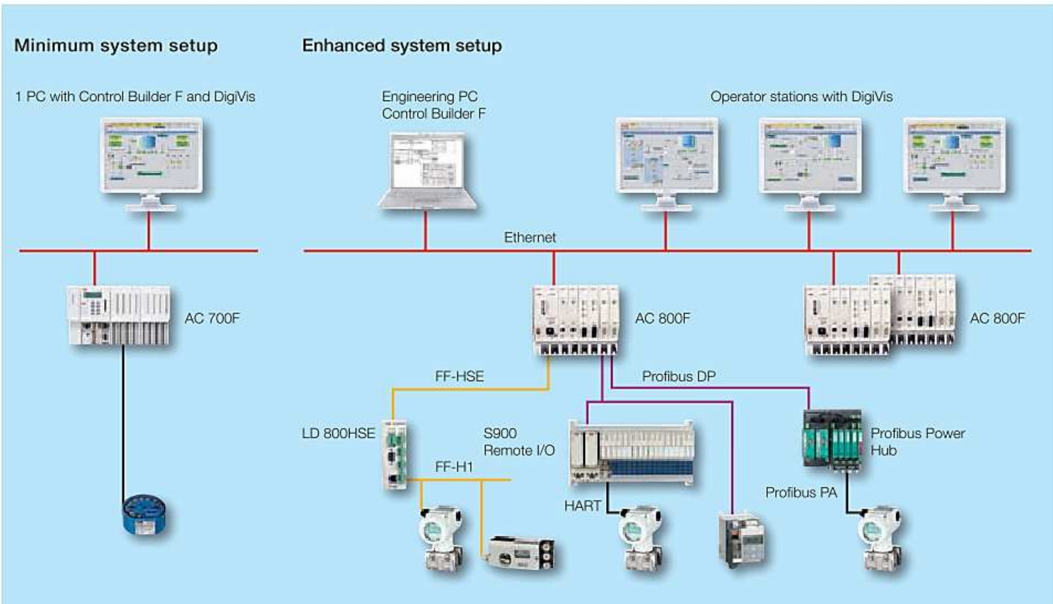


Figure (4.4): Freelance 800F system

4.4 Process Description

4.4 .1 Level Monitoring

Monitoring the level of crude oil can be accompli

4.4.2 Processes

The main process in this project is:

1. Tank Filling & discharge Process.

4.4.3Tank Filling & discharge Process

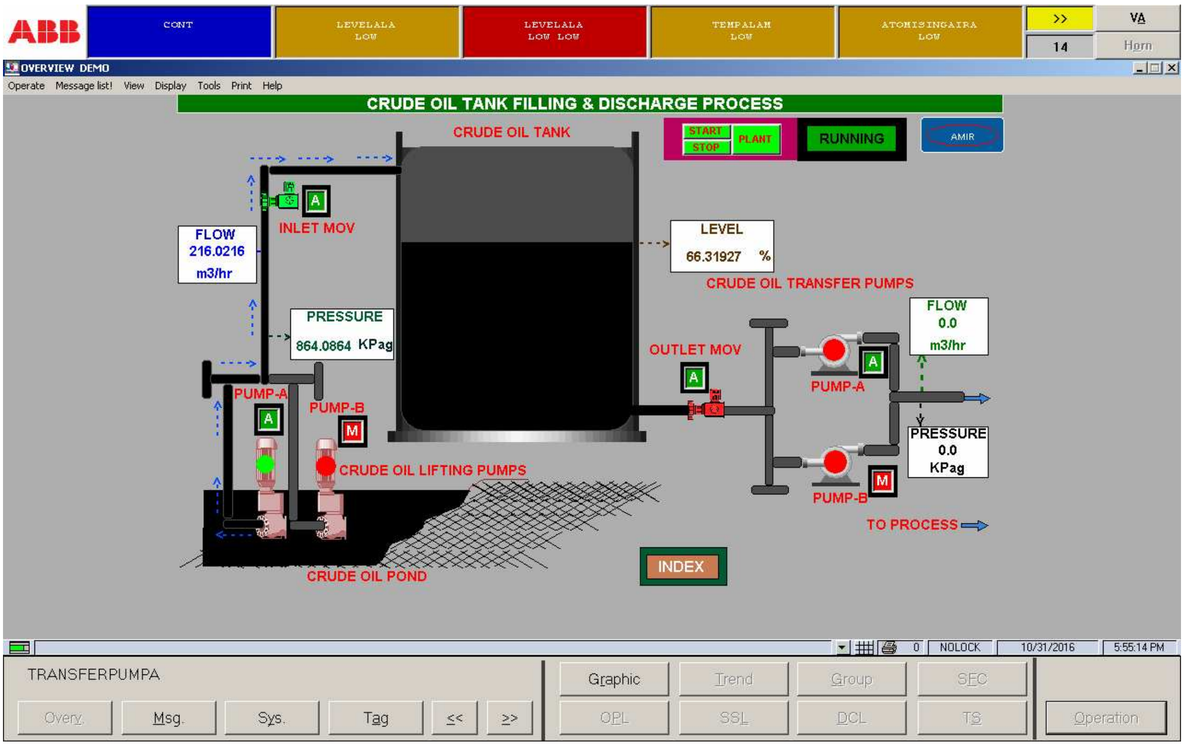


Figure (4.5): Graphic of tank filling &discharge process

4.4.3.1 Components of Tank filling & discharge Process Station:

1. Reservoir (lake, pond etc.)
2. Lifting pumps.
3. Pressure transmitter.
4. Tank.
5. Level transmitter.
6. Transfer pumps.
7. MOV (Motorized Operating Valve)
8. Level switches.

The tank is filled with water using the lifting pumps from the reservoir. When tank is filled up to the HIGH-HIGH level, the lifting pump is stopped and the inlet MOV is closed. According to the requirement of the next process, the water is transferred using the transfer pumps. When the water level comes to LOW-LOW level, the transfer pumps are stopped and outlet MOV is closed. Now the lifting pump is turned on.

This process repeats. We have alarm for inlet pressure Low and outlet pressure low, tank level high and low. When inlet pressure is low, we have to start both lifting pumps. When the pressure is optimum, only one lifting pump A is turned on and lifting pump B will be in standby. When the outlet pressure is low, we have to start both transfer pumps. When the outlet pressure is optimum, we start only the pump A and the transfer pump B will be in standby. Tank level high and low will give alarm for the operator for making appropriate operation during manual mode.

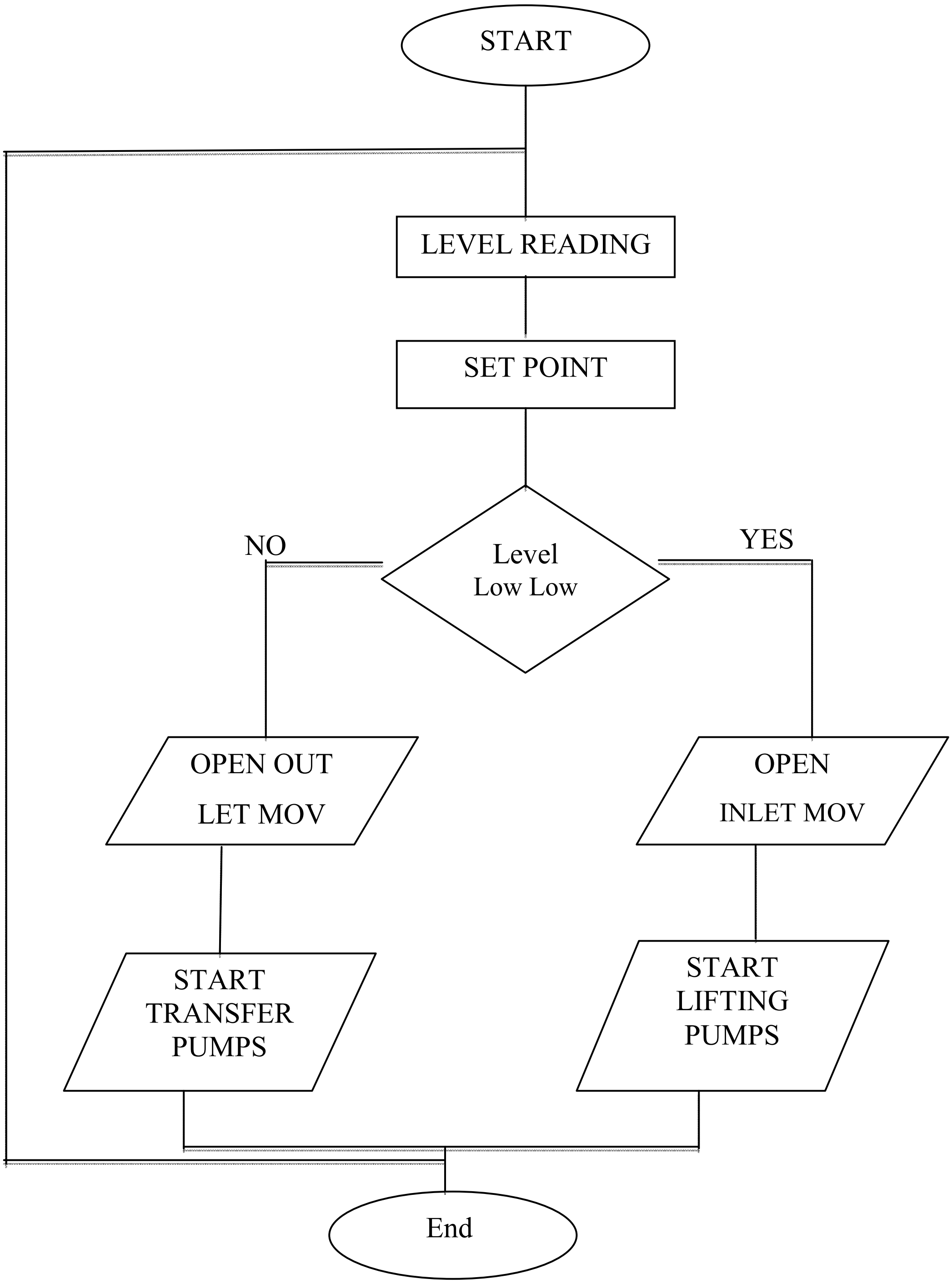


Figure (4.6): The above flow chart illustrated tank filling and discharging process

4.3.2 Lifting Pumps

4.3.2.1On interlocks:

1. The pressure has to be optimum.
2. The tank level has to be LOW-LOW.
3. The inlet MOV has to be open.

4.3.2.2Trip interlocks:

1. The pressure is low.
2. The tank level is HIGH-HIGH.
3. Inlet MOV is closed.

4.3.2.3Logic:

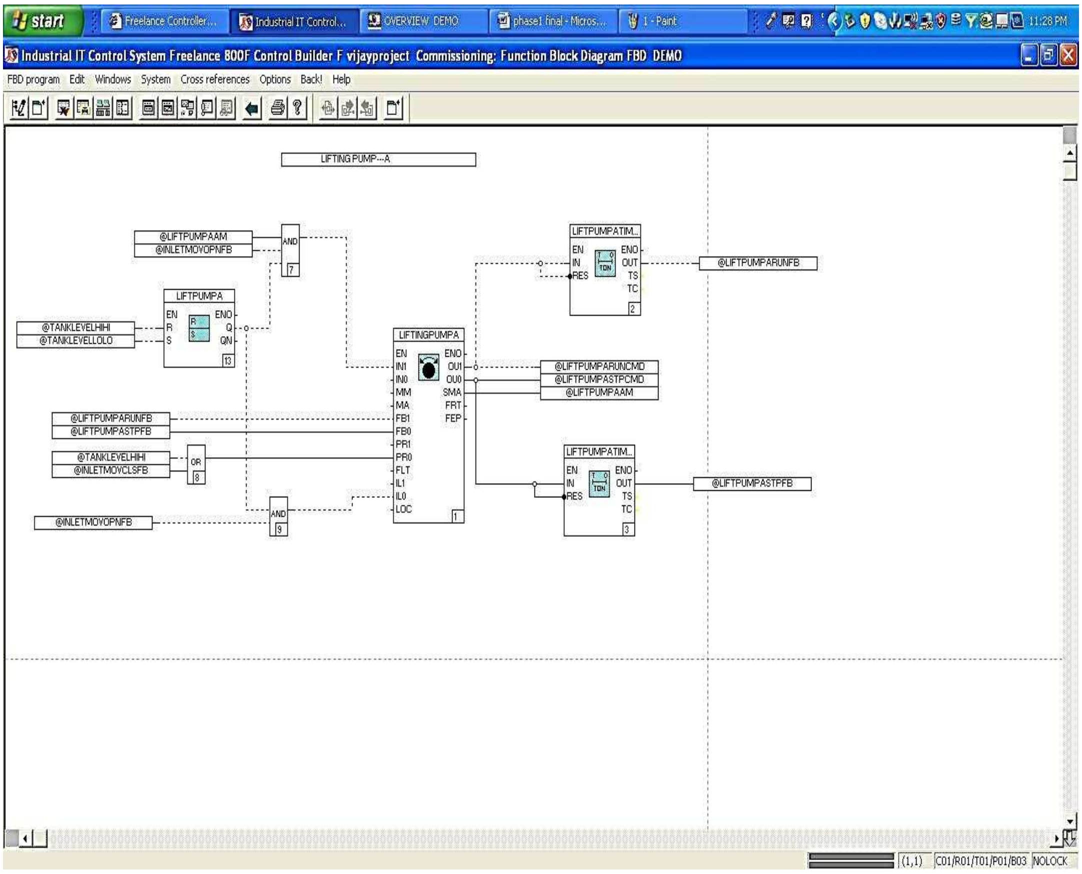


Figure (4.7): Lifting Pumps Function block diagram

4.3.3 Transfer pumps

4.3.3.1 On interlocks:

1. Tank level more than LOW-LOW.
2. Optimum pressure.
3. Outlet MOV has to be open.

4.3.3.2 Trip interlocks:

1. Tank level is LOW-LOW.
2. Low pressure.
3. Outlet MOV closed.

4.3.3.3 Logic

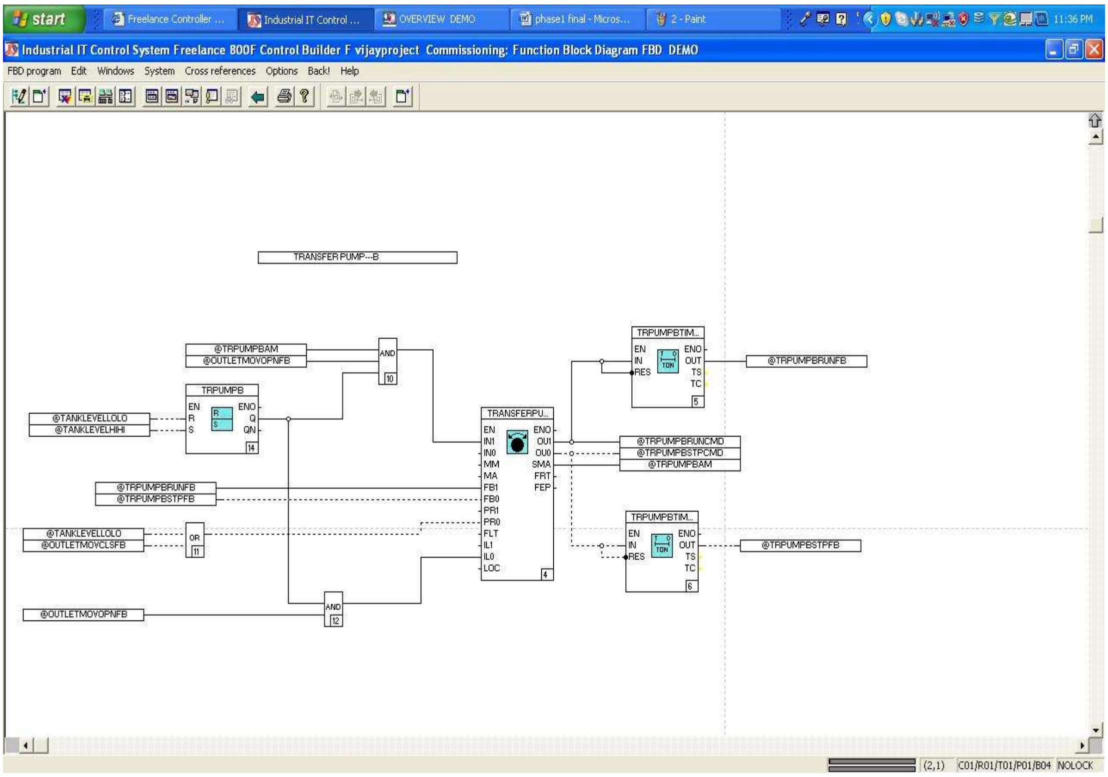


Figure (4.8:) Transfer Pumps Function block diagram

4.3.4 Inlet MOV:

4.3.4 .1 Interlocks:

