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2002-10

PRE-STANDARD

Function blocks (FB) for process control –

Part 1: Overview of system aspects

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INTERNATIONAL
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FUNCTION BLOCKS (FB) FOR PROCESS CONTROL –

Part 1: Overview of system aspects

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC/PAS 61804-1 has been prepared by subcommittee 65C: Digital communications, of IEC technical committee 65: Industrial-process measurement and control.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:
Draft PAS	**Report on voting**
65C/283/PAS	65C/286/RVD

Full information on the voting for the approval of this PAS Pre-Standard can be found in the report on voting indicated in the above table.

IEC 61804 consists of the following parts, under general title ***Function Blocks (FB) for Process Control***

– Part 1: Overview of system aspects
– Part 2: Specification of FB concept and electronic device description language (EDDL)

INTRODUCTION

This PAS pre-standard is an end-user driven specification of the requirements of distributed process control systems based on Function Blocks (FB). This general requirement pre-standard and its associated FB standard (IEC/PAS 61804-2) originate from the power-plant industrial sector. It is validated by applications in oil and gas, petrochemicals, pharmaceuticals and fine chemicals, pulp and paper, food and beverage, waste water treatment plants, steel milling and others. There will be other general requirement standards and associated specifications for other industrial sectors.

Present and future digital process control systems need to fulfil the following requirements:

- increase security and safety;
- reduce time to market;
- be supportable with available tools;
- reduce costs of development and support;
- minimize training costs;
- support integration of distributed control applications
- support integrated methodology for implementation;
- have increased maintainability, modifiability, agility, upgradability, flexibility, ability to validate, accessibility, availability, compatibility of support tools, multi-vendor device/application compatibility, re-usability of knowledge and designs, re-usability of software components;
- be made up of digital devices that are compatible, interworkable, interconnectable interoperable and interchangeable with each other.

Process control systems are required to fulfil these requirements in terms of their architecture and their operation during all the phases of the life cycle. The accepted basic concept for the design process control system is to describe all necessary implementation-specific functions with FB. A FB is an encapsulation of data and algorithms to provide a specific function, which can be self-standing. Process control systems can involve many instances of many different FBs operating in an environment providing common services (for example communications) and interfaces to other applications. See Figure 1.

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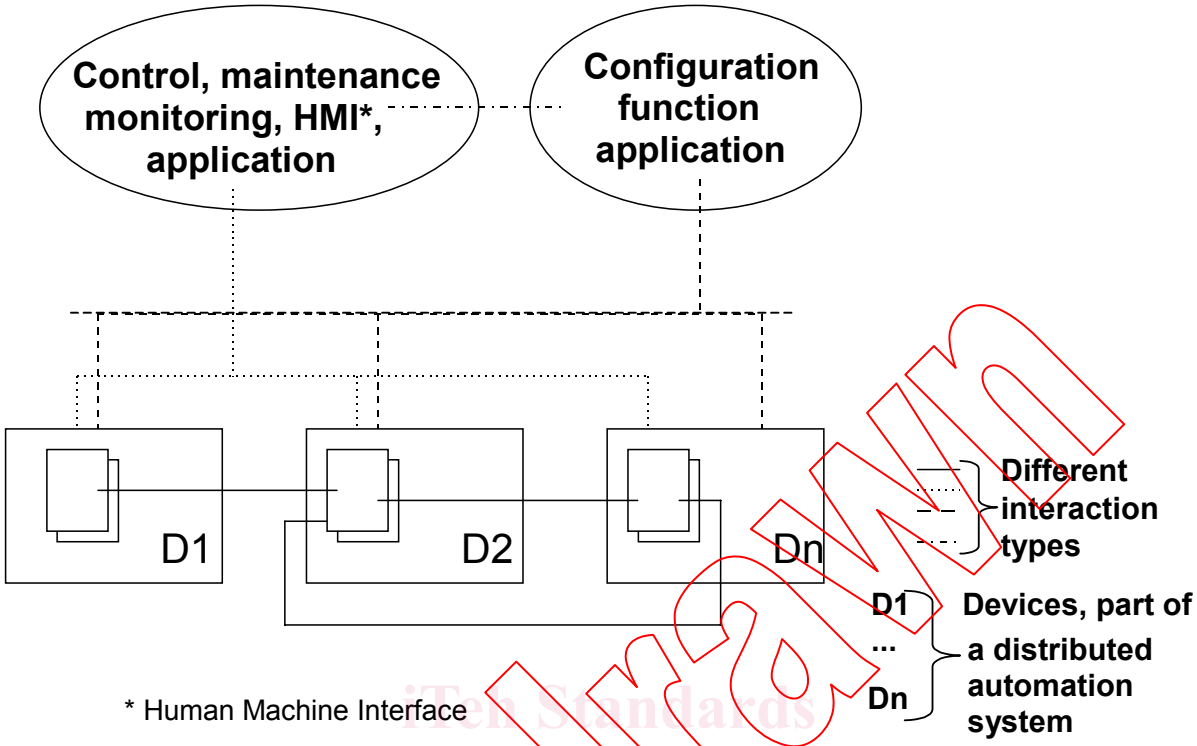

