



BSI Standards Publication

Industrial process control systems — Guidelines for evaluating process control systems

Part 1: Specifications

National foreword

This Published Document is the UK implementation of CLC/TS 62603-1:2014. It supersedes PD IEC/TS 62603-1:2014, which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee GEL/65, Measurement and control, to Subcommittee GEL/65/2, Elements of systems.

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

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English Version

**Industrial process control systems - Guideline for evaluating
process control systems - Part 1: Specifications
(IEC/TS 62603-1:2014)**

Systèmes de commande des processus industriels - Lignes
directrices pour l'évaluation des systèmes de commande de
processus - Partie 1: Spécifications
(CEI/TS 62603-1:2014)

Industrielle Prozessleitsysteme - Richtlinie für die
Beurteilung der Leistung von Prozessleitsystemen - Teil 1:
Festlegungen
(IEC/TS 62603-1:2014)

This Technical Specification was approved by CENELEC on 2013-06-26.

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Foreword

The text of document 65B/875/DTS, future edition 1 of IEC/TS 62603-1, prepared by SC 65B "Measurement and control devices" of IEC/TC 65 "Industrial-process measurement, control and automation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as CLC/TS 62603-1:2014.

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Endorsement notice

The text of the Technical Specification IEC/TS 62603-1:2014 was approved by CENELEC as a Technical Specification without any modification.

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.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60038 (mod)	2009	IEC standard voltages	EN 60038	2011
IEC 60050	series	International Electrotechnical Vocabulary	-	series
IEC 60079-10	-	Electrical apparatus for explosive gas atmospheres -- Part 10: Classification of hazardous areas	EN 60079-10	-
IEC 60079-10-1	-	Explosive atmospheres -- Part 10-1: Classification of areas - Explosive gas atmospheres	EN 60079-10-1	-
IEC 60079-10-2	-	Explosive atmospheres -- Part 10-2: Classification of areas - Combustible dust atmospheres	EN 60079-10-2	-
IEC 60079-11	-	Electrical apparatus for explosive gas atmospheres -- Part 11: Intrinsic safety "i"	EN 60079-11	-
IEC 60079-14	-	Explosive atmospheres -- Part 14: Electrical installations design, selection and erection	EN 60079-14	-
IEC 60300-3-4	-	Dependability management -- Part 3-4: Application guide - Guide to the specification of dependability requirements	EN 60300-3-4	-
IEC 60654-1	-	Industrial-process measurement and control equipment - Operating conditions -- Part 1: Climatic conditions	EN 60654-1	-
IEC 60654-2	-	Operating conditions for industrial-process measurement and control equipment -- Part 2: Power	EN 60654-2	-
IEC 60654-3	-	Operating conditions for industrial-process measurement and control equipment -- Part 3: Mechanical influences	EN 60654-3	-
IEC 60654-4	-	Operating conditions for industrial-process measurement and control equipment -- Part 4: Corrosive and erosive influences	EN 60654-4	-
IEC 60721-3-1	-	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities -- Section 1: Storage	EN 60721-3-1	-
IEC 60721-3-2	-	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities -- Section 2: Transportation	EN 60721-3-2	-
IEC 60721-3-3	-	Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities -- Section 3: Stationary use at weatherprotected locations	EN 60721-3-3	-

IEC 60721-3-4	-	Classification of environmental conditions - EN 60721-3-4 - Part 3: Classification of groups of environmental parameters and their severities -- Section 4: Stationary use at non-weatherprotected locations	-
IEC 60848	-	GRAFCET specification language for sequential function charts	EN 60848 -
IEC 60870-4	-	Telecontrol equipment and systems -- Part 4: Performance requirements	HD 546.4 S1 -
IEC 61000-4-2	-	Electromagnetic compatibility (EMC) -- Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	EN 61000-4-2 -
IEC 61000-4-3	-	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	EN 61000-4-3 -
IEC 61000-4-4	-	Electromagnetic compatibility (EMC) -- Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	EN 61000-4-4 -
IEC 61000-4-5	-	Electromagnetic compatibility (EMC) - Part 4-5: Testing and measurement techniques - Surge immunity test	EN 61000-4-5 -
IEC 61000-4-6	-	Electromagnetic compatibility (EMC) -- Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	EN 61000-4-6 -
IEC 61000-4-8	-	Electromagnetic compatibility (EMC) -- Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	EN 61000-4-8 -
IEC 61000-4-9	-	Electromagnetic compatibility (EMC) -- Part 4-9: Testing and measurement techniques - Pulse magnetic field immunity test	EN 61000-4-9 -
IEC 61000-4-10	-	Electromagnetic compatibility (EMC) -- Part 4-10: Testing and measurement techniques - Damped oscillatory magnetic field immunity test	+prA1
			+AB
IEC 61000-4-11	-	Electromagnetic compatibility (EMC) -- Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests	+prA1
			+AB
IEC 61000-6-4	-	Electromagnetic compatibility (EMC) -- Part 6-4: Generic standards - Emission standard for industrial environments	EN 61000-6-4 -
IEC 61025	-	Fault Tree Analysis (FTA)	EN 61025 -
IEC 61069-1	-	Industrial-process measurement and control - Evaluation of system properties for the purpose of system assessment -- Part 1: General considerations and methodology	EN 61069-1 -
			+EN 61069-1:1993/corrigendum Nov. 1993

1993
1:1993/corrigendum
Nov. 1993

IEC 61069-4	-	Industrial process measurement and control - Evaluation of system properties for the purpose of system assessment -- Part 4: Assessment of system performance	EN 61069-4	-
IEC 61069-5	-	Industrial-process measurement and control - Evaluation of system properties for the purpose of system assessment -- Part 5: Assessment of system dependability	EN 61069-5	-
IEC 61069-6	-	Industrial-process measurement and control - Evaluation of system properties for the purpose of system assessment -- Part 6: Assessment of system operability	EN 61069-6	-
IEC 61069-7	-	Industrial-process measurement and control - Evaluation of system properties for the purpose of system assessment -- Part 7: Assessment of system safety	EN 61069-7	-
IEC 61069-8	-	Industrial-process measurement and control - Evaluation of system properties for the purpose of system assessment -- Part 8: Assessment of non-task-related system properties	EN 61069-8	-
IEC 61078	-	Analysis techniques for dependability - Reliability block diagram and Boolean methods	EN 61078	-
IEC 61131-2	-	Programmable controllers -- Part 2: Equipment requirements and tests	EN 61131-2	-
IEC 61131-3	-	Programmable controllers -- Part 3: Programming languages	EN 61131-3	-
IEC 61140	-	Protection against electric shock - Common aspects for installation and equipment	EN 61140	-
IEC 61158	series	Industrial communication networks - Fieldbus specifications	FprEN 61158	series
IEC 61326-1	-	Electrical equipment for measurement, control and laboratory use - EMC requirements -- Part 1: General requirements	EN 61326-1	-
IEC 61508	series	Functional safety of electrical/electronic/programmable electronic safety-related systems	EN 61508	series
IEC 61511	series	Batch control Industrial communication networks - Profiles	EN 61511	series
IEC 61512	series		EN 61512	series
IEC 61784	series		EN 61784	series
IEC 62305-1 (mod)	-	Protection against lightning -- Part 1: General principles	EN 62305-1	-
IEC 62347	-	Guidance on system dependability specifications	+AA EN 62347	201X -
IEC 62381	-	Automation systems in the process industry - Factory acceptance test (FAT), site acceptance test (SAT) and site integration test (SIT)	EN 62381	-
IEC 62443-2-1	-	Industrial communication networks - Network and system security -- Part 2-1: Establishing an industrial automation and control system security program	-	-

