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Part 2: Guidance for inspection and routine testing

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Introduction

This draft standard is based on international discussions in which the UK has taken an active part. Your comments on this draft are welcome and will assist in the preparation of the consequent standard. There is a high probability that this text could be adopted by CENELEC as a reference document for harmonization or as a European Standard. Recipients of this draft are requested to comment on the text bearing in mind this possibility.

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Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	(7)
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/ Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



65B/957/CD

COMMITTEE DRAFT (CD)

IEC/TC or SC: 65B	Project number IEC 61131-2 Ed 4.0	
Title of TC/SC: Measurement and control devices	Date of circulation 2014-11-14	Closing date for comments 2015-02-20
Also of interest to the following committees	Supersedes document 65B/932/CD, 65B/955/CC	
Proposed horizontal standard ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the TC/SC secretary		
Functions concerned: ☐ Safety ☐ EMC ☐ Environment ☐ Quality assurance		
Secretary: David Vasko		THIS DOCUMENT IS STILL UNDER STUDY AND SUBJECT TO CHANGE. IT SHOULD NOT BE USED FOR REFERENCE PURPOSES. RECIPIENTS OF THIS DOCUMENT ARE INVITED TO SUBMIT, WITH THEIR COMMENTS, NOTIFICATION OF ANY RELEVANT PATENT RIGHTS OF WHICH THEY ARE AWARE AND TO PROVIDE SUPPORTING DOCUMENTATION.

Title: IEC 61131-2 Ed 4.0: Industrial-process control systems - Instruments with analogue inputs and two- or multi-state outputs - Part 2: Guidance for inspection and routine testing

(Titre) :

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PROGRAMMABLE CONTROLLERS –

Part 2: Equipment requirements and tests

FOREWORD

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International Standard IEC 61131-2 has been prepared by subcommittee 65B: Measurement and control devices, of IEC technical committee 65: Industrial-process measurement, control and automation.

This fourth edition cancels and replaces the third edition published in July 2007.

IEC 61131-2 consists of the following parts, under the general title: Industrial-process measurement and control –

- | | |
|---------|---|
| Part 1: | General information |
| Part 2: | Equipment requirements and tests |
| Part 3: | Programming languages |
| Part 4: | User guidelines |
| Part 5: | Communications |
| Part 6: | Functional safety |
| Part 7: | Fuzzy control programming |
| Part 8: | Guidelines for the application and implementation of languages for programmable controllers |
| Part 9: | Single-drop digital communication interface for small sensors and actuators (SDCI) |

This edition constitutes a technical revision.

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

- a) Removal of safety requirements and instead pointing to IEC 61010-2-201
- b) Addition of negative logic digital inputs and outputs
- c) Addition of Type 3-d digital input
- d) Addition of 2,7-6GHz requirement for Radio-frequency Electro-magnetic Amplitude modulated Immunity
- e) Clarification of temperature testing
- f) Clarification of type testing
- g) Deprecation of certain technologies

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

FDIS	Report on voting
65B/xxx/FDIS	65B/xxx/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.

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

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

The National Committees are requested to note that for this publication the stability date is **20XX**.

THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED AT THE PUBLICATION STAGE.

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.

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INTRODUCTION

IEC 61131-2 is part of a series of standards on programmable controllers and the associated peripherals and should be read in conjunction with the other parts of the series.

Where a conflict exists between this and other IEC standards, the provisions of this standard should be considered to govern in the area of programmable controllers and their associated peripherals.

Service and physical environment requirements are specified in Clause 5. Functional requirements are specified in Clause 6. Electromagnetic compatibility requirements are specified in Clause 8. Safety requirements are specified in IEC 61010-2-201:2013, this replaces the requirements of Clause 12, 13 and 14 of the previous IEC 61131-2:2007.

INDUSTRIAL-PROCESS MEASUREMENT AND CONTROL – PROGRAMMABLE CONTROLLERS –

Part 2: Equipment requirements and tests

1 Scope

This part of IEC 61131 specifies functional and electromagnetic compatibility requirements and related verification tests for control equipment of the following types:

- Programmable controllers (PLC and PAC)
- the components of remote I/O - systems
- Programming and Debugging Tools (PADTs)
- Human-Machine Interfaces (HMI)
- any product performing the function of PLC and/or PAC and/or their associated peripherals which have as their intended use the control and command of machines, automated manufacturing and industrial processes, e.g. discrete, batch and continuous control.

Note Industrial PC (computers) and the components of Distributed Control Systems (DCS) may also utilize this standard as they are part of the suite of control equipment peripherals which have as their intended use the control and command of machines, automated manufacturing and industrial processes, e.g. discrete, batch and continuous control.

