Programmable controllers –

Part 2:
Equipment requirements and tests

Automates programmables –

Partie 2:
Spécifications et essais des équipements
Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

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Part 2:
Equipment requirements and tests

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PROGRAMMABLE CONTROLLERS –
Part 2: Equipment requirements and tests

FOREWORD

1. The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations having liaisons with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2. The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.

3. The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.

4. In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

5. The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

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

This second edition of IEC 61131-2 cancels and replaces the first edition published in 1992 and constitutes a technical revision.

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

<table>
<thead>
<tr>
<th>FDIS</th>
<th>Report on voting</th>
</tr>
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<tbody>
<tr>
<td>65B/470A/FDIS</td>
<td>65B/481/RVD</td>
</tr>
</tbody>
</table>

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.

IEC 61131 consists of the following parts under the general title Programmable controllers:

Part 1: General information
Part 2: Equipment requirements and tests
Part 3: Programming languages
Part 4: User guidelines
Part 5: Communications
Part 6: Reserved
Part 7: Fuzzy control programming
Part 8: Guidelines for the application and implementation of programming languages
The committee has decided that the contents of this publication will remain unchanged until 2007. At this date, the publication will be

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

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

This part of IEC 61131 constitutes Part 2 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 (except basic safety standards), the provisions of this standard should be considered to govern in the area of programmable controllers and their associated peripherals.

Compliance with Parts 1 and 2 of this standard cannot be claimed unless the requirements of 7.2 of this part are met.

Service and physical environment requirements are specified in Clause 4. Functional requirements are specified in Clause 5. Electromagnetic compatibility requirements are specified in Clause 8. Safety requirements are specified in Clause 11.

Terms of general use are defined in Part 1 of this standard. More specific terms are defined in each part.
1 General

1.1 Scope and object

This Part of IEC 61131 specifies requirements and related tests for programmable controllers (PLC) and their associated peripherals (for example, programming and debugging tools (PADTs), human-machine interfaces (HMIs), etc.) which have as their intended use the control and command of machines and industrial processes.

PLCs and their associated peripherals are intended to be used in an industrial environment and may be provided as open or enclosed equipment. If a PLC or its associated peripherals are intended for use in other environments, then the specific requirements, standards and installation practices for those other environments must be additionally applied to the PLC and its associated peripherals.

This standard also applies to any products performing the function of PLCs 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 mains supply voltage does not exceed a.c. 1 000 V r.m.s. (50/60 Hz), or d.c. 1 500 V. (If PLCs 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 or other aspects of the overall automated system. PLCs, their application programme and their associated peripherals are considered as components of a control system.

Since PLCs are component devices, safety considerations for the overall automated system including installation and application are beyond the scope of this standard. However, PLC safety as related to electric shock and fire hazards, electrical interference immunity and error detecting of the PLC-system operation (such as the use of parity checking, self-testing diagnostics, etc.), are addressed. Refer to IEC 60364 or applicable national/local regulations for electrical installation and guidelines.

The object of this standard is

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

This Part also specifies

a) service, storage and transportation requirements for PLCs and their associated peripherals (Clause 4);
b) functional requirements for PLCs and their associated peripherals (Clause 5);
c) EMC requirements for PLCs and their associated peripherals (Clause 8);
d) safety requirements for PLCs and their associated peripherals (Clause 11);
e) information that the manufacturer is required to supply (Clauses 7, 10 and 13);

f) test methods and procedures that are to be used for the verification of compliance of PLCS and their associated peripherals with the requirements (5.12, 8.5, 11.18 and Clause 13).

The tests are type tests or production routine tests, and not tests related to the ways PLC systems are applied.

1.2 Compliance with this standard

When compliance with this Part of IEC 61131 is indicated without qualification, compliance with all clauses, including all tests and verifications required in this part, must be verified. Moreover, the manufacturer’s obligations expressed in this part are not waived if no type test is required, or if the test conditions are restricted for practical reasons.

When compliance with some portion of this Part of IEC 61131 is indicated, it is only necessary to verify compliance with those clauses against which the compliance claim is made. The manufacturer’s obligations as indicated above are still applicable. The smallest unit of this part for compliance purposes shall be a clause, such as Clauses 5, 8 or 11.

Compliance with a portion of this Part of IEC 61131 is provided to facilitate efforts with respect to particular conformity assessment requirements (for example, Clause 8 as the compliance requirement for the EU electromagnetic compatibility directive or Clause 11 as the compliance requirement for the EU low-voltage directive).

Compliance with constructional requirements and with requirements for information to be provided by the manufacturer shall be verified by suitable examination, visual inspection and/or measurement.

All requirements not tested according to the clauses on tests and verifications shall be verifiable under a procedure to be agreed to by the manufacturer and the user.

The manufacturer shall provide, on request, compliance verification information for all requirements referenced in the claims of compliance with all or a portion of this Part of IEC 61131.

It is the manufacturer’s responsibility to ensure that delivered PLC equipment and associated peripherals are equivalent to the sample(s) which have been type-tested according to this Part of IEC 61131 and therefore that they comply with all requirements of this part.

Significant modifications shall be indicated through the use of suitable revision level indexes and markings (see 5.11 and 11.15) and shall comply with this Part of IEC 61131.

NOTE A new type test may be required to confirm compliance.

Where the manufacturer is allowed to select among several options, he shall clearly specify in his catalogues and/or datasheets those to which any portion of the PLC-system equipment complies. This applies to severity classes of voltage drops (i.e. PS1 or PS2) and types of digital inputs (i.e. Type 1 or Type 3).