IEC 62443-3-3	-	Industrial communication networks - Network and system security - Part 3-3: System security requirements and security levels	-	-
IEC/TR 62380	-	Reliability data handbook - Universal model for reliability prediction of electronics components, PCBs and equipment	-	-
ISO/IEC 14764	2006	Software Engineering - Software Life Cycle- Processes - Maintenance	-	-
IEEE 802.11	-	IEEE Standard for Information technology- Telecommunications and information exchange between systems-Local and metropolitan area networks-Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications	-	-
ISA 18.1- 1979(R1992)	-	annunciator sequences and specifications	-	-
ISA 18.2-2009	-	Management of alarm systems for the process industries	-	-
ISA 37.1-1975 (R1982)	-	Electrical Transducer Nomenclature & Terminology	-	-
ISA S88	-	Batch control	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL PROCESS CONTROL SYSTEMS – GUIDELINE FOR EVALUATING PROCESS CONTROL SYSTEMS –

Part 1: Specifications

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. 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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The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62603-1, which is a technical specification, has been prepared by subcommittee 65B: Measurement and control devices, of IEC technical committee 65: Industrial-process measurement, control and automation.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
65B/875/DTS	65B/905/RVC

Full information on the voting for the approval of this technical specification 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 62603 series, published under the general title *Industrial process control systems – Guideline for evaluating process control systems*, 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 web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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

This International Technical Specification defines a procedure for verifying if a given Process Control System (PCS) satisfies the technical requirements specified by the end-user or by an engineering company for a specific application. The basic concept of this document is that “you can test what you have specified”. A testing procedure is meaningless if it does not include a procedure for specifying the technical requirements to be tested.

This Technical Specification was developed in the framework of the existing standards that define the general concepts of PCS design and testing, that is:

- IEC 61069 Industrial process measurement and control – Evaluation of system properties for the purpose of system assessment – Parts 1,2,3,4,5,6,7,8
- IEC 62381 Automation systems in the process industry – Factory acceptance test (FAT), site acceptance test (SAT), and site integration test (SIT)

The group of standards 61069 defines the general methodology, definitions, and procedures for assessing the functional characteristics of a PCS (Part 1 and 2) in terms of functionalities (Part 3), performances (Part 4), dependability (Part 5), operability (Part 6), safety (Part 7), and non-task-related properties (Part 8). IEC 62381 gives additional details about the general procedures for testing a PCS in factory, on site, and after the general integration of the complete system.

The IEC 62603 fully complies with these standards and gives a detailed guidance for specifying a PCS and for testing the specified functions. IEC 61069 and 62381 create a framework that is valid for any PCS as a system, while 62603, inside this framework, gives the users guidance for specifying the PCS he needs for carrying out the required functions.

INDUSTRIAL PROCESS CONTROL SYSTEMS – GUIDELINE FOR EVALUATING PROCESS CONTROL SYSTEMS –

Part 1: Specifications

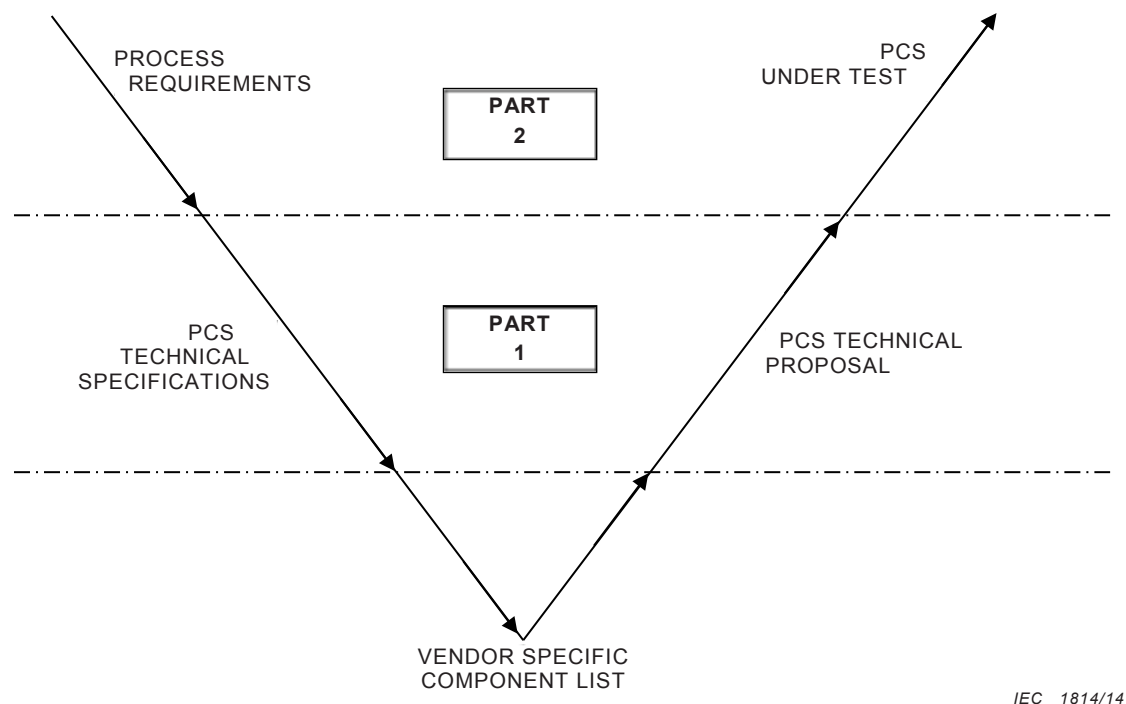
1 Scope

This International Technical Specification describes methods and provides guidance for the evaluation of Process Control Systems (PCS) during the phase of selection between different proposals.

The methods of evaluation proposed in this technical specification are intended for use mainly by users, engineering companies, or independent test laboratories, to verify manufacturers' proposals during the tender (as described in IEC 62603-1) or the provided Process Control System during the FAT procedure.