1. When level is high, inlet MOV is closed.
2. When level is low, inlet MOV is open.

4.3.4 .2 Logic:

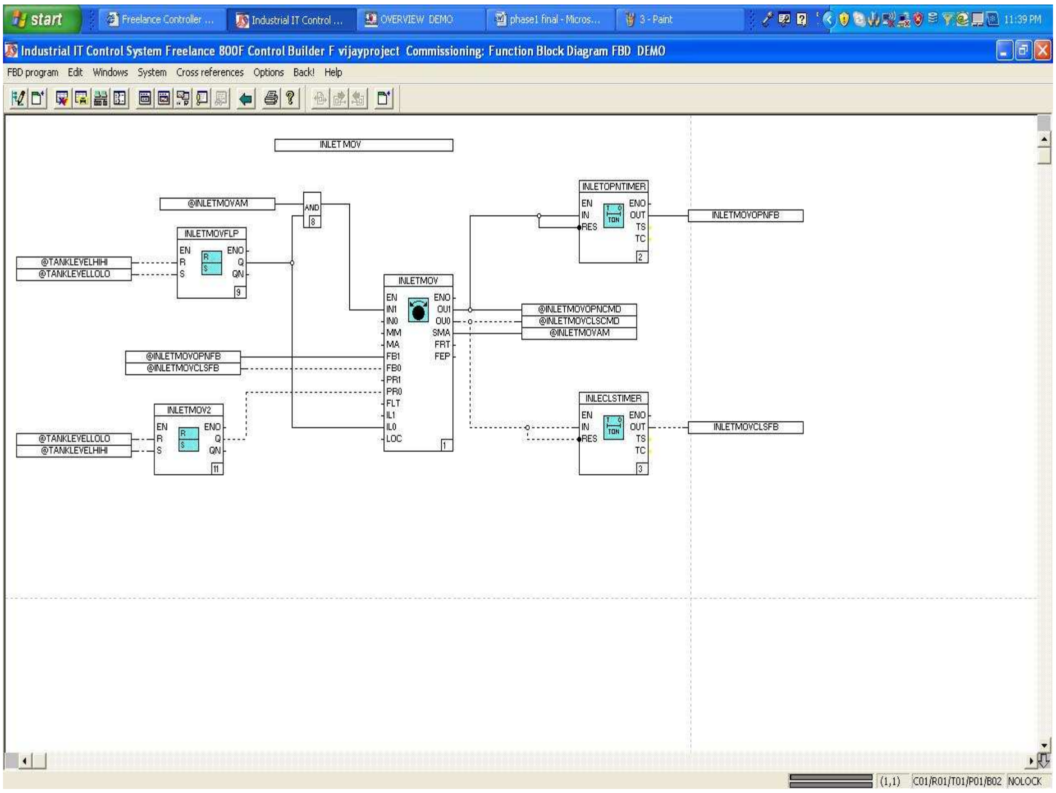


Figure (4.9): Inlet MOV Function block diagram

4.3.5 Outlet MOV:

4.3.5.1 Interlocks:

1. When level is high, outlet MOV is open.
2. When level is low, outlet MOV is closed.

4.3.5.2 Logic:

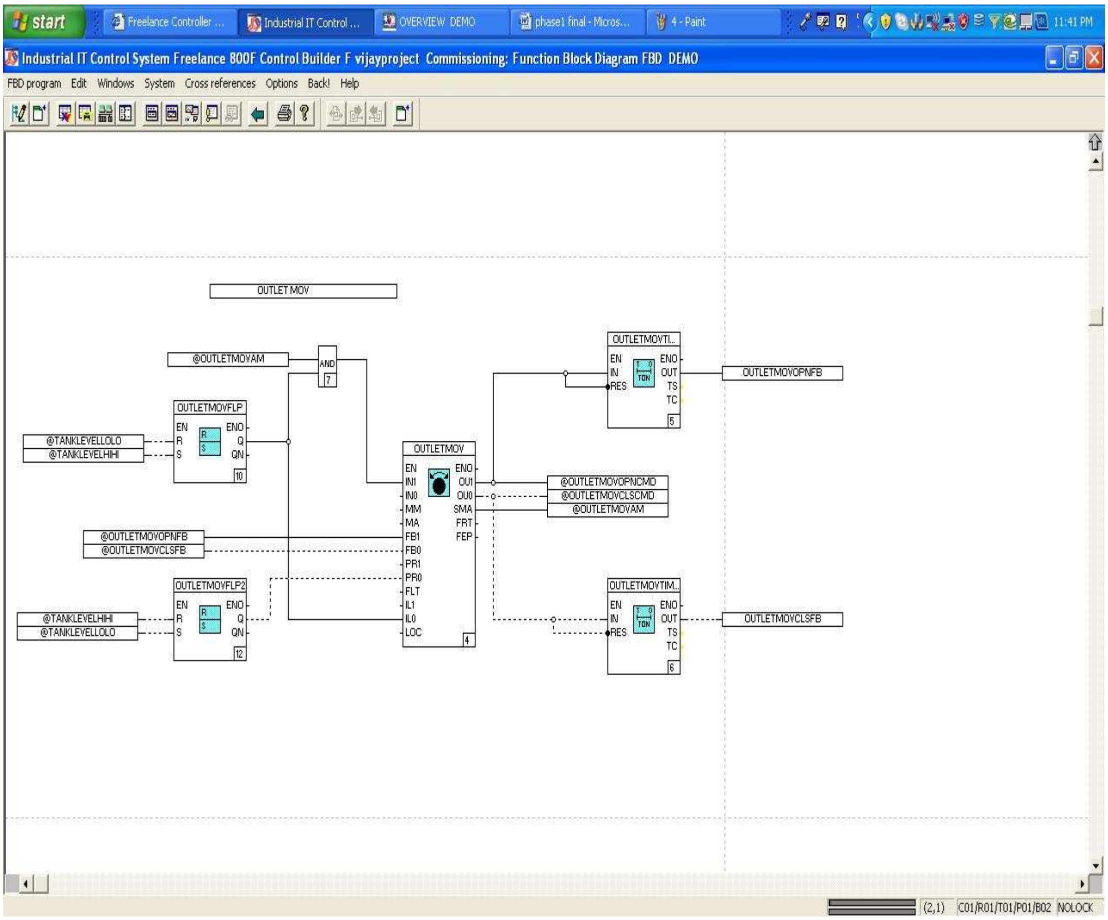


Figure (4.10): Outlet MOV Function block diagram

- Transmitters
- Pressure Transmitter
- Flow Transmitter
- Level Transmitter
- Inlet Pressure Transmitter