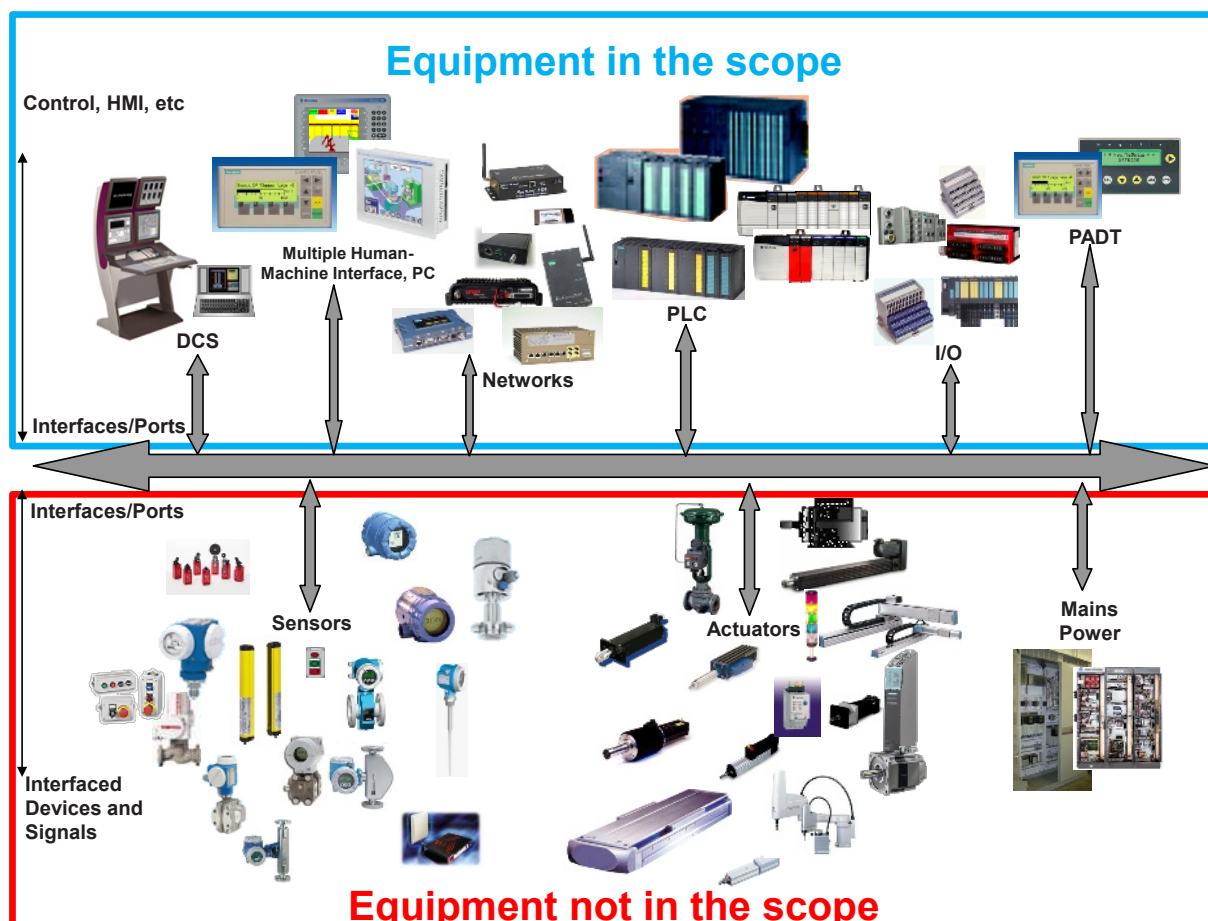


Figure 1 – Equipment in the scope and not in the scope

Components of the above named equipment and in the scope of this standard are:

- (auxiliary) stand-alone power supplies
- peripherals such as digital and analog I/O
- industrial network equipment

Control equipment and their associated peripherals are intended to be used in an industrial environment and may be provided as open or enclosed equipment.

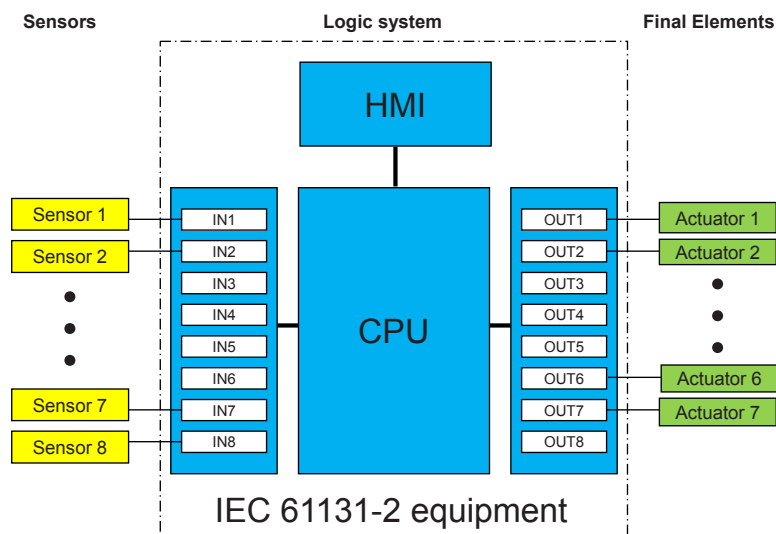


Figure 2 – Generalized equipment in the scope

Control equipment and their associated peripherals are intended to be used in an industrial environment and may be provided as open or enclosed equipment. If control equipment or its associated peripherals are intended for use in other environments (light industrial, commercial, residential), then the specific requirements, standards and installation practices for those other environments should be additionally applied to the control equipment and its associated peripherals.

This standard also applies to any products performing the function of control equipment and/or their associated peripherals.

