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**Industrial automation systems and
integration — Numerical control
systems for machine tools —**

**Part 2:
Requirements for numerical control
system integration**

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Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols and abbreviated terms	2
5 Technical requirements	2
5.1 Basic requirements.....	2
5.1.1 Marking.....	2
5.1.2 Colour.....	3
5.1.3 Wires and connections.....	3
5.1.4 Protection.....	3
5.1.5 Operation and maintainability.....	3
5.1.6 Nameplate.....	3
5.2 AC input power supply requirements.....	4
5.3 Protection and safety requirements.....	4
5.3.1 Protection against electric shock.....	4
5.3.2 Safety protection of electric cabinet.....	4
5.3.3 Protective earth and protective bonding.....	4
5.3.4 Insulation resistance.....	4
5.3.5 Withstand voltage.....	5
6 Test methods	5
6.1 Electrical cabinet and enclosure protection degree test.....	5
6.2 Protection and safety test.....	5
6.2.1 Protection against electric shock test.....	5
6.2.2 Safety verification of electric cabinet.....	5
6.2.3 Protective earthing and protective bonding circuit continuity test.....	5
6.2.4 Insulation resistance tests.....	6
6.2.5 Withstand voltage tests.....	6
Bibliography	8

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 184, *Automation systems and integration*, Subcommittee SC 1, *Industrial cyber and physical device control*.

A list of all parts in the ISO 23218 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Numerically controlled machine tools are effective production assets with an operations stock of more than four million units and still increasing.

While mechanical construction sets the base for accuracy and durability, the numerical control system (NC system) is the enabler to leverage the potential of the system.

The NC system comprises a powerful computing hardware, a sophisticated NC-Kernel, and an elaborated connectivity, stretching from internal process parameters to high level manufacturing execution system (MES) integration and beyond. It supports operation concepts from push buttons to sophisticated touch-panel systems.

Machine tools and their NC systems are used in harsh environments facing operational conditions such as vibrations, dirt, coolant spray and electromagnetical interferences. Purchasers and operators of machine tools require confidence on the appropriate quality, durability and usability in order to ensure intended use and productivity.

The ISO 23218 series addresses requirements for NC systems. This document provides requirements for NC system integration, and ISO 23218-1 specifically provides requirements for the NC system itself.

Expected users of this document include:

- design engineers working for a company that uses an NC system for machine tools, for developing a new and/or improving a current NC system for machine tools;
- design engineers working for a machine tools builder company, for developing and providing new and/or improving current machine tools by procuring an NC system;
- facility planning engineers, for procuring new and/or improving current machine tools with an NC system.

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Industrial automation systems and integration — Numerical control systems for machine tools —

Part 2: Requirements for numerical control system integration

1 Scope

This document specifies requirements for the integration of numerical control systems (NC systems). It consists of technical and inspection requirements and test methods.

This document is applicable to all machine tools using NC systems not already covered by class C standards (including metal cutting machine tools, metal forming machine tools and woodworking machine tools) and for partial assemblies of machine tools (including cabinets and auxiliary devices) intended to be integrated into machine tools. It is also applicable to other production equipment using NC systems.

NOTE NC system integration with machine tools is performed mainly by machine tool builders using an NC system to control their machine tools, system integrators by assembling machine tools with the NC system to a production line, and machine tool users by upgrading their existing equipment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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

ISO 2806, *Industrial automation systems — Numerical control of machines — Vocabulary*

ISO 23218-1, *Industrial automation systems and integration — Physical device control — Numerical control systems for machine tools — Part 1: Requirements for numerical control systems*

IEC 60204-1:2016, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

IEC/TS 60204-34:2016, *Safety of machinery — Electrical equipment of machines — Part 34: Requirements for machine tools*

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

IEC 61310-1, *Safety of machinery — Indication, marking and actuation — Part 1: Requirements for visual, acoustic and tactile signals*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2806, ISO 23218-1 and the following apply. ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1
numerical control system
NC system

system that realizes the automatic control of a process by using numerical data introduced while the operation is in progress

Note 1 to entry: Driving devices are not included in NC systems.

3.2
port

access to a device or network of a *numerical control system (NC system)* (3.1) where electromagnetic energy or signals may be supplied or received or where the device or network variables may be observed or measured

Note 1 to entry: The port generally refers to the boundary on the external interface of the NC system, and interface generally refers to the boundary of each unit in an NC system.

[SOURCE: IEC 60050-131:2002, 131-12-60, modified — The term "NC system" was added to the definition and in the Note 1 to entry, "An example of a port is a terminal pair" has been redrafted.]

3.3
surge

transient wave of electrical current, voltage or power propagating along a line or a circuit and characterized by a rapid increase followed by a slower decrease

[SOURCE: IEC 60050-161:1990, 161-08-11, modified — The term "voltage surge" has been modified to "surge" and "voltage wave" to "electrical current, voltage or power propagating".]