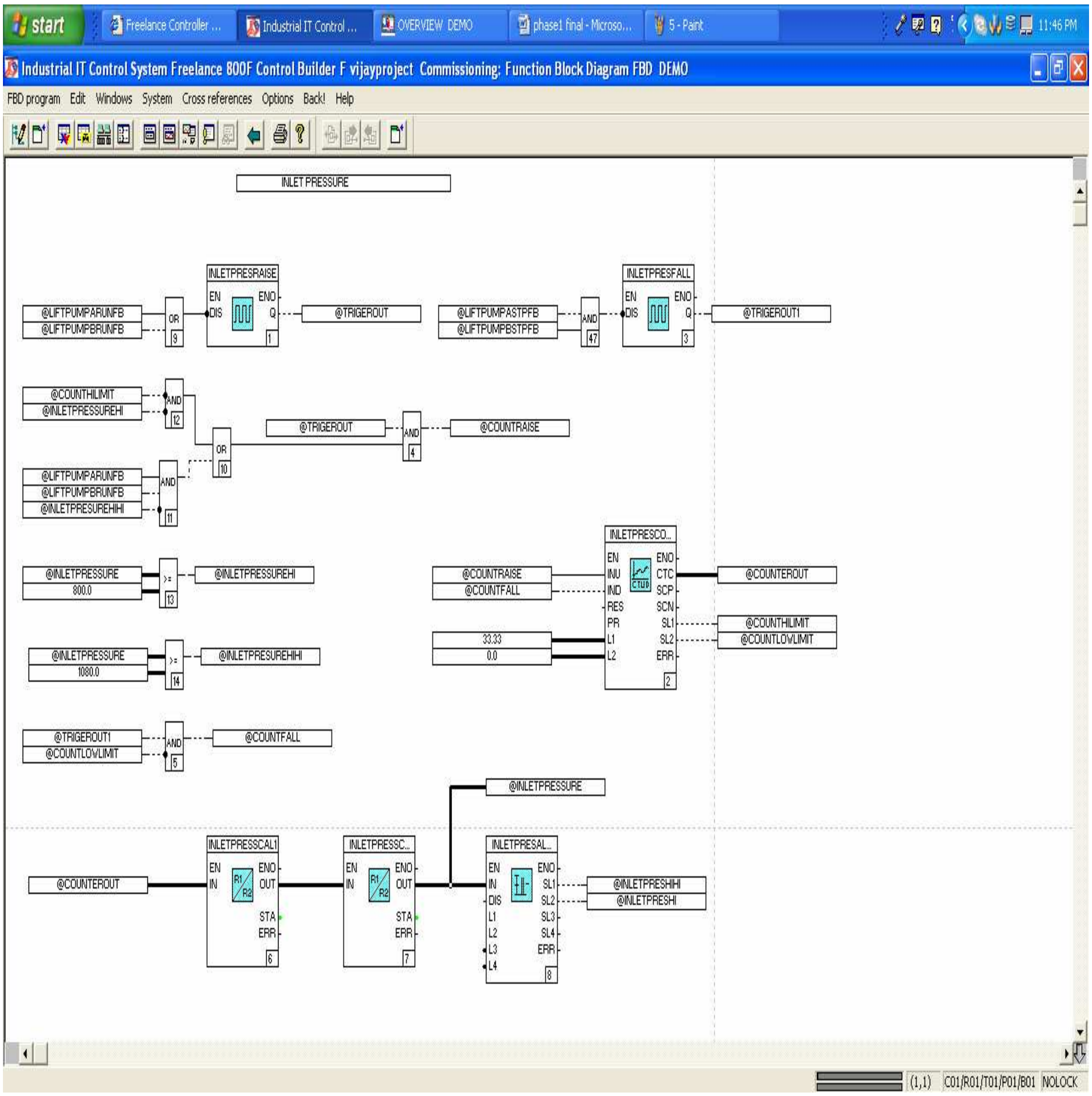


Figure (4.11): Inlet pressure Transmitter Function block diagram

- **Outlet Pressure Transmitter**

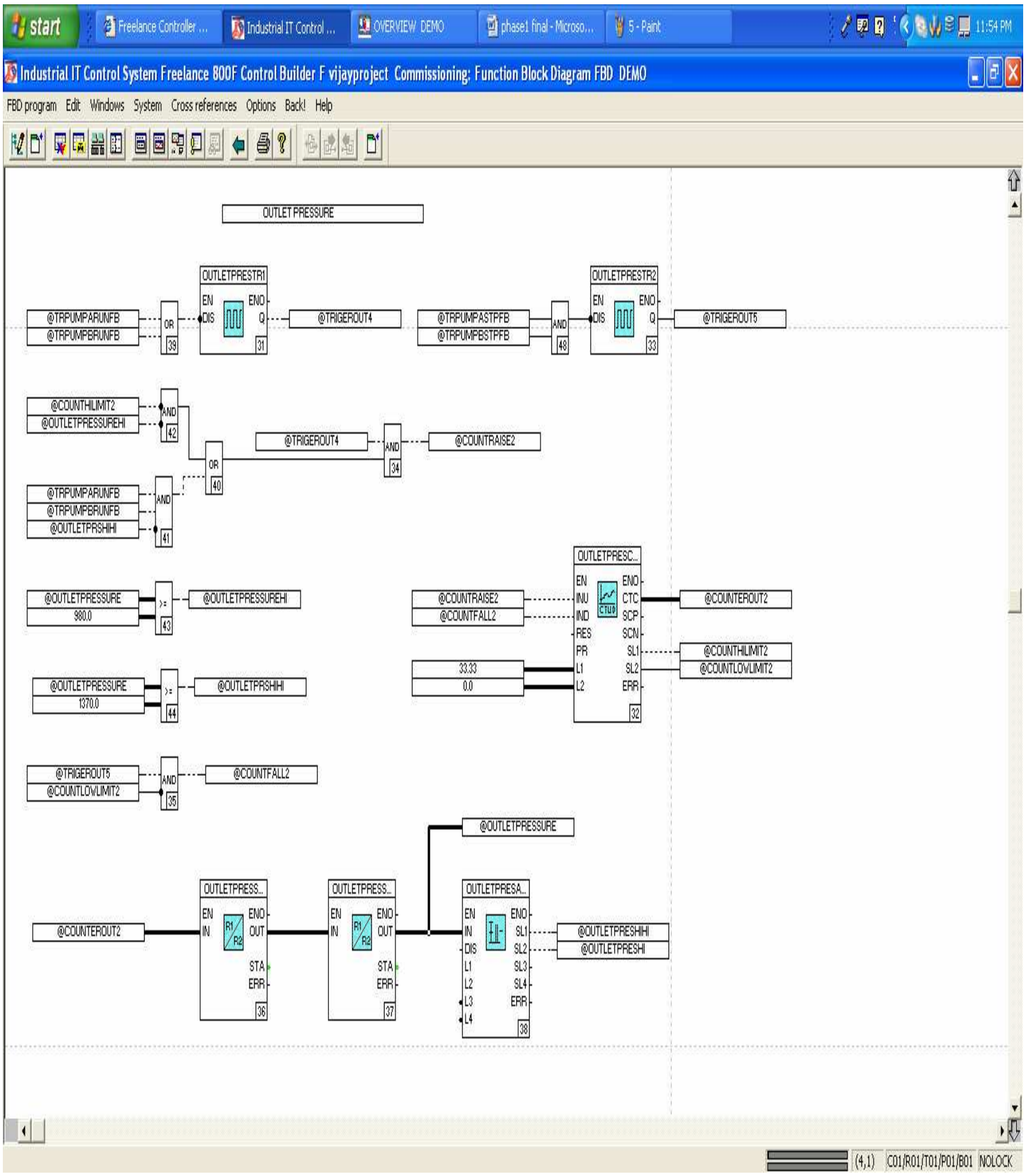


Figure (4.12): Outlet Pressure Transmitter Function block diagram

- **Inlet Flow Transmitter:**

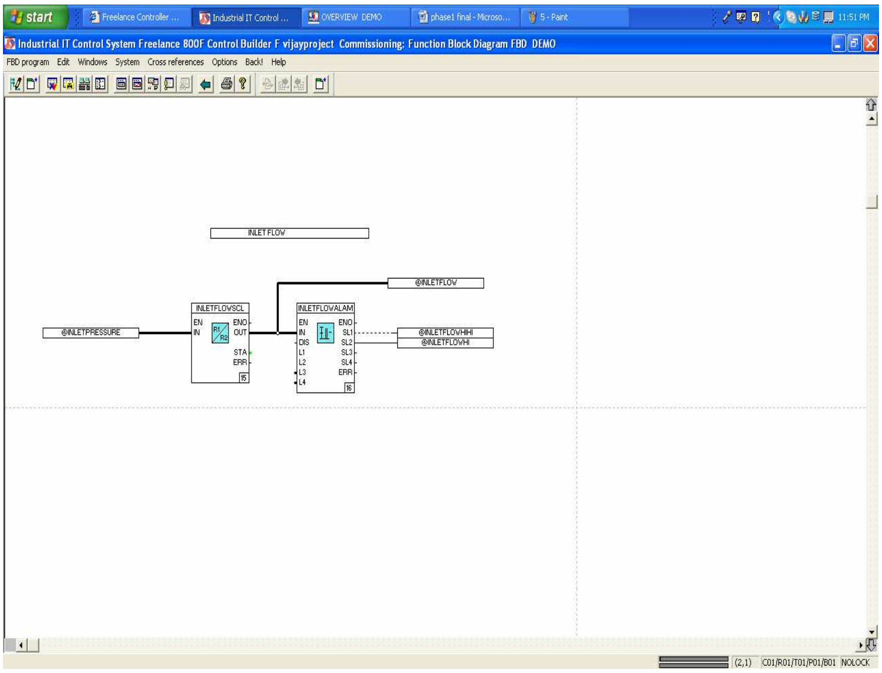


Figure (4.13): Inlet Flow Transmitter Function block diagram

- **Outlet Flow Transmitter:**

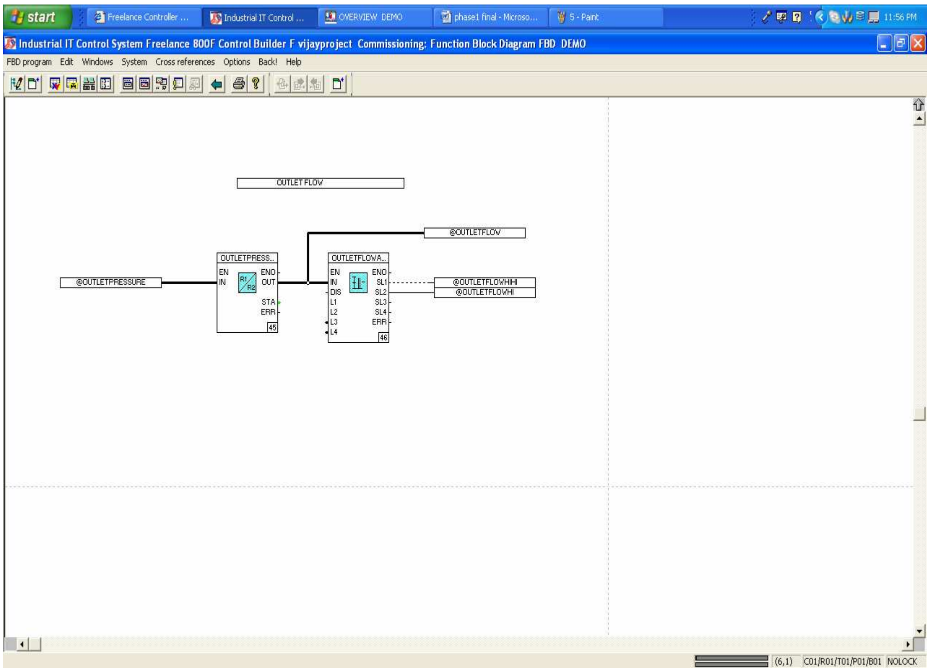


Figure (4.14): Outlet Flow Transmitter Function block diagram

- **Tank Level Transmitter:**

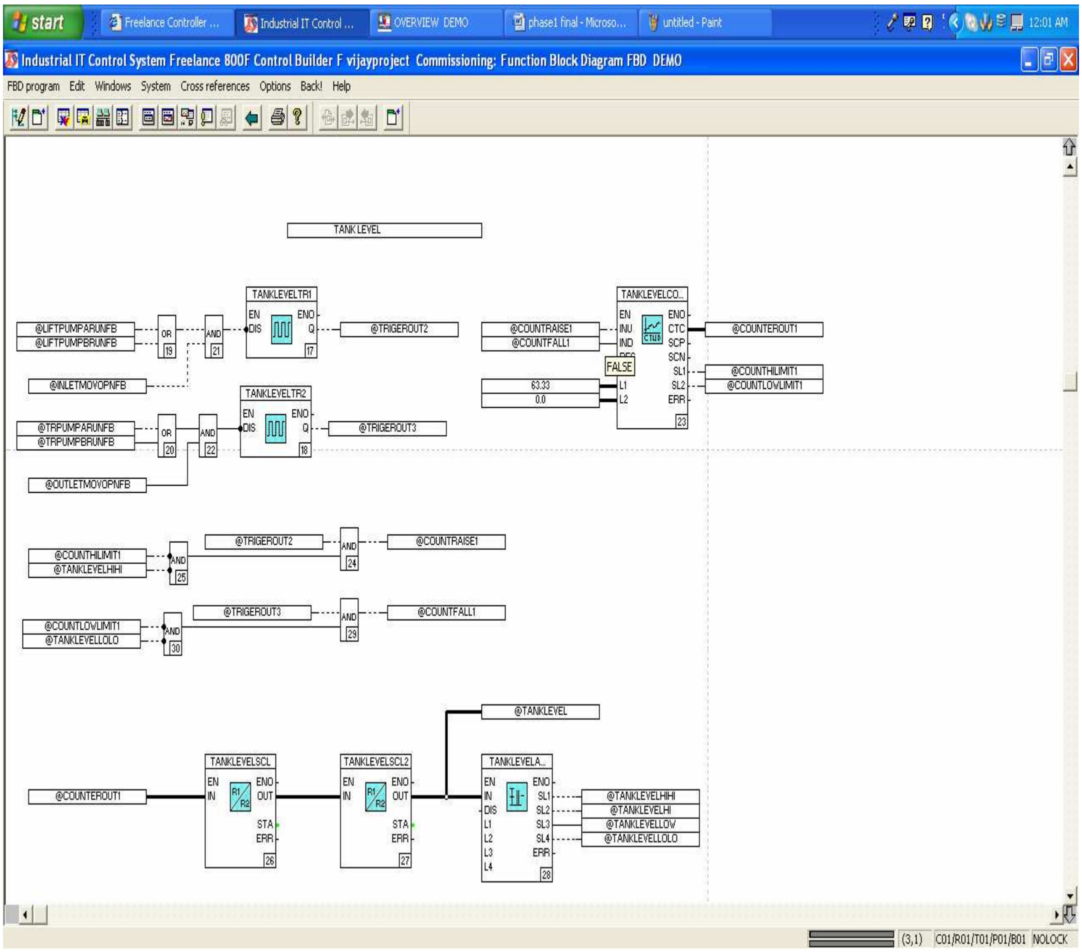


Figure (4.15): Tank Level Transmitter Function block diagram

CHAPTER FIVE

Conclusion and Recommendations

5.1 Conclusion

Distributed control system (DCS) have made it possible to precisely control large process machines and driven equipment with less physical wiring and lower installation costs than is required.

Monitoring and control systems can be a conventional system with recorders, indicators, switches, push buttons, indicating lights, control panels, etc. or it can be a computerized control system that utilizes various configurations of hardware and software to provide the control required. Computerized systems can be separated into two groups, PLC (Programmable Logic Controller) Systems and Distributed Control Systems.[7]

The DCS based system is a multipurpose system with extensive scope for modification. The plant status, alarms, motor starters, meters and analyzers are all wired into input/output cards located in what are called racks. The racks may be mounted separately or placed in specific plant areas to reduce wiring costs. The input/output racks are associated with controllers that are programmed to perform the required process control functions. Changes can generally be made relatively easily by modification of or addition to the DCS controller programs.

DCS control systems have been designed to be easily installed and maintained. Troubleshooting is simplified by the use of fault indicators and messaging displayed on the programmer screen. Input/output modules for connecting the field devices are easily connected and replaced.

Several factors should be considered when developing a plan for the instrumentation and controls. A monitoring requirement varies depending on the type of facility being considered and its location; this will impact on the selection and type of instrumentation being considered. Instrumentation and control requirements will also depend on the size of the plant, and as each process has its own set of conditions to be monitored and controlled there will be different technical requirements to be met. In general, instrumentation and control should provide efficient and safe automatic and manual operation of all plant systems with a minimum of operator effort. Automatic systems should also be provided with manual back-up systems.

5.2 Recommendations

Programmable logic controllers (PLCs) are the result of evolution of hardwired analog control systems. Automatic systems should use either Programmable Logic Controllers (PLC's) or a Distributed Control System (DCS). The operator interface may be in the form of traditional control panels (i.e.: lights, gauges and switches), electronic control panels (with text and/or graphics) and computers. Digital communication between components of the control system must be reliable and self-monitoring. The communication protocol must meet the following requirements: [8]

1. It must include error checking and reporting, to ensure that data is correctly transferred from one component to another;
2. The components of the system must detect the failure of the communication system (either between individual components of the system or between the system and the operator); and
3. It must be compatible with a variety of manufacturer's instruments and equipment, in order to allow for expansion of the system.

The operator interface may consist of a local hard wired control panel or mimic, character based input/output panel, personal computer or workstation depending on system size, process complexity, control system functions and operator interface manufacturer. Where personal computers or workstations are used, select the hardware based on reliability, software compatibility, vendor support and suitability for continuous operation in the plant environment. The operator interface software may provide the operator with interactive control and monitoring of the plant, handle and annunciate alarms, log and trend events and process variables and generate the required reports. Process control and logic should be performed by PLC and not the operator interface computer or workstation.

Complete design documents should be prepared to ensure that construction can be completed correctly and also to properly record the system for future reference. The following are required in the design documents:

1. Design and construction standards, specifications and installation details
2. Panel sizing and general arrangement
3. Control system functional requirements
4. Control component and instrument data sheets
5. Operator interface and control hardware and software specifications including input and output (I/O) lists
6. Control system programming and packaged system configuration standards, structure and scope.

Referances

1. Khaled kamel, Eman Kamel, "Programmable Logic Controllers Industrial Control" Cenveo® Publisher Services Version 1.0 (2013).
2. ABB Automation "Engineering Manual Process Station" - AC 800F Version 7”.
3. Frank D. Petruzella "Programmable Logic Controllers", McGraw-Hill 4th editions (2011).
4. Terry R. Borden, Richard A. Cox. " Technician's Guide to Programmable Controllers",Delmar,Cengage Learning 6th editions (2012).
5. L.A. Bryan, E.A. Bryan" Programmable controllers: theory and implementation " , Industrial Text Company 2nd editions (1997).
6. W. Bolton "Programmable Logic Controller" , Newnes is an imprint of Elsevier 5th Edition (2009).
7. Hugh Jack "Automated manufacturing system with PLC" version 5.1(2008)
8. E.A. Parr "Programmable Controllers An engineer’s guide", Newnes is an imprint of Elsevier 3th Edition (2003).
9. Béla G. Lipták, " Instrument engineers’ handbook : process software and digital networks" , CRC PRESS 3th editions(2002).
10. Frank Petruzella. Electric motors and control systems, McGraw-Hill (2010)
11. W. Bolton "Instrumentation and Control System ", Elsevier Science & Technology Books August (2004).
12. Dominique Placko "Fundamentals of Instrumentation and Measurement",Hermès Science (2007).