Equipment covered in this standard is intended for use in overvoltage category II (IEC 60664-1) in low-voltage installations, where the rated equipment supply voltage does not exceed a.c. 1 000 V r.m.s. (50/60 Hz), or d.c. 1 500 V. (If control equipment or their associated peripherals are applied in overvoltage category III installations, then additional analysis will be required to determine the suitability of the equipment for those applications.)

This standard does not deal with the functional safety of control equipment used as the logic solver element of a functional safety system. For those requirements refer to IEC 61131-6.

The object of this standard is

- to establish the definitions and identify the principal characteristics relevant to the selection and application of control equipment and their associated peripherals;
- to specify the minimum requirements for functional, electrical, mechanical, environmental and construction characteristics, service conditions, EMC, user programming and tests applicable to control equipment and the associated peripherals.

This standard also specifies

- a) service (operating, storage and transportation) requirements for control equipment and their associated peripherals (Clause 5);
- b) functional requirements for control equipment and their associated peripherals (Clause 6);
- c) EMC requirements for control equipment and their associated peripherals (Clause 8);
- d) information that the manufacturer is required to supply (Clause 10);
- e) test methods and procedures that are to be used for the verification of compliance of control equipment and their associated peripherals with the requirements (Clauses 7 and 9).

Safety requirements for control equipment and their associated peripherals are specified in IEC 61010-2-201.

The requirements of ISO/IEC Guide 51 and IEC Guide 104, as they relate to this Part, are incorporated herein.

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.

Editor's note: double check these at final version

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2: Tests – Tests B: Dry heat*

IEC 60068-2-6:2007, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-14:2009, *Environmental testing – Part 2: Tests – Test N: Change of temperature*

IEC 60068-2-27:2008, *Environmental testing – Part 2: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30:2005, *Environmental testing – Part 2: Tests – Test Db: Damp heat, cyclic (12 h + 12-hour cycle)*

IEC 60068-2-31:2008, *Environmental testing – Part 2: Tests – Test Ec: Drop and topple, Rough handling shocks, primarily for equipment-type specimens*

IEC 60417, *Graphical symbols for use on equipment*

IEC 60529:2013, *Degrees of protection provided by enclosures (IP Code)*

IEC 60947-5-1:2009, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 60947-5-2:2012, *Low-voltage switchgear and controlgear – Part 5-2: Control circuit devices and switching elements – Proximity switches*

IEC 60947-7-1:2009, *Low-voltage switchgear and controlgear – Part 7-1: Ancillary equipment – Terminal blocks for copper conductors*

IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3:2010, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated radio-frequency electromagnetic field immunity test*

IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test*

IEC 61000-4-5:2005, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances induced by radio-frequency fields*

IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-11:2004, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity test*

- 499 IEC 61000-4-18:2011, *Electromagnetic compatibility (EMC) – Part 4-18: Testing and measure-*
500 *ment techniques – Damped oscillatory waves immunity test*
- 501 IEC 61000-4-29:2000, *Electromagnetic compatibility (EMC) – Part 4-29: Testing and measure-*
502 *ment techniques – Voltage dips, short interruptions and voltage variations on d.c. input power*
503 *port immunity test*
- 504 IEC 61000-6-1:2005, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards –*
505 *Immunity for residential, commercial and light-industrial environments*
- 506 IEC 61000-6-2:2005, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards –*
507 *Immunity for industrial environments*
- 508 IEC 61000-6-4:2011, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards –*
509 *Emission standard for industrial environments*
- 510 IEC 61010-2-201:2013, *Safety requirements for electrical equipment for measurement,*
511 *control, and laboratory use – Part 2-201: Particular requirements for control equipment*
- 512 IEC 61131-1:2003, *Programmable controllers – Part 1: General information*
- 513 IEC 61131-3:2013, *Programmable controllers – Part 3: Programming languages*
- 514 IEC 61131-4:2004, *Programmable controllers – Part 4: User guidelines*
- 515 IEC 61158:2???, *Industrial communication networks - Fieldbus specifications – all parts*
- 516 IEC 61784:2???, *Industrial communication networks - Profiles – all parts*
- 517 CISPR 11
- 518 CISPR 14-1:2011, *Electromagnetic compatibility – Requirements for household appliances,*
519 *electric tools and similar apparatus – Part 1: Emission*
- 520 CISPR 16-1-2:2014, *Specification for radio disturbance and immunity measuring apparatus*
521 *and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Ancillary*
522 *equipment – Conducted disturbances*
- 523 CISPR 16-1-4:2012, *Specification for radio disturbance and immunity measuring apparatus*
524 *and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Ancillary*
525 *equipment – Radiated disturbances*
- 526 CISPR 16-2-1:2014, *Specification for radio disturbance and immunity measuring apparatus*
527 *and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted*
528 *disturbance measurements*
- 529 CISPR 16-2-3:2014, *Specification for radio disturbance and immunity measuring apparatus*
530 *and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated*
531 *disturbance measurements*
- 532 **3 Terms, definitions, abbreviated terms, acronyms, conventions and symbols**
- 533 **3.1 Terms and definitions**
- 534 For the purposes of this document, the terms and definitions given in IEC 61131-1 and the
535 following apply.
- 536 **3.1.1**
- 537 **analog input**
- 538 device which converts a continuous signal to a discretely valued multi-bit binary number, for
539 use by the system

3.1.2**analog output**

device which converts a multi-bit binary number from the system to a continuous signal

3.1.3**battery**

electrochemical energy source which may be rechargeable or non-rechargeable

3.1.4**coating, protective**

covering of suitable insulating material that encloses the clearance and/or creepage distance of the printed wiring board and conforms to the surface of the board in such a manner that the environment is excluded and the clearance and/or creepage distance can withstand the required impulse and continuous potential

3.1.5**current sinking**

property of receiving current

3.1.6**current sourcing**

property of supplying current.

