INTERNATIONAL STANDARD

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Industrial automation systems and integration — Physical device control — Data model for computerized numerical controllers —

Part 10: General process data

Systèmes d'automatisation industrielle et intégration — Commande des dispositifs physiques — Modèle de données pour les contrôleurs numériques informatisés —

Partie 10: Données des procédés généraux

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14649-10 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 1, *Physical device control*.

ISO 14649 consists of the following parts, under the general title *Industrial automation systems and integration — Physical device control — Data model for computerized numerical controllers*:

NOTE Phase numbers below refer to the planned release phases of ISO 14649 which are described in Annex D of ISO 14649-1:2002.

— *Part 1: Overview and fundamental principles* (Phase 1)

— *Part 10: General process data* (Phase 1)

— *Part 11: Process data for milling* (Phase 1)

— *Part 12: Process data for turning* (Phase 2)

— *Part 13: Process data for wire-EDM* (Phase 2)

— *Part 14: Process data for sink-EDM* (Phase 2)

— *Part 111: Tools for milling* (Phase 1)

— *Part 121: Tools for turning* (Phase 2)

Gaps in the numbering were left to allow further additions. ISO 14649-10 is the ISO 10303 Application Reference Model (ARM) for process-independent data. ISO 10303 ARMs for specific technologies are added after part 10.

ISO 14649 is harmonized with ISO 10303 in the common field of Product Data over the whole life cycle. Figure 1 of ISO 14649-1 shows the different fields of standardization between ISO 14649, ISO 10303 and CNC manufacturers with respect to implementation and software development.

Introduction

Modern manufacturing enterprises are built from facilities spread around the globe, which contain equipment from hundreds of different manufacturers. Immense volumes of product information must be transferred between the various facilities and machines. Today's digital communications standards have solved the problem of reliably transferring information across global networks. For mechanical parts, the description of product data has been standardized by ISO 10303. This leads to the possibility of using standard data throughout the entire process chain in the manufacturing enterprise. Impediments to realizing this principle are the data formats used at the machine level. Most computer numerical control (CNC) machines are programmed in the ISO 6983 “G and M code” language. Programs are typically generated by computer-aided manufacturing (CAM) systems that use computer-aided design (CAD) information. However, ISO 6983 limits program portability for three reasons. First, the language focuses on programming the tool center path with respect to machine axes, rather than the machining process with respect to the part. Second, the standard defines the syntax of program statements, but in most cases leaves the semantics ambiguous. Third, vendors usually supplement the language with extensions that are not covered in the limited scope of ISO 6983.

ISO 14649 is a new model of data transfer between CAD/CAM systems and CNC machines, which replaces ISO 6983. It remedies the shortcomings of ISO 6983 by specifying machining processes rather than machine tool motion, using the object-oriented concept of Workingsteps. Workingsteps correspond to high-level machining features and associated process parameters. CNCs are responsible for translating Workingsteps to axis motion and tool operation. A major benefit of ISO 14649 is its use of existing data models from ISO 10303. As ISO 14649 provides a comprehensive model of the manufacturing process, it can also be used as the basis for a bi- and multi-directional data exchange between all other information technology systems.

ISO 14649 represents an object oriented, information and context preserving approach for NC-programming, that supersedes data reduction to simple switching instructions or linear and circular movements. As it is object- and feature oriented and describes the machining operations executed on the workpiece, and not machine dependent axis motions, it will be running on different machine tools or controllers. This compatibility will spare all data adaptations by postprocessors, if the new data model is correctly implemented on the NC-controllers. If old NC programs in ISO 6983 are to be used on such controllers, the corresponding interpreters shall be able to process the different NC program types in parallel.

ISO TC 184/SC 1/WG 7 envisions a gradual evolution from ISO 6983 programming to portable feature-based programming. Early adopters of ISO 14649 will certainly support data input of legacy “G and M codes” manually or through programs, just as modern controllers support both command-line interfaces and graphical user interfaces. This will likely be made easier as open-architecture controllers become more prevalent. Therefore, ISO 14649 does not include legacy program statements, which would otherwise dilute the effectiveness of the standard.

