



**International
Standard**

ISO 23247-5

**Automation systems and
integration — Digital twin
framework for manufacturing —**

**Part 5:
Digital thread for digital twin**

*Systèmes d'automatisation et intégration — Cadre technique de
jumeau numérique dans un contexte de fabrication —*

Partie 5: Continuité numérique pour le jumeau numérique

**First edition
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Contents

	Page
Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 General	2
4.1 Concept of digital thread for digital twins.....	2
4.2 Digital twin utilisation of digital thread.....	3
4.3 Structure of a digital thread.....	4
4.4 Data utilisation facilitated by digital threads.....	6
5 Digital thread entity	6
5.1 General.....	6
5.2 Digital thread ledger.....	7
5.3 Digital thread management.....	8
5.4 Digital thread metadata.....	8
5.5 Digital thread query and response.....	9
6 Digital thread life cycle	9
6.1 General.....	9
6.2 Digital thread creation.....	10
6.3 Maintenance of digital thread ledger.....	11
6.3.1 Overview.....	11
6.3.2 Validating digital thread links.....	11
6.3.3 Managing digital thread metadata and its attributes.....	11
6.3.4 Performance monitoring.....	11
6.3.5 Error handling.....	11
6.4 Digital thread life cycle and standards integration.....	12
6.4.1 Overview.....	12
6.4.2 Concept and definition.....	12
6.4.3 Conceptual design.....	12
6.4.4 Detailed engineering.....	13
6.4.5 Prototype and validation.....	13
6.4.6 Manufacturing planning.....	13
6.4.7 Production and assembly.....	13
6.4.8 Deployment and distribution.....	13
6.4.9 Operation and monitoring.....	13
6.4.10 Maintenance support.....	13
6.5 Digital thread obsolescence.....	13
7 Requirements on digital threads	14
7.1 Digital thread entity.....	14
7.2 Defining digital threads.....	14
7.3 Publishing digital threads.....	14
7.4 Searching for digital twins and digital threads.....	15
7.5 Support for accessing digital twin.....	15
7.6 Updating digital thread links.....	15
7.7 Digital thread management.....	15
7.8 Digital thread interoperability.....	16
Annex A (informative) Digital twin prototype, digital twin instance, and digital twin aggregate	17
Annex B (informative) Scenarios between digital twin and digital thread	19
Bibliography	25

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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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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 4, *Industrial data*.

A list of all parts in the ISO 23247 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

The ISO 23247 series defines a framework to support digital twins in manufacturing. A digital twin assists with detecting events in manufacturing processes to achieve functional objectives such as real-time control, predictive maintenance, in-process adaptation, big data analytics, process and manufactured component validation, and machine learning. A digital twin monitors its observable manufacturing elements by constantly updating and analysing relevant operational and environmental data as process/part changes. This visibility into process and execution enabled by a digital twin enhances manufacturing operations and business cooperation.

Manufacturing supported by implementing the ISO 23247 framework depends on the standards and technologies available to model the observable manufacturing elements. Different manufacturing domains can use different data standards. As a framework, this document does not prescribe specific data formats or communication protocols.

The subject areas of the six parts of this series are defined below:

- ISO 23247-1: General principles and requirements for developing digital twins in manufacturing;
- ISO 23247-2: Reference architecture with functional views;
- ISO 23247-3: List of basic information attributes for the observable manufacturing elements;
- ISO 23247-4: Technical requirements for information exchange between entities within the reference architecture;
- ISO 23247-5: Requirements and guidance to use digital threads for connecting manufacturing lifecycle data to digital twins;
- ISO 23247-6: Requirements and guidance for performing digital twin composition.

Figure 1 shows how the six parts of the series are related.