3.1.7**d.c. power network**

local electricity supply network in the infrastructure of a certain site or building intended for flexible use by one or more different types of equipment and guaranteeing continuous power supply independently from the conditions of the public mains network

3.1.8**digital input, type 1**

device for sensing signals from mechanical contact switching devices, such as relay contacts, push-buttons, switches, etc. Converts an essentially two-state signal to a single-bit binary number

NOTE Type 1 digital inputs may not be suitable for use with solid-state devices such as sensors, proximity switches, etc.

3.1.9**digital input, type 3**

device for sensing signals from solid-state switching devices such as 2-wire proximity switches. Converts an essentially two-state signal to a single-bit binary number

NOTE 1 This class could also be used for Type 1 applications.

NOTE 2 Type 3 digital inputs offer lower power characteristics than Type 2 digital inputs. Generally, this allows much higher input channel densities per module or product. Type 3 differs from Type 2 in that it is compatible with those IEC 60947-5-2 devices that offer low current in the off state. See Table 9 for details of operating ranges. Proximity switch compatibility is such that a high percentage of proximity switches having Type 2 compatibility will also have Type 3 compatibility.

3.1.10**digital output**

device which converts a single-bit binary number to a two-state signal

3.1.11**earth**

conducting mass of the Earth, whose electric potential at any point is conventionally taken as zero

[IEV 195-01-01]

3.1.12**EMC (electromagnetic compatibility)**

ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

[IEV 161-01-07]

3.2**enclosed equipment**

equipment which is enclosed on all sides with the possible exception of its mounting surface to prevent personnel from accidentally touching live or moving parts contained therein and to protect the equipment against ingress of medium-size solid foreign bodies, and meeting requirements of mechanical strength, flammability, and stability (where applicable). Protection degree shall be $\geq$ IP20

3.2.1**enclosure**

housing affording the type and degree of protection suitable for the intended application

[IEV 195-02-35]

3.2.2**equipment under test (EUT)**

representative configuration(s), as defined by the manufacturer, used for type tests (see clause 4.2)

3.2.3**external wiring**

wiring of the system equipment, which is installed by the user

3.2.4**field wiring**

external wiring

3.2.5**fixed equipment**

equipment fastened to a support, or otherwise secured in a specific location

[SOURCE: [IEC 60050-826:2004, 826-16-07, modified]]

3.2.6**functional earthing conductor**

conductor that is in electrical contact with the Earth or earth palne, for purposes of interference immunity improvement

3.2.7**hand-held equipment**

equipment which is intended to be held in one hand while being operated with the other hand

3.2.8**immunity (to a disturbance)**

ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[IEV 161-01-20]

NOTE Not used exclusively to refer to EMC in this standard. It may also refer, for example, to vibration, humidity, etc.

3.2.9**immunity type test (immunity test)**

type test verifying that the equipment operation is not altered by the application of specified influencing quantities that are intended to approximate normal operation

3.2.10**interface**

shared boundary between a considered system and another system, or between parts of a system, through which information or electrical energy is conveyed

3.2.11**internal wiring**

wiring which is inside the equipment, which is installed by the manufacturer

3.2.12**isolated (devices, circuits)**

devices or circuits without galvanic connection between them

3.2.13**module**

part of the system containing an identified function(s) (MPU(CPU), analog input, etc.), which may plug into a backplane or base

3.2.14**multi-channel module**

module containing multiple input and/or output signal interfaces which could be isolated or not isolated from each other

3.2.15**normal use**

operation, including stand-by, according to the instructions for use or for the obvious intended purpose

NOTE Normal service conditions are stated in Clause 5.

3.2.16**open equipment**

equipment that may have live electrical parts accessible, for example, a main processing unit. Open equipment should be incorporated into other assemblies manufactured to provide safety

3.2.17**operator**

person commanding and monitoring a machine or process through an HMI connected to the control equipment. The operator does not change the control equipment hardware configuration, software or the application programme. Control equipment is not intended for use by untrained personnel. The operator is assumed to be aware of the general hazards in an industrial environment

3.2.18**overvoltage category (of a circuit or within an electrical system)**

classification based on limiting (or controlling) the values of prospective transient overvoltages occurring in a circuit (or within an electrical system having different nominal voltages) and depending upon the means employed to influence the overvoltages.

[IEC 60664-1, 1.3.10, modified]

NOTE 1 In an electrical system, the transition from one overvoltage category to another of lower category is obtained through appropriate means complying with interface requirements. These interface requirements may be an overvoltage protective device or a series-shunt impedance arrangement capable of dissipating, absorbing, or

679 diverting the energy in the associated surge current, to lower the transient overvoltage value to that of the desired
680 lower overvoltage category.