Figure 1– Interactions of applications

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FUNCTION BLOCKS (FB) FOR PROCESS CONTROL –

Part 1: Overview of system aspects

1 Scope

This part of IEC 61804 provides a specification for suppliers to meet evolving requirements for digital process control systems by having a common standard through which users can be assured of compatibility, interworkability, interconnectability, interoperability and interchangeability of the devices they choose. This part gives the overall requirements. For better understanding, this part gives background information and examples in annexes.

This document defines the requirements for FBs to provide control, and to facilitate maintenance and technical management as applications, which interact with actuators and measurement devices:

- control covers functions necessary to bring and hold the process at the desired behaviour;
- maintenance covers functions to acquire information about the state of the process equipment and the state of automation devices including their adjustments for example calibrate a sensor that has drifted;
- technical management deals with information for the optimization of the process.

A prerequisite for designing, implementing and operating a FB-based process control system is that the tools, the devices and other components follow the same architecture based on a common specification. The architecture is required to define the components of the systems, for example FB, device, data, data connections and more as well as relations between these components. The IEC 61499 series generic FB model on which this general requirement pre-standard is related is able to provide these basic components for FBs for process control. One add-on to the IEC 61499 series is the specification of parameters and functions of FBs that are implementable in devices.

The architecture and the range of FBs that have to be specified are described in clause 6. Subclause 6.4 contains a minimum set of FBs that will be required for the process industries. These are presented in 2 different clauses. One deals with “rich” FBs covering complex but common functions such as control loop (for example proportional, integral, differential - PID) required by the majority of the process industries. Another covers a set of elementary FBs (EFB) such as Boolean functions required to compose very specific and unique functionality.

FBs are used during the complete life cycle of process control systems but viewed from different aspects. This is covered in detail in annex A. The process design starts with the Piping & Instrumentation Diagram (P&ID), which gives the requirements of the process and instrumentation from a purely functional point of view. From the P&ID, the desired behaviour of the process control system is extracted into a functional requirements diagram (FRD) without considering the detailed behaviour of the underlying devices. The bricks making up the FRD are application blocks (AB), the representation of the data and algorithms in the design phase. After discussion between the process and automation engineers (end-user and system integrator), the FRDs are turned into detailed designs for the application via several design using devices available on the market together with interconnections and configurations of these devices. In this way a PID loop shown in via bubbles on a P&ID will be transformed into implementable FBs in specific field and/or control-room devices. It should be noted that many parts of the process industries, in particular those with many similar and relatively simple processes (for example the water industry), do not use the concept or term FRD. They go directly from P&IDs to the implementable FBs and will use a variety of names to describe the process and the resulting design documents. The FRD approach is used here

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since it represents the most formal view of the design cycle and illustrates the use of FBs at the earliest of phases in the life cycle. Clause 4 summarizes the requirements from this life cycle point of view.

This document specifies a system (an industrial process measurement and control system based on distributed FB application). A system is described step-vice in terms of architecture, models and the life cycle. The architecture is the "road map" which names the components and presents the structure of the system. The models describe the details of the components, i.e. their functions in the system. The life cycle makes visible how the components work together during their use in different phases of the lifetime, i.e. it makes the operation visible.

Figure 2 shows the different influences, basic specifications and technology support on IEC 61804 from the top-down and bottom-up point of view.