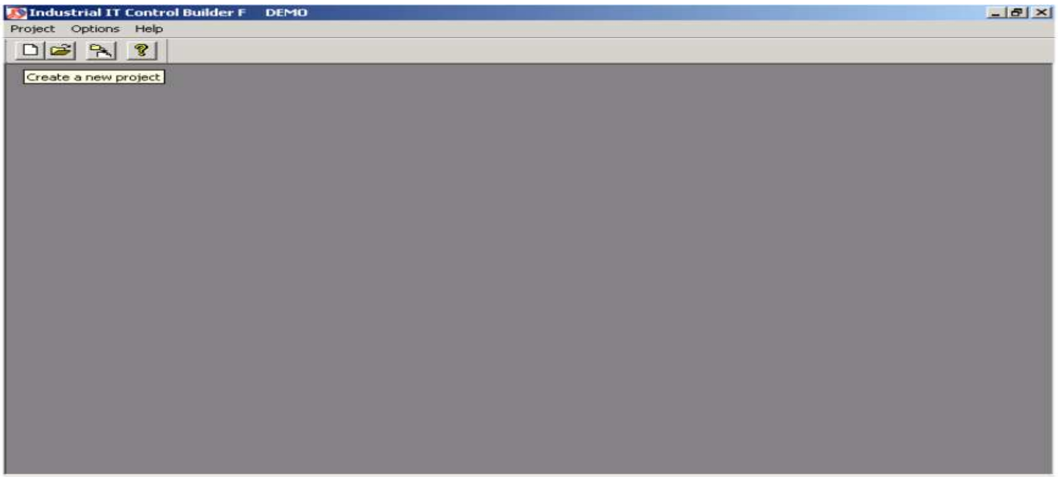
13. Robert B. Northrop "Introduction to Instrumentation and Measuremen Taylor & Francis Group 2th Edition (2005).
14. Albert F. Cutter, Sr "Electrician’s Guide to Control and Monitoring Systems"McGraw-Hill.
15. Jonathan Love "Process Automation Handbook",Springer-Verlag London Limited (2007).
16. ABB Automation "Freelance 2000 DigiVis Operators Manual-Operator Station".
17. W. Bolton "Process control in the chemical industries ", Elsevier Science &

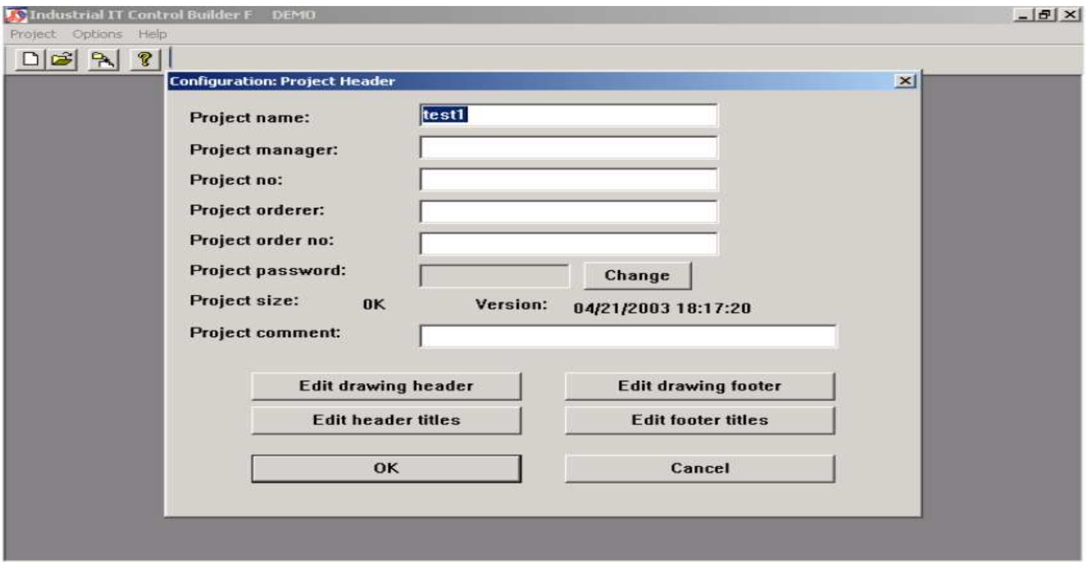
Appendices

This appendices details the steps needed to create a project and simulate it using the Freelance 2000 and development software.

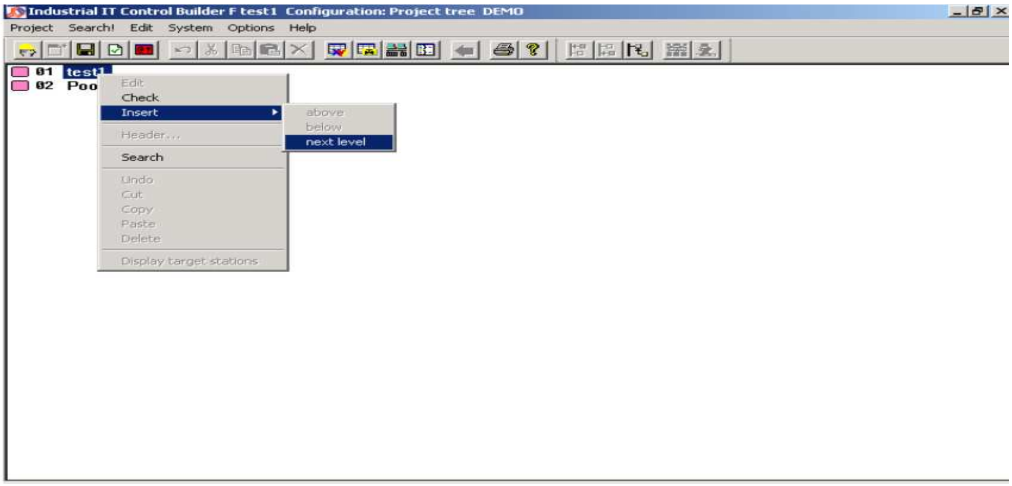
It can help through the detailed tasks involved in the implementation, simulation, and testing of typical industrial automation tasks. The focus here is on the graphical user interface, including both command and status.