681 NOTE 2 Equipment covered in this standard is intended for use in overvoltage category II.

682 3.2.19

683 permanent installation

684 portion of the system that can only be connected to or disconnected from the system by the
685 use of a tool

686 Adapted from [IEV 151-11-29]

687 NOTE See Annex A.

688 3.2.20

689 port

690 access to a device or network where electromagnetic energy or signals may be supplied or
691 received or where the device or network variables may be observed or measured

692 NOTE Most commonly used with respect to EMC.

693 [IEV 131-12-60]

694 3.2.21

695 portable equipment

696 enclosed equipment that is moved while in operation or which can easily be moved from one
697 place to another while connected to the supply

698 NOTE Examples are programming and debugging tools (PADTs) and test equipment (TE).

699 3.2.22

700 public mains

701 power from the conductors/mains of the permanent installation of the building

702 3.2.23

703 total output current (of an output module)

704 current that a multi-channel module operating at the most adverse combination of normal
705 operation can supply without any part of it (insulation, terminals, exposed conductive parts,
706 etc.) exceeding the specified temperature limits

707 NOTE For a multi-channel module, the total output current is generally less than the sum of the output currents of
708 the channels.

709 3.2.24

710 type test

711 conformity test made on one or more items representative of the production

712 [IEV 151-16-16]

713 3.2.25

714 unit

715 integral assembly (which may consist of modules plugged in or otherwise connected within
716 the assembly) connected to other units within the system by means of cables for permanently
717 installed units and cables or other means for portable units

718 3.2.26

719 withstand type test (withstand test)

720 type test verifying that the application of more severe influencing quantities to the equipment
721 does not impair its ability to assume its intended mission

722 3.3 Abbreviated terms, acronyms, conventions and symbols

723 Acronym	Description
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724 BCD	Binary-Coded decimal
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725	CDN	coupling/decoupling network
726	CISPR	Comité International Spécial des Perturbations Radioélectriques (CISPR;
727		English: Special International Committee On Radio Interference)
728	CMRR	Common-Mode Rejection Ratio
729	CMV	Common-Mode Voltage
730	CPU	Central Processing Unit
731	DCS	Distributed Control System
732	DIN	Deutsches Institut für Normung
733	EMC	Electromagnetic Compatibility
734	EMI	Electromagnetic Interference
735	ESD	Electrostatic Discharge
736	EU	European Union
737	EUT	Equipment Under Test
738	HMI	Human Machine Interface
739	I/O	Input/Output
740	IEC	International Electrotechnical Commission
741	IEV	International Electrotechnical Vocabulary
742	ISO	International Organization for Standardization
743	LOP	List of Properties
744	LSB	Least Significant Bit
745	MOV	Metal Oxide Varistor
746	MPU	Main Processing Unit
747	MTBF	Mean Time Between Failures
748	NC	Normally Closed
749	NO	Normally Open
750	PAC	Programmable automation controller
751	PADT	Programming and Debugging Tool
752	PC	Personal Computer
753	PELV	Protected Extra-Low Voltage
754	PFVP	Proper Functioning Verification Procedures
755	PLC	Programmable Logic Controller
756	RC	Resistor Capacitor
757	RFI	Radio-Frequency Interference

758	RIOS	Remote input/output Station
759	RMS	Root Mean Square
760	RTD	Resistive Temperature Device
761	SDCI	Single-drop Digital Communication Interface
762	SELV	Safety Extra-Low Voltage
763	TE	Test Equipment
764	USB	Universal Serial Bus

765 **4 Compliance and type tests**

766 **4.1 Compliance with this standard**

767 Compliance to this standard can be claimed in a number of ways.

768 1) Complete compliance to this standard:

769 “compliant to IEC 61131-2”

770 This means the equipment complies with all clauses.

771 2) Compliance to a clause or clause(s) statement:

772 “Compliant to IEC 61131-2 clause 9” or

773 “Compliant to IEC 61131-2 clause 6.2 and 9”

774 This means the equipment complies with only the clauses stated.

775 3) Compliance to functionality statement:

776 “Functionality: Digital Input Type 3 according to IEC 61131-2” and/or

777 “Temperature: 60C according to IEC 61131-2”

778 This means the equipment complies with the functionality item stated as defined in this
779 standard.

780 One exception is clause 8, Electromagnetic compatibility (EMC) requirements. It is mandatory
781 all equipment complies with this clause.

782 When the normal service conditions are different than the specifications given in clauses 5.3,
783 5.4 and 5.5 or other adverse environmental conditions exist the manufacturer should be
784 consulted to determine suitability of the equipment or the steps to be taken for proper
785 installation and utilization.

786 Where the manufacturer is allowed to select among several options for normal service
787 conditions, catalogues and/or datasheets shall clearly specify which option the equipment has
788 been evaluated against. This applies to operating temperature ranges, severity classes of
789 voltage dips (e.g. PS1 or PS2), and types of digital inputs (e.g. Type 1 or Type 3).

790 **4.2 Type tests**

791 The object of this clause is to define how to verify compliance of the control equipment and
792 the associated peripherals with the requirements set forth in this standard. This compliance
793 verification includes

794 – verification by type tests given in Clauses 7 and 9;

795 – verification by suitable examination, visual inspection or/and measurement.