The specification and test procedures specified in this technical specification apply to a large variety of automation systems, both based on conventional technology (e.g. 4 mA to 20 mA field devices) and based on Intelligent Field Devices (IFD) with serial communication of any kind. For this reason, the tests specified in this technical specification are not necessarily sufficient for automation systems specifically designed for special duties. In such cases, user and manufacturer should define additional tests for assessing specific functions or performances.

The procedure for specifying the PCS technical requirements, evaluating the different offers, and carrying out the tests on the chosen PCS differs from one company to another and from one project to another, but some common steps exist, as Figure 1 shows. The IEC 62603 considers this process divided into two steps: definition of the PCS technical requirements (in the scope of IEC 62603-1) and test of the chosen PCS.



IEC 1814/14

Figure 1 – Procedure for specifying and testing a PCS

The first step of the specification of a PCS is to define the process requirements, in terms of required performances to achieve a satisfactory control of the process. Normally these requirements are defined with a joint effort of process engineers, automation, and instrumentation experts. From the process requirements, the automation engineers derive the PCS technical requirements, that is the functionalities the PCS should offer to achieve the required goals. Based on the process requirements and the PCS technical requirements, suppliers prepare their technical offers, and the evaluation procedure starts. IEC 62603-1 suggests a possible procedure for assessing the fitness of a proposed PCS to the specifications, based on a simple algorithm that considers the weight (importance) of each single required function.

After the selection of the PCS maker, the implementation stage starts. When the PCS is ready, prior to shipping the PCS on site and sometimes even during the implementation stage, the user/engineer may perform a set of Factory Acceptance Tests.

The technical evaluation of the tenders (IEC 62603-1) is mostly based on the evaluation of documents and data-sheets, and it may require simple calculations, e.g. for performance calculation. These verifications are based on general data of the proposed automation systems, not dedicated to any specific piece of hardware or software.

On the contrary, the FAT is mostly based on testing activities in laboratories or factories on a specific PCS including both the physical devices and the application software.

Figure 2 shows the typical process of PCS evaluation in an automation project.

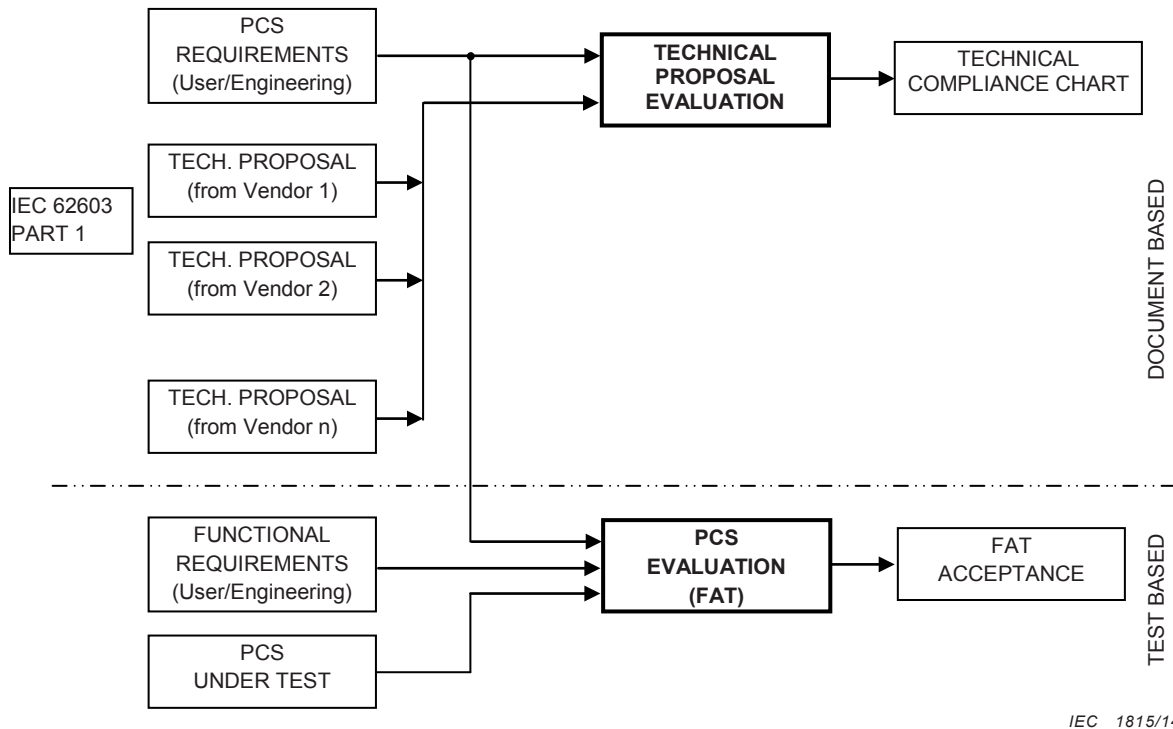


Figure 2 – The process of PCS evaluation

The first evaluation is needed to select one supplier from a number of proposals. The reference document is the PCS technical requirements provided by the user or by a delegated engineering company. Scope of the evaluation at this stage is to verify if the proposed systems support the specified functions and performances. Evaluation is mostly based on the documents supplied by the supplier, such as technical data-sheets, manuals, conformity declarations, and so on. The PCS technical requirements should include the description of the required FAT procedure.

After the supplier's selection, the detailed engineering stage starts, and the user (or the delegated engineering company) produces a document that describes the software requirements in details. The PCS supplier assembles the PCS and implements the logic. After the completion of in-house tests, the Factory Acceptance Tests starts.

Several aspects of process control systems are in the scope of existing IEC standards that are to be considered together with the present document. This technical specification reports abstracts of the cited IEC standards based on the revisions available at the date of submission. Users should consult the most recent versions of the referenced standards for the actual requirements.

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 60038:2009, *IEC standard voltages*

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

IEC 60079-10, *Electrical apparatus for explosive gas atmospheres – Part 10: Classification of hazardous areas*¹

IEC 60079-10-1, *Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres*

IEC 60079-10-2, *Explosive atmospheres – Part 10-2: Classification of areas – Combustible dust atmospheres*

IEC 60079-11, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"*

IEC 60079-14, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*

IEC 60300-3-4, *Dependability management – Part 3-4: Application guide – Guide to the specification of dependability requirements*

IEC 60654-1, *Industrial-process measurement and control equipment – Operating conditions – Part 1: Climatic conditions*

IEC 60654-2, *Operating conditions for industrial-process measurement and control equipment – Part 2: Power*

IEC 60654-3, *Operating conditions for industrial-process measurement and control equipment – Part 3: Mechanical influences*

IEC 60654-4, *Operating conditions for industrial-process measurement and control equipment – Part 4: Corrosive and erosive influences*

IEC 60721-3-1, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 1: Storage*

IEC 60721-3-2, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 2: Transportation*

IEC 60721-3-3, *Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weatherprotected locations*

¹ Withdrawn.