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.

1.3 Normative references

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


IEC 60417 (all parts), Graphical symbols for use on equipment

IEC 60529:1989, Degrees of protection provided by enclosures (IP Code)

IEC 60664-1:1992, Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests

IEC 60664-3:1992, Insulation coordination for equipment within low-voltage systems – Part 3: Use of coatings to achieve insulation coordination of printed board assemblies

IEC 60695-2-1 (all sheets), Fire hazard testing – Part 2: Test methods – Section 1: Glow-wire test and methods

IEC 60707:1999, Flammability of solid non-metallic materials when exposed to flame sources – List of test methods

IEC 60947-5-1:1997, Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices

IEC 60947-7-1:2002, Low-voltage switchgear and controlgear – Part 7-1: Ancillary equipment – Terminal blocks for copper conductors


IEC 61000-4-2:1995, Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test

IEC 61000-4-3:2002, Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated radio-frequency electromagnetic field immunity test

IEC 61000-4-4:1995, Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test


IEC 61000-4-6:1996, Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances induced by radio-frequency fields
IEC 61000-4-8:1993, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*

IEC 61000-4-12:1995, *Electromagnetic compatibility (EMC) – Part 4-12: Testing and measurement techniques – Oscillatory waves immunity test*

IEC 61010-1:2001, *Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*

CISPR 11:1999, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement*


2 Type tests

The object of this clause is to define how to verify compliance of the PLC and the associated peripherals with the requirements set forth in this part of IEC 61131. This compliance verification includes

- verification by type tests given in 5.12, 8.5 and 11.18,
- verification by suitable examination, visual inspection or/and measurement.

These tests are qualification tests, and not tests related to the ways PLCs are employed. According to the scope of this standard, the above compliance verification may not cover the verification of the ability of the PLC-system to satisfy the intended automated system requirements. Where needed, special tests, not covered by this standard, shall be agreed to by the manufacturer and the user.

In addition, routine tests are specified in Clause 13.

NOTE Peripherals, used in the same environment as the PLC-system, must meet the same requirements as the PLC-system.

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

PLC-systems span the range from stand-alone products to modular designs; this leads to an infinite variety of user-built actual PLC-system configurations. For obvious practical reasons, in most cases type tests cannot be conducted on EUT identical to user-built PLC-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 basic PLC 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 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  The application of statistical criteria based on samples for a large number of I/Os (for example, >100) may be considered.

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

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 basic PLC-system only 1 arbitrarily chosen member of the family. If the type test is dependent on the differences between the modules, then a single family member may 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 PLC-system and if its maximum cable length cable is less than, or equal to, 3 m, it is considered to be an internal PLC bus. As such, it should not be considered a port for test.

If a local bus extension is part of the PLC-system and is capable of driving cables with a length of >3 m, then only 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 PLC-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 must reflect this need. See specific test clauses for recommendations for EUTs.
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.

Each subpart of the PLC-system as shown in Figure 2 may constitute an EUT represented in Figure 1 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 1 subsystem is under test at any time, the others being considered as auxiliary equipment.

For instance, 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 PLC-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 PLC-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 1 of each type or a representative number of I/O ports of the EUT must be connected and be functional.

Figure 1 – EUT configurations
A selection of the representative functional modes shall be made considering that only the most typical functions of the PLC can be tested.

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. Refer to those clauses dealing with withstand tests for specifics.

2.4 Verification procedure

Type tests shall be conducted on the EUT(s) defined in 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 analogue I/Os.

The appropriate test programmes and proper functioning verification procedures provided by the manufacturer shall satisfy the requirements given in 2.5.

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 analogue I/Os out of the limits specified in item 4 of 710.2 and item 3 of 7.11.2.

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 PLC-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 basic PLC-system shall be exercised and tested.
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>
<thead>
<tr>
<th>Test conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains power supply</td>
</tr>
<tr>
<td>Temperature</td>
</tr>
<tr>
<td>Relative humidity</td>
</tr>
<tr>
<td>Barometric pressure</td>
</tr>
<tr>
<td>Output loads</td>
</tr>
<tr>
<td>Pollution</td>
</tr>
<tr>
<td>Rated voltage and frequency</td>
</tr>
<tr>
<td>15 °C to 35 °C</td>
</tr>
<tr>
<td>≤ 75 %</td>
</tr>
<tr>
<td>86 kPa to 106 kPa (650 mm Hg to 800 mm Hg)</td>
</tr>
<tr>
<td>Outputs loaded to rated load</td>
</tr>
<tr>
<td>Pollution degree 2</td>
</tr>
</tbody>
</table>

3 Terms and definitions

For the purposes of this Part of IEC 61131, the following terms and definitions, in addition to those given in IEC 61131-1, apply.

3.1 analogue input
device which converts a continuous signal to a discretely valued multi-bit binary number, for use by the PLC-system

3.2 analogue output
device which converts a multi-bit binary number from the PLC-system to a continuous signal

3.3 accessible
able to be touched by the jointed test finger or test pin, when installed as intended. See 12.1.2, 12.1.3 and Annex C

3.4 basic PLC (-system)
configuration which consists, at a minimum, of a processing unit, power supply and I/O. See Figure 2

3.5 battery
electrochemical energy source which may be rechargeable or non-rechargeable

3.6 clearance
shortest distance in air between two conductive parts

[IEC 60664-1]