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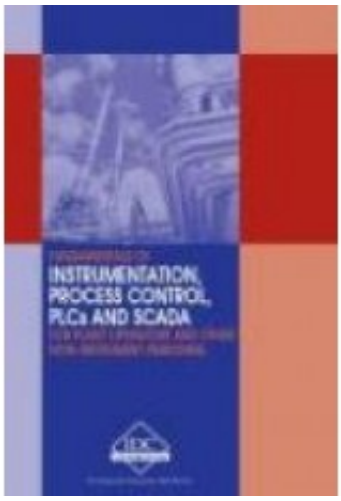
SQ-E - Fundamentals of Instrumentation, Process Control, PLCs and SCADA for Plant Operators and Other Non-Instrument Personnel



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Short Description

This manual covers an introduction to instrumentation and measurement ranging from pressure, level, temperature and flow devices followed by a review of process control including the all important topic of PID loop tuning. This manual also includes an explanation of PLC and SCADA systems and an examination of industrial data communication networks – again from a very simple understandable point of view. Finally, the manual is rounded off with a hands-on review of reading and interpreting simple plant documentation such as P&IDs so that you can see and understand the operation of the plant through the documentation.

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review of reading and interpreting simple plant documentation such as P&IDs so that you can see and understand the operation of the plant through the documentation.

Overall, this book will give you a strong understanding of the key concepts in instrumentation, process control, SCADA and PLCs.

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Instrumentation, Process Control, PLCs and SCADA - First Chapter

Introduction

In this chapter we will discuss about the instrumentation and control system, the key building blocks of PLCs and SCADA systems and about the outline of the IDC Technologies course that this technical manual is used in.

Learning objectives

- Overview of instrumentation and control
- Key building blocks of PLCs and SCADA systems
- Outline of the course

1.1 Overview of instrumentation and control

In an instrumentation and control system, data is acquired by measuring instruments and transmitted to a controller, typically a computer. The controller then transmits data (control signals) to control devices, which act upon a given process.

The integration of systems with each other enables data to be transferred quickly and effectively between different systems in a plant along a data communications link. This eliminates the need for expensive and unwieldy wiring looms and termination points.

Productivity and quality are the principal objectives in the good management of any production activity. Management can be substantially improved by the availability of accurate and timely data. From this, we can surmise that a good instrumentation and control system can facilitate both quality and productivity.

The main purpose of an instrumentation and control system, in an industrial environment, is to provide the following:

- Control of the processes and alarms
- Control of sequencing, interlocking and alarms
- An operator interface for display and control
- Management information
- Distributed Control Systems (DCSs)
- Programmable Logic Controllers (PLCs)
- Supervisory Control and Data Acquisition (SCADA) system
- Smart instrumentation systems

1.2 Key building blocks of PLC and SCADA systems

1.2.1 PLC Systems

In the past, processes were controlled manually, which was a very tedious job. During the early years of control, hard-wired relays were used to control the same process. However, relays could not meet all the needs of modern times, and a faster solution was required. Simply, when a change of control logic was required, the entire hardware wiring needed to be changed. This was time-consuming as well as tiresome. Then, PLCs were developed to automate this process, hence the origin of the so-called “ladder diagram” programming.

Since the late 1970s, PLCs have replaced hard-wired relays with a combination of ladder logic software and solid state electronic input and output modules. They are often used in place of RTUs as they offer a standard hardware solution, which is very economically priced.

The PLCs have become important building blocks for automated systems. Because they have constantly increased in capability while decreasing in cost, PLCs have solidified their position as the device of choice for a wide variety of control tasks.

In brief terms, a PLC is a digital electronic device that contains a programmable

(changeable) memory in which a sequence of instructions is stored. Those instructions enable the PLC to perform various useful control functions such as relay logic, counting, timing, sequencing, and arithmetic computation. These functions are usually used to monitor and control individual machines or complex processes via inputs and outputs (I/Os). Input/output modules connected to the PLC provide analogue or digital electronic interfaces to the external world. The PLC reads inputs, processes them through a program, and generates outputs.

1.2.2 SCADA system

A Supervisory Control and Data Acquisition (SCADA) system means a system consisting of a number of Remote Terminal Units (RTUs) collecting field data connected back to a master station via a communications system.

In the first generation of telemetry systems, the objective was to simply have an idea of the system operation. Telemetry is all about remote monitoring. The basic approach was to gather data (generally restricted to measurements of the same type), and relay those results to another location.

These early systems were followed by data acquisition systems, which also captured and stored data. Finally, the control aspect was added as well. It needs to be emphasized that applications of SCADA cover all types of services, not just electrical systems.

SCADA found its first application in the power generation and transmission sectors of the electric utility industry. The interconnection of large power grids in the Midwestern and the Southern U.S. (1962) created the largest synchronized system in the world. The blackout of 1965 prompted the U.S. Federal Power Commission to urge closer coordination between regional coordination groups (Electric Power Reliability Act of 1967), and led to the consequent formation of the National Electric Reliability Council (1970). The importance and urgency of closer coordination was re-emphasized with the northeast blackout of 2003. Transmission SCADA became the base to manage the transmission grid.

In the late 1980s and the early 1990s, when SCADA vendors delivered reasonably priced “small” SCADA systems on low-cost hardware architectures to the small co-ops and municipality utilities, the first real deployments of distribution SCADA systems began. As the market expanded, SCADA vendors who had been providing transmission SCADA began to take notice of the distribution market.

1.3 Outline of the IDC Technologies related course

The title of the IDC Technologies course related to this manual is "Fundamentals of Instrumentation, Process Control, PLC’s and SCADA for Plant Operators and other Non-Instrument Personnel". This course gives a brief introduction to the measurement and instruments used for measurements. Different types of measurements exist and depending on the type of measurement the instruments used will vary. This will be discussed in detail.

Automation of the control system is gaining prominence due to the ease of controlling facilities it provides. Some of such control systems are PLC, SCADA, DCS and others. These control systems and their components are given in this course. The practical exercises are given which makes the candidate understand the systems in a better way.

Anybody with an interest in gaining know-how in the full range of instrumentation, process control, PLCs, SCADA and P&ID documentation. This can range from operators, trades personnel, procurement staff, sales staff, technicians and engineers from other backgrounds/disciplines, such as mechanical, electrical and civil. Even the plant secretary who is keen to have a good understanding of the key concepts would benefit. Managers who are keen to understand the key workings and the future of their plants would also benefit from this course.

The IDC Technologies course and accompanying technical manual mainly cover the following topics:

- Process measurement
- Pressure measurement
- Level measurement
- Temperature measurement
- Flow measurement
- Fundamentals of process loop tuning
- Introduction to control valves
- Different types of control valves
- Fundamentals of PLCs
- Fundamentals of PLC hardware
- Fundamentals of PLC software
- Introduction to SCADA systems
- SCADA systems hardware
- SCADA systems software
- Basics of data communications between PLC and SCADA systems
- Drawing types and standards