Industrial automation systems and integration — Physical device control — Data model for computerized numerical controllers —

Part 10: General process data

1 Scope

This part of ISO 14649 specifies the process data which is generally needed for NC-programming within all machining technologies. These data elements describe the interface between a computerized numerical controller and the programming system (i.e. CAM system or shopfloor programming system). On the programming system, the programme for the numerical controller is created. This programme includes geometric and technological information. It can be described using this part of ISO 14649 together with the technology-specific parts (ISO 14649-11, etc.). This part of ISO 14649 provides the control structures for the sequence of programme execution, mainly the sequence of working steps and associated machine functions.

The “machining_schema” defined in this part of ISO 14649 contains the definition of data types which are generally relevant for different technologies (e.g. milling, turning, grinding). The features for non-milling technologies like turning, EDM, etc. will be introduced when the technology specific parts like ISO 14649-12 for turning, ISO 14649-13 for EDM, and ISO 14649-14 for contour cutting of wood and glass are published. It includes the definition of the workpiece, a feature catalogue containing features which might be referenced by several technologies, the general executables and the basis for an operation definition. Not included in this schema are geometric items and representations, which are referenced from ISO 10303's generic resources, and the technology-specific definitions, which are defined in separate parts of ISO 14649.

This part of ISO 14649 cannot stand alone. An implementation needs in addition at least one technology-specific part (e.g. ISO 14649-11 for milling, ISO 14649-12 for turning).

Additionally, the schema uses machining features similar to ISO 10303-224 and ISO 10303-214. The description of process data is done using the EXPRESS language as defined in ISO 10303-11. The encoding of the data is done using ISO 10303-21.

2 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.

ISO 286-1:1988, *ISO system of limits and fits — Part 1: Bases of tolerances, deviations, and fits*

ISO 286-2:1988, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts*

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 10303-1, *Industrial automation systems and integration — Product data representation and exchange — Part 1: Overview and fundamental principles*

ISO 10303-11, *Industrial automation systems and integration — Product data representation and exchange — Part 11: Description methods: The EXPRESS language reference manual*

ISO 10303-21, *Industrial automation systems and integration — Product data representation and exchange — Part 21: Implementation methods: Clear text encoding of exchange structure*

ISO 10303-41, *Industrial automation systems and integration — Product data representation and exchange — Part 41: Integrated generic resource: Fundamentals of product description and support*

ISO 10303-42, *Industrial automation systems and integration — Product data representation and exchange — Part 42: Integrated generic resource: Geometric and topological representation*

ISO 10303-43, *Industrial automation systems and integration — Product data representation and exchange — Part 43: Integrated generic resource: Representation structures*

ISO 10303-203, *Industrial automation systems and integration — Product data representation and exchange — Part 203: Application protocol: Configuration controlled design*

ISO 10303-214:2001, *Industrial automation systems and integration — Product data representation and exchange — Part 214: Application protocol: Core data for automotive mechanical design processes*

ISO 10303-224:2001, *Industrial automation systems and integration — Product data representation and exchange — Part 224: Application protocol: Mechanical product definition for process planning using machining features*

ISO 10303-514:1999, *Industrial automation systems and integration — Product data representation and exchange — Part 514: Application interpreted construct: Advanced boundary representation*

3 Terms and definitions

For the purposes of this document, the following terms, definitions and abbreviations apply.

2D: Geometry in an xy-plane, where all the geometry's points have only x and y coordinates.

2½D machining: Machining of a prismatic part. Typically, the workpiece is processed in several layers which are located perpendicular to the tool axis. In the EXPRESS listing of ISO 14649, the term “two5D” is used for entity and attribute names.

3D: Geometry in three-dimensional space, where all points have x, y, and z coordinates.

freeform machining: Machining of freeform surfaces. For this kind of machining, the tool has to move in at least three axes simultaneously while processing the workpiece. Sometimes five-axes milling machines are used to reach an optimised angle between the tool and the workpiece surface.

CAM Computer Aided Manufacturing

CNC Computer Numerical Control

EDM Electrical Discharge Machining

EXPRESS: The language described in ISO 10303-11.

EXPRESS-G: The graphic representation of the EXPRESS language as described in ISO 10303-11.

