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

Part 1: Requirements for numerical control systems

Systèmes d'automatisation et intégration — Systèmes de commandes numériques des machines-outils —

Partie 1: Exigences relatives aux systèmes de commandes numériques

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Foreword

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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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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) enables the 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 systems (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 electromagnetic interference. Purchasers and operators of machine tools require confidence in the appropriate quality, durability and usability in order to ensure the intended use and productivity.

The ISO 23218 series addresses requirements for the NC systems. This document specifically provides requirements for the NC system itself, and ISO 23218-2[1)] provides requirements for NC system integration.

Expected users of this document include:

— design engineers working for an NC system company for machine tools, for developing a new and/or improving a current NC system for machine tools;

— design engineers working for a machine tool 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.

1) Under preparation. Stage at the time of publication: ISO/FDIS 23218-2.

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

Part 1: Requirements for numerical control systems

1 Scope

This document specifies general requirements for the design and manufacturing of numerical control systems (NC systems) for machine tools. It consists of technical and inspection requirements and test methods.

This document is applicable to NC systems used in machine tools (including metal cutting machine tools, metal forming machine tools and woodworking machine tools) and to 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.

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 780, *Packaging — Distribution packaging — Graphical symbols for handling and storage of packages*

ISO 841, *Industrial automation systems and integration — Numerical control of machines — Coordinate system and motion nomenclature*

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

ISO 6983-1, *Automation systems and integration — Numerical control of machines — Program format and definitions of address words — Part 1: Data format for positioning, line motion and contouring control systems*

ISO 10303-238, *Industrial automation systems and integration — Product data representation and exchange — Part 238: Application protocol: Model based integrated manufacturing*

ISO 14649 (all parts), *Industrial automation systems and integration — Physical device control — Data model for computerized numerical controllers*

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

IEC 60068-2-2:2007, *Environmental testing — Part 2-1: Tests — Test B Dry heat*

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

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

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

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

IEC 60068-2-78:2012, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state*

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

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

IEC 61000-4-3:2020, *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 4-4: Testing and measurement techniques — Electrical fast transient/burst immunity test*

IEC 61000-4-5:2014, *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 61000-4-11:2020, *Electromagnetic compatibility (EMC) — Part 4-11: Testing and measurement techniques — Voltage dips, short interruptions and voltage variations immunity tests*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity for industrial environments*

IEC 61800-3:2017, *Adjustable speed electrical power drive systems — Part 3: EMC requirements and specific test methods*

IEC 82079-1, *Preparation of instructions for use — Structuring, content and presentation — Part 1: General principles and detailed requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2806 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 the use of 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 the *numerical control (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 numerical control (NC) system, and interface generally refers to the boundary of each unit in NC system.

[SOURCE: IEC 60050-131:2002, 131-12-60, modified]

3.3
enclosure port
physical boundary of the *numerical control (NC) system* (3.1) through which electromagnetic fields can radiate or impinge

3.4
power port
port (3.2) which connects a *numerical control (NC) system* (3.1) to a power supply, which usually includes a protection grounding port

Note 1 to entry: Power output port of a driver unit connecting to motor is the motor power interface.

[SOURCE: IEC 60050-131:2002, 131-12-60, modified]

3.5
signal interfaces of control and measurement
control and measurement signal interface between a device and unit of the *numerical control (NC) system* (3.1)

Note 1 to entry: Interfaces are connected with a signal line or signal cable to perform a specified function(s).

3.6
computer signal port
signal port
port between each device of the *numerical control (NC) system* (3.1) and computer(s), usually including ports of, e.g. RS232/485, USB, keyboard, network signal

3.7
second environment
environment that includes all establishments other than those directly connected to a low-voltage power supply network, which supplies buildings used for residential purposes

Note 1 to entry: Industrial areas or technical areas of any building fed from a dedicated transformer are examples of second environment locations.

[SOURCE: IEC 61800-3:2017, 3.2.3]

3.8
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

[SOURCE: IEC 60050-161:1990, 161-01-07]

3.9
immunity
<to disturbance> ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[SOURCE: IEC 60050-161:1990, 161-01-20]

3.10
electrostatic discharge
ESD
transfer of electric charge between bodies of different electrostatic potential in proximity or through direct contact

[SOURCE: IEC 60050-161:1990, 161-01-22]

3.11
electrical fast transient/burst
burst
sequence of a limited number of distinct pulses or an oscillation of limited duration

[SOURCE: IEC 60050-161:1990, 161-02-07]

3.12
transient, adj
pertaining to or designating a phenomenon or a quantity which varies between two consecutive steady-states during a time interval which is short compared with the time-scale of interest

[SOURCE: IEC 60050-161:1990, 161-02-01]

3.13
surge
transient (3.12) 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]

3.14
voltage dip
sudden reduction of the voltage at a particular point of an electricity supply system below a specified dip threshold followed by its recovery after a brief interval

Note 1 to entry: Typically, a dip is associated with the occurrence and termination of a short circuit or other extreme current increase on the system or installations connected to it.

Note 2 to entry: A voltage dip is a two-dimensional electromagnetic disturbance, the level of which is determined by both voltage and time (duration).

[SOURCE: IEC 61000-4-11:2020, 3.3]

3.15
conducted disturbance
electromagnetic disturbance for which the energy is transferred via one or more conductors

[SOURCE: IEC 61050:1991, 3.20]

4 Abbreviated terms

AC	Alternating Current
CDN	Coupling/Decoupling Network
DC	Direct Current
EMC	Electromagnetic Compatibility
EMI	Electro-Magnetic Interference
ESD	Electrostatic Discharge
MTBF	Mean Time Between Failures
NC	Numerical Control
NCSUT	Numerical Control System Under Test
PELV	Protective Extra-Low Voltage

RCD	Residual Current protective Device
RF	Radio Frequency
SPD	Surge Protective Devices
SELV	Safe Extra-Low Voltage

5 Technical requirements

5.1 NC system functional requirements

5.1.1 Coordinate system and motion direction

Coordinate system and motion direction of the NC system shall be in accordance with ISO 841.

5.1.2 Programming languages

Programming languages used by the NC system should be in accordance with the relevant ISO standards, e.g. G codes (preparatory function codes) and M codes (miscellaneous function) shall be in accordance with ISO 6983-1, STEP-NC shall be in accordance with the ISO 14649 series and ISO 10303-238.

5.1.3 Control function of the NC system

Control functions of NC systems should be able to fulfill the control requirements of the machine tools controlled.

The control functions of the NC system shall be described in detail in the manual.

NC systems should have all relevant modes to fulfill the control requirements of the controlled machine tools, e.g.

— automatic operation,

— manual operation,

— manual data input (MDI),

— program input and editing,

— home return.

Special function requirements of the NC system can be specified between the supplier and user of the NC system.

5.2 Interface signals of NC systems

5.2.1 Analogue interface signal

The control signal between each device or unit of the NC system can use analogue interface signals. Analogue input and output interface signals should be in accordance with the provisions of IEC 61131-2:2007, 5.3.

5.2.2 Digital interface signal

Digital pulse interface signals between each device or unit for NC systems can have many types: control level signal, interface signal, feed pulse interface signal, measurement feedback interface signal, communication interface signal (e.g. RS232/485, USB, keyboard interface). The NC system