796 These tests are qualification tests and not tests related to the ways control equipment is
797 employed. According to the scope of this standard, the above compliance verification may not
798 cover the verification of the ability of the system to satisfy the intended automated system
799 requirements.

800 NOTE Peripherals, used in the same environment as the system, should meet the same requirements as
801 the system.

4.2.1 Equipment to be tested (equipment under test/EUT)

Systems span the range from stand-alone products to modular designs; this leads to an infinite variety of user-built actual system configurations. For obvious practical reasons, in most cases type tests cannot be conducted on EUT identical to user-built systems, and engineering judgement is necessary. Therefore, the manufacturer is required to define the EUTs and document the corresponding test plan and test programmes to meet the following principles.

Combination of tests/EUTs/test programmes shall be such that one may reasonably think that any configuration built by the user according to the manufacturer's specifications and installation instructions would pass satisfactorily the same tests, and will properly function in normal operation, which these tests are intended to reflect.

Unless otherwise specified in this standard, the manufacturer may elect to use various EUTs to achieve the objectives of a given type test.

If an EUT representing a system or a remote I/Os (RIOS) is of modular structure, it shall fulfil the following minimum requirement.

All types of modules shall be represented in one (1) or several EUT configurations in which any mix of modules is permissible.

All types of modules shall be configured in the EUTs and tested at least once.

NOTE It may be appropriate to consider statistical criteria based on samples for a large number of I/Os (for example, >100).

If there are too many families to be included into a single EUT, the manufacturer shall define several EUTs as follows.

- For the type test of a family with very similar modules (i.e. modules using the same schematic and basic manufacturing and differing mainly by, for example, the number of inputs and outputs), the manufacturer may elect to include in the system only one (1) arbitrarily chosen member of the family. If the type test is dependent on the differences between the modules, then a single family member shall not be used.
- Appropriate catalogued options, such as power supply units, application memory(ies), processing unit(s) etc. shall be used to build the relevant EUT(s).
- If a local bus extension is part of the system and if its maximum cable length cable is less than, or equal to, 3 m, it is considered to be an internal EQUIPMENT bus. As such, it should not be considered a port for test.
- If a local bus extension is part of the system and is capable of driving cables with a length of >3 m, then only one (1) end of the link is part of the EUT and it is considered as a communication port.

When new units/modules are introduced after initial release of a system catalogue, which has already been satisfactorily tested according to this standard, EUT(s) simpler than those originally used can be defined. This is only permissible if such EUTs and the associated test programmes provided by the manufacturer allow proper verification as if these new units/modules had been tested within the originally tested EUTs.

Unless otherwise specified in this standard, the manufacturer may elect either that each type test be conducted on a new EUT or that several type tests be performed successively on the same EUT.

Certain tests can be easily targeted at a single item, others are more appropriate to a set of items configured together. Equipment to be tested shall reflect this need. See specific test clauses for recommendations for EUTs.

4.2.2 Special features for immunity and EMC tests

Interfaces/ports shown are meant to represent major/example links, not all links. Most EUTs will have multiple interface/ports active during testing.