IEC 60721-3-4, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 4: Stationary use at non-weatherprotected locations*

IEC 60848, *GRAFCET specification language for sequential function charts*

IEC 60870-4, *Telecontrol equipment and systems – Part 4: Performance requirements*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-8, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-9, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 9: Pulse magnetic field immunity test. Basic EMC Publication*

IEC 61000-4-10, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 10: Damped oscillatory magnetic field immunity test. Basic EMC Publication*

IEC 61000-4-11, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

IEC 61025, *Fault tree analysis (FTA)*

IEC 61069-1, *Industrial-process measurement and control – Evaluation of system properties for the purpose of system assessment – Part 1: General considerations and methodology*

IEC 61069-4, *Industrial-process measurement and control – Evaluation of system properties for the purpose of system assessment – Part 4: Assessment of system performance*

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

IEC 61069-6, *Industrial-process measurement and control – Evaluation of system properties for the purpose of system assessment – Part 6: Assessment of system operability*

IEC 61069-7, *Industrial-process measurement and control – Evaluation of system properties for the purpose of system assessment – Part 7: Assessment of system safety*

IEC 61069-8, *Industrial-process measurement and control – Evaluation of system properties for the purpose of system assessment – Part 8: Assessment of non-task-related system properties*

IEC 61078, *Analysis techniques for dependability – Reliability block diagram and boolean methods*

IEC 61131-2, *Programmable controllers – Part 2: Equipment requirements and tests*

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

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

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

IEC 61158-2, *Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition*

IEC 61326-1, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61511 (all parts), *Functional safety – Safety instrumented systems for the process industry sector*

IEC 61512 (all parts), *Batch control*

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

IEC 62305-1, *Protection against lightning – Part 1: General principles*

IEC TR 62380, *Reliability data handbook – Universal model for reliability prediction of electronics components, PCBs and equipment*

IEC 62381, *Automation systems in the process industry – Factory acceptance test (FAT), site acceptance test (SAT), site integration test (SIT)*

IEC 62347, *Guidance on system dependability specifications*

IEC 62443-2-1, *Industrial communication networks – Network and system security – Part 2-1: Establishing an industrial automation and control system security program*

IEC 62443-3-3, *Industrial communication networks – Network and system security – Part 3-3: System security requirements and security levels*

ISO/IEC 14764:2006, *Software Engineering – Software Life Cycle Processes – Maintenance*

IEEE 802 (all parts), *IEEE Standards for Local and Metropolitan Area Networks*

ISA 18.1-1979 (R1992), *Annunciator sequences and specifications*

ISA 18.2-2009, *Management of alarm systems for the process industries*

ISA 37.1-1975 (R1982), *Electrical transducer nomenclature and terminology*

ISA S88 (all parts), *Batch Control*

3 Symbols and abbreviated terms

ADC	Analog-to-Digital Converter
BMS	Burner Management System
BPCS	Basic Process Control System
CFC	Continuous Function Chart
CR	Control Room
CT	Counter
DCS	Distributed Control System
EMC	ElectroMagnetic Compatibility
EFT/B	Electric Fast Transient / Burst
ERP	Enterprise Resource Planning
ESD	Emergency Shut-Down
FAT	Factory Acceptance Test
FBD	Function Block Diagram
F&G	Fire and Gas
HMI	Human Machine Interface
KPI	Key Performance Indicator
IFD	Intelligent Field Device
IIS	Internet Information Server
ICT	Information Communication Technology
ISM	Industrial Scientific and Medical
IPC	In-plant Point of Coupling
LD	Ladder Diagram
LOI	Local Operator Interface
LPZ	Lightning Protection Zone
MES	Manufacturing Execution System
OLE	Object Linking and Embedding
OPC	OLE for Process Control
OS	Operator Station
PAM	Plant Asset Management
PFD	Probability of Failure on Demand
PFH	Average Probability of Failure per Hour

PLC	Programmable Logic Controller
PCS	Process Control System
PCU	Process Control Unit
PCC	Point of Common Coupling
RF	Radio Frequency
SAT	Site Acceptance Test
SCADA	Supervisory, Control, And Data Acquisition
SELV	Safety Extra Low Voltage
SFC	Sequential Function Chart
SIL	Safety Integrity Level
SIS	Safety Instrumented System
SIT	Site Integration Test
SLA	Service Level Agreement
SLC	Single Loop Controller
SOE	Sequence Of Events
SSL	Secure Socket Layers
VBA	Visual Basic for Applications

4 Technical specifications of a PCS

For the technical evaluation of a Process Control System, it is necessary that the Technical specification of the required PCS include a clear list of requirements to check-out. For the sake of simplicity, it is useful to split the technical requirements into homogeneous groups, each one containing a set of specific items. An example of a possible structure of the technical requirements is shown in Figure 3. The itemised content of each group is described in the subclauses of this technical specification reported in Figure 3. Application software specifications are not included in the general PCS technical requirements since they do not impact on the selection of the PCS.

