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

Part 17:
Process data for additive manufacturing

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

Partie 17: Données de processus pour la fabrication additive

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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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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, *Physical device control*.

A list of all parts in the ISO 14649 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

Modern manufacturing enterprises are built from facilities spread around the globe, which contain equipment from hundreds of different manufacturers. Immense volumes of product information need to 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 realising 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. Programmes are typically generated by computer-aided manufacturing (CAM) systems that use computer-aided design (CAD) information. However, ISO 6983 limits programme portability for three reasons. Firstly, the language focuses on programming the tool centre path with respect to machine axes, rather than the machining process with respect to the part. Secondly, ISO 6983 defines the syntax of programme statements, but in most cases leaves the semantics ambiguous. Thirdly, 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 programmes in ISO 6983 are to be used on such controllers, the corresponding interpreters need to be able to process the different NC programme types in parallel.

A gradual evolution is envisioned 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 programmes, 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. ISO 14649 does not include legacy programme statements, which would otherwise dilute its effectiveness.

This document extends the suite of processes covered by ISO 14649 for physical device control. The data model focuses on device control and expression of requirements for the results of the additive process rather than technology specific constructs. For the shape of the manufactured part, ISO 14649 takes the exact geometry to be made and avoids the necessity of the user having to decide on an approximation without necessarily knowing the precision and details of the process. The exact geometry is also important when additive manufacturing is used together with other processes in order to avoid having multiple representations of the same shape.

This document differentiates between explicit data and derived data. Support structures, for example, depend on the shape and process and need to be derived when the process and the machine are chosen in order to achieve maximum flexibility. The workingstep structure is sufficiently flexible to allow support structures to be added explicitly, if they are required. Assemblies can be described with different elements, with different materials, in different workingsteps. Additive manufacturing can be sequential or parallel and there is the possibility to define explicit parallel features.

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

Part 17: Process data for additive manufacturing

1 Scope

This document specifies the process data for additive manufacturing. This document describes additive manufacturing at the micro process plan level without making a commitment to particular machines, processes or technologies.

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 14649-1:2003, *Industrial automation systems and integration — Physical device control — Data model for computerized numerical controllers — Part 1: Overview and fundamental principles*

ISO 14649-10:2004, *Industrial automation systems and integration — Physical device control — Data model for computerized numerical controllers — Part 10: General process data*

ISO 14649-11:2004, *Industrial automation systems and integration — Physical device control — Data model for computerized numerical controllers — Part 11: Process data for milling*

ISO 10303-242, *Industrial automation systems and integration — Product data representation and exchange — Part 242: Application protocol: Managed model-based 3D engineering*

ISO/ASTM 52900, *Additive manufacturing — General principles — Terminology*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14649-1, ISO 14649-10, ISO 14649-11, ISO 10303-242, ISO/ASTM 52900 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
feature
geometric entity of a workpiece which has semantic significance

Note 1 to entry: In the context of ISO 14649, manufacturing features are used.