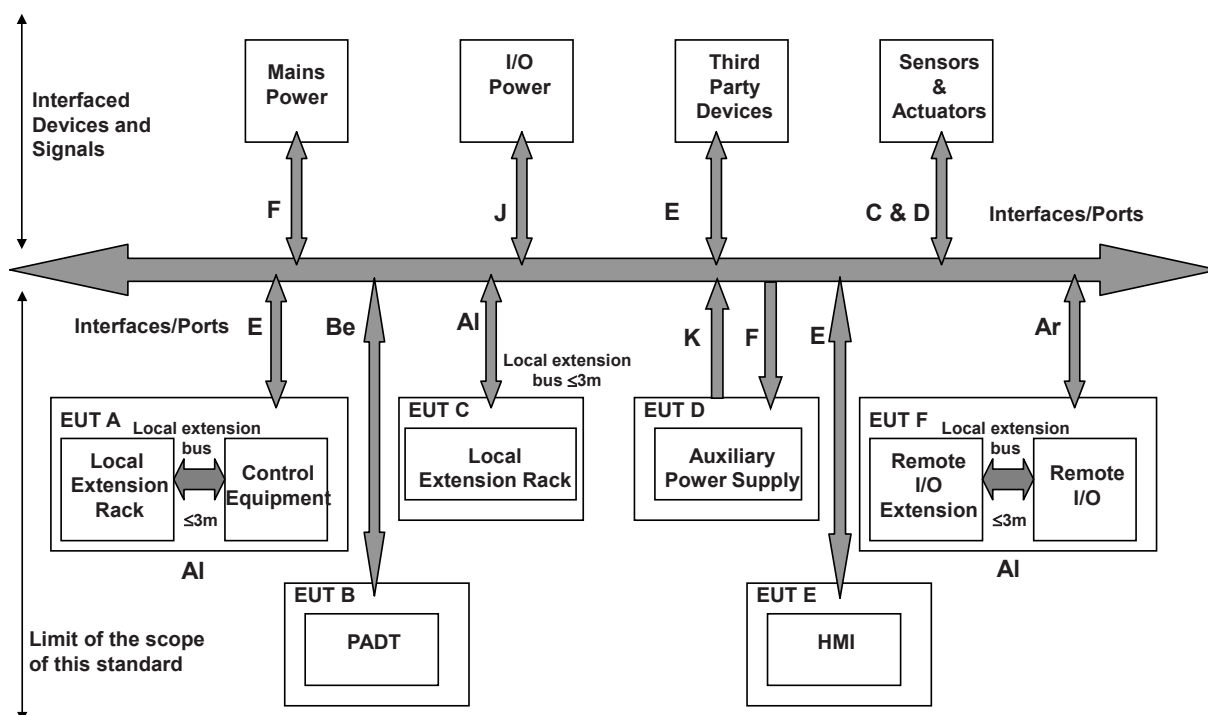


Figure 3 – EUT configurations

Each subpart of the system as shown in Figure 4 may constitute an EUT represented as EUT A, B, C, D, E and/or F. To exercise the different ports of each EUT, the manufacturer may define subsystems and the different EUTs are tested in turn.

Only one (1) subsystem is under test at any time, the others being considered as auxiliary equipment.

For example, to achieve a given test on the EUT A, equipment of the other EUTs may be connected but are not in the test bed.

For example, to check the electrical interference immunity of the system, the manufacturer may choose between the following, as applicable:

- to build a single global EUT including the PADT/TE/RIOSs, and check the whole configuration; or
- to define a suite of simpler EUTs (for example, a system without any PADT/TE/RIOS, and a single PADT and a single RIOS and a single PADT and a single TE, or any other suite of partial combinations of them which make sense) but correspondingly exercise the appropriate ports of each EUT with an equipment part of the test bed (the laboratory equipment necessary to test the EUT) as would do the missing PADT/TE/RIOSs. For practical reasons, the manufacturer may elect to use actual PADTs/TEs/RIOSs to exercise the EUT ports.

At least one (1) of each type or a representative number of I/O ports of the EUT shall be connected and be functional.

A selection of the representative functional modes shall be made considering that only the most typical functions of the EQUIPMENT can be tested.

4.2.3 Withstand test conditions

In general, the module which is in the manufacturer's catalogue should be tested alone, providing that mixing several modules does not affect the result of the test. Those clauses dealing with withstand tests for specifics should be referred to.

4.2.4 Verification procedure

Type tests shall be conducted on the EUT(s) defined in 4.2.1, unless otherwise specified.

For each test, the manufacturer shall

- specify how this configuration shall be installed and externally connected;
- provide the suitable test programmes which shall be run during the test;
- provide the proper operation verification procedure including the way to measure accuracy and temporary deviations of analog I/Os.

The appropriate test programmes and proper functioning verification procedures provided by the manufacturer shall satisfy the requirements given in 4.2.5.

4.2.5 Requirements for test programmes and proper functioning verification procedures (PFVPs) to be provided by the manufacturer

During the type tests, there shall be no

- destruction of hardware, unless required by the test;
- modification of the operating system and test programmes and/or alteration of their execution;
- unintended modification of system and application data stored or exchanged;
- erratic or unintended behaviour of the EUT;
- deviation of the analog I/Os out of the limits specified in item 4 of 10.1.8.2 and item 3 of 10.1.9.2.

All relevant functions and parts of the EUT (i.e. units and modules) shall be functioning in such a way that the information paths to/from these functions and parts are exercised.

All the I/O and communication channels of the EUT shall be exercised.

NOTE It is acceptable to apply statistical criteria based on samples, for large number of I/Os, etc. (for example, >100).

All external and internal product status information reporting means, such as displays, lamps, alarm signals, self-test result registers, shall be exercised. The test procedures shall include conditions to verify the related activities.

All various system operation modes significant for the user's implementation such as start-up and shut-down, cold/warm/hot restart, "normal run", "normal stop", "programme/ monitor with PADTs", etc., as applicable, shall be verified for performance and behaviour.

Initialization and reset conditions of all system components shall be checked for controlled start-up and shut-down. The various modes, such as "run", "programme", "monitor", shall be verified for performance and behaviour.

Any special feature/performance not covered in this standard but necessary for the proper operation of the system shall be exercised and tested.

4.2.6 General conditions for tests

The tests shall be carried out in accordance with the appropriate test procedure.

The tests shall be carried out under the general test conditions given in Table 1, unless otherwise specified.

Unless otherwise specified, no sequence is imposed for type tests.

Table 1 – General conditions for tests

	Test conditions
Equipment power supply	Rated voltage and frequency
Temperature	15 °C to 35 °C
Relative humidity	≤75 %
Barometric pressure	86 kPa to 106 kPa (650 mm Hg to 800 mm Hg)
Output loads	Outputs loaded to rated load
Pollution	Pollution degree 2

4.3 Test report

A test report shall be created for documenting the testing and verification of the equipment.

The test report shall describe all the tests, the rationale for the selection of the typical (representative) configuration of the EUT and the test results.

The EUT software used during the test shall be documented.

5 Normal service conditions and requirements

5.1 General

The equipment is intended to be used in an industrial environment.

Service conditions encompass operating, transport and storage.