3.4
reliability

ability of a *numerical control system (NC system)* (3.1) to perform a required function under given conditions for a given time interval

Note 1 to entry: It is generally assumed that the NC system is in a state to perform this required function at the beginning of the time interval.

Note 2 to entry: Generally, NC system reliability performance is quantified using appropriate measures. In some applications, these measures include an expression of an NC system reliability performance as a probability, which is also called NC system reliability.

4 Symbols and abbreviated terms

AC	Alternating Current
DC	Direct Current
NC	Numerical control
SELV	Safe Extra-Low Voltage

5 Technical requirements

5.1 Basic requirements

5.1.1 Marking

The marks of NC systems shall be in accordance with IEC 60204-1:2016, 16.

5.1.2 Colour

5.1.2.1 Conductors

The conductor colours of NC systems shall be in accordance with IEC 60204-1:2016, 13.2.4.

5.1.2.2 Actuators

The colour of actuators shall be in accordance with IEC 60204-1:2016, 10.2 and IEC 61310-1.

5.1.2.3 Indicating elements

The indicating elements of NC systems shall be in accordance with IEC 60204-1:2016, 10.3.

5.1.3 Wires and connections

Wires and connections of NC systems shall be in accordance with IEC 60204-1:2016, 13.

5.1.4 Protection

5.1.4.1 Degrees of protection

Degrees of protection of cabinet and enclosure of NC systems shall be in accordance with IEC 60204-1:2016, 11.3.

5.1.4.2 Protection degree design

Protection degree design of cabinet and enclosure of NC systems shall be in accordance with IEC 60204-1:2016, 11.4.

5.1.4.3 Other requirements for protection

If work, storage and transportation environments have excessive pollutants, e.g. dust, acids, corrosive gases or salts, and radiation, IEC 61000-4-3 should be considered.

5.1.5 Operation and maintainability

Operation and maintainability of the cabinet and enclosures shall be in accordance with IEC 60204-1:2016, 11.2.

5.1.6 Nameplate

NC system enclosure nameplate shall include at least the following information:

- rated voltage, number of phases and frequency (if AC), and rated current, rated power,
- certification mark or other marking that can be required by local or regional legislation, when required, and
- serial number where applicable.

5.2 AC input power supply requirements

AC input power supply of NC system should consider the target market power supply system and earthing system should be in accordance to IEC 60364-1. According to the combination of neutral conductor N and protective conductor PE, there are three subsystems in the TN system:

- TN-S system: power systems TN with separate neutral function and the protective conductor throughout the system.
- TN-C systems: power systems TN with neutral and protective functions combined in a single conductor throughout the system.
- TN-C-S systems; power systems TN with neutral and protective functions combined in a single conductor in a part or throughout the system.

The TN-S power supply system should be used by an NC machine tool and NC system users.

NOTE In TN-S systems, its PE line and N line are completely separated. In normal work conditions, a PE line has no load current and the electromagnetic disturbance introduced is low. This is helpful to improve the stability and reliability of a complex NC system.

For NC machine tools and the NC system using a PE line connect to the earth separately (such as directly earthing through an independent electrode) and disconnecting with the power supply system, the power supply grounding system will change into a TT system. In this case, the NC system shall be equipped with a special isolation transformer, otherwise the protection circuit of an NC system will not be triggered when fault occurs, which can cause significant safety consequences on the system. The NC system manufacturer shall describe this in the product instructions or manual.

If a neutral conductor is used in the NC system, it shall be clearly described in technical documents (e.g. installation diagram and circuit diagram) and an N conductor with a special insulation terminal shall be provided. A PE conductor and N conductor in NC machine tools and NC systems are not allowed to connect in any case, and a PEN terminal shall not be used either.

When the NC system adopts the power supply of three-phase line of the AC 200 V to AC 220 V, the three-phase power transformer can be used. Three-phase power transformers can be used for isolation and suppression of power system electromagnetic disturbance. Parameters can be given in the instructions or manual by NC systems manufacturer.

5.3 Protection and safety requirements

5.3.1 Protection against electric shock

NC systems shall provide protection of persons against electric shock according to IEC 60204-1:2016, 6.

5.3.2 Safety protection of electric cabinet

Safety protection of electrical cabinets shall be in accordance with IEC/TS 60204-34:2016, 9.3.

5.3.3 Protective earth and protective bonding

Protective earth and protective bonding of NC systems shall be in accordance with IEC 60204-1:2016, 13.2.2.

5.3.4 Insulation resistance

For NC system in all kinds of working climate environments, the insulation resistance should be in accordance with IEC 60204-1, 18.3.