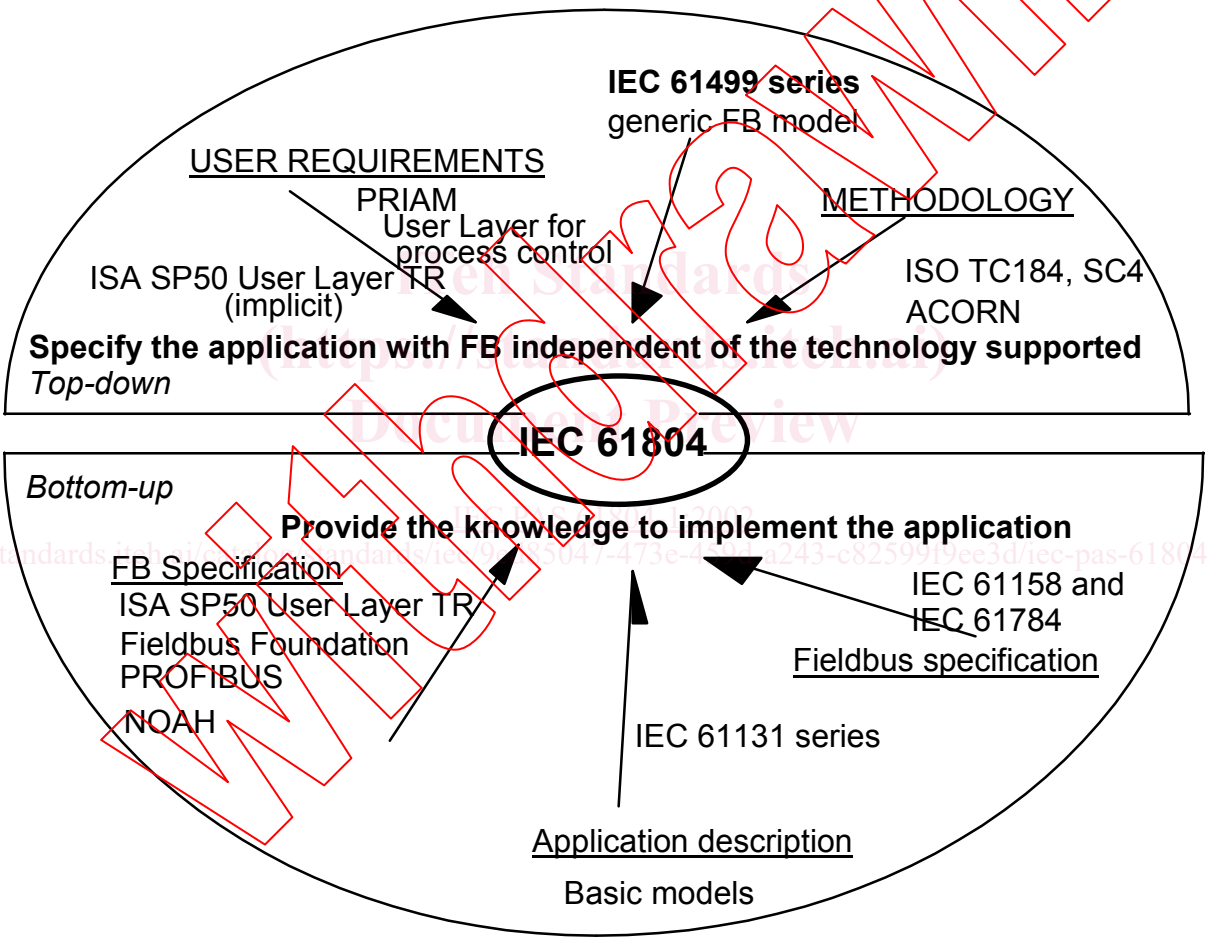

Figure 2 – Influences on IEC 61804

The influences are international standards and projects, which relate to the same area as IEC 61804. These standards are either technology-independent ones supporting the top-down approach or dedicated to a certain technology, for example programmable controller or fieldbus. Both together will build the basis of the standard specified by IEC 61804.

The main purpose of this document is the harmonization of different views, models and starting points of end-users, system providers and device manufacturers. It will be the reference document leading the discussions during the specification and the guideline for the readers of IEC 61804-2.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-351:1998, *International Electrotechnical Vocabulary (IEV) – Part 351: Automation control. Terms and definition*

IEC 61131-3:1992, *Programmable controllers – Part 3: Programming languages*

IEC/PAS 61499-1:2000, *FBs for industrial-process measurement and control systems – Part 1: Architecture*

IEC 61512-1:1997, *Batch control – Part 1:Model and terminology*

IEC 61784:2001, *Digital data communication for measurement and control – Fieldbus for use in industrial control systems – Profile sets for continuos and discrete manufacturing*

ISO/IEC 7498-1:1994, *Information technology – Open System Interconnection – Basic Reference – Basic Model*

ISO/IEC/TR 10000-1:1998, *Information technology – Framework and taxonomy of International Standardized Profiles – Part 1: General principles and documentation framework*

EN 50170 series:1995, *General Purpose Fieldbus Communication System*

3 Terms and definitions

3.1 Definitions

For the purpose of this part of IEC 61804, the following definitions apply.

