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Automation systems and integration — Interfaces for automated machine tending —

Part 1:
Overview and fundamental principles

Systèmes d'automatisation et intégration — Interfaces pour le chargement automatisé des machines —

Partie 1: Aperçu et principes fondamentaux

Reference number
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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, *Physical device control*.

A list of all parts in the ISO 21919 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

Automated machine tending refers to the automatic loading or unloading of one or more machines by using a machine tending device.

NOTE Examples for machines are machine tools, typically computer numerically controlled (CNC), metrology co-ordinate measuring machines (CMM), 3D structured light scanner (3DSL), and X-ray machines. Examples for machine tending devices are robots, handling systems, gantries, autonomous intelligent vehicles (AIV), and automated guided vehicles (AGV).

Automated machine tending is a substantial element in highly productive industrial environments. It is a complex endeavour. Necessary devices are complex systems in themselves, are often provided by different suppliers and they encounter each other for the first time at the production site. For a trouble-free collaboration of all units, a clear definition of the interfaces is indispensable. For manufacturing systems, such standardized interfaces at an international level have not yet been defined.

The definition of the interfaces is often project-specific from the start or each supplier tries to establish its in-house standards. These procedures cause great efforts, are prone to failure and take a lot of time and manpower. As each interface is built individually and testing beforehand is often not possible, commissioning times exceed the planned ones. Machine builders, system integrators and production plant operators report these issues being substantial obstacles for such automation projects.

Standardized interfaces lead to lean coordination processes, give higher planning reliability, shorten times for commissioning and are less error-prone.

On the other hand, automated machine tending systems can be very complex systems and standards need to be flexible enough to allow an adaption to the requirements of individual projects.

Applications range from simple parts removal to material flow dedicated complex production lines. The processing technologies of the machines are independent from the interface and a majority of machine technologies can be integrated with the same standard.

Figure 1 and Figure 2 display the range of complexity of machine tending systems covered by ISO 21919. Figure 1 shows an example of a simple automated machine tending system, consisting of a machine tool loaded by a conveyor.

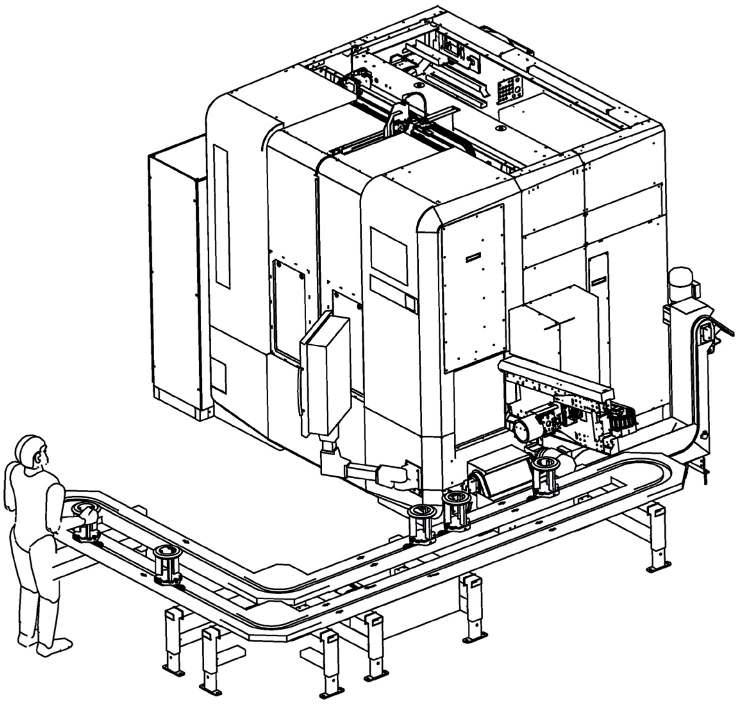

Figure 1 — Example of a simple automated machine tending system

Figure 2 shows an example of a complex production line with five computer numerically controlled machine tools tended by a loading gantry.

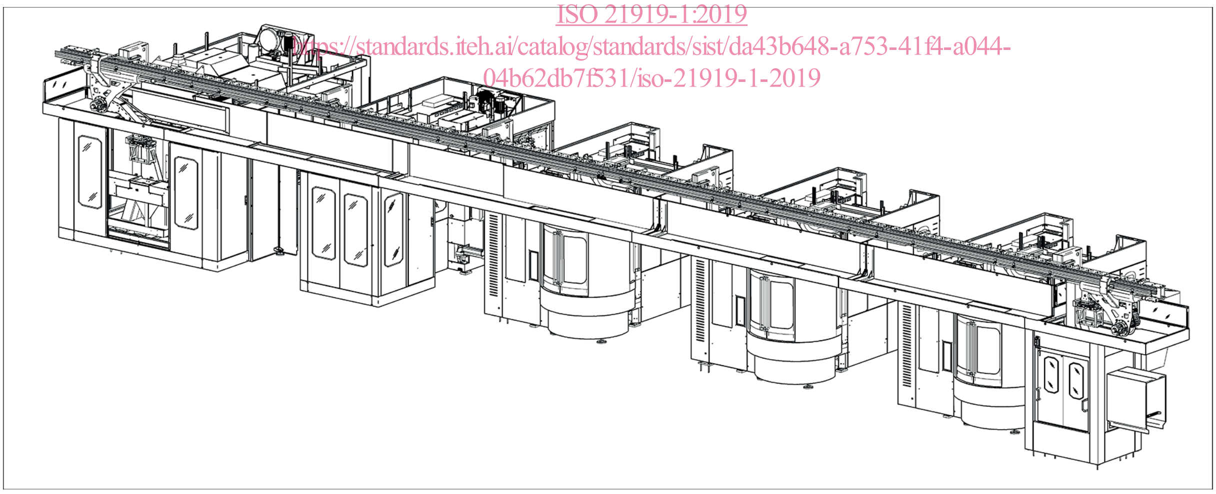

Figure 2 — Example of a complex production line loaded by a gantry

In general, the interfaces for automated machine tending are composed of mechanical, control-related, and safety-related connections.

Automation systems and integration — Interfaces for automated machine tending —

Part 1: Overview and fundamental principles

1 Scope

ISO 21919 describes interfaces for automated machine tending of at least one computer numerically controlled (CNC) machine by using a machine tending device. These interfaces are the link between automated machine tending devices and machines used for production. The automated machine tending is initiated by either the machine tending system or by the machine.

This document gives an overview and defines the fundamental principles on how the interfaces are set up. It defines the necessary vocabulary and sets the syntax for the structure of signals. It distinguishes between the safety interface, