BS EN 61069-3:2016

BSI Standards Publication

Industrial-process measurement, control and automation — Evaluation of system properties for the purpose of system assessment

Part 3: Assessment of system functionality

bsi.

National foreword

This British Standard is the UK implementation of EN 61069-3:2016. It is identical to IEC 61069-3:2016. It supersedes BS EN 61069-3:1997 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee GEL/65, Measurement and control, to Subcommittee GEL/65/1, System considerations.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Mesure, commande et automation dans les processus industriels - Appréciation des propriétés d'un système en vue de son évaluation - Partie 3: Évaluation de la fonctionnalité d'un système (IEC 61069-3:2016)

Leittechnik für industrielle Prozesse - Ermittlung der Systemeigenschaften zum Zweck der Eignungsbeurteilung eines Systems - Teil 3: Eignungsbeurteilung der Systemfunktionalität (IEC 61069-3:2016)

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European foreword

The text of document 65A/791/FDIS, future edition 2 of IEC 61069-3, prepared by SC 65A “System aspects” of IEC/TC 65 “Industrial-process measurement, control and automation” was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61069-3:2016.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2017-04-28
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2019-10-28

This document supersedes EN 61069-3:1996.

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In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61069-5:2016	NOTE	Harmonized as EN 61069-5:2016 (not modified).
IEC 61131-3	NOTE	Harmonized as EN 61131-3.
IEC 61158 Series	NOTE	Harmonized as EN 61158 Series.
IEC 61297	NOTE	Harmonized as EN 61297.
IEC 61512 Series	NOTE	Harmonized as EN 61512 Series.
IEC 61784 Series	NOTE	Harmonized as EN 61784 Series.
IEC/TS 62603-1:2014	NOTE	Harmonized as CLC/TS 62603-1:2014.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu

Publication	Year	Title	EN/HD	Year
IEC 61069-1	2016	Industrial-process measurement, control and automation - Evaluation of system properties for the purpose of system assessment - Part 1: Terminology and basic concepts	EN 61069-1	2016
IEC 61069-2	2016	Industrial-process measurement, control and automation - Evaluation of system properties for the purpose of system assessment - Part 2: Assessment methodology	EN 61069-2	2016

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION – EVALUATION OF SYSTEM PROPERTIES FOR THE PURPOSE OF SYSTEM ASSESSMENT –

Part 3: Assessment of system functionality

FOREWORD

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International Standard IEC 61069-3 has been prepared by subcommittee 65A: System aspects, of IEC technical committee 65: Industrial-process measurement, control and automation.

This second edition cancels and replaces the first edition published in 1996. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Reorganization of the material of IEC 61069-3:1996 to make the overall set of standards more organized and consistent;
b) IEC TS 62603-1:2014 has been incorporated into this edition.

The text of this standard is based on the following documents:

FDIS	Report on voting
65A/791/FDIS	65A/800/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61069 series, published under the general title *Industrial-process measurement, control and automation – Evaluation of system properties for the purpose of system assessment*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

IEC 61069 deals with the method which should be used to assess system properties of a basic control system (BCS). IEC 61069 consists of the following parts:

Part 1: Terminology and basic concepts

Part 2: Assessment methodology

Part 3: Assessment of system functionality

Part 4: Assessment of system performance

Part 5: Assessment of system dependability

Part 6: Assessment of system operability

Part 7: Assessment of system safety

Part 8: Assessment of other system properties

Assessment of a system is the judgement, based on evidence, of the suitability of the system for a specific mission or class of missions.

To obtain total evidence would require complete evaluation (for example under all influencing factors) of all system properties relevant to the specific mission or class of missions.

Since this is rarely practical, the rationale on which an assessment of a system should be based is:

– the identification of the importance of each of the relevant system properties,
– the planning for evaluation of the relevant system properties with a cost-effective dedication of effort to the various system properties.

In conducting an assessment of a system, it is crucial to bear in mind the need to gain a maximum increase in confidence in the suitability of a system within practical cost and time constraints.

An assessment can only be carried out if a mission has been stated (or given), or if any mission can be hypothesized. In the absence of a mission, no assessment can be made; however, evaluations can still be specified and carried out for use in assessments performed by others. In such cases, IEC 61069 can be used as a guide for planning an evaluation and it provides methods for performing evaluations, since evaluations are an integral part of assessment.

In preparing the assessment, it can be discovered that the definition of the system is too narrow. For example, a facility with two or more revisions of the control systems sharing resources, for example a network, should consider issues of co-existence and inter-operability. In this case, the system to be investigated should not be limited to the “new” BCS; it should include both. That is, it should change the boundaries of the system to include enough of the other system to address these concerns.

The part structure and the relationship among the parts of IEC 61069 are shown in Figure 1.

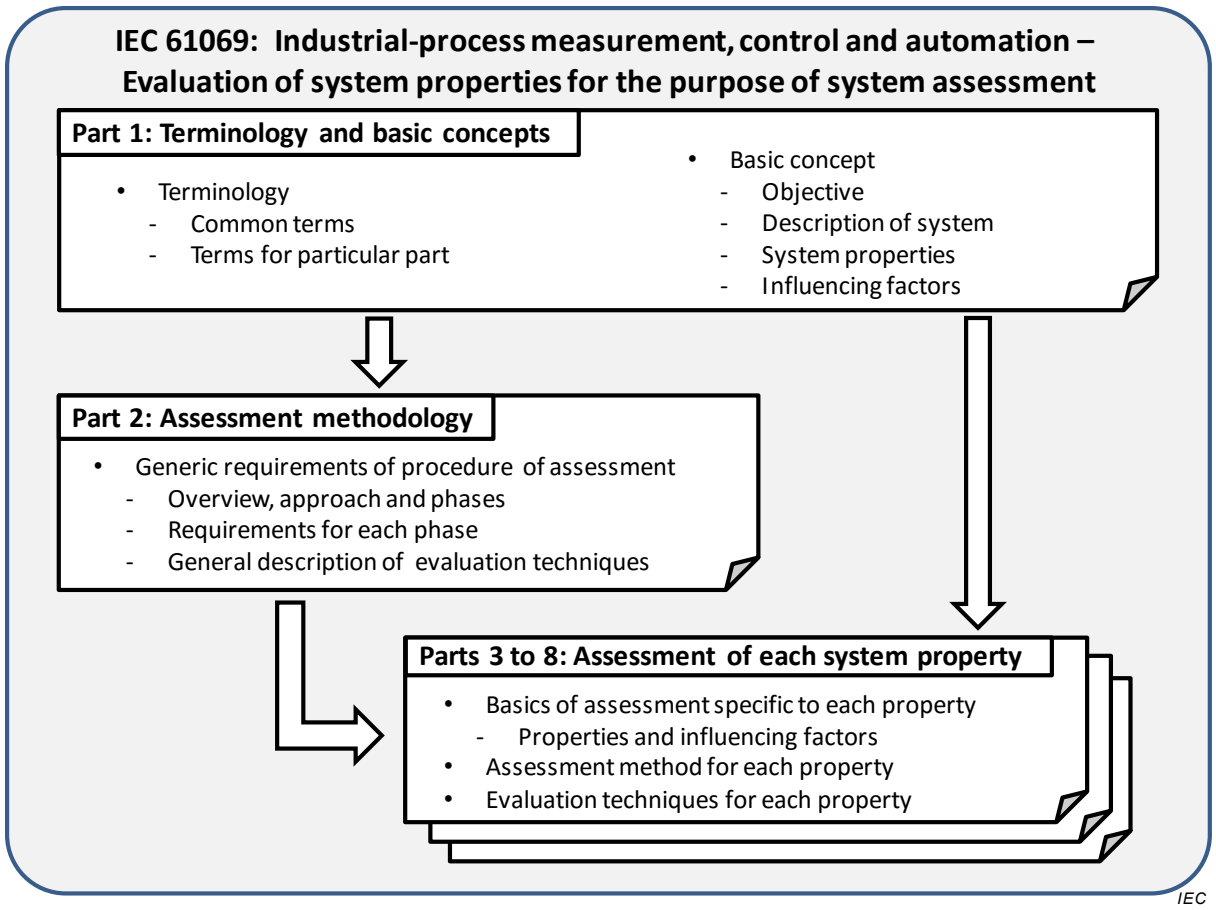

Figure 1 – General layout of IEC 61069

Some example assessment items are integrated in Annex C.

INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION – EVALUATION OF SYSTEM PROPERTIES FOR THE PURPOSE OF SYSTEM ASSESSMENT –

Part 3: Assessment of system functionality

1 Scope

This part of IEC 61069:

– specifies the detailed method of the assessment of functionality of a basic control system (BCS) based on the basic concepts of IEC 61069-1 and methodology of IEC 61069-2,

– defines basic categorization of functionality properties,

– describes the factors that influence functionality and which need to be taken into account when evaluating functionality, and

– provides guidance in selecting techniques from a set of options (with references) for evaluating the functionality.

2 Normative references

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

IEC 61069-1:—[1], *Industrial-process measurement, control and automation – Evaluation of system properties for the purpose of system assessment – Part 1: Terminology and basic concepts*

IEC 61069-2:—[2], *Industrial process measurement, control and automation – Evaluation of system properties for the purpose of system assessment – Part 2: Assessment methodology*

3 Terms, definitions, abbreviated terms, acronyms, conventions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61069- apply.

3.2 Abbreviated terms, acronyms, conventions and symbols

For the purposes of this document, the abbreviated terms, acronyms, conventions and symbols given in IEC 61069-1 apply.

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1 Second edition to be published simultaneously with this part of IEC 61069.

2 Second edition to be published simultaneously with this part of IEC 61069.

4 Basis of assessment specific to functionality

4.1 Functionality properties

4.1.1 General

A system is able to perform the required mission if the functions provided by the system cover the mission. The extent to which this is the case can be expressed as the system property coverage.

For a system designed for a set of rigid and fixed tasks, coverage can describe fully the functionality of a system.

Tasks required, however, can differ for different applications of the system or the mission can change or be extended over time due to changes in the industrial process or arrangements in the control strategy. To cope with this, the system should provide means for configuring the selection and arrangement of modules, and should have a system configuration which provides flexibility for additions and modifications.

To fully assess the functionality of a system, the system properties are categorised in a hierarchical way.

Functionality properties are categorized as shown in Figure 2.

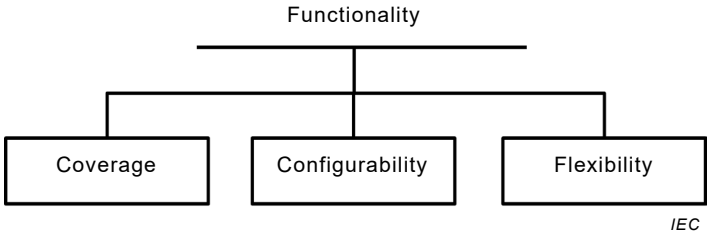

Figure 2 – Functionality

Functionality cannot be assessed directly and cannot be described by a single property. Functionality can only be determined by analysis and testing of each of the functionality properties individually.

Some of the functionality properties can be expressed in quantitative terms as an absolute or relative value; others can only be described in a qualitative way with some quantitative elements.

When assessing the functionality of a system, the availability of facilities necessary for the system to operate should be taken into account.

4.1.2 Coverage

Coverage is determined by:

– the range of distinct functions provided, each differentiated by type, execution frequency, data volume, etc.;

– the variety of ways in which the functions cooperate, as determined by the system configuration, to perform the task(s) required;

– the number of replications available of each function, as determined by the way in which the system modules provide these functions and how these functions are allocated within the modules.

The way in which the individual functions are set up and combined to perform tasks can impose interdependent limits on each function. It can also impose limits on the simultaneous use of separate functions when there is sharing of system resources.

The coverage of the system should be quantified as a coverage factor, which is the ratio of tasks which the system covers against the totality of tasks required by the system mission. If appropriate, partial coverage factors should be expressed for each individual task.

System mission = n Tasks

Coverage factor (CF) = tasks covered / n tasks

4.1.3 Configurability

Configurability is dependent upon the architecture of the system and the ease with which modules can be selected, set up, arranged and combined to assemble function(s) to perform tasks required by the mission of system.

There can be configuration elements at any level of the system. Methods to configure systems are shown in Figure 3. The method can be implemented by hardware or software.

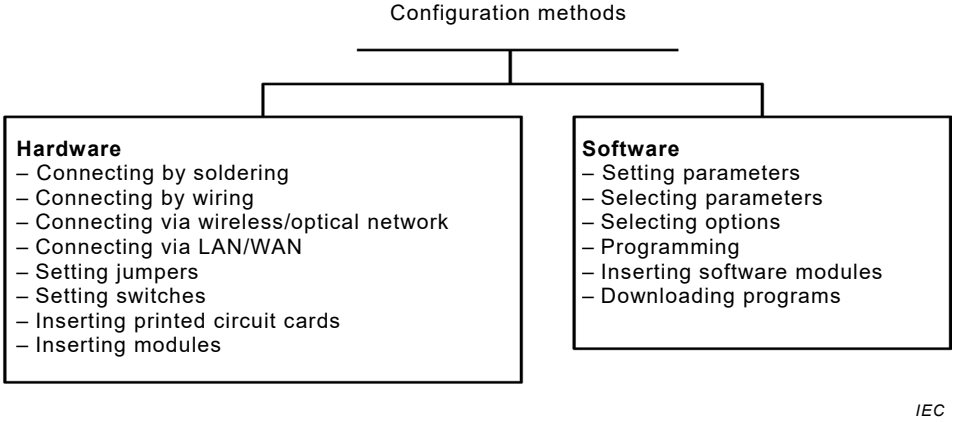

Figure 3 – Configuration methods

It is also important to bear in mind that configuration changes can modify system properties unexpectedly.

The configuration facilities are parts of the system and considered as "supporting functions" if they are fully described in the system specification document.

In practice the activity of configuring a system sometimes requires deep knowledge of system architecture, module behaviour and module interfaces. The need for this knowledge can be reduced by the configuration facilities.

Depending on the mode of operation of the system ("on-line”, “off-line", etc.) some of the configuration actions are permissible or not permissible. Some actions (such as module set-up, changes to module connections, module insertion or removal, etc.) are possible only while the system is disabled from process operation. Configurability cannot be quantified as a number. It can be described in a qualitative manner by detailing configuration actions and tools, and stating for each of these the know-how, skills and time required.

4.1.4 Flexibility

4.1.4.1 General

The flexibility of a system depends on the ways the system can be adapted.

The system has higher flexibility when it has more capability to add, remove, change and/or rearrange modules of the system.

Flexibility cannot be expressed by a single system property.

4.1.4.2 Scalability

A system can be designed in such a way that it is possible to scale the system. For example, a system might be able to increase in size (more I/O points) or in communication capabilities (more network interfaces) or supported operator workstations, or in some other countable/measurable way.