5.2 Special conditions and requirements

When the service conditions are outside those given in 5.3, 5.4, 5.5 and 0 or other adverse environmental conditions exist (for example, extra-low temperature operation or storage, higher altitude operation or transportation, wider voltage range, air pollution by dust, smoke, corrosive or radioactive particles, vapours or salts, attack by fungi, insects or small animals), the manufacturer should be consulted to determine suitability of the equipment or the steps to be taken for proper installation and utilization.

5.3 Climatic operating conditions and requirements

5.3.1 Operating air temperature

Operating air temperature and surrounding air temperature are equivalent terms.

At a minimum, the equipment shall be suitable for operating temperature ranges stated as temperature severity class 1 (TSV1) in Table 2. Equipment may also be suitable for extended operating temperature ranges. Refer to Table 2, for additional accepted temperature ranges.

Table 2 – Operating air temperature

Temperature Severity Class	Equipment Type	Max Temp	Min. Temp
TSV1	Enclosed	40 °C	5 °C
	Open	55 °C	5 °C
TSV2	Enclosed	45 °C	0 °C
	Open	60 °C	0 °C
TSV3	Enclosed	50°C	-5 °C
	Open	65 °C	-5 °C
TSV4	Enclosed	55°C	-10 °C
	Open	70 °C	-10 °C
TSV5	Enclosed	60°C	-15 °C
	Open	70 °C	-25 °C
Note Table based on guidance from IEC 60721-3-3 to 5 and historical experience. Homework to adjust the table			

The requirements of this subclause are verified in accordance with 7.3 and 7.3.1.

5.3.2 Relative humidity

The equipment shall be suitable for a relative humidity level from 10 % to 95 %, non-condensing.

The requirements of this subclause are verified in accordance with 7.3.2.

5.3.3 Altitude

The equipment shall be suitable for operation up to 2 000 m (minimum 79.5 kPa).

If the equipment is rated at an altitude greater than 2000 m, the operating temperature shall be multiplied by the applicable factor of Table 3

Table 3 – Multiplication factors for operating temperature of equipment rated for operation at altitudes up to 5000m

Rated operating altitude m	Operating temperature multiplication factor
Up to 2000	1,00
2001 to 3000	0,88
3001 to 4000	0,78
4001 to 5000	0,68
NOTE These factors compensate for the reduction in cooling capacity of air at higher altitudes, due to lower density.	

No verification required.

5.4 Mechanical operating conditions and requirements

Experience shows that equipment meeting these requirements is suitable for industrial use.

For the purpose of this standard, the operating conditions are indirectly defined by the following requirements which apply to fixed equipment as well as to unpackaged portable and hand-held equipment (see exceptions in 5.4.2). They do not apply to equipment containing assemblies outside the scope of this standard.

Fixed equipment is equipment which is part of the permanent installation.

5.4.1 Vibrations

Immunity requirements are as shown in Table 4.

Table 4 – Sinusoidal vibration conditions

Displacement	3,5 mm constant displacement, $5 \leq f < 8,5$ Hz
Acceleration	10m/s^2 (1 g) constant acceleration, $8,5 \leq f \leq 150$ Hz
All amplitude figures are peak values. The break point frequency should be adjusted to yield a smooth cross-over without discontinuity from the constant amplitude displacement requirement to the constant amplitude acceleration requirement. NOTE $g_n = 10\text{m/s}^2$	

Vibration is applicable to each 3 mutually perpendicular axes.

The requirements of this subclause are verified in accordance with 7.4.1.

5.4.2 Shock

Immunity requirements are occasional excursions to 150m/s^2 (15 g), 11 ms, half-sine, in each of 3 mutually perpendicular axes.

Electromechanical relays may temporarily respond to 150m/s^2 (15 g) shocks. Temporary malfunctioning is allowed during the test, but equipment should be fully functional after the test.

The requirements of this subclause are verified in accordance with 7.4.2.

5.4.3 Free falls (portable and hand-held equipment)

Immunity requirements for free falls are as shown in Table 5.

Table 5 – Free fall on concrete floor for portable and hand-held equipment

	Portable and hand-held (any weight) (withstand)	Hand-held (any weight) (immunity)	Normative items
Random drops		1 000 mm; 2 trials	1, 2, 4
Flat drops	100 mm; 2 trials		1, 4
Supported drops	30° or 100 mm; 2 trials		1, 3, 4
¹ Caution: temporary malfunctioning is allowed at the impact, but equipment shall be fully functional after the test. Therefore, if equipment is operating during the fall, erroneous operation could be introduced upon impact which may require operator correction. ² From prescribed altitude (normal position of use) Free fall test is for hand-held and portable equipment only. Fixed equipment does not require testing. During test it is allowed to use new sample for each drop of the equipment. The equipment may show signs of physical damage, but should continue to operate as intended after each drop. Table 19. ³ See Free fall test is for hand-held and portable equipment only. Fixed equipment does not require testing. During test it is allowed to use new sample for each drop of the equipment. The equipment may show signs of physical damage, but should continue to operate as intended after each drop. Table 19. ⁴ Random drops are drops on any edge, surface or corner. Flat drops are only on surfaces. Supported drops are only on edges.			

Free fall type tests are required and may be combined with the safety evaluation according to IEC 61010-2-201.

The requirements of this subclause are verified in accordance with 7.4.3.