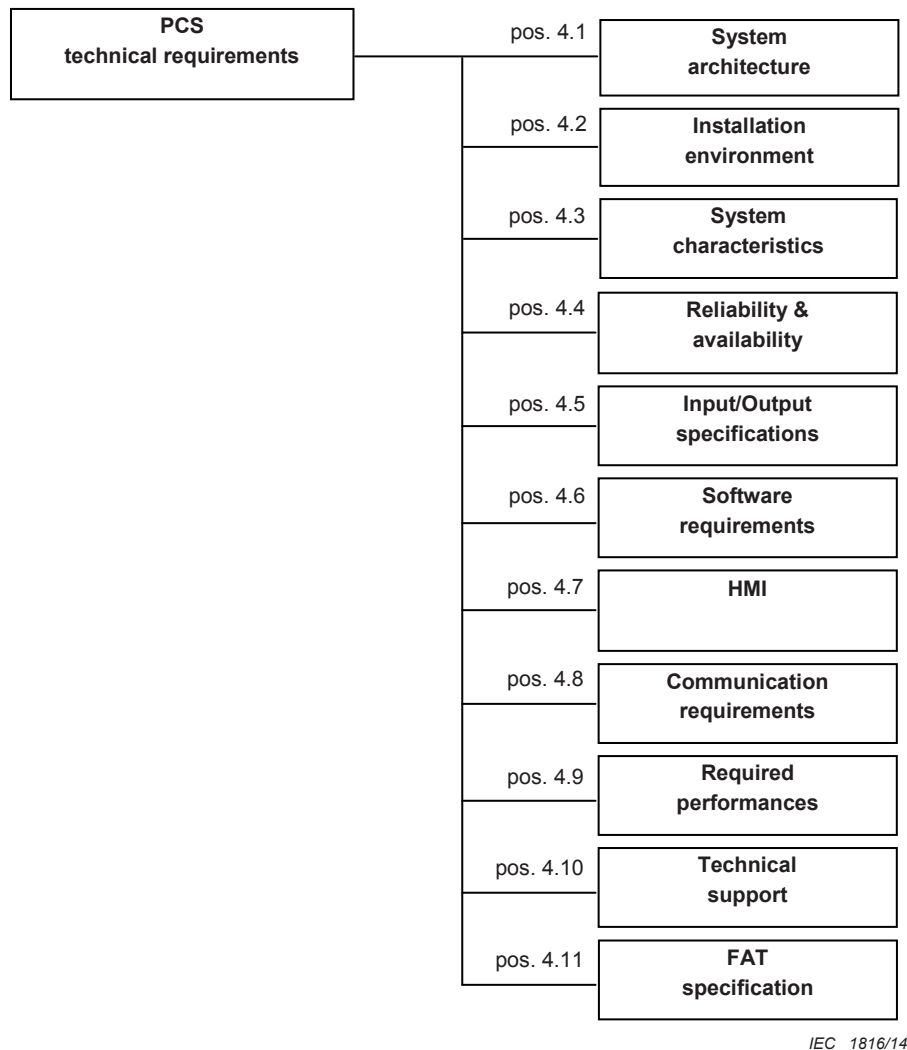


Figure 3 – Content of the PCS technical specifications

The end-user or the delegated engineering company indicates the required functions and performances of the PCS, and checks if the proposed system fulfils the requirements. This phase can be accelerated if requirements are presented in table form in a spreadsheet with boxes where the supplier can write down his answers.

The process of evaluating a proposal can become quantitative if a voting system is defined. A voting system is very useful for comparing different proposals. To do this, a weight should be assigned to each requirement. Weights can vary from one application to another, and they can be defined according to a heuristic scale such as:

- the function is **optional** weight D
- the function **would help** weight C
- the function **should** be implemented weight B
- the function **shall** be implemented weight A

Similarly, the suitability of the proposed PCS for each requirement can be rated according to the following scale:

- the PCS **does not meet** the function vote 0
- the PCS does not meet the function, but **it can be applied or created** vote 1
- the PCS **meets the function** vote 2
- the PCS **meets the function and is clearly stated** vote 3

Proposals may not state whether specific specification requirements are met or not. In such cases, the evaluator should use judgment whether to

- attribute a rating (vote) based on the evaluator's own knowledge, experience and judgment, possibly reducing the vote by 1 to make an allowance for uncertainty, or
- seek additional specific information from the supplier.

Votes of all the offers are summarised in a table that shows each technical requirement, its weight (A-B-C-D), and vote (0-1-2-3). The proposal of each supplier has its column (see Table 1).

Table 1 – Summary table for proposal evaluation

Technical requirement	Weight	Bid #1	Bid #2	Bid #3
Item #1	w_1	v_{11}	v_{21}	v_{31}
Item #2	w_2	v_{12}	v_{22}	v_{32}
.....	...	...	...	...
Item #n	w_n	v_{1n}	v_{23}	v_{33}

Of course, the function weight and the PCS votes are derived from the specific process category to which the plant belongs. For example, the same PCS may fulfil some requirements for a manufacturing plant, but it may not be adequate for a chemical plant, and so on.

For considering a proposal acceptable, all the functions with weight A and B should have a vote not lower than 2. Proposals receiving a vote of 1 for a function with an A or B weight can be made acceptable through including the means of getting the function applied or created (e.g. additional cost) included in the evaluation.

For defining a global proposal vote, first a numerical value should be assigned to weights and votes, then the average vote can be calculated with Equation (1):

$$Bid_k \text{ value} = \frac{\sum_{i=1}^n (w_i \cdot v_{ki})}{\sum_{i=1}^n (w_i)} \quad (1)$$

where

- n is the number of functions;
- w_i is the i -th function weight;
- v_{ki} is the vote of proposal “ k ” for the i -th function.

A simplified example of a proposal vote calculation is shown in Table 2, where a set of typical values for weights and votes is selected. Three imaginary proposals are compared on the base of the respective votes for ten generic functions. Obviously, different numerical values of weights and votes can lead to different global votes, even if with reasonable choices the ranking is likely to remain unaffected.

In the following subclauses, a list of requirements is reported as a base for PCS evaluation. Users have the possibility either of removing requirements not applicable to the specific application or to add special requirements not listed here.

Table 2 – Example of proposal global vote calculation

WEIGHT											
A	8										
B	4										
C	2										
D	1										

VOTE											
3	10										
2	8										
1	4										
0	0										

FUNCTION	WEIGHT		BID 1		BID 2		BID 3	
1	3	8	3	80	2	64	3	80
2	3	8	3	80	3	80	2	64
3	2	4	2	32	3	40	3	40
4	0	1	2	8	2	8	1	4
5	1	2	1	8	3	20	1	8
6	2	4	3	40	2	32	2	32
7	2	4	3	40	1	16	3	40
8	3	8	1	32	2	64	3	80
9	1	2	3	20	3	20	3	20
10	2	4	2	32	2	32	2	32
Σw		45	8,27		8,36		8,89	

4.1 System architecture

4.1.1 General

This subclause describes the general characteristics of the PCS, namely the physical structure and the preliminary sizing of the components. The scope of this subclause is to identify the general characteristics of the desired PCS, the fundamental technologies, the topology of the system and its size. Non-programmable technologies for PCSs, such as hard-wired, non-programmable electronics and single-loop controllers (SLC) are not covered by this document.

The user/engineer should specify the system architecture in accordance with the technical definitions of the following subclauses. Annex A may be used as a guidance.

4.1.2 Technology and scope of the PCS

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

- PLC based;
- Soft PLC based;
- DCS;
- SCADA;
- others (to be specified).