The extent to which the system can be scaled can be assessed by analysis of the system configuration, communication functions and shared resources.

Scalability can be expressed by a qualitative description containing some quantified elements.

4.1.4.3 Variability

A system can be designed in such a way that it is possible to vary the range of executable tasks.

Variability can be assessed by analysis of the system configuration, the degree of modularity, the specification of interfaces between the modules, and the number and scope of functions provided by the individual modules.

Variability can be expressed by a qualitative description containing some quantified elements.

4.1.4.4 Enhanceability

A system can be designed in such a way that it is possible to enhance certain system properties.

Enhanceability can be assessed by analysing the system configuration and the range of available modules with alternative property values.

Some examples of implementation which achieve higher enhanceability are:

– modules with a larger main memory to allow a decrease in response time via reduced data transfers;
– modules which allow an increased number of iterations of mathematical procedures to increase the accuracy of a calculated value;
– use of better protected input or output cards against electrical noise to increase the system's security, or to increase the system's usability in areas where there is explosive atmosphere.

The potential for improvement of these properties can extend beyond the requirements stated in the system requirements document.

Enhanceability can be expressed by a qualitative description containing some quantified elements.

4.2 Factors influencing functionality

The functionality of a system can be affected by the influencing factors listed in IEC 61069-1:–, 5.3.

For each of the system functionality properties listed in 4.1, the primary influencing factors are as follows:

a) Coverage can be affected by:

   No influencing factors.

b) Configurability can be affected by:

   1) licensing of specific functionality;

   2) installation, for example all modules and elements are in place.

c) Operational rules, dictated by the mission, training of personnel, and deficiencies in documentation, manuals and technical support can hamper the full use of the system functionality.

5 Assessment method

5.1 General

The assessment shall follow the method as laid down in IEC 61069-2:—, Clause 5.

5.2 Defining the objective of the assessment

Defining the objective of the assessment shall follow the method as laid down in IEC 61069-2:—, 5.2.

5.3 Design and layout of the assessment

Design and layout of the assessment shall follow the method as laid down in IEC 61069-2:—, 5.3.

Defining the scope of assessment shall follow the method laid down in IEC 61069-2:—, 5.3.1.

Collation of documented information shall be conducted in accordance with IEC 61069-2:—, 5.3.3.

The statements compiled in accordance with IEC 61069-2:—, 5.3.3, should include the following in addition to the items listed in IEC 61069-2:–, 5.3.3:

– No additional items are noted.

Documenting collated information shall follow the method in IEC 62069-2:—, 5.3.4.

Selecting assessment items shall follow IEC 61069-2:—, 5.3.5.

Assessment specification should be developed in accordance with IEC 61069-2: —, 5.3.6.

Comparison of the SRD and the SSD shall follow IEC 61069-2:—, 5.3.

NOTE 1 A check list of SRD for system functionality is provided in Annex A.

NOTE 2 A check list of SSD for system functionality is provided in Annex B.

5.4 Planning of the assessment program

Planning the assessment program shall follow the method as laid down in IEC 62069-2:—, 5.4.

Assessment activities shall be developed in accordance with IEC 61069-2:—, 5.4.2.

The final assessment program should specify points specified in IEC 61069-2:—, 5.4.3.

5.5 Execution of the assessment

The execution of the assessment shall be in accordance with IEC 61069-2:—, 5.5.

5.6 Reporting of the assessment

The reporting of the assessment shall be in accordance with IEC 61069-2:—, 5.6.

The report shall include information specified in IEC 61069-2:—, 5.6. Additionally, the assessment report should address the following points:

– information specified in Clause 6.

6 Evaluation techniques

6.1 General

Within IEC 61069-3 several evaluation techniques are suggested. Other methods may be applied, but in all cases the assessment report should provide references to documents describing the techniques used.

Those evaluation techniques are categorized as described in IEC 61069-2:—, Clause 6.

Factors influencing the functionality properties of the system as per 4.2 shall be taken into account.

The techniques given in 6.2, 6.3 and 6.4 are used to assess the functionality properties.

It is not possible to evaluate the functionality property as one entity. Instead each functionality property should be addressed separately.

Functionality which is built in the system but is not specified in the SRD may be omitted from the evaluation, but such omissions shall be recorded in the report.

NOTE An example of a list of assessment items is provided in Annex C.

6.2 Analytical evaluation techniques

6.2.1 Coverage

Coverage can be evaluated by analytically checking whether the number of modules or elements of the system and their scopes specified in the SSD are able to perform the system functions required for the tasks specified in the SRD.

The following information shall be included in the report:

– the tasks and the supporting functions analysed,

– the functions not provided,

– the deficiencies of function found.

6.2.2 Configurability

Configurability can be evaluated by listing the actions to be taken and the time necessary to set up, change or add a system function to perform a task under defined circumstances, for example:

– know-how and skill of personnel involved;
– the tools used, which are provided by the system or specified in the SSD;
– the system modes of operation ("on-line, "off-line", etc.) for which each configuration action is permissible.

6.2.3 Flexibility

Flexibility can be evaluated by analytically:

– listing the maximum number of functional replicas to which the system can be expanded without hampering the correct performance of the functions necessary to perform tasks for the mission;
– listing the number of different functions to which the system can be extended without hampering the correct performance of the functions necessary to perform tasks for the mission;
– listing alternative modules and elements available to the system to enhance the system with different performance, dependability, operability and system safety characteristics, which can be used without hampering the correct performance of the functions necessary to perform tasks for the mission.

6.3 Empirical evaluation techniques

Empirical evaluation shall also be conducted for coverage, compatibility and flexibility.

Empirical evaluation is conducted to verify the result of the analytical evaluation described in 6.2.

6.4 Additional topics for evaluation techniques

No additional items are noted.

Annex A
(informative)

Checklist and/or example of SRD for system functionality

The matrix in Table A.1 provides guidance on the type of information (task by task and/or information translation) which should be given in the SRD for the purpose of performance assessment.

Particular attention should be given to checking that the required configuration facilities and the future requirements for the system have been stated and appropriately quantified, both in relation to individual tasks as well as in relation to the total system mission.

Table A.1 – SRD checklist

Property	Data, drawings, etc.
Coverage	Present and future required tasks supported by: – process control and measurement diagram; – description of the control and measurement requirements in support of each task; – operational and monitoring requirements of each task; – importance of task for mission. Environment including: – a plot plan showing suggested location of measurement and control points, operator's control desk/panel, etc.; – hazardous area classification drawing; – space, location, physical access, expansion constraints.
Configurability	Level of provision required, for example: – fixed; – configurable within constraints (under lock, etc.); – freely programmable. Operational circumstances under which configuration is allowed and/or required.
Flexibility	Expected future expansion of the mission in terms of: – replication of tasks; – new set of tasks, measurements, outputs, etc.; – additional or extended displays or reports. Gradual or "all at once" project realisation. Expected future change in property requirements: – higher dependability; – higher performance (faster, higher accuracy); – better operability (use of touch screen, etc.); – maximum I/O per controller; – task rate; – scan rate.

Annex B
(informative)

Checklist and/or example of SSD for system functionality

B.1 SSD information

The system specification document should be reviewed to check that the properties given in the SRD are listed as described in IEC 61069-2:–, Annex B.

B.2 Check points for system functionality

Particular attention should be paid to check that information is given on:

a) the modules and elements, both hardware and software, supporting each function;
b) quantitative and/or qualitative data on the properties of these modules and elements, and the availability of modules and elements with alternative properties;
c) details of configuration tools, their use and constraints on the system operation;
d) facilities provided by the system which, in the assembled operational system, support analysis of functionality properties. Examples of these facilities are utilities for:
    1) listing all loaded programs, the supporting modules and elements;
    2) calculation of the spare capacity on memories devices, etc.;
    3) statistical analysis of system resource utilisation, etc.;
    4) listing any side-effects on any of the other system properties, which can occur due to changes to the system.

Annex C
(informative)

Example of a list of assessment items (information from IEC TS 62603-1)

C.1 Overview

Annex C provides some examples about assessment items related to this part of IEC 61069 which were extracted from IEC TS 62603-1.

The classifications of the values of properties described in this document are only examples.

C.2 System characteristics

C.2.1 Overview

Clause C.2 of the standard defines the main characteristics that influence the BCS structure and capability in general terms, with a special focus on its integration and scalability.

C.2.2 System scalability

Scalability is the ability of a system and/or an application to grow incrementally larger without total replacement of hardware or software, and without the need to re-engineer the entire architecture of the system.

C.2.3 System expandability

The system expandability is the possibility of the system to be enlarged without changing the architecture and/or the used equipment. The expandability can be both for the entire system and for each apparatus.

The system expandability means that it is possible to add usable components to the system.

For a component, i.e. a programmable logic controller, expandability means that it is possible to add usable spare parts to the components (i.e. free memory or Central Processing Unit (CPU) in a Programmable Logic Controller (PLC)).

C.2.4 Integration of subsystems

The integration of subsystems needs a procedure for combining separately developed modules of components so that they work together as a unique system. A subsystem is a set of components that operates as a part of a system and that is capable of performing a specific task within a system.

Another option is that a subsystem has been provided by other suppliers and manufactures (i.e. third party subsystem).

C.2.5 Automatic documentation

The BCS automatically generates the documentation after the configuration phase. Documents can include:

– system architecture,
– configuration parameters,

– list of material,
– application software,
– wiring table for terminations,
– cables and plugs configuration,
– others.

C.2.6 Programming languages for control

C.2.6.1 General

The control part of the system should support specific programming languages for implementing the control logic. According to the type of functions required for the BCS, a different standard programming language can be used.

Programmable (logic) controller (PLC) is a digitally operating electronic system, designed for use in an industrial environment, that uses a programmable memory for the internal storage of user-oriented instructions for implementing specific functions such as logic, sequencing, timing, counting and arithmetic. A PLC can control, through digital or analog inputs and outputs, counter inputs and pulse outputs, various types of machines or processes. In large scale BCS, the term controller is often used with the same meaning. Both the PLC and its associated peripherals are designed so that they can be easily integrated into an industrial control system and easily used in all their intended functions.

The term PLC-system means a user-built configuration, consisting of a programmable controller and associated peripherals, that is necessary for the intended automated system. It consists of units interconnected by cables or plug-in connections for permanent installation and by cables or other means for portable and transportable peripherals.

C.2.6.2 Programming languages for programmable controllers

IEC 61131-3 defines a set of languages for programming PLCs and controllers. The standard programming languages are divided into two categories:

a) graphical languages:
   1) Ladder: (LL) it is a symbolic representation that schematically illustrates the control functions in the form of electrical circuit diagrams;
   2) Function Block Diagram (FBD): it allows program elements (i.e. PID and other algorithms) to appear as blocks that are connected together as shown in a visual presentation similar to a logic diagram;
b) textual languages:
   1) Instruction List (IL): it is a low level language similar to an assembler in which only one elementary operation, such as storing a value in a register, is allowed per line;
   2) Structured Text (ST): it is a high-level, block-structure language, whose syntax resembles Pascal. ST allows to express complex statements involving variables that represent a wide range of different types of data.

C.2.6.3 Sequential Function Chart (SFC) programming tool

In addition to the programming languages defined in IEC 61131-3, the SFC programming tool allows a graphical representation and structuring of the control software. SFC is a way of graphically representing a complex control program as a sequence of alternating steps and transitions.

C.2.6.4 Continuous Function Chart (CFC) programming tool

Continuous Function Chart (CFC) allows the straightforward conversion of technological specifications into executable automation programs: it works using function blocks that are linked together and configured individually.

The CFC can be intended as a special form of FBD. The main difference between CFC and FBD is that it also shows the resources and task assignments. Each function block shows the name of the task that controls its execution.

The CFC is mainly used to show the top-level structure of the resources and programs.

C.2.6.5 Definition of custom function block

IEC 61131-3 defines a set of standard function blocks common to all the programmable controllers. A function block is a set of elements consisting of:

a) the definition of a data structure partitioned into input, output, and internal variables; and
b) a set of operations to be performed upon the elements of the data structure when an instance of the function block type is invoked.

Examples of standard function blocks are:

– latch;
– edge detection;
– counter;
– timer.

In addition to the standard function blocks it can be useful to define custom function blocks actuating specific functions. Once defined, a custom function block behaves like standard ones.

C.2.6.6 Batch programming tool

The BCS can support the environment for batch control defined in either IEC 61512.

C.2.6.7 Multitasking operating software for controller

Multitasking operating software is a method for managing the resources of the controller CPU in order to allow multiple tasks to share common processing resources. The multitasking facility allows the programmer to make use of the multiprogramming capability of the controller. The term multiprogramming refers to a programming method in which more than one task is in an executable state contemporaneously.

C.2.6.8 Advanced process control (APC)

The APC can be simply defined as the process control strategies beyond straightforward PID control loops. APCs are software tools sold as additional packages that can be either interfaced or installed in the BCS. The APC allows a better control and optimization of the process, and it normally makes use of sophisticated control techniques, such as: expert systems, sliding mode control, multi-variable control, etc.

C.2.7 BCS localisation

Localisation is the ability of a BCS to support local languages for different functions, such as:

– programming;
– documentation;

– human-machine interface (HMI).

The required language(s) and function(s) are to be specified.

C.3 Functionality properties

C.3.1 Input/output specifications

The considered types of input/output are: conventional analog I/O (i.e. 4 mA to 20 mA, 0 V to 10 V, etc.), digital I/O, counters (for example high speed counters), pulse outputs, Hart I/O and fieldbus. For each type of I/O the user should specify the resolution, the accuracy and the repeatability.

C.3.2 Conventional input/output

C.3.2.1 Digital input

The specification of the digital inputs can include:

– the rated input voltage (i.e. 24 V direct current) and current (i.e. 10 mA);
– the input delay (fixed or variable);
– the local status display of the inputs;
– the electrical insulation between inputs and between inputs and backplane;
– the insulation level (i.e. 1 kV direct current).

C.3.2.2 Digital output

The specification of the digital output can include:

– the type of output: static or relay;
– the connected load, i.e. solenoid valves, contactors, lights, etc.;
– the rated output voltage (i.e. 24 V direct current);
– the rated output current (permanent and short time);
– the local display of outputs (i.e. led);
– the electrical insulation between inputs and between inputs and backplane;
– the insulation level (i.e. 1 kV).

C.3.2.3 Analog input

The specification of the analog input can include:

– the type of inputs, i.e. thermo-couple, RTD (2-3-4 wires), 4 mA to 20 mA;
– the reverse polarity protection;
– the electrical insulation between inputs and between inputs and backplane;
– the insulation level (i.e. 500 V direct current).

C.3.2.4 Analog output

The specification of the analog output can include:

– the type of output, i.e. 4 mA to 20 mA, ± 10 V, 0 V to 5 V, etc.;
– the resolution (or the number of conversion bits);
– the electrical insulation between outputs and between outputs and backplane;
– the insulation level (i.e. 500 V direct current);

– the individual output protection with fuse.

C.3.2.5 Counters

These are typically digital and are used for items such as flow meter totalizers.

C.3.2.6 Pulse outputs

These are typically digital and are particularly good for leaving items such as valves in a fixed position on failure of the BCS. Recovery from failure also avoids moving the output to an unexpected position.

C.3.3 Input/output from/to smart devices

It is a common practice to use smart devices in the field. In this case the analog input/output supports the conversion between the protocol used for the smart devices (i.e. Hart) and the protocol used for process control. In addition to the data specified for analog I/Os the user specifies the protocols used.

C.3.4 Fieldbus connection to the remote I/O

The user specifies if a fieldbus connection is used for connecting the remote I/O and the controllers. The fieldbus can be either a standard IEC 61158 fieldbus or a proprietary fieldbus.

C.3.5 Input validation

When a single pole double throw (SPDT) contact is acquired as two digital inputs, validation logic is implemented to detect abnormal statuses. Similarly, the out-of-range of an analogue signal is detected when the signal rises above or drops below the valid range.

C.3.6 Special inputs

Specific requirements for inputs different from the usual ones are to be specified.

C.3.7 Software requirements

C.3.7.1 System database requirements

The system database provides the information needed by various system transactions (functions) to perform their tasks. Input data comes from the field devices (sensors, transmitters, switches, etc.) via the controller's data acquisition interfaces, from supervisory control systems (PC, DCS, PLC), via external controller links, and from other controllers via inter-controller connections. Output data are directed to field control and indication devices, supervisory systems, and other controllers.

The system database is a real-time database, i.e. it needs to provide a predictable response time to guarantee the completion of time-critical transactions.

C.3.7.2 Physical layout of database (implementation)

The system database can have two possible physical layouts:

– distributed database: data are distributed across multiple physical locations. The control of the entire database is under a central database management system (DBMS) that has the role of coordinating all the data files;

– concentrated database: all the data are stored into a central database, i.e. all the records are recorded on an unique machine and can be accessed by the database management system (DBMS).

C.3.7.3 Compatibility with external database

If the system database guarantees the compatibility and the connection with other databases, it is necessary to specify which are the databases that have access or that are accessed by the system database.

C.3.7.4 Type of software

The software for implementing the database can be a commercial product or a proprietary one. If some specific requirement or constraint applies, it is necessary to specify the needed programming language for the database. Normally, this choice is up to the BCS manufacturer.

C.3.8 Alarm management

C.3.8.1 General

The alarm management system of the BCS supports the selection of the events to be considered as alarms, the setting of the alarm priorities, the acknowledgement procedures, etc.

The alarm management should be designed in order to avoid a flood of alarms prompted to the operator interface. The alarm management should be designed by following the following rules:

– simple alarms have to show the location and recommended action;
– access to appropriate screen views should be quick, decisive and with minimum keystrokes;
– handling techniques should be implemented, in particular priority settings and annunciating;
– techniques should be easily reconfigurable.

C.3.8.2 Types of alarms

Different types of alarm can be set or defined. Typical alarm functions include:

– absolute threshold: a given parameter reaches a certain set threshold;
– single delta: an additional alarm notifies that the signal continues to rise. The signal has overcome a certain percentage above the defined threshold;
– repetitive delta: there is an alarm at every selected change beyond that has been selected for the single delta alarm;
– rate of change: there is an alarm if there is a rapid rate of change of the variable even though a threshold has not been passed. The rate of change is normally expressed either in units per second or percent per time;
– return to normal: when required, the operator needs to be notified when a parameter returns to normal, not just when that parameter goes into an alarm;
– time delay: some parameters are relatively unstable, or just continually fluctuate, such as pressures and flows. Often it is useful to set some time delay on those alarms to act as a dead band, so that a spike does not trip an unnecessary alarm;
– “snooze” alarm: the “snooze” alarm re-alarms if the conditions persists beyond some selected time after acknowledging. In some cases, this type of alarm can be set to acknowledge itself if the condition clears;
– hysteresis alarm: a hysteresis alarm has different thresholds in each direction, up or down. Used much like the time delay, this dead band reduces unnecessary alarms in dynamically active fluids.

C.3.8.3 Alarm severity

Any failure or abnormal operation of the BCS should be signalled to the operator with an indication of the alarm severity. Alarm severity indicates the order in which users should handle that event relative to alarms of other severities. Levels of severity can help schedule the maintenance and repair activities, and are an important feature of self-diagnostic messages (system alarms). Severity is not relevant to process alarms.

A possible definition of severity levels is:

– down: no response from the monitored entity or device;
– high (critical): alarm condition that seriously impairs service and requires immediate correction;
– medium (advisory): alarm condition impairing service but not seriously;
– low (journal): alarm condition that does not currently impair service, but the condition needs to be corrected before it becomes more severe.

The definition of severity levels is up to the BCS maker as well as their display procedures.

C.3.8.4 Alarm priority level

Alarm priority indicates the urgency of operator response, for example seriousness of consequences and allowable response time. Three levels of priority are defined:

– level 1: immediate operator action. Endangerment of personnel, catastrophic equipment failure/environmental impact, unit shutdown or shutdown of other units imminent;
– level 2: rapid operator action required. Unit shutdown possible. Partial shutdown has occurred. Emergency priority alarm possible;
– level 3: prompt operator action required. High-priority alarm possible. Off-spec or production loss imminent.

User should specify if the BCS alarm management system should support the priority levels.

C.3.8.5 Alarm grouping

Alarms can be organized into groups according to geographical or functional criteria. The purpose of alarm grouping is to allow the operator to quickly recognize patterns in a sequence of alarms and to find-out the areas or machines involved.

C.3.8.6 Alarm acknowledgment

All the alarms should be acknowledged by the operator(s). For each alarm, according to its group, severity and priority, a sequence of actions that indicate that the alarm has been recognized is defined. Different acknowledgment sequences can be implemented.

C.3.8.7 “Smart” alarming/alarm hiding

To reduce the effort for the operator to understand the causes of an abnormal event, alarms that are obvious or redundant shall not be displayed. The BCS supports “smart” alarming whereby pre-defined alarms can be automatically hidden to the operator on the occurrence of specific process or plant conditions.

The system should provide tools and capability for easy configuration of which alarms will be “hidden” based on plant state or process condition.

Hidden alarms are not presented to the operator on the standard alarm displays or on process graphics, but their occurrence is recorded in the alarm history. A “hidden alarm” display will be provided which lists all of the alarms that are currently hidden from the operator.

C.3.8.8 Alarm annunciation

Alarm annunciation is the capacity of the system to notify the alarms to the operators. The annunciation process can include, for example:

– activation of an external audible alarm or lights;
– activation of the internal PC audio card (e.g. to play .wav files);
– updating an alarm display with the current alarm;
– updating an alarm overview screen to indicate the occurrence of an alarm in a specific process area / display;
– printing the alarm message on an alarm printer;
– any graphic object associated with the alarm point will change colour, shape, appear, disappear, etc. as configured.

C.3.8.9 Alarm summary display lists

A summary of the alarms could be useful, and it can include:

– active process alarms
– cleared process alarms
– acknowledged process alarms
– active system alarms
– cleared system alarms
– acknowledged system alarms
– alarm history
– operator action list
– suppressed (locked) alarm list
– hidden alarm list
– alarm frequency display (hit) list

Accessing an alarm summary display from any other display shall require the minimum number of operator actions.