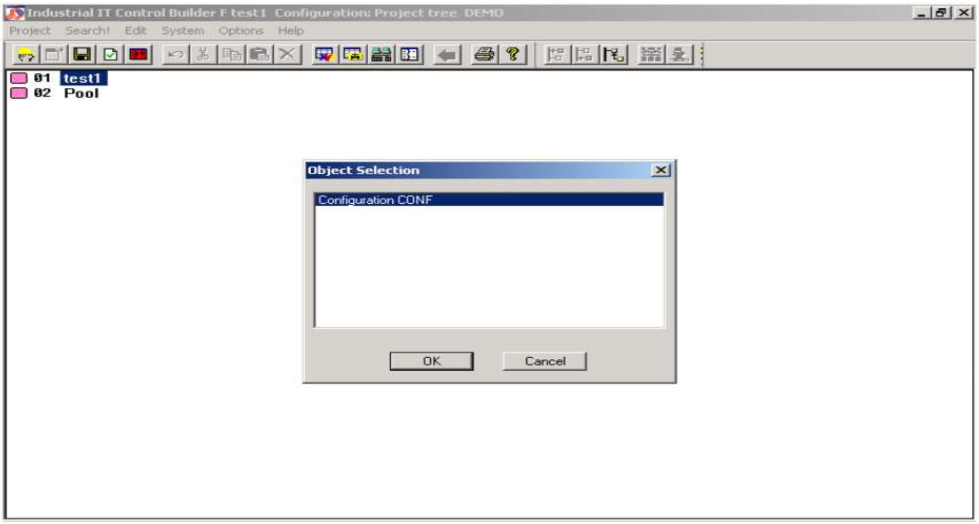
Appendix A: Creating New Projects

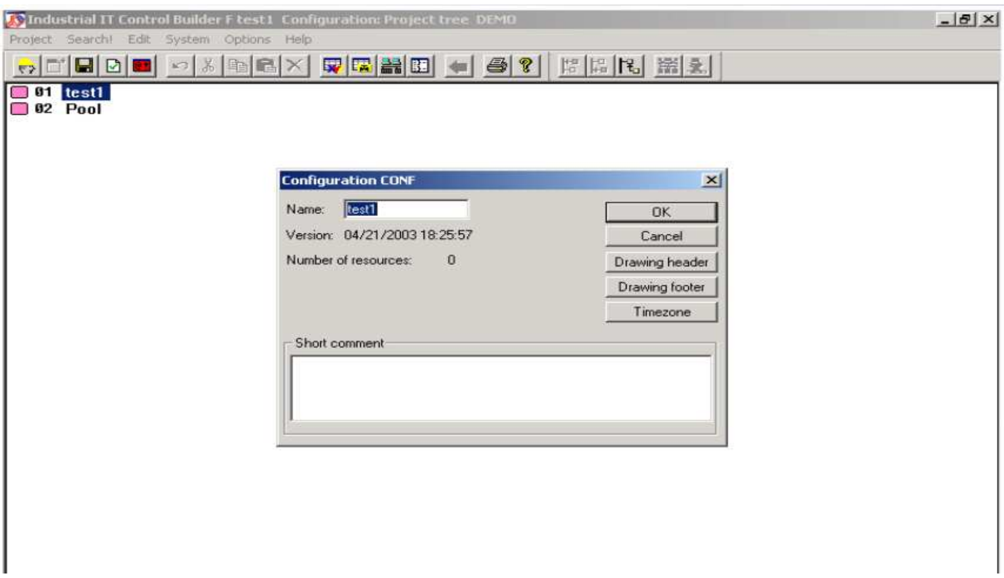




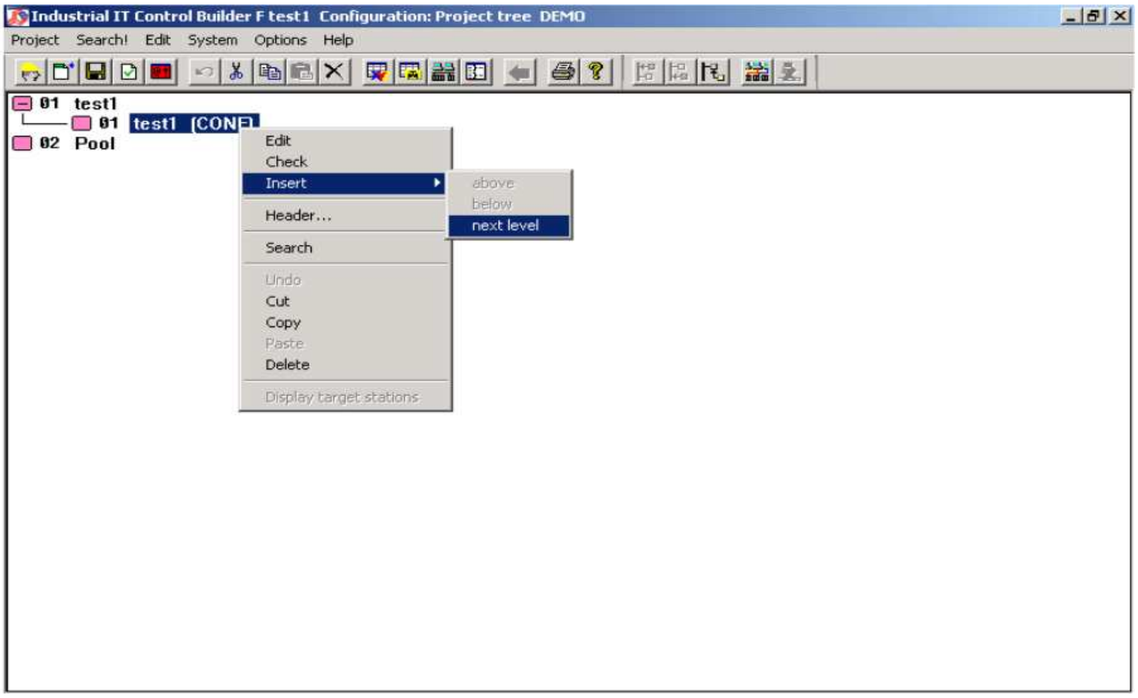
Appendix B: Starting The Project Tree

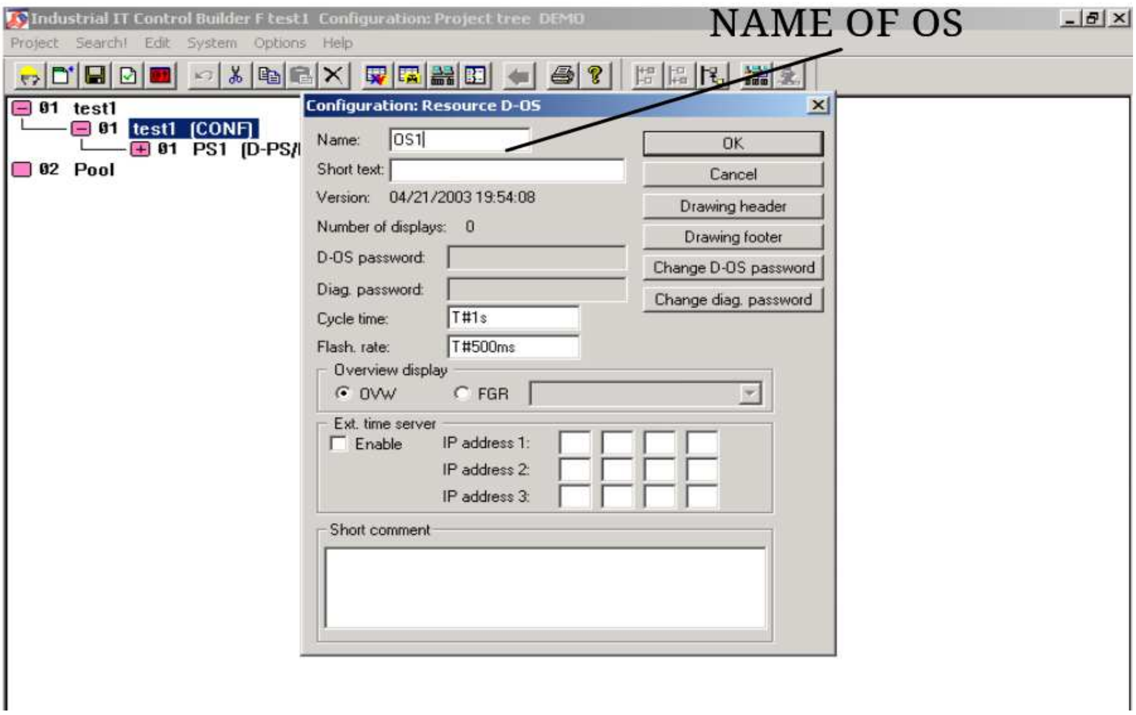


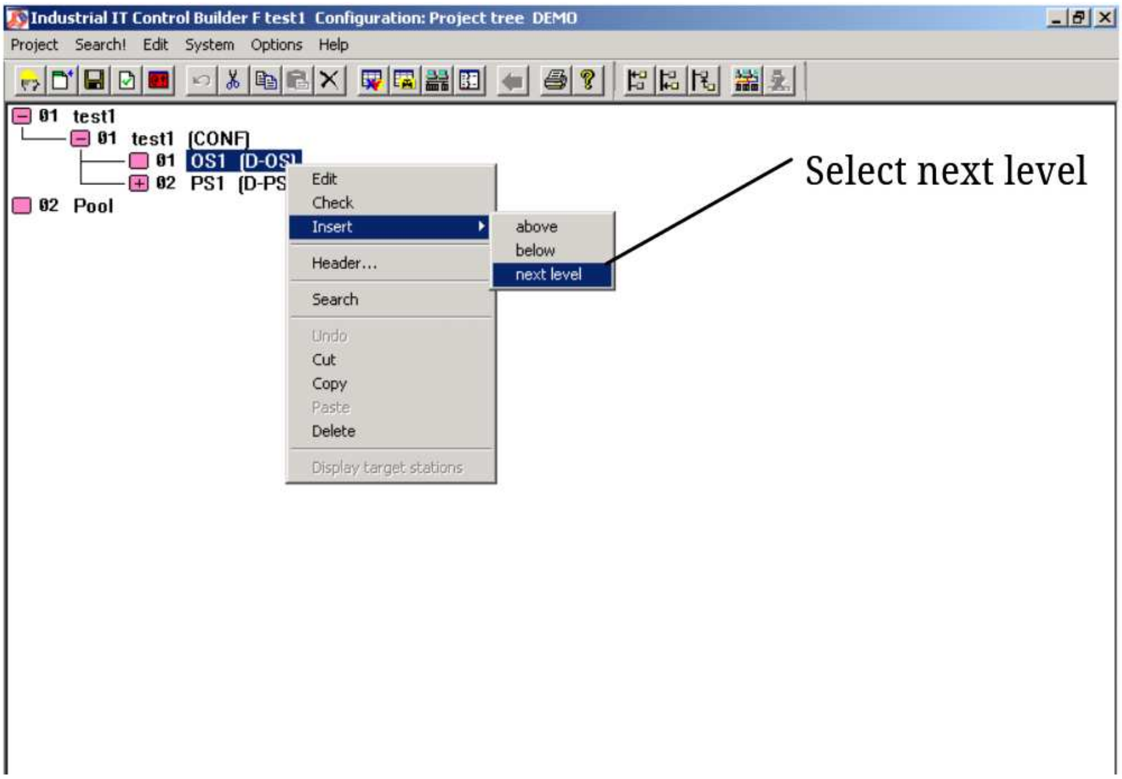


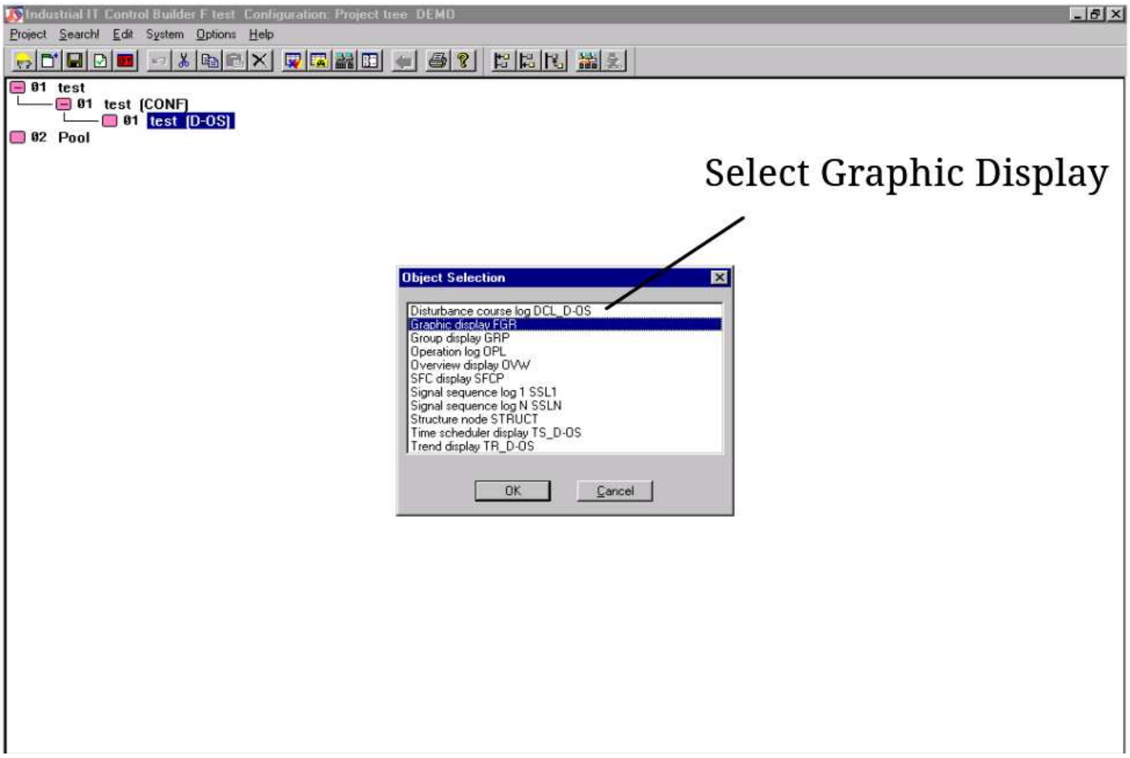


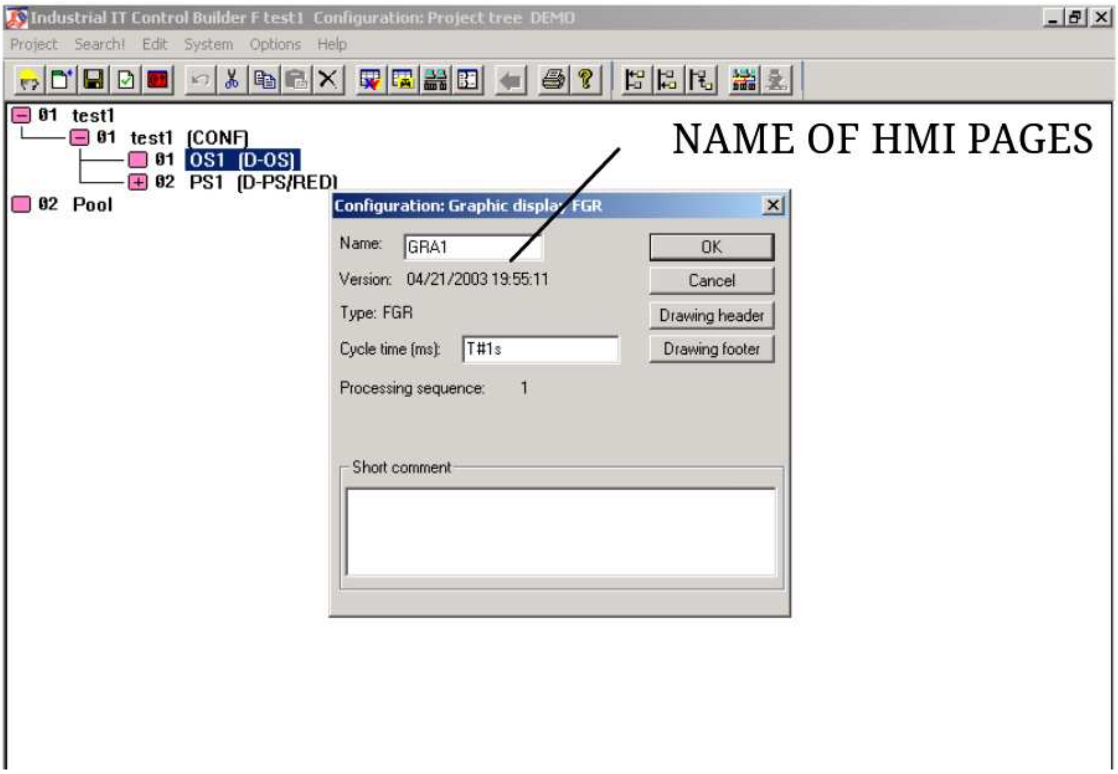
Appendix C: Create Operator Station

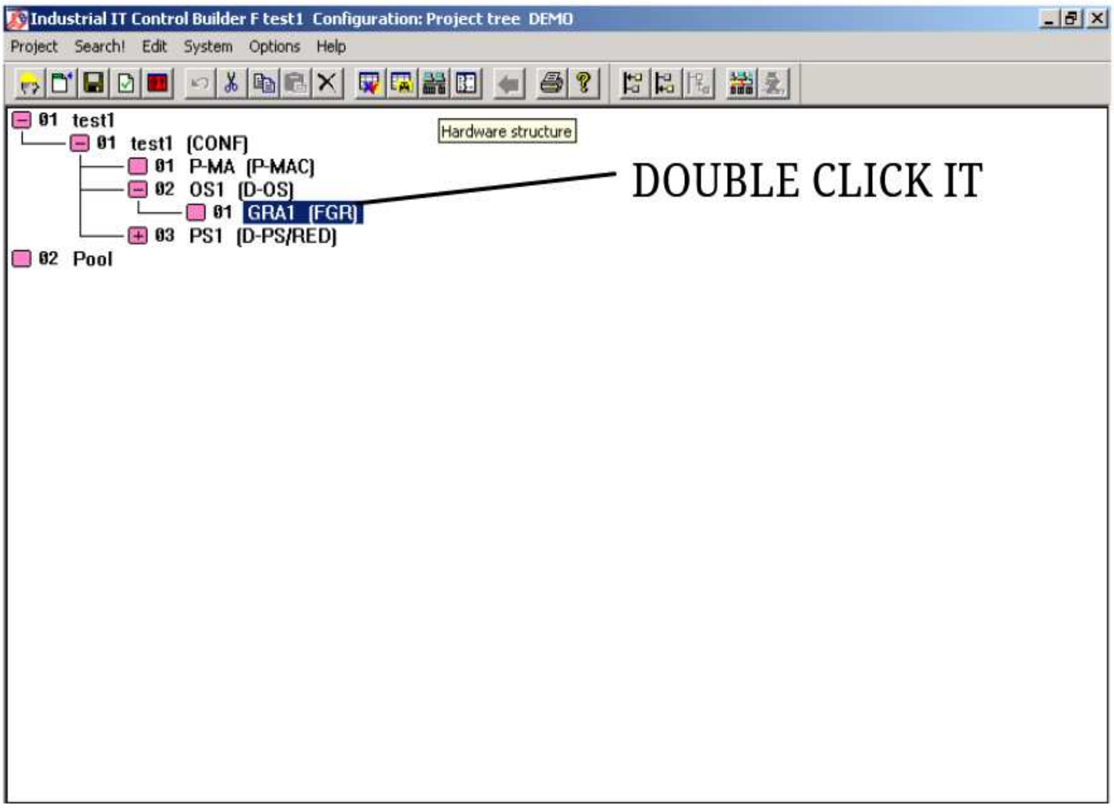




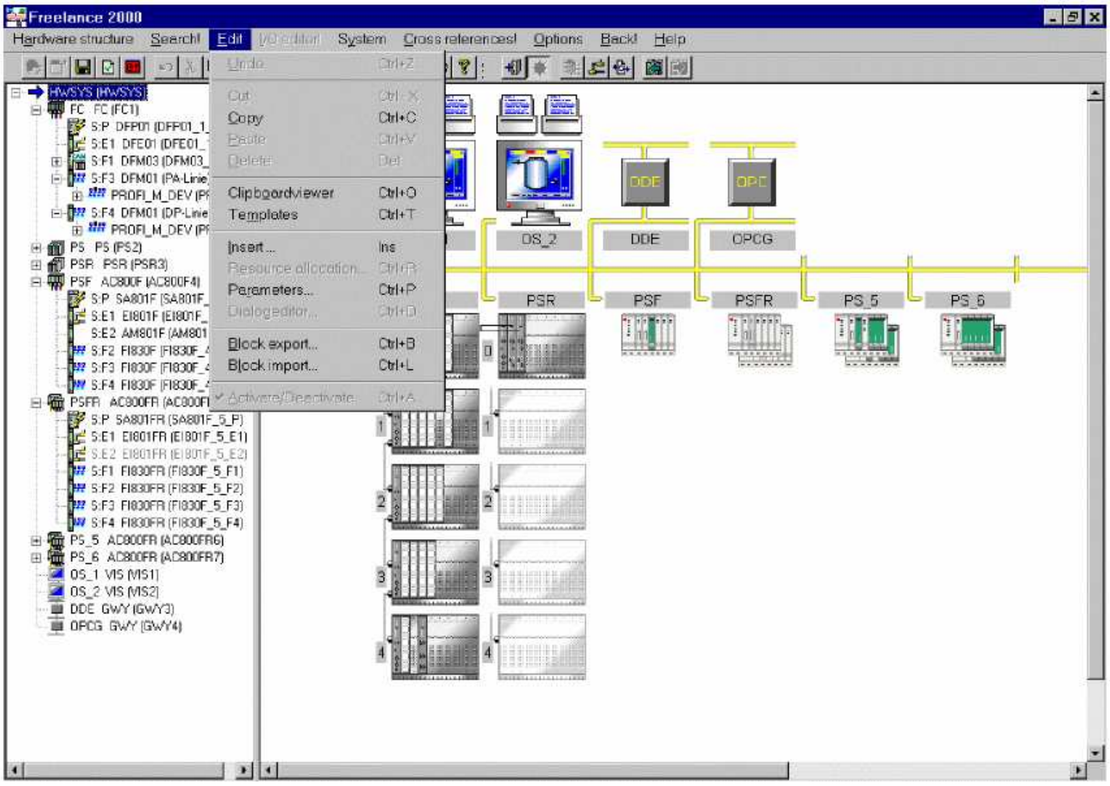

Industrial IT Control Builder F test1 Configuration: Project tree DEMO
Project Search! Edit System Options Help
01 test1
01 test1 (CONF)
01 OS1 (D-OS)
02 PS1 (D-PS
02 Pool
Edit
Check
Insert
Header...
Search
Undo
Cut
Copy
Paste
Delete
Display target stations
above
below
next level
Select next level


Industrial IT Control Builder F test Configuration: Project tree DEMO
Project Search! Edit System Options Help
01 test
01 test (CONF)
01 test (D-OS)
02 Pool
Select Graphic Display
Object Selection
Disturbance course log DCL_D-OS
Graphic display FGR
Group display GRP
Operation log OPL
Overview display OVW
SFC display SFCP
Signal sequence log 1 SSL1
Signal sequence log N SSLN
Structure node STRUCT
Time scheduler display TS_D-OS
Trend display TR_D-OS
OK
Cancel

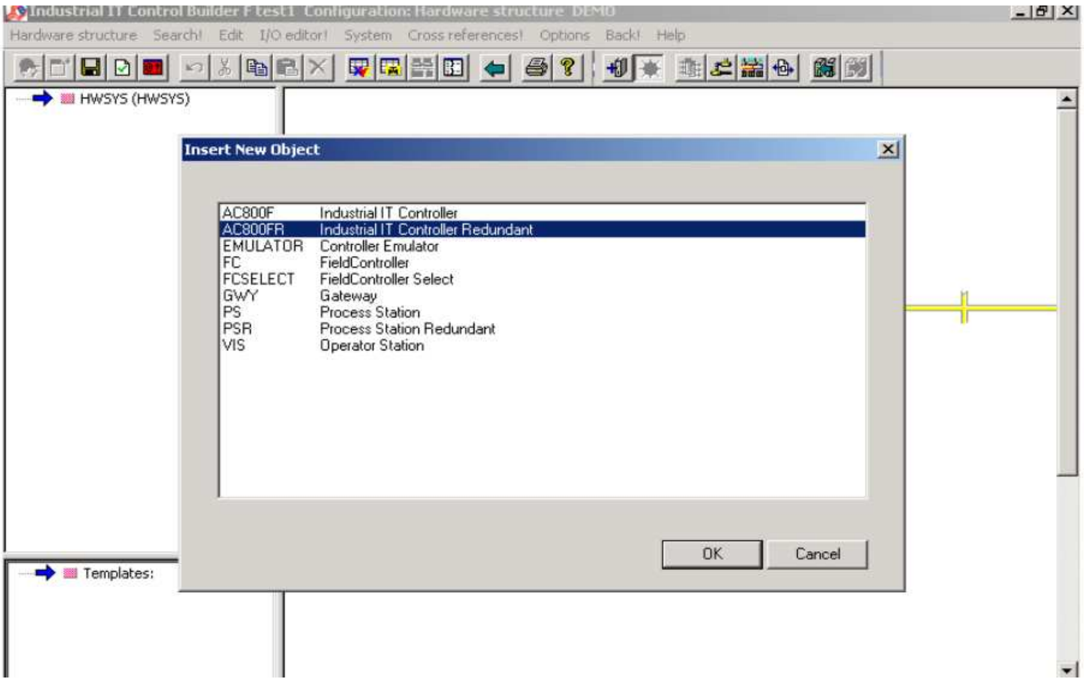

Industrial IT Control Builder F test1 Configuration: Project tree DEMO
Project Search! Edit System Options Help
01 test1
01 test1 (CONF)
01 OS1 (D-OS)
02 PS1 (D-PS/RED)
02 Pool
NAME OF HMI PAGES
Configuration: Graphic display FGR
Name: GRA1
Version: 04/21/2003 19:55:11
Type: FGR
Cycle time (ms): T#1s
Processing sequence: 1
Short comment
OK
Cancel
Drawing header
Drawing footer