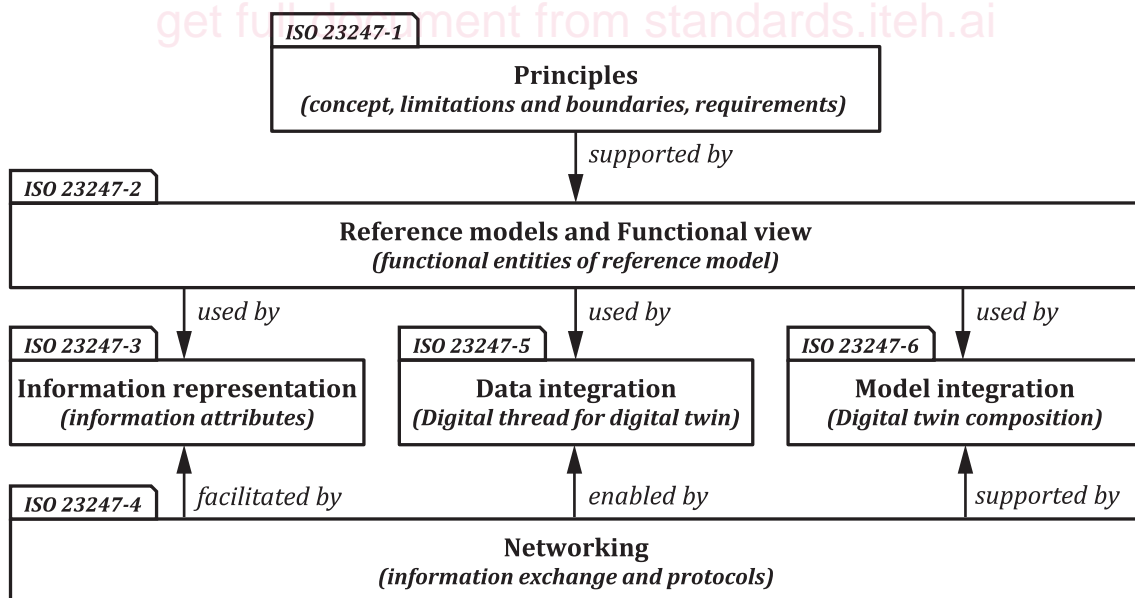


Figure 1 — ISO 23247 series relationships

This document describes how the digital thread supports the generation, implementation and transformation of digital twins in manufacturing.

In manufacturing, without digital threads, data from various stages of the product life cycle, such as design, production, quality management, and maintenance, usually remains isolated within individual digital twins.

Such isolation causes data and information to be fragmented, leading to inefficiencies such as processing delays, information duplications and disruption. These problems hinder manufacturers in conducting simulations and analyses with digital twins, as these functions depend on a continuous and integrated data flow. The absence of digital threads makes it difficult to associate various events and complicates time series analysis. The disconnection of information can cause delays or inhibitions in retrieving and processing data, leading to poor decision-making and difficulty in addressing issues as they arise.

Digital threads connect digital twins representing different aspects of the product life cycle. The scalability and adaptability of manufacturing are enhanced by digital threads that support seamless connections between digital twins for manufacturing processes across the life cycle, and production facilities across the extended enterprise.

This document defines the concept, requirements and operational characteristics of digital threads for digital twins in manufacturing.

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Automation systems and integration — Digital twin framework for manufacturing —

Part 5: Digital thread for digital twin

1 Scope

This document specifies how a digital thread enables the creation, connectivity, management, and maintenance of manufacturing digital twins across the product life cycle, including design, planning, production, and testing by defining principles, presenting methodologies, and providing use case examples.

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 23247-2, *Automation systems and integration — Digital twin framework for manufacturing — Part 2: Reference architecture*

3 Terms and definitions

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 digital thread

digital thread for digital twins

bidirectional, dependable and trustworthy information that links digital twins with multiple data dimensions, including structure, behaviour, space, time, and lifecycle stages

Note 1 to entry: The linked digital twins can model design requirements, product models, manufacturing processes, inspection results and verification data.

Note 2 to entry: This definition was derived from a definition developed by the Digital Twin Consortium.

3.2 digital thread entity

component that manages the *digital thread for digital twins* (3.1)

3.3 digital thread link

<digital twin> reference or pointer that connects one digital twin to another with *digital thread metadata* (3.6) to establish a relationship

Note 1 to entry: Depending on performance constraints, a *digital thread link* (3.3) can connect digital twins using data structure, URL, Universally Unique Identifier (UUID), DB query or other mechanisms.

3.4

data store

<digital twin> repository that collects, organises and manages content for the digital twin(s)

Note 1 to entry: Multiple data stores can be used for the digital twins depending on their roles (e.g. design, engineering, manufacturing, verification).

Note 2 to entry: Depending on system architecture, a data store can be implemented as a relational database, a graph database, a cloud storage, a distributed ledger, or other suitable solutions.

3.5

digital thread ledger

<digital twin> repository of *digital thread links* (3.3) that identifies digital twins and their relationships with other digital twins

Note 1 to entry: In the simplest case, a *digital thread ledger* (3.5) contains a list of digital thread links for the life cycle stages of one digital twin.

3.6

digital thread metadata

<digital twin> information about the *digital thread link* (3.3) between two digital twins

Note 1 to entry: The information can describe the purpose of the link, the date of the link, summarize an aspect of the digital twins in the link, etc.