Multi-page displays may be used. If so, it shall be possible to page forward or backward. The display shall list alarms in tabular format in order of occurrence.

C.3.9 Events management

C.3.9.1 General

An event is a change of the status of any variable in the process. Typical events are:

– change of status of digital inputs,
– reaching a threshold for analog variables,
– commands from operator, etc.

An event can start or alter a control action.

C.3.9.2 Sequence of events (SOE)

Time resolution is the minimum time by which two events should be separated in order that the corresponding time tags are different. Separating capability is the minimum time by which two events should be separated such that the sequence of their occurrence is determined

correctly. Time resolution cannot be shorter than the separating capability, and it is normally specified.

C.3.9.3 Integration of SOE with third parties systems

If the data processed by the SOE can be accessed by other applications and/or systems, it is necessary to specify them and whether some particular driver or communication interface is required (i.e. OPC alarm and event).

C.3.9.4 Types of events

The types of events are classified according to their sources:

– operator: operator changes such as set points changes, control output changes or controller mode changes. Reactions to alarms, such as acknowledgments;
– alarm: each alarm presents always two events: switching into alarm condition and switching out of alarm condition (sometimes the latter might or might not prompt a reset);
– process: the events are related to the state of the monitored system, such as protecting events, quality changes in the measures, etc.

C.3.10 Historical archiving

C.3.10.1 General

Events can be archived in the historical database, which means recording in a centralised machine a particular signal from the controller where the event was either generated or acquired from a sensor. Only some events should be archived in the historical database. Subclauses C.3.10.2 and C.3.10.3 report the methods for archiving and the specifications to define data that should be archived.

C.3.10.2 Archiving method

The historical database can store events according to different methods:

– cyclically: there is a fixed collection frequency that is used to sample the data;
– on variation: on/off data are stored only when they change their status; analog data are stored when their value changes more than a given threshold;
– on event: data are collected on the basis of a triggering event or interrupt.

The number of events to archive should be defined.

C.3.10.3 Back-up of the archives

The historical database is a critical part of the entire BCS and for such a reason a back-up media should be chosen. The back-up archives are important to restore the data after a disaster or after the corruption of some data.

In order to select the best back-up archive for the historical database, the following features should be defined:

– hardware type of back-up depository;
– expected life span of the back-up;
– need for a software back-up tool that guides the process of intelligent back-up;
– frequency of the back-up (daily, weekly, monthly, etc.);
– format required for the stored data.

C.3.11 Trend and statistics management

C.3.11.1 General

For process or plant supervision and control, HMI should show both instantaneous and recorded values in different format according to process requirements.

C.3.11.2 Features of the trend

The main features defining the trending application are:

– number of traces available per screen/window;
– type of variables to trend;
– minimum/maximum sampling rate;
– the span time or the total capacity of data displayed on the same trend.

C.3.11.3 Analog values trending

The trend of analog value can include the following features:

– current value;
– average;
– minimum;
– maximum;
– standard deviation.

C.3.11.4 Discrete value trending

The trend of discrete value can include the following features:

– current state;
– start state;
– transition count;
– statistics.

C.3.11.5 Trend navigation requirements

The trend system should have some requirements for a comfortable navigation, such as:

– panning: moving “back and forth” along the same time divisions within a much longer trend than fits in a single screen;
– zoom: moving to different time divisions.

In addition to the function of panning and zooming the cursor may have additional functions, such as:

– time/date of placement;
– value/state of intersected traces;
– tags and titles of all traces viewed;
– select area of zoom for more detail.

C.3.12 Communication requirements

Communication plays a key role in a BCS. Different communication networks co-exist in a BCS, each one with specific features and requirements. Usually communication networks may be divided into three or four levels according to the technology used. Figure C.1 schematically shows these alternatives.

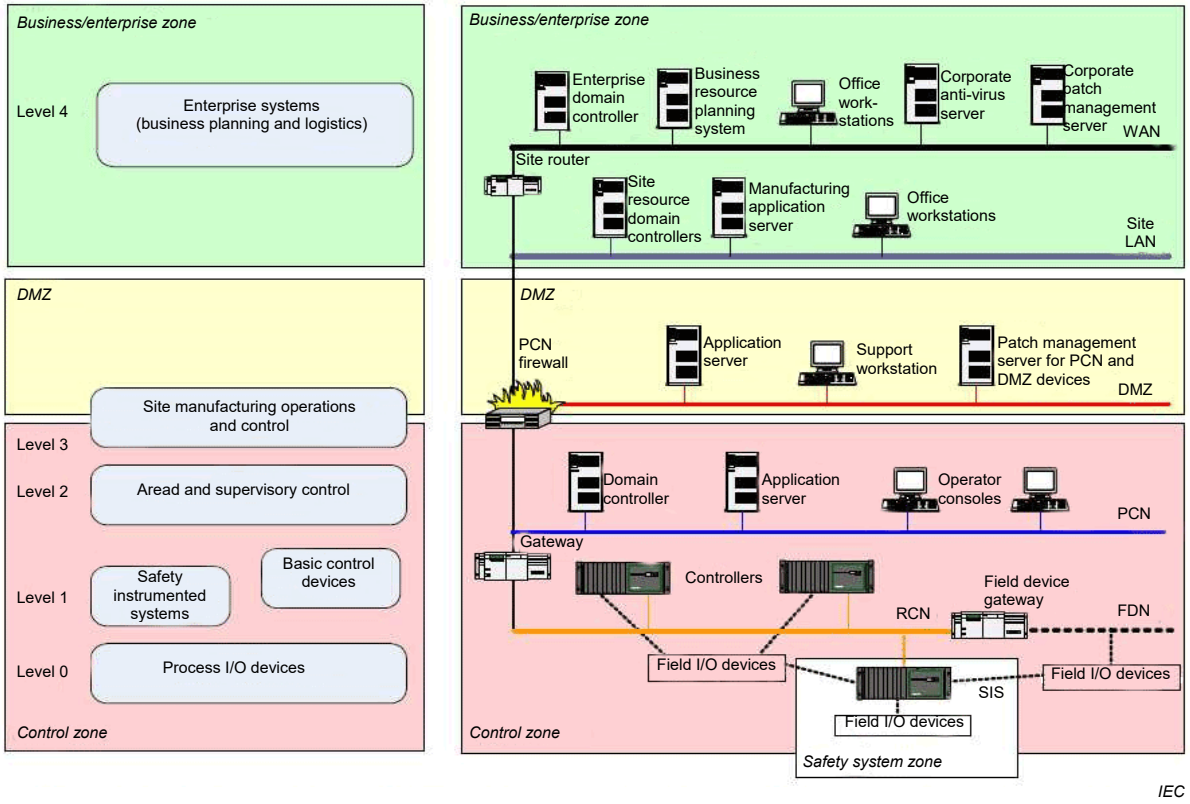

Figure C.1 – Communication networks in a BCS

C.3.13 Fieldbus

According to the IEC 61158, the principal requirements for fieldbuses that should be specified are:

– the physical layer: copper, fiber optic or wireless,
– communication profile (CPF) according to IEC 61784,
– number of devices connected to the network,
– installation in hazardous areas,
– redundancy of the communication medium required,
– maximum distance between the field device and the controller.

C.3.14 Controller network

The requirements for the controller network that should be specified are:

– the type of protocol used,
– the physical layer,
– installation in hazardous areas,
– redundancy of the communication medium required,
– maximum distance of the connection.