3.1.1 Interface

A shared boundary between two *functional units,* defined by functional characteristics, signal characteristics, or other characteristics as appropriate.

[60050-351:1998, 11-19]

3.1.2 System

A set of interrelated elements considered in a defined context as a whole and separated from its environment.

[IEC 60050-351:1998, 11-01]

NOTE 1 Such element may be material objects and concepts as well as the results thereof (for example forms of organization, mathematical methods, and programming languages).

NOTE 2 The system is considered to be separated from the environment and other external systems by an imaginary surface, which can cut the links between them and the considered system.

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3.1.3 Data type

A set of values together with a set of permitted *operations.*

[ISO 2382 series]

3.1.4 Data connection

An association established between *functional units* for the conveyance of *data.*

[IEC/PAS 61499-1:2000, 1.3.2.22]

3.1.5 Data

A representation of facts, concepts or instructions in a formalized manner suitable for communication, interpretation or processing by human beings or by automatic means[ISO modified [1]].

3.1.6 Functional unit

An *entity* of *hardware* or *software,* or both, capable of accomplishing a specified purpose.

[ISO 2382 series]

3.1.7 Hardware

Physical equipment, as opposed to programs, procedures, rules and associated documentation. [ISO/AFNOR Dictionary of Computer Science]

3.1.8 Mapping

A set of values having defined correspondence with the quantities or values of another set.

[ISO 2382 series]

3.1.9 Parameter

A *variable* that is given a constant value for a specified *application* and that may denote the application.

[ISO 2382 series]

3.1.10 Algorithm

A finite set of well-defined rules for the solution of a problem in a finite number of *operations*.

[IEC/PAS 61499-1:2000, 1.3.2.5]

3.1.11 Application

A *software functional unit* that is specific to the solution of a problem in industrial-process measurement and control.

[IEC/PAS 61499-1:2000, 1.3.2.6]

NOTE An application may be distributed among resources, and may communicate with other applications.

3.1.12 Attribute

a property or characteristic of an *entity*, for instance, the version identifier of a *FB type* specification.

[IEC/PAS 61499-1:2000, 1.3.2.7]

NOTE The formal description of Attributes is to specify to get interoperability. IEC 61499-1 do not specify certain Attributes like FB Type-Info. IEC 61499-1 gives the general rules to define the attributes and IEC 61804-2 specifies the attributes for process control like other groups may specify their own. Rules are required able to prevent non-unique attribute names.

3.1.13 Configuration (of a *system* or *device*)

A step in system design: selecting *functional units*, assigning their locations and defining their interconnections.

[IEC/PAS 61499-1:2000, 1.3.2.17]

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3.1.14 Device

An independent physical *entity* capable of performing one or more specified *functions* in a particular context and delimited by its *interfaces*.

[IEC/PAS 61499-1:2000, 1.3.2.26]

3.1.15 Device management application

An *application* whose primary function is the management of a multiple *resources* within a *device.*

[IEC/PAS 61499-1:2000, 1.3.2.27]

3.1.16 Entity

A particular thing, such as a person, place, *process*, object, concept, association, or *event*.

[IEC/PAS 61499-1:2000, 1.3.2.28]

3.1.17 Event

An instantaneous occurrence that is significant to scheduling the *execution* of an *algorithm*.

[IEC/PAS 61499-1:2000, 1.3.2.29]

NOTE The execution of an algorithm may make use of variables associated with an event.

3.1.18 Exception

An event that causes suspension of normal *execution.*

[IEC/PAS 61499-1:2000, 1.3.2.35]

3.1.19 Function

A specific purpose of an *entity* or its characteristic action.

[IEC/PAS 61499-1:2000, 1.3.2.42]

3.1.20 FB (FB instance)

A software functional unit comprising an individual, named copy of a data structure and associated *operations* specified by a corresponding *FB type*.

NOTE Typical operations of a FB include modification of the values of the data in its associated data structure.

[IEC/PAS 61499-1:2000, 1.3.2.43]

3.1.21 FB diagram

A *network* in which the *nodes* are *FB instances*, *variables*, *literals*, and *events*.

NOTE This is not the same as the FB diagram defined in IEC 61131-3.

3.1.22 Implementation

The development phase in which the *hardware* and *software* of a *system* become operational.

[ISO modified[1]]

3.1.23 Input variable

A *variable* whose value is supplied by a *data input*, and which may be used in one or more *operations* of a *FB*.

NOTE An input parameter of a FB, as defined in IEC 61131-3, is an input variable.

[IEC/PAS 61499-1:2000, 1.3.2.48]

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