Note 2 to entry: When the term “metadata” is not further qualified, then it is assumed to be digital thread metadata.

3.7

digital twin prototype

DTP

informational sets necessary to describe and produce a *digital twin instance* (3.8) that duplicates or “twins” the corresponding *observable manufacturing element (OME)* (3.9), including, but not limited to, requirements, fully annotated 3D model, bill of materials (with material specifications), bill of processes, bill of services and bill of disposal

Note 1 to entry: A digital twin prototype is not linked to an OME.

3.8

digital twin instance

DTI

fit for purpose digital representation of an *observable manufacturing element* (3.9) with synchronisation between the element and its digital representation

Note 1 to entry: When the term “digital twin” is not further qualified, then it is assumed to be a digital twin instance.

3.9

observable manufacturing element

OME

element that has an observable physical presence or operation in manufacturing

Note 1 to entry: Observable manufacturing elements include personnel, equipment, material, process, facility, environment, product and supporting documentation.

[SOURCE: ISO 23247-1:2021, 3.2.5, modified — “item” was replaced by “element”.]

4 General

4.1 Concept of digital thread for digital twins

The digital thread facilitates utilization of data and information for the life cycle of digital twins. The digital thread precedes and follows the definition and implementation of the manufacturing digital twin. In manufacturing, a digital twin is a digital representation of an observable manufacturing element (OME).

A digital twin prototype has to meet the design requirement of the product OME, before being transformed into a digital twin instance when the actual product is being manufactured. When the OME is in place, plans are made for its manufacture. When the necessary equipment has been allocated, the plans are applied to the OME. At this stage, the digital twin prototype becomes a digital twin instance. When manufacturing is finished, the product is tested and inspected. If it is judged ready, the product is delivered to a customer.

NOTE Detailed descriptions of digital twin prototype, digital twin instance and digital twin aggregate are in [Annex A](#).

As the product OME moves from design concept to delivery, the digital twins are linked together using the digital thread. These links enable upstream processes to observe their impact on the final product and allow downstream processes to access information that affected the upstream processes. The linked digital twins can model requirement data, product data, manufacturing process data, inspection data and verification data. The digital thread establishes a chain of custody for the digital twins so that users and applications can inspect their evolution from design through planning, manufacturing and inspection. With this information, manufacturers can optimise their processes, reduce waste and adapt effectively to changes, ultimately driving innovation and competitiveness.

The digital thread enables digital twins and diverse applications to access data and information within the context of the appropriate digital twin, ensuring seamless data flow across the product life cycle. In the engineering stage, the digital thread connects design digital twins with simulation results, enabling validation and optimisation before production starts. In the manufacturing stage, the digital thread links the design digital twins and the manufacturing digital twins to ensure products are manufactured as designed. In the validation stage, the digital thread integrates testing, manufacturing, and design digital twins to facilitate problem analysis and quality improvements. Beyond production, the digital thread supports predictive maintenance by combining multiple digital twins into digital twin aggregates that model operational performance and historical trends for proactive decision making. The digital thread facilitates multi-manufacturer collaboration and supply chain optimisation through digital twin sharing.

4.2 Digital twin utilisation of digital thread

The information of a digital twin is derived from information systems that support and enable the OME. This information is contextualised for traceability, allowing users to monitor the status of the product OMEs and thereby enhancing the visibility of the production process.

[Figure 2](#) shows how digital twins utilise digital threads to integrate and interpret manufacturing data from various sources. Life cycle data and information are often siloed, logically or physically separated. The digital thread enables connection to digital twins from disparate data sources. Digital twins use digital threads to obtain base information about the manufacturing process and model components. This allows data analysis and optimisation to represent the characteristics of the target OME. By connecting and contextualising life cycle data, the digital thread facilitates continuous monitoring and improvement of the OME. This process enhances decision-making, optimises production processes and fosters collaboration throughout the supply chain, ultimately driving improvements in product design, innovation and overall visibility.

In [Figure 2](#), the lower left box (i.e. life cycle data of digital twins) shows the existing information system, and the upper left box (i.e. digital thread of life cycle data) shows that digital twins are realised from those systems and linked by the digital thread. The middle figure (i.e. digital twins in manufacturing) shows a subset of the digital twins within a digital twin entity for various life cycle stages. Changes to the OME are mirrored in the digital twins using the infrastructure described in ISO 23247-1, ISO 23247-2, ISO 23247-3 and ISO 23247-4. Some of the information is aggregated for further analysis. New digital twins are linked to the digital thread for usage by subsequent manufacturing processes.