C.3.15 Control room network

The requirements for the control room network that should be specified are:

– the type of protocol used,

– the physical layer,
– redundancy of the communication medium required,
– maximum distance of the connection.

C.3.16 External link

The external link allows to put in communication different networks, for example the control room network and the corporate network (refer to Figure C.1).

The user should specify:

– the networks that need the communication link,
– the security level needed,
– the need for a firewall,
– the need for an antivirus.

C.3.17 Communication interfaces

Several communication networks can exist within a BCS, thus it is necessary to define the interfaces between the networks and between different systems.

The user should specify:

– the communication protocol between the networks that exchange data and information;
– the quantity of data exchanged;
– the refresh time required for using valid data;
– the physical medium of connected networks;
– the desired security level.

A communication interface allows to share and pass data and information between different communication systems that use different physical medium and/or different data structure. In this way the data can be moved across the entire BCS communication system and they can be used where they are needed.

C.3.18 Communication with ERP system

Enterprise resource planning (ERP) integrates internal and external management information across an entire organization, embracing finance/accounting, manufacturing, sales and service, etc. ERP systems automate this activity with an integrated software application. Its purpose is to facilitate the flow of information between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders.

The ERP needs to communicate and exchange data with the control system, where the productivity data are generated. ERP systems connect to real-time data and transaction data in a variety of ways:

– direct integration: ERP systems connectivity (communications to control system) as part of their product offered by vendors. This requires the vendors to offer specific support for the control system that their customers operate;
– database integration: ERP systems connect to control system through staging tables in a database. Control systems deposit the necessary information into the database. The ERP system reads the information in the table,
– enterprise appliance transaction modules (EATM): These devices communicate directly with the control system and with the ERP system via methods supported by the ERP

system. EATM can employ a staging table, web services, or system-specific program interfaces (APIs);

– standard protocols: Communication drivers are available for control system and separate products have the ability to log data to staging tables. Standards exist within the industry to support interoperability between software products, the most widely known being OPC,

– security needs shall be reviewed and considered for this ERP system particularly considering that breaches of security may originate in the office (i.e. non-control) part of the network.

C.3.19 Communication with a manufacturing execution system (MES)

An MES is a production scheduling and tracking system used to analyze and report resource availability and status, schedule and update orders, collect detailed execution data such as material usage, labour usage, process parameters, order and equipment status, and other critical information. It accesses bills of material, routing and other data from the base ERP system and is typically the system used for real-time shop floor reporting and monitoring that feeds activity data back to the base system.

The methods for connecting with the MES are:

– direct integration: MES systems connectivity (communications to control system) as part of their product offered by vendors. This requires the vendors to offer specific support for the control system that their customers operate;

– database integration: MES systems connect to the control system through staging tables in a database. Control systems deposit the necessary information into the database. The MES system reads the information in the table;

– standard protocols: Communications drivers are available for control system and separate products have the ability to log data to staging tables. Standards exist within the industry to support interoperability between software products, the most widely known being OPC;

– security needs shall be reviewed and considered for this MES system particularly considering that breaches of security may originate in the office (i.e. non-control) part of the network.

C.3.20 Software simulator

A software simulator is a program that allows the user to observe an operation through simulation without actually running the program.

The simulation software allows testing the system behaviour after a modification or a new configuration without the need of having the real hardware connected. The simulation software allows a better debugging performance in a simulation environment before the downloading of the program or the configuration on the real system.

C.3.21 Simulator of the control logic

The implemented control logic can be tested on the configuration PC or workstation. The simulator allows to test the logic without having the hardware connected. The simulation is useful for checking the overall consistency of the control logic program and the effect of modifications.

C.3.22 On-line debugging

On-line debugging allows checking and correcting a program during its execution even if other programs are running simultaneously. Debug allows detecting and correcting any program faults.

C.3.23 Simulator of the I/O

The I/O simulator allows the simulation of the operation of the I/Os. In this case, it is possible to force the values of the I/Os in order to check a specific logic or control loops.

C.3.24 Remote supervisory functions

A remote computer with the proper trustee rights can supervise the BCS. Remote supervision extends to displays, tags or variables, control-loop setting, alarm acquisition, etc. The user can specify the functions the remote supervision can carry on.

C.3.25 Technology and scope of the BCS

According to today's terminology, the available technologies for BCSs can be selected amongst:

– PLC based;
– soft PLC based;
– DCS;
– SCADA;
– others (to be specified).

The basic function or functions of the required BCS are selected amongst one or more of the following choices:

– supervisory;
– control;
– ESD;
– batch;
– others (to be specified).

C.3.26 Basic architecture

The BCS topology is normally shown in a drawing attached to the technical specification, where all the main components are indicated and named. In case of complex systems, the drawing can be split into several sheets: outline, subsystems, control room layout, etc. Figure C.2 shows an example of a layout for a medium-size BCS.

This standard defines the requirements of the components of the BCS, from field devices to the control room, and the requirements of the interfaces for connecting the BCS to other digital and communication systems of the factory, for example ICT, not within the scope of this standard.

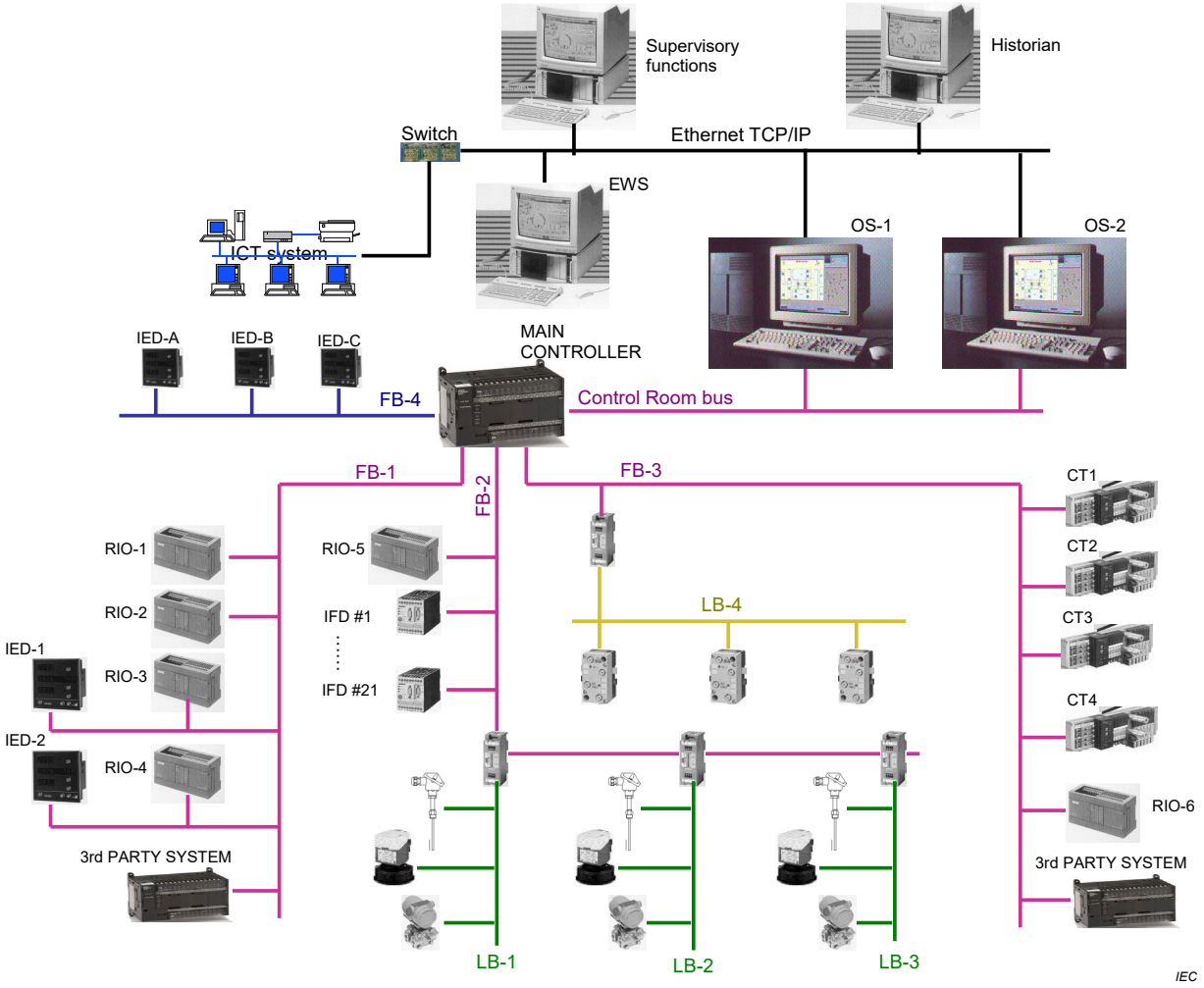

Figure C.2 – Example of a layout drawing

C.4 Configurability

C.4.1 System configuration

The system configuration is the construction of a control system by selecting functional or modular units out of a given set and by defining their interconnections. Configurability of the system defines the extent to which the system facilitates the selection, set-up and arrangement of its modules to perform its mission.

The configuration can be both hardware and software.

The main functionalities for the software configuration of the system are:

– definition of the system architecture by means of the configuration tool;
– inserting software modules;
– selecting and setting parameters;
– selecting options;
– programming;
– compiling and downloading programmes;
– basic engineering.

Some of the software configuration actions might be permissible also if the system is running. Some configuration tools allow the configuration of the entire system even if there is no hardware connected (emulated mode).

The basic functionalities for the hardware configuration of a BCS are:

– inserting modules;
– mounting devices;
– connection by soldering and/or by wiring;
– setting jumpers;
– setting switches;
– inserting printed circuit boards.

Normally, for performing the hardware configuration it is necessary that the system is disabled from process operation.

C.4.2 On-line configuration

If the system supports on-line configuration, then it is possible to run the system configuration procedure while the BCS is running with no loss of functionalities. On-line configuration can have different levels:

– both hardware and software full re-configuration is possible,
– only minor hardware changes are allowed,
– only minor software changes are possible.

On-line configuration is often related to the redundancy policy of the BCS.

C.4.3 Off-line configuration

Off-line configuration means that for setting up the functional parameters of the BCS it is necessary to switch the BCS into off-line, to load the changes, and then to switch the system on-line again, after the validation of the parameter changes.

C.4.4 Configuration in simulation mode

Configuration in simulation mode means that before loading any configuration change in the BCS it is possible to run a simulation of the system with the new parameters for a preventive evaluation of the effect of changes.

C.4.5 Graphical resources

Graphical resources are software tools that support the engineering and the configuration phases. The BCS architecture is drawn starting from a library of devices (click-and-drag) with a graphic tool for defining data exchange and component interconnection. It is also possible to input parameters and functions with graphic procedures (pop-up menus, forms, etc.).

C.5 Flexibility

C.5.1 Spare capacity of the system

C.5.1.1 General

After the final configuration of the system, The BCS should have a spare capacity in order to allow adding functionalities or upgrade the system over time. The spare capacity is installed and available with only the standard configuration.

The desired or needed spare capacity of the system should be specified in the design of the system for the different sub-systems (memory, I/O, terminations, etc.).

C.5.1.2 Spare memory

The spare memory gives the possibility to expand and change the control software in the future. The spare memory is expressed as a percentage of the total available memory installed, and strictly depends on the implemented software applications.

The user should indicate the spare memory needed after the final configuration of the system.

C.5.1.3 Expandability of control room communications

The expandability of communications defines the possibility of adding new communication ports and devices to the control network. The added communication ports can be configured without modifications in the existing software and with no need of re-configuring the entire communication network.

C.5.1.4 Expandability of field communications

Expandability of field communications defines the possibility of adding new communication ports and devices to the field network. The added communication ports can be configured without modifications in the existing software and with no need of re-configuring the entire communication network.

C.5.1.5 Field device expandability

Field device expandability is the possibility of adding new field devices to the existing communication fieldbus(es) or the possibility of adding new field devices to the I/O cards. The maximum number of field devices that can be added to the BCS without any hardware intervention should be indicated, and as a percentage of the existing devices.

C.5.1.6 Available room for BCS expansion

The amount of room that should remain available after the completion of the BCS should be specified. Available room is indicated as a percentage of used space:

– inside the control cubicle, for adding new devices inside,

– in the cabinet room, for adding new control cabinets.

C.5.2 Total number of I/O

The total number of estimated I/O defines the overall size of the BCS. Physical I/O are divided into the conventional analog/digital input/output. If a fieldbus technology is required, the total number of intelligent devices and/or remote input/output devices connected to the BCS is indicated as well.

C.5.3 Number of tags

A tag indicates an elementary piece of information used or produced by the BCS. Tags are often grouped into process objects (transmitters, valves, circuit breakers, etc.) and divided into two categories:

– tags for process control: a limited set of information or commands necessary for process control. For example, the process object “valve” may include the following tags: valve position, open/close status, set-point;

– tags for additional functions, such as device remote setting, diagnostic, alarm setting, etc. These functions are possible only with intelligent devices connected through a fieldbus, and the relevant number of tags may become very high.

C.5.4 Number of control loops

A control loop is based on the use of a software controller with PID functions or similar. The total number of loops gives an idea of the complexity of the system, mainly in terms of software performances. The system should be able to handle the total amount of control loops with the specified time requirements. Advanced controls of special control functions are not to be considered at this point.

C.5.5 System scalability

Scalability is the ability of a system and/or an application to grow incrementally larger without total replacement of hardware or software, and without the need to re-engineer the entire architecture of the system.

C.5.6 System expandability

The system expandability is the possibility of the system to be enlarged without changing the architecture and/or the used equipment. The expandability can be both for the entire system and for each apparatus.

The system expandability means that it is possible to add usable components to the system.

For a component, i.e. a programmable logic controller, expandability means that it is possible to add usable spare part to the component (i.e. the free memory or CPU in a PLC).

Bibliography

[1] IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at http://www.electropedia.org)

[2] IEC 61069-5[3], *Industrial-process measurement, control and automation – Evaluation of system properties for the purpose of system assessment – Part 5: Assessment of system dependability*

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

[4] IEC 61158 (all parts), *Industrial communication networks – Fieldbus specifications*

[5] IEC 61297, *Industrial-process control systems – Classification of adaptive controllers for the purpose of evaluation*

[6] IEC 61512 (all parts), *Batch control*

[7] IEC 61784 (all parts), *Industrial communication networks – Profiles*

[8] Dutch Standard Institute NPR 5269, *Industrial-process measurement and control. Basic documentation set for process control installations*

[9] IEC TS 62603-1:2014, *Industrial process control systems – Guideline for evaluating process control systems – Part 1: Specifications*

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3 Second edition to be published simultaneously with this part of IEC 61069.

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