Industrial IT Control Builder F test1 Configuration: Project tree DEMO
Project Search! Edit System Options Help
Hardware structure
01 test1
01 test1 (CONF)
01 P-MA (P-MAC)
02 OS1 (D-OS)
01 GRA1 (FGR)
03 PS1 (D-PS/RED)
02 Pool
DOUBLE CLICK IT

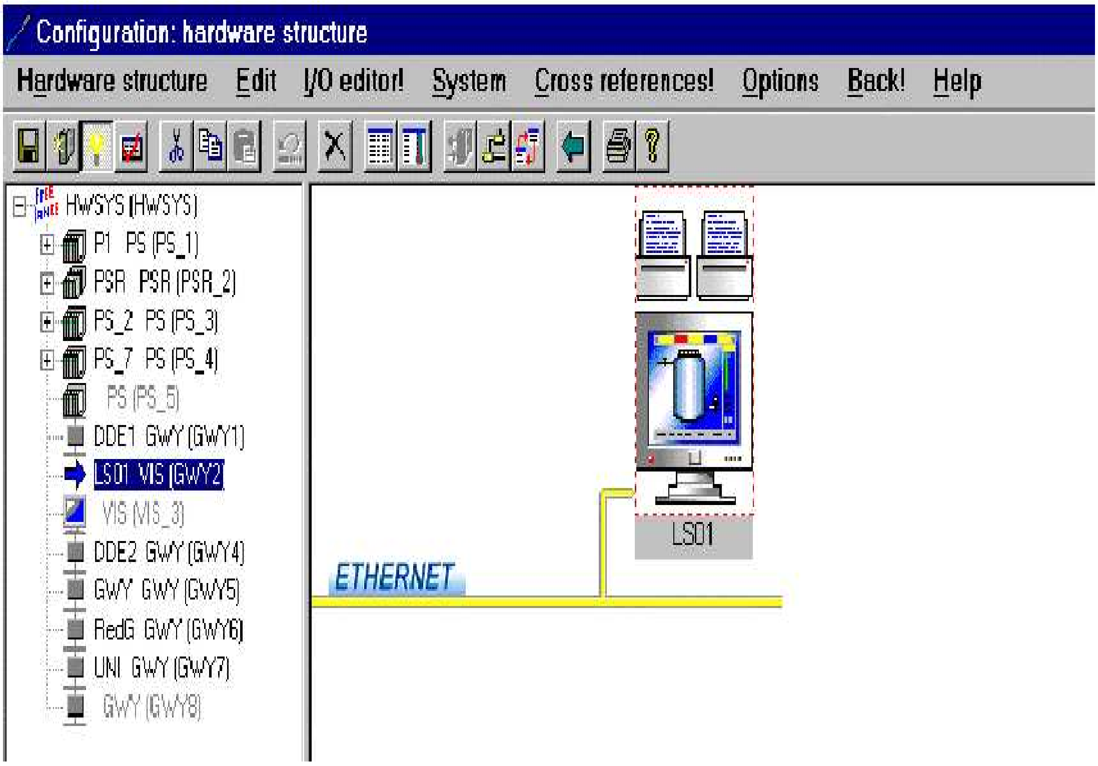
Appendix D: Editing The Hardware Structure



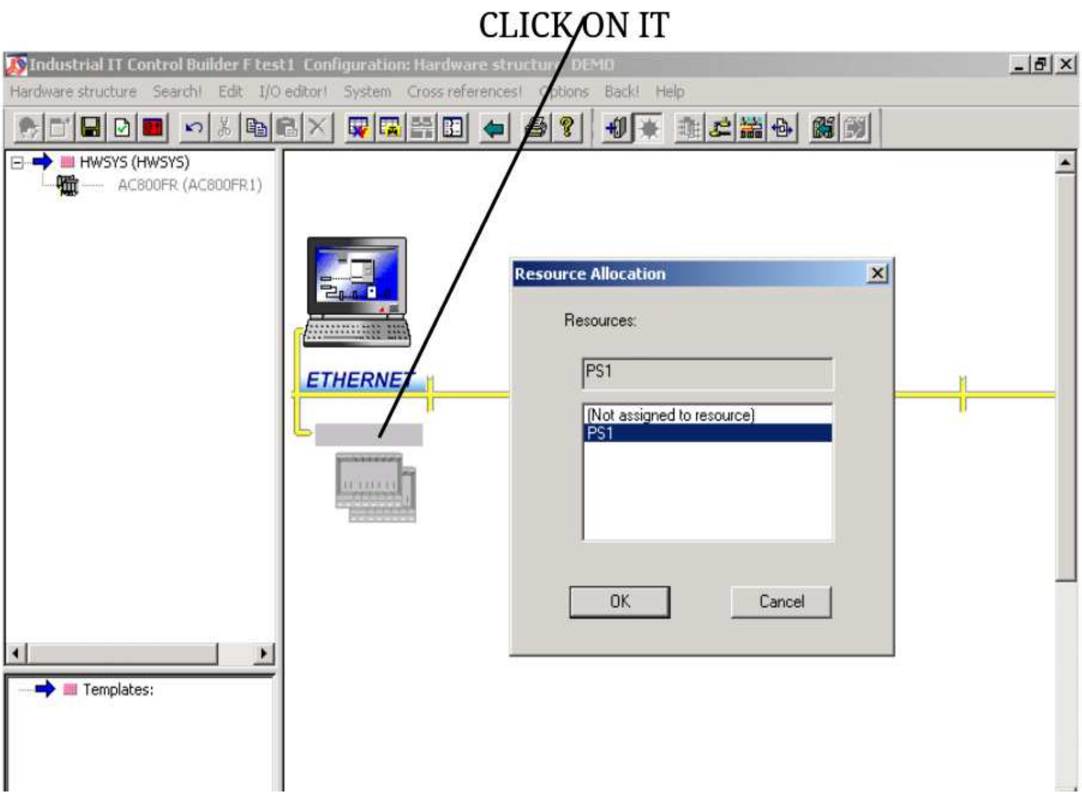
Appendix E: Insert an AC 800F



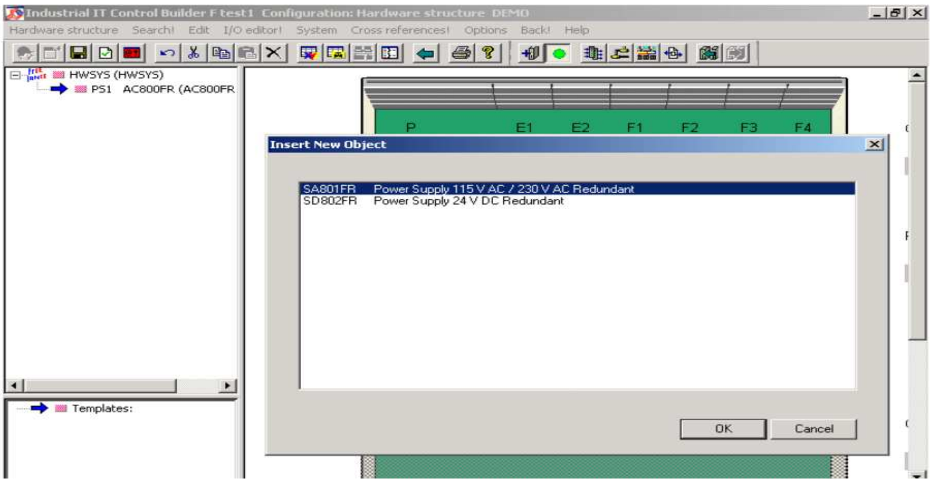
Appendix F: Insert PC Components in The Operator Station

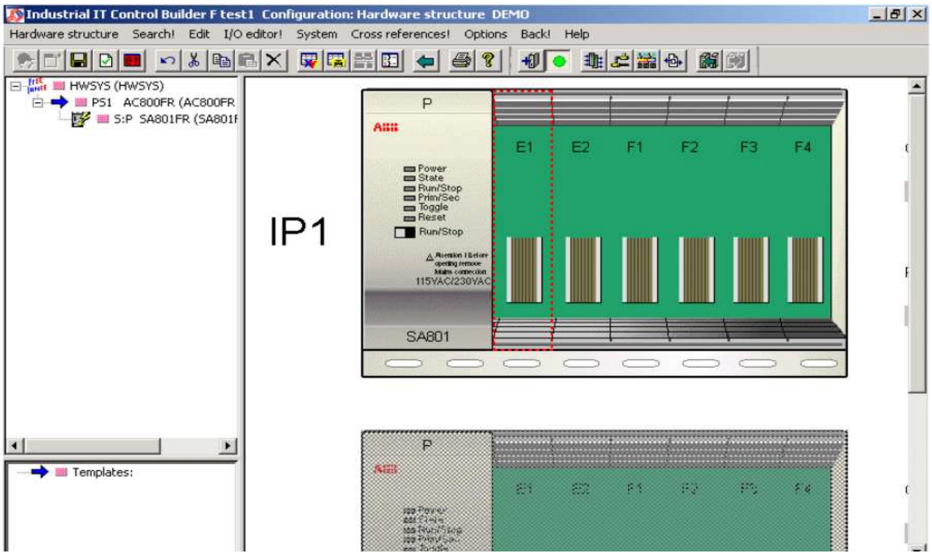


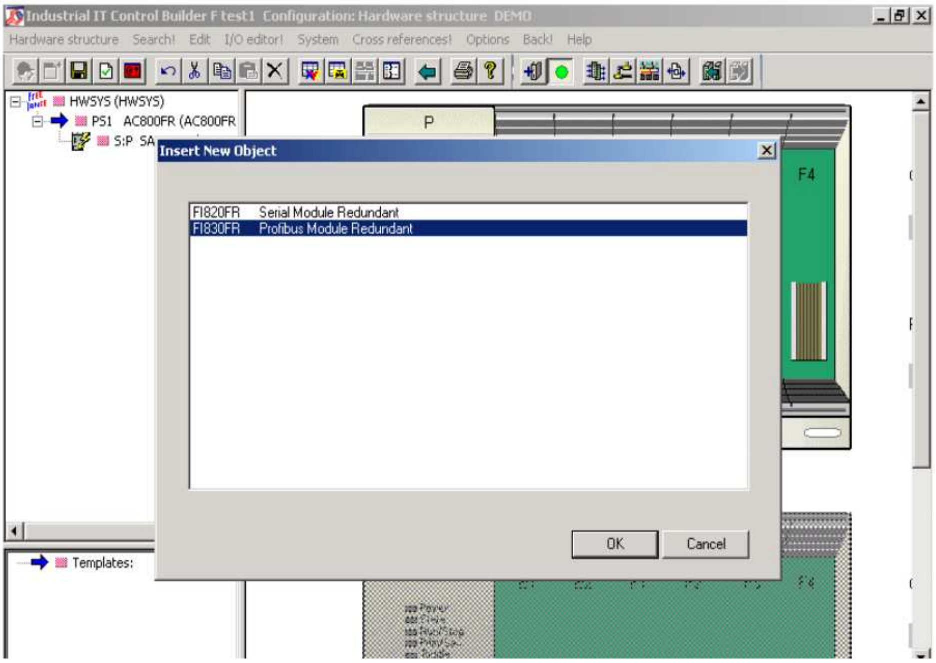
Appendix G: Insert Operator Station



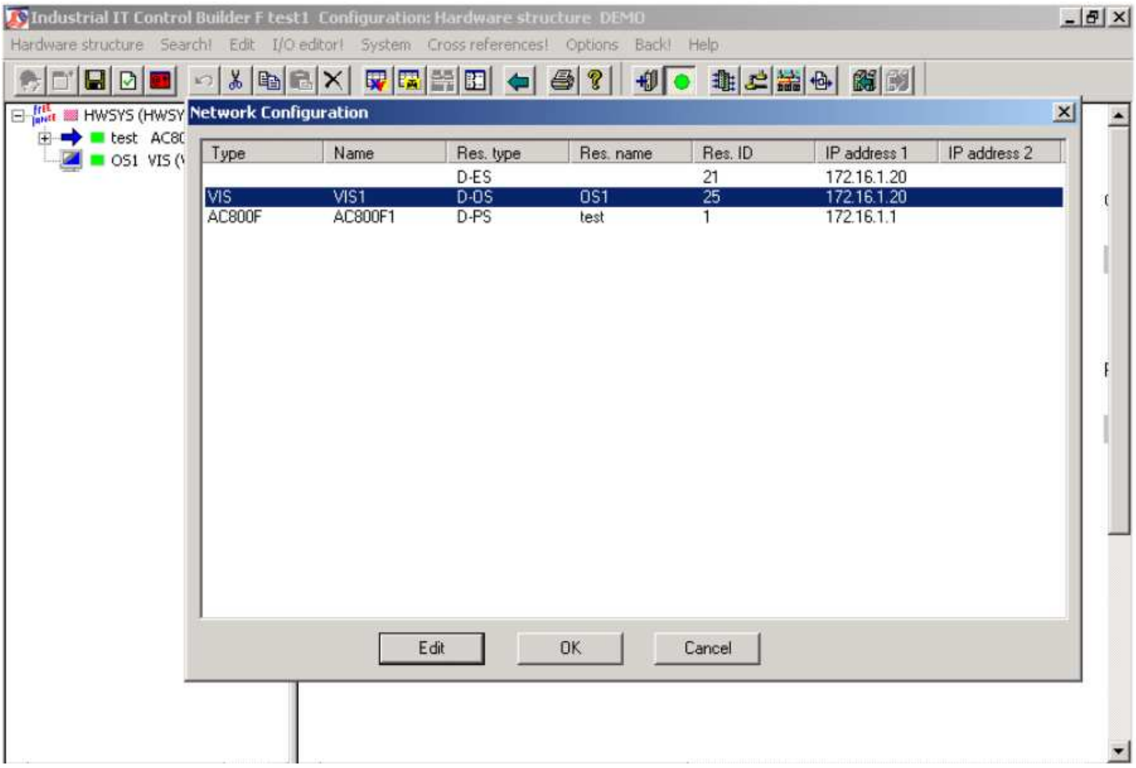
Appendix H: Insert Power Supply, Ethernet & Profibus Master Modules