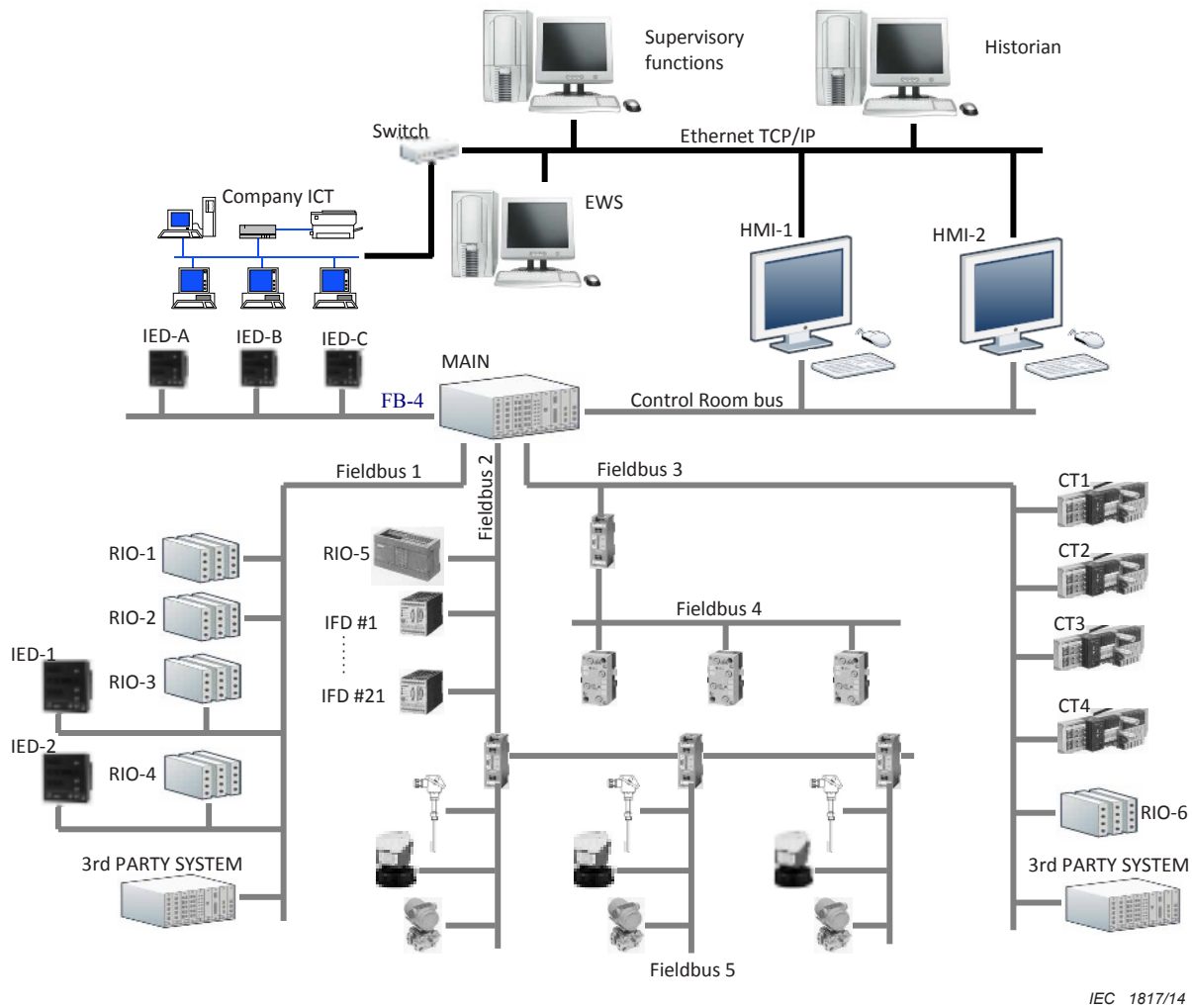
The basic function or functions of the required PCS are selected amongst one or more of the following choices:

- supervisory;
- control;
- protection, including interlocking, trips and ESD;
- batch;
- others (to be specified).

4.1.3 Basic architecture

User/engineer normally show the requested PCS topology 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 4 shows an example of a layout for a medium-size PCS. The supplier can propose modifications to the PCS architecture in his technical proposal.

This Guideline assists the user in defining the user requirements for the components of the PCS, from field devices to the control room, and the requirements of the interfaces for connecting the PCS to other digital and communication systems of the factory, e.g. ICT, not in the scope of this document.



IEC 1817/14

Figure 4 – Example of a layout drawing

4.1.4 Total number of I/Os

The total number of estimated I/Os is generally used to define the overall size of the PCS. Physical I/Os are divided into the conventional analogue/digital input/output. If a serial communication technology is required, the total number of intelligent devices and/or remote input/output devices connected to the PCS is indicated as well. The user should specify the estimated number of I/Os for the various categories.

4.1.5 Number of tags

A tag indicates an elementary piece of information used or produced by the PCS. 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 serial communications, and the relevant number of tags may become very high.

The user should specify:

- the tag naming scheme;

- requirements on length of tags;
- all classes of data which require to be tagged.

4.1.6 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 within the specified time requirements. Advanced controls of special control functions are not to be accounted at this point.

The user should specify the estimated number of control loops to handle and the required time cycle.

4.1.7 Reference standards and marking

Local laws or rules, corporate policies or industry sector definitions of good practice may require specific marking or certification of the electrical devices composing the PCS, mainly for safety reasons. Special standards may be requested for the specific application, e.g., marine installation, nuclear plants, oil and gas, etc.

4.2 Installation environment

4.2.1 General

This subclause describes the general characteristics of the environment in which the PCS and its components are installed. The user/engineer should specify the installation environment in accordance with the technical definitions of the following subclauses. Annex B may be used as a guidance.

The operating conditions for the PCS components are divided into four main categories, according to the classification made by the IEC 60654 family of standards:

- the climatic conditions of the location in which the components are installed (e.g., temperature, humidity, etc.);
- the power supply to which the components are connected: electrical specification of the power supply and the EMC requirements in terms of immunity and emission;
- mechanical influences to which the components are exposed during their operation (e.g., vibration, shock, etc.);
- corrosive and erosive influences to which the components are exposed during their operation (e.g., sand, gases, corrosive liquids, etc.).

4.2.2 Climatic conditions

Considered climatic conditions are air temperature, humidity and barometric pressure in the specific location where the system and its components are installed. Location classes are classified into four severity levels that define the expected climatic conditions of the site. Location classes apply for operation, storage and transportation. Specific classes may apply for storage and transportation as stated in IEC 60721-3-1 and in IEC 60721-3-2.

Location classes are:

- **Class A**: weather-protected locations, air-conditioned locations. In these locations, both air temperature and humidity are controlled within specified limits;
- **Class B**: weather-protected locations, heated and/or cooled enclosed locations. In these locations, only air temperature is controlled within specified limits;
- **Class C**: weather-protected locations, sheltered and/or unheated enclosed locations. In these locations, neither air temperature nor humidity is controlled, and equipment is

protected against direct exposure to such climatic elements as direct solar radiation, rainfall, full wind pressure, etc.

- **Class D:** non weather-protected locations, outdoor locations. In these locations, neither air temperature nor humidity are controlled and the equipment is exposed to atmospheric conditions such as direct solar radiation, rainfall, full wind pressure, etc.

Table 3 is extracted from IEC 60654-1:1993, and reports the limit values of the climatic conditions for each location class.