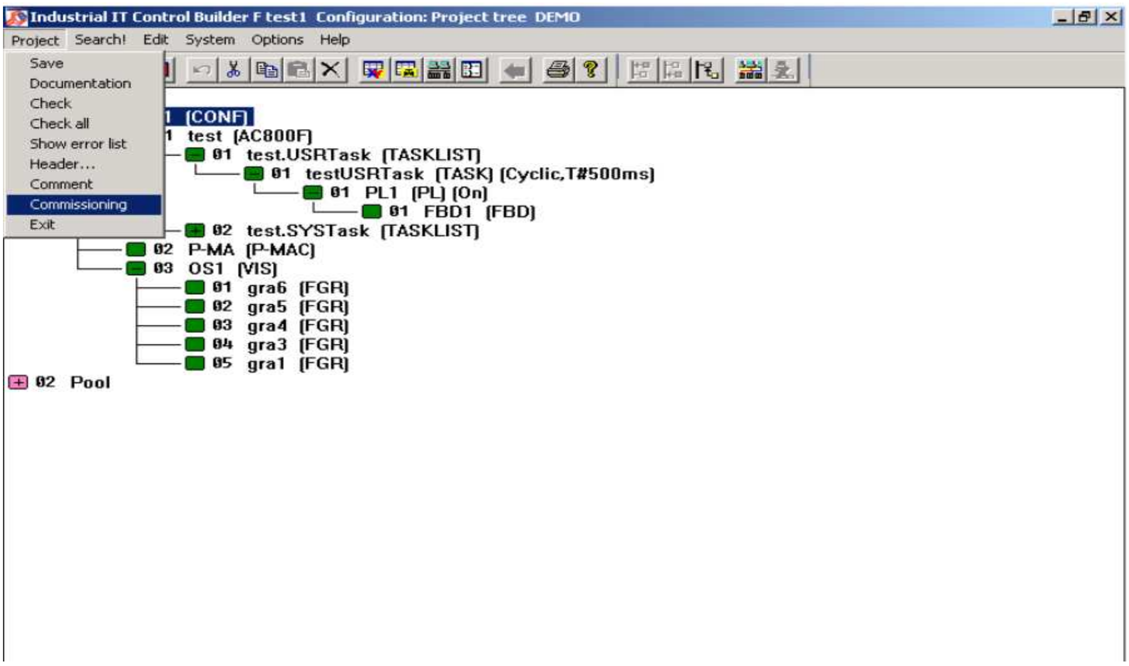


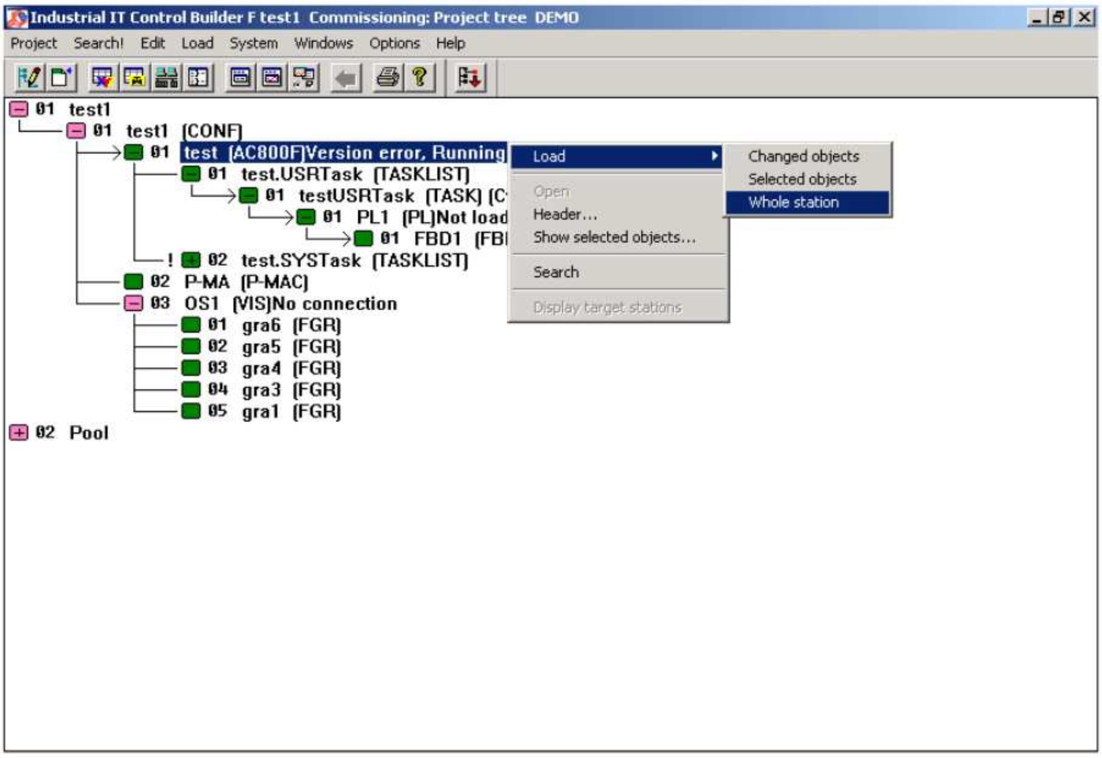


Appendix I: Network Configuration

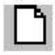
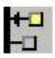
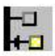


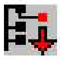
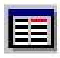
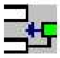
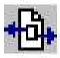
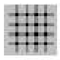
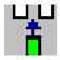
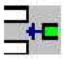
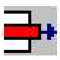
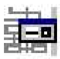
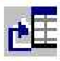
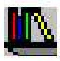
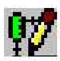
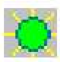
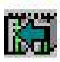
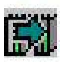
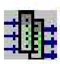
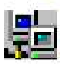
Appendix J: Commissioning



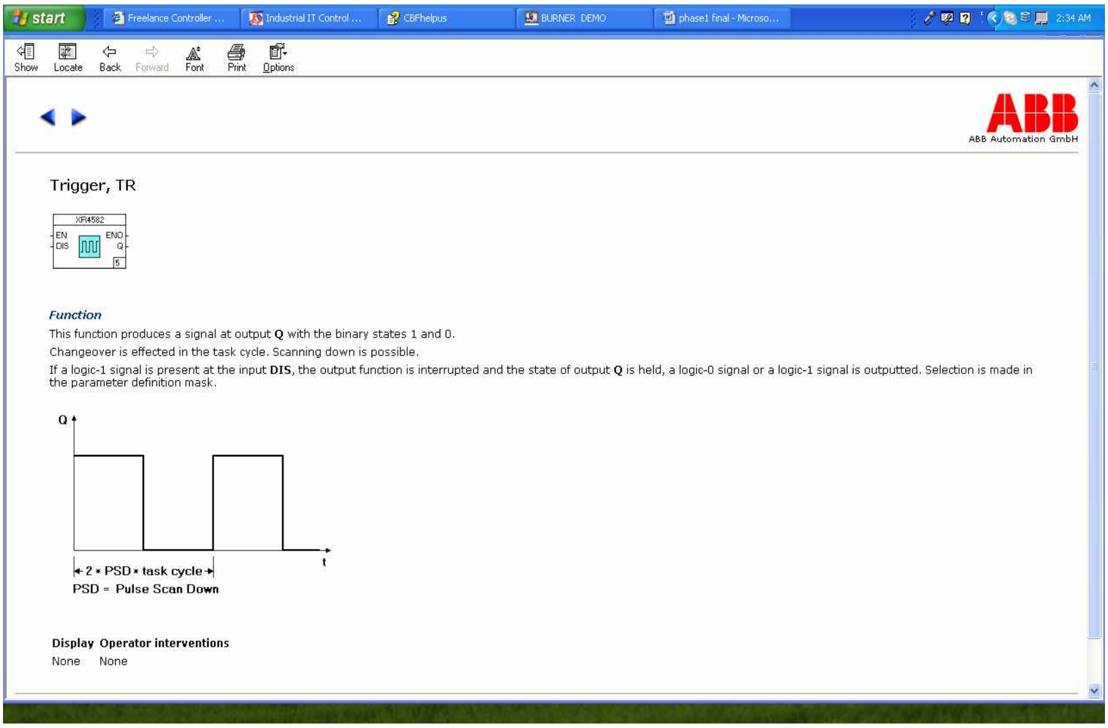

Industrial IT Control Builder F test1 Commissioning: Project tree DEMO
Project
Search!
Edit
Load
System
Windows
Options
Help
01 test1
01 test1 [CONF]
01 test [AC800F]Version error, Running
01 test.USRTask [TASKLIST]
01 testUSRTask [TASK] [C
01 PL1 [PL]Not load
01 FBD1 [FB
02 test.SYSTask [TASKLIST]
02 P-MA [P-MAC]
03 OS1 [VIS]No connection
01 gra6 [FGR]
02 gra5 [FGR]
03 gra4 [FGR]
04 gra3 [FGR]
05 gra1 [FGR]
02 Pool
Load
Open
Header...
Show selected objects...
Search
Display target stations
Changed objects
Selected objects
Whole station

Appendix K: Toolbar-Buttons

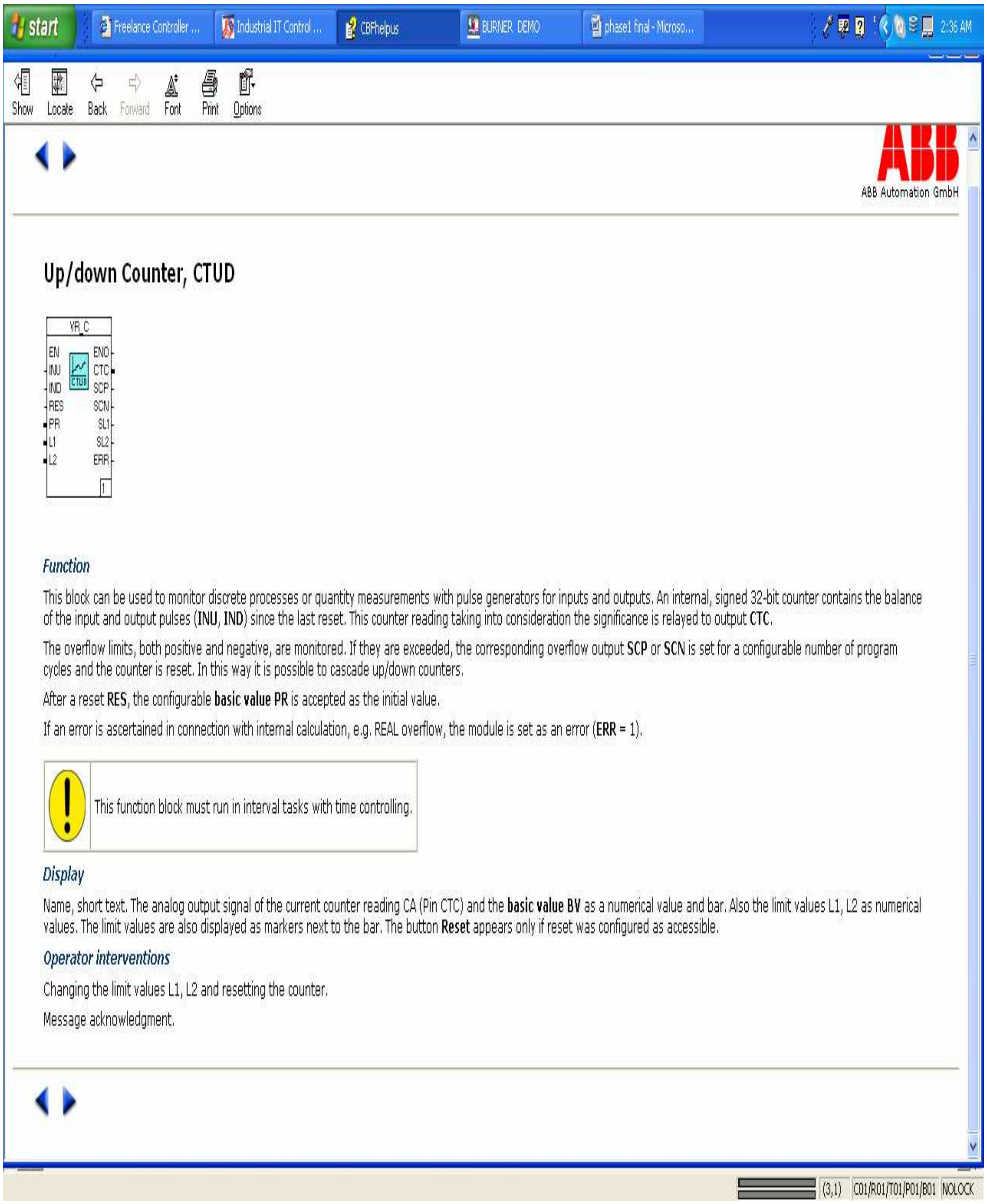
	Change to configuration mode
	Change to commissioning mode
	Check selected object with all accompanying sub objects
	List all check messages of selected object and the accompanying sub objects
	Save project or project part currently working on
	Create a new project
	Open existing project
	Import a project file
	Export of the current project
	Call online help system
	Edit the general data (header data) of the selected object
	Call up the variable list
	Call up the tag list
	Call up the hardware structure
	Call up the structured data types
	Back to the program from which the current program has been called
	Hardcopy the monitor content
	Show value window
	Show trend window
	Define content for value and/or trend window
	Insert a new object above the selected object
	Insert a new object below the selected object
	Insert a new object in next hierarchical level
	Close all communication links

	Load changed objects into selected station
	Call up dialog editor
	Insert following line
	Show all cross references of selected variable or tag
	Show interface declaration of current user defined function block
	Show parameter mask of the accompanying task
	Toggle display of drawing grid
	Insert a column into a SFC program
	Insert a row into a SFC program
	Delete a column of a SFC program
	Delete a row of a SFC program
	Call up the operation dialog of on SFC program
	Select all graphic objects of a graphic display
	Return to the parameter mask of the graphic object
	Change between graphic display and graphic pool
	Call up the library functions for graphic macros
	Edit a graphic macro
	Activate or deactivate a station or a module
	Show previous hardware object
	Show next hardware object
	Call up the I/O editor
	Call up network editor

Appendix K : Trigger



Appendix L : Up /down



Up/down Counter, CTUD

Function

This block can be used to monitor discrete processes or quantity measurements with pulse generators for inputs and outputs. An internal, signed 32-bit counter contains the balance of the input and output pulses (**INU**, **IND**) since the last reset. This counter reading taking into consideration the significance is relayed to output **CTC**.

The overflow limits, both positive and negative, are monitored. If they are exceeded, the corresponding overflow output **SCP** or **SCN** is set for a configurable number of program cycles and the counter is reset. In this way it is possible to cascade up/down counters.

After a reset **RES**, the configurable **basic value PR** is accepted as the initial value.

If an error is ascertained in connection with internal calculation, e.g. REAL overflow, the module is set as an error (**ERR** = 1).

This function block must run in interval tasks with time controlling.