Table 3 – Climatic condition parameters and severities for classes of location

Environmental parameter	Unit	Class of location (Notations in brackets are climatic classes of IEC 60721-3-1, IEC 60721-3-3 and IEC 60721-3-4)												
		A1 ^a (3K1) /	Ax ^b /	B1 (3K2) /	B2 (3K3) (1K2)	B3 (3K4) /	Bx ^b /	C1 (3K5) (1K3)	C2 (3K6) /	C3 (3K7) (1K5)	Cx ^b /	D1 (4K2) (1K8)	D2 (4K3) /	Dx2) /
Low air temperature	°C	+20		+15	+5	+5		-5	-25	-40		-33	-50	
High air temperature	°C	+25		+30	+40	+40		+45	+55	+70		+40	+40	
Low relative humidity	%	20		10	5	5		5	10	10		15	15	
High relative humidity	%	75		75	85	95		95	100	100		100	100	
Low absolute humidity	g/m³	4		2	1	1		1	0,5	0,1		0,26	0,03	
High absolute humidity	g/m³	15		22	25	29		29	29	35		25	36	
Solar radiation	W/m²	500		700	700	700		700	1 120	1 120		1 120	1 120	
Rate of change of temperature ^c	°C/min	0,1		0,5	0,5	0,5		0,5	0,5	0,1		0,5	0,5	
Condensation		No		No	No	Yes		Yes	Yes	Yes		Yes	Yes	
Wind-driven precipitation (rain, snow, hail, etc.)		No		No	No	No		No	Yes	Yes		Yes	Yes	
Formation of ice		No		No	No	No		Yes	Yes	Yes		Yes	Yes	
Low air pressure	kPa	86 ^d		86 ^d	86 ^d	86 ^d		86 ^d	86 ^d	86 ^d		86 ^d	86 ^d	
High air pressure		106		106	106	106		106	106	106		106	106	
^a Tolerance of ± 2 °C on stated temperature values.														
^b For “special” classes Ax, Bx, Cx e Dx, values should be selected from IEC 60721-3-1, IEC 60721-3-2, IEC 60721-3-3 and IEC 60721-3-4.														
^c To be considered when significant.														
^d 70 kPa for high altitude and/or transportation.														

For each location class A,B,C, or D several levels are defined (e.g., B1, B2, C1, C2, etc.) according to different values of the environmental parameters defining the class of location.

4.2.3 Power supply

4.2.3.1 AC power supply

4.2.3.1.1 General

The values of the nominal voltages of the power supply are in accordance with the requirements of IEC 60038. The allowed frequencies are 50 Hz and 60 Hz and the nominal voltages applicable to PCSs are:

- 120/240 V for single phase systems (60 Hz);
- 230/400 V for three phase systems (50 Hz);
- 277/480 V for three phase systems (60 Hz).

If required, the power supply distribution of the PCS may internally generate different voltages to feed devices or assemblies (i.e., 110 V, 50 Hz).

The AC power supply characteristics are: voltage, frequency, harmonic distortion and switching time between alternative power supplies. As indicated in the following subclauses, IEC 60654-2:1979 defines a set of different classes for each characteristic.

4.2.3.1.2 AC power voltage classes

Power voltages are classified in accordance with the percentage of variation of the voltage from its nominal value. Four classes are defined:

- Class AC1: $\pm 1 \% V_{nom}$;
- Class AC2: $\pm 10 \% V_{nom}$;
- Class AC3: from $10 \% V_{nom}$ to $-15 \% V_{nom}$;
- Class AC4: from $15 \% V_{nom}$ to $-20 \% V_{nom}$.

A special class exists for the cases where the power supply voltages are not included in the requirements of the above listed classes.

4.2.3.1.3 AC power frequency classes

The frequency variation is stated as a percent deviation from the nominal frequency value. Three classes are defined:

- Class F1: $\pm 0,2 \% F_{nom}$;
- Class F2: $\pm 1 \% F_{nom}$;
- Class F3: $\pm 5 \% F_{nom}$.

A special class exists for the cases where the power supply frequency is not included in the requirements of the above listed classes.

4.2.3.1.4 Harmonic content

The total harmonic distortion is defined as the percentage of the square root of the sum of square the harmonic voltages divided by the fundamental power supply frequency voltage (r.m.s.), as reported in formula [1].

$$THD = \frac{\sqrt{\sum_{h=2}^{h=10} V_h^2}}{V_{1N}} \quad [1]$$

where

h is the harmonic order;

V_k is the RMS value of the voltage harmonic component of order h ;

V_{1N} is the RMS value of the fundamental voltage component.

Four classes are defined:

- H1: harmonic content is less than 2 %;
- H2: harmonic content is less than 5 %;
- H3: harmonic content is less than 10 %;
- H4: harmonic content is less than 20 %.

A special class exists for all the cases where the harmonic content is not included in the above listed classes.

4.2.3.1.5 Switching time

For a system with alternative power supplies (i.e., main and back-up), switching time is the time interval between the deviation of voltage in the primary supply that initiates switching, and the restoration of normal voltage by the auxiliary supply. After the switching time, the voltage has to be within the limit values for the specified class of power. The value of deviation required to initiate switching is, in general, a characteristic of the switching system.

Five classes for the switching time are defined:

- ST1: switching time less than 3 ms;
- ST2: switching time less than 10 ms;
- ST3: switching time less than 20 ms;
- ST4: switching time less than 200 ms;
- ST5: switching time less than 1 s.

A special class exists for all the case where the switching time is not included in the above listed classes.

4.2.3.2 DC power supply

4.2.3.2.1 General

In accordance with the requirements of IEC 60038 the values of the nominal voltages of the DC power supply are: 12 / 48 / 110 / 220 V.

If required, the power supply distribution of the PCS may internally generate different voltages to feed devices or assemblies (i.e., 24 V).

The DC power supply characteristics are: voltage, ripple and switching time between the power supply failure and an auxiliary power supply taking over. As indicated in the following subclauses, IEC 60654-2:1979 defines a set of different classes for each characteristic.

4.2.3.2.2 DC power voltage classes

DC power voltages are classified by their percent variation of the voltage from the nominal value. Four classes are defined:

- DC1: $\pm 1 \% V_{nom}$;
- DC2: from 10 % V_{nom} to $-15 \% V_{nom}$;
- DC3: from 15 % V_{nom} to $-20 \% V_{nom}$;
- DC4: from 30 % V_{nom} to $-25 \% V_{nom}$.

A special class exists for all the cases where the voltage variations are not included in the above listed classes.

4.2.3.2.3 DC power voltage ripple classes

Ripple voltage is defined as the percentage of the peak-to-peak value of the total AC component of the power supply voltage to the measured (average) power supply voltage, as measured at rated load. Four classes are defined:

DC1: ripple voltage less than 0,2 %;

DC2: ripple voltage less than 1 %;

DC3: ripple voltage less than 5 %;

DC4: ripple voltage less than 15 %.