Display

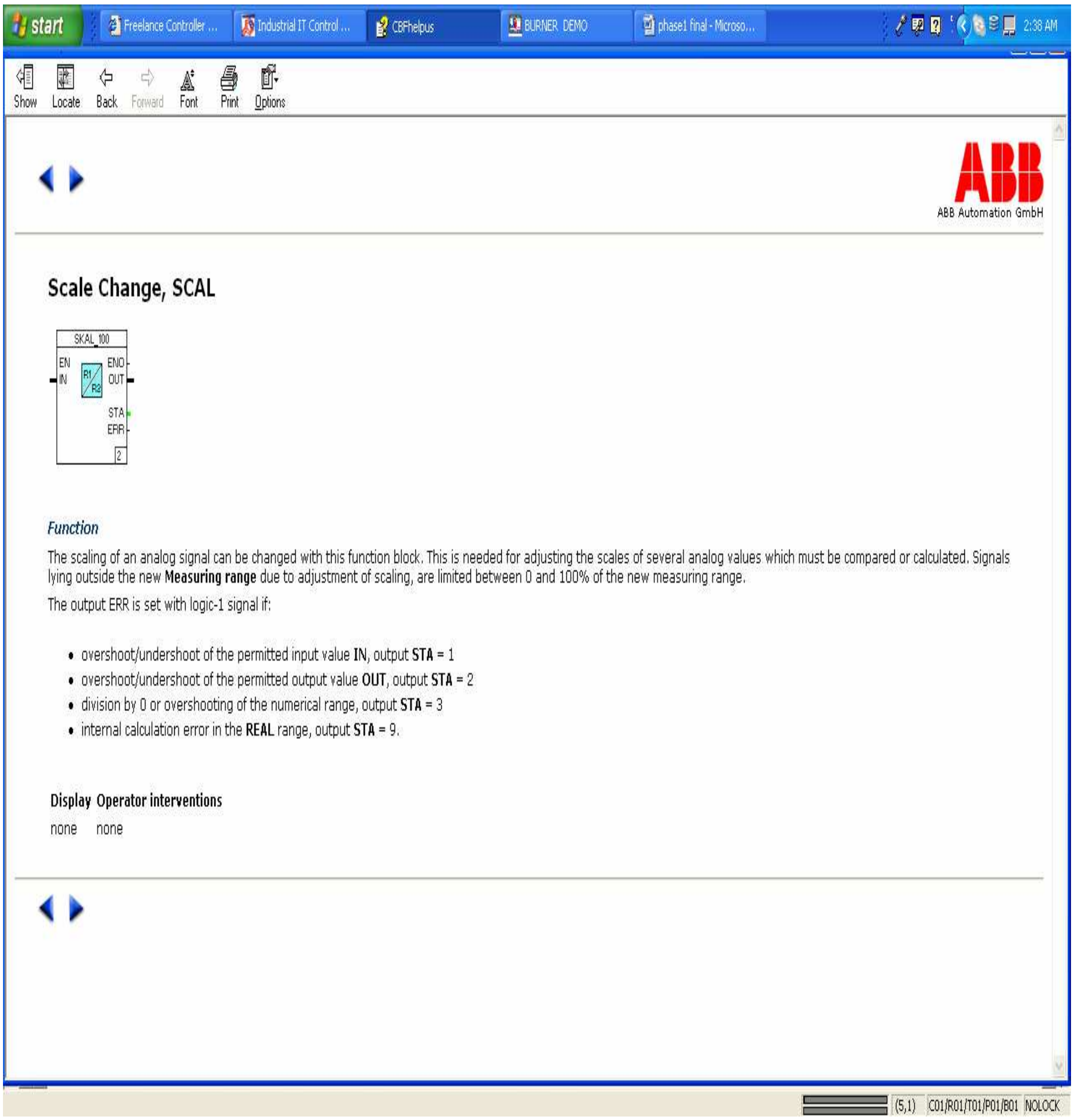
Name, short text. The analog output signal of the current counter reading CA (Pin CTC) and the **basic value BV** as a numerical value and bar. Also the limit values L1, L2 as numerical values. The limit values are also displayed as markers next to the bar. The button **Reset** appears only if reset was configured as accessible.

Operator interventions

Changing the limit values L1, L2 and resetting the counter.

Message acknowledgment.

Appendix M : Scale Change



Scale Change, SCAL

Function

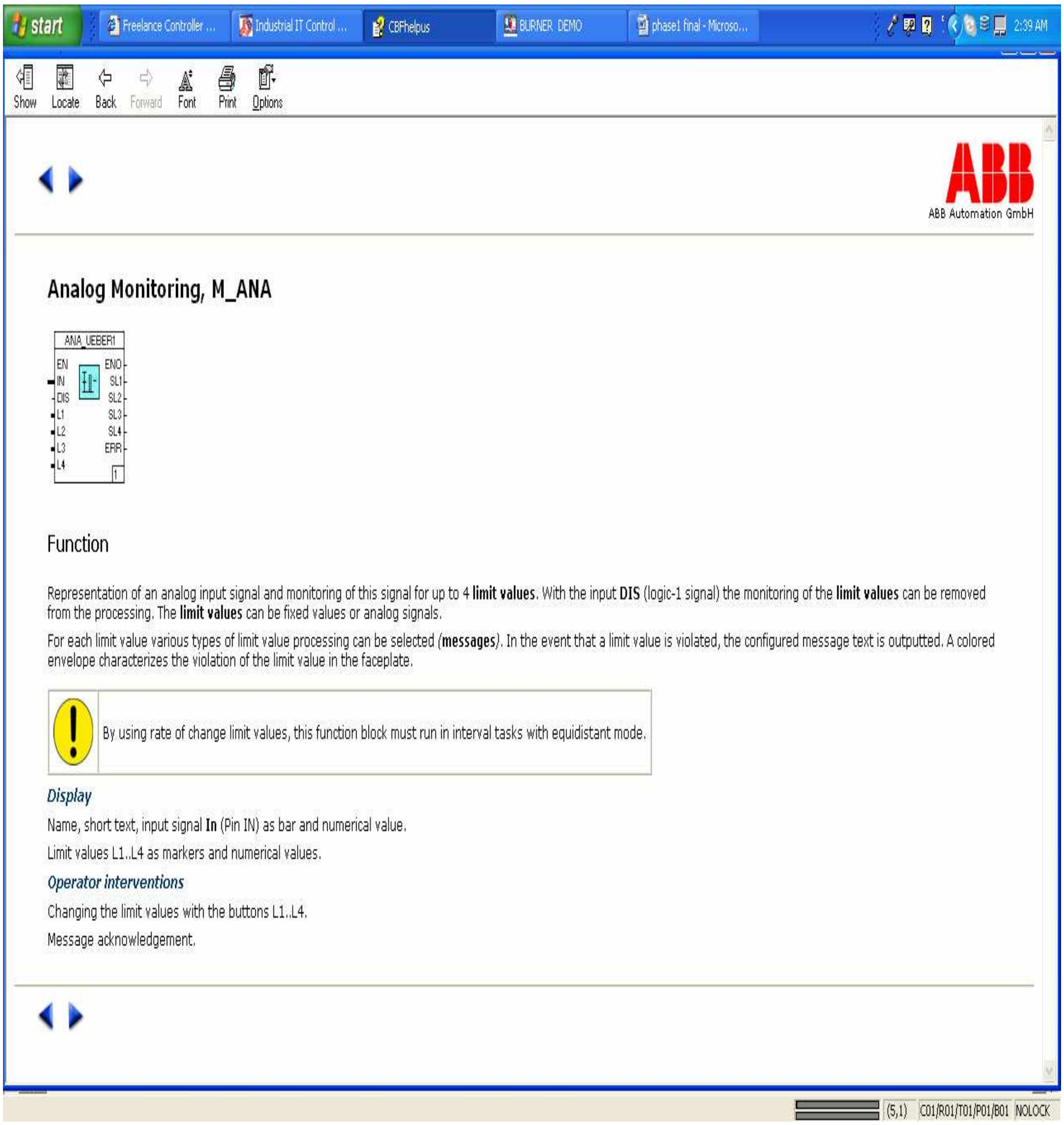
The scaling of an analog signal can be changed with this function block. This is needed for adjusting the scales of several analog values which must be compared or calculated. Signals lying outside the new **Measuring range** due to adjustment of scaling, are limited between 0 and 100% of the new measuring range.

The output ERR is set with logic-1 signal if:

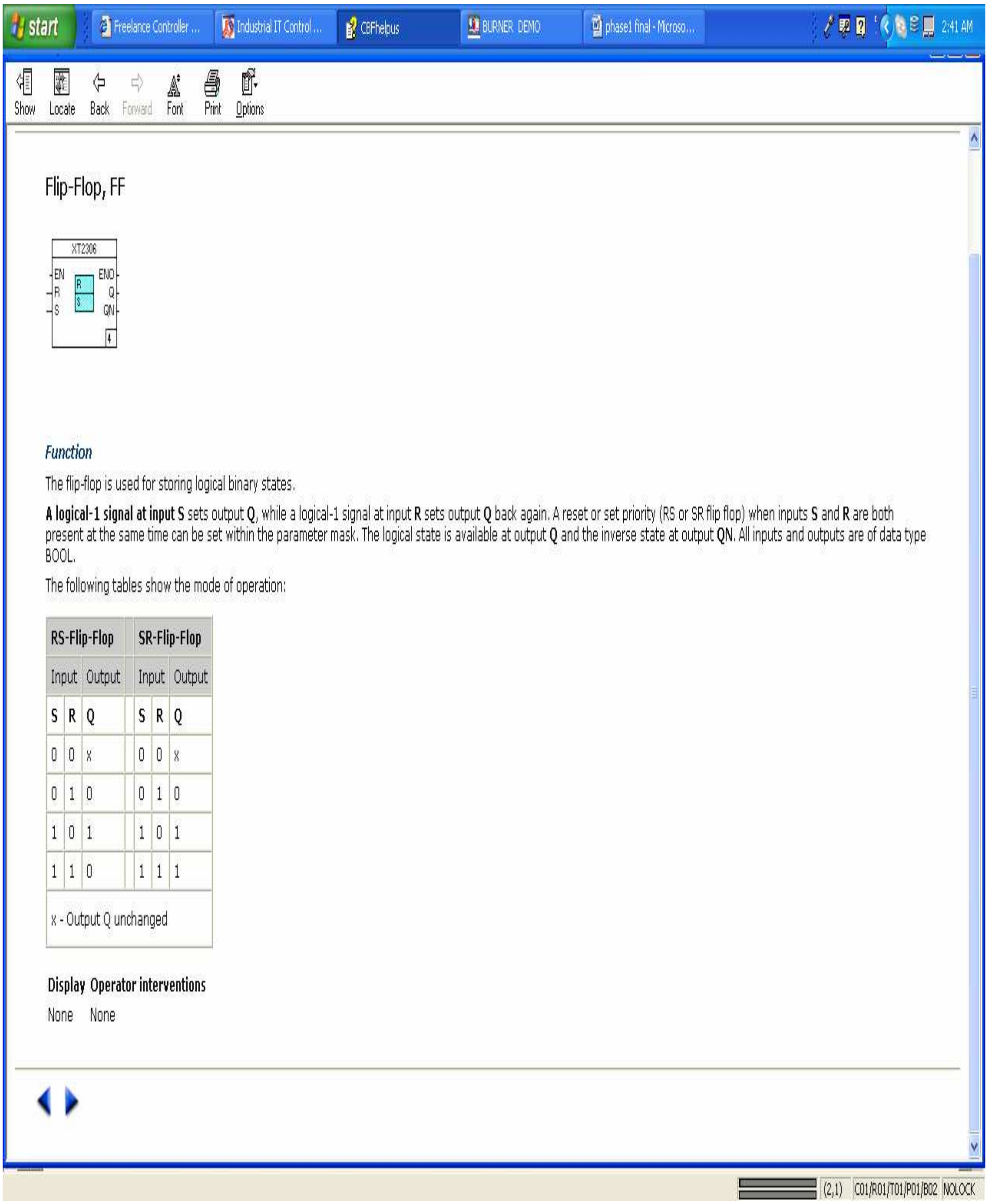
- overshoot/undershoot of the permitted input value **IN**, output **STA** = 1
- overshoot/undershoot of the permitted output value **OUT**, output **STA** = 2
- division by 0 or overshooting of the numerical range, output **STA** = 3
- internal calculation error in the **REAL** range, output **STA** = 9.

Display	**Operator interventions**
none	none

Appendix N: Analog Monitoring



Appendix O :Flip flop



Flip-Flop, FF

XT2306

EN R S END Q QN

Function

The flip-flop is used for storing logical binary states.

A logical-1 signal at input S sets output **Q**, while a logical-1 signal at input **R** sets output **Q** back again. A reset or set priority (RS or SR flip flop) when inputs **S** and **R** are both present at the same time can be set within the parameter mask. The logical state is available at output **Q** and the inverse state at output **QN**. All inputs and outputs are of data type BOOL.

The following tables show the mode of operation:

RS-Flip-Flop			SR-Flip-Flop		
Input		Output	Input		Output
S	R	Q	S	R	Q
0	0	x	0	0	x
0	1	0	0	1	0
1	0	1	1	0	1
1	1	0	1	1	1
x - Output Q unchanged					

Display	Operator interventions
None	None

Appendix P : Bi -driectiolnal Units

Individual Drive Function for Bi-directional Units, IDF_2

Function

The dual-channel individual drive function relays control commands to technical control equipment (e.g. electric motor with two directions of rotation; valve with stop position) in the process. The field device connected can be configured.

The function has two separate inputs (**IN0, IN1**) and outputs (**OU0, OU1**) for the command outputs 0 and 1.

If both inputs are deleted or are on logic-1 signal, this will be considered a stop command. The control commands can come from a higher-ranking control (**automatic** operating mode) or can take place manually (**manual** operating mode).

The operating mode inputs **MM** and **MA** have priority over operating mode selection, i.e. the selection of the **manual/automatic** operating modes is enabled only if both inputs are on logic-0 signal.

If both inputs are on logic-1 signal, the **manual** operating mode has priority over **automatic**.

The output of control commands can be made dependent on **safety**, **inhibit**, **local intervention** and **fault signals**.

After the control command has changed, the time is monitored as **run time** until feedback occurs (end position reached). The feedback can be **external** (feedback variable available) or **internal**.

If the **run time** is exceeded, an error message appears.

Arrival at the end positions of the two outputs is signaled to inputs **FB0** and **FB1**. A dead time can be configured for the feedback inputs FB0 and FB1 (default = 0 ms). This can prevent an end-position being triggered by delayed feedback in the event of a STOP near the end position. The dead time is included in the configured run time.

If the valve is configured, each time the end position is exited without a control command this is reported as an error.

With an electric motor configured, the stop command sent when the end position is reached is evaluated as a STOP control command, and run-time monitoring is activated. Within the runtime the feedback inputs must receive the STOP feedback to avoid a runtime error. If the STOP end position is left while in an end-position-reached state, this is reported as an end-position error.

If both feedback inputs are received, then the end-position states are portrayed as active and an end-position error reported.

End-position monitoring is carried out irrespective of whether or not runtime monitoring is activated. If a local signal **LOC** is present, this ignores any end-position errors that there may be and resets them.

Run time and end position monitoring only take place if feedback inputs are connected.

Inhibition inputs

Appendix Q : Timer switch –on delay