A special class exists for all the cases where the power supply ripple is not included in the above listed classes.

4.2.3.2.4 Switching time

For a system with an auxiliary or back-up power supply, switching time is the time interval between the deviation of voltage in the primary supply, which initiates switching, and the restoration of normal voltage by the auxiliary supply. After the switching time, the voltage has to be within the limit values for the specified class of power.

Five classes for the switching time are defined:

STDC1: switching time less than 1 ms;

STDC2: switching time less than 5 ms;

STDC3: switching time less than 20 ms;

STDC4: switching time less than 200 ms;

STDC5: switching time less than 1 s.

A special class exists for all the cases where the switching time that is not included in the above listed classes.

4.2.3.2.5 Earth connection

One of the following three possibilities for grounding DC power supply should be specified:

- a) positive to earth;
- b) negative to earth;
- c) floating.

4.2.4 EMC requirements

4.2.4.1 General

The requirements for immunity and emission levels regarding electromagnetic compatibility (EMC) are referred to electrical equipment operating with a voltage level lower than 1 000 V a.c. or 1 500 V d.c.

4.2.4.2 Immunity

The general performance criteria for the evaluation of the immunity of the devices are as listed below:

- Class A normal operation, within the specification limits, during the exposure to the EM disturbance
- Class B during the EM exposure temporary degradation, or loss of function or performance which is self-recovering

Class C during the EM exposure temporary degradation, or loss of function or performance which requires operator intervention or system reset

The performance criteria should be applied to each single disturbance to which the device can be exposed. The limit values for every disturbance are reported in the next subclauses.

The base immunity requirements for a generic application are given in Table 4 extracted from IEC 61326-1:2005.

Particular immunity requirements for equipment intended for use in industrial locations are reported in Table 5 (from IEC 61326-1:2005).

Table 4 – Base immunity requirements

Port	Phenomenon	Basic standard	Test value	Performance criteria
Enclosure	Electrostatic discharge (ESD)	IEC 61000-4-2	4 kV/4 kV contact/air	B
	EM field	IEC 61000-4-3	3 V/m (80 MHz to 1 GHz) 3 V/m (1,4 GHz to 2 GHz) 1 V/m (2,0 GHz to 2,7 GHz)	A
AC power (including protective earth)	Voltage dip	IEC 61000-4-11	0 % during half cycle 0 % during 1 cycle 70 % during 25/30 ^e cycles	B B C
	Short interruptions	IEC 61000-4-11	0 % during 250/300 ^e cycles	C
	Burst	IEC 61000-4-4	1 kV (5/50 ns, 5 kHz)	B
	Surge	IEC 61000-4-5	0,5 kV ^a /1 kV ^b	B
	Conducted RF	IEC 61000-4-6	3 V (150 kHz to 80 MHz)	A
DC power ^d (including protective earth)	Burst	IEC 61000-4-4	1 kV(5/50 ns, 5 kHz)	B
	Surge	IEC 61000-4-5	0,5 kV ^a /1 kV ^b	B
	Conducted RF	IEC 61000-4-6	3 V (150 kHz to 80 MHz)	A
I/O signal/control (including lines connected to functional earth port)	Burst	IEC 61000-4-4	0,5 kV ^d (5/50 ns, 5 kHz)	B
	Surge	IEC 61000-4-5	1 kV ^{b, c}	B
	Conducted RF	IEC 61000-4-6	3 V ^d (150 kHz to 80 MHz)	A
I/O signal/control connected directly to mains supply	Burst	IEC 61000-4-4	1 kV(5/50 ns, 5 kHz)	B
	Surge	IEC 61000-4-5	0,5 kV ^a /1 kV ^b	B
	Conducted RF	IEC 61000-4-6	3 V (150 kHz to 80 MHz)	A
^a Line to line. ^b Line to earth (ground). ^c Only in the case of long-distance lines. ^d Only in the case of lines >3 m. ^e "25/30 cycles" means "25 cycles for 50 Hz test" and "30 cycles for 60 Hz test."				

Table 5 – Immunity requirements for industrial applications

Port	Phenomenon	Basic standard	Test value	Performance criteria
Enclosure	Electrostatic discharge (ESD)	IEC 61000-4-2	4 kV/8 kV contact/air	B
	EM field	IEC 61000-4-3	10 V/m (80 MHz to 1 GHz) 3 V/m (1,4 GHz to 2 GHz) 1 V/m (2,0 GHz to 2,7 GHz)	A
	Rated power frequency magnetic field	IEC 61000-4-8	30 A/m ^e	A
AC power	Voltage dip	IEC 61000-4-11	0 % during 1 cycle 40 % during 10/12 ^h cycles 70 % during 25/30 ^h cycles	B C C
	Short interruptions	IEC 61000-4-11	0 % during 250/300 ^h cycles	C
	Burst	IEC 61000-4-4	2 kV (5 kHz)	B
	Surge	IEC 61000-4-5	1 kV ^a /2 kV ^b (1,2/50 µs)	B
	Conducted RF	IEC 61000-4-6	3 V ^f (150 kHz to 80 MHz)	A
DC power ^g	Burst	IEC 61000-4-4	2 kV (5 kHz)	B
	Surge	IEC 61000-4-5	1 kV ^a /2 kV ^b (1,2/50 µs)	B
	Conducted RF	IEC 61000-4-6	3 V ^f (150 kHz to 80 MHz)	A
I/O signal/ control (including functional earth lines)	Burst	IEC 61000-4-4	1 kV (5 kHz) ^d	B
	Surge	IEC 61000-4-5	1 kV ^b , ^c (1,2/50 µs)	B
	Conducted RF	IEC 61000-4-6	3 V ^d , ^f (150 kHz to 80 MHz)	A
I/O signal/ control connected directly to power supply network	Burst	IEC 61000-4-4	2 kV (5 kHz)	B
	Surge	IEC 61000-4-5	1 kV ^a /2 kV ^b (1,2/50 µs)	B
	Conducted RF	IEC 61000-4-6	3 V ^f (150 kHz to 80 MHz)	A
^a Line to line. ^b Line to ground. ^c Only in the case of long-distance lines (see 3.6). ^d Only in the case of lines > 3 m. ^e Only to magnetically sensitive equipment. CRT display interference is allowed above 1 A/m. ^f The test level for the conducted RF test is lower than the level for the EM field test because the conducted RF test simulates the resonance condition at each frequency and is thus a more severe test. ^g DC connections between parts of equipment/system which are not connected to a d.c. distribution network are treated as I/O signal/control ports. ^h "25/30 cycles" means "25 cycles for 50 Hz test" and "30 cycles for 60 Hz test".				

4.2.4.2.1 Electrostatic discharge (ED)

Four installation and environmental classes are defined according to the humidity and the type of material, as Table 6 shows, extracted from IEC 61000-4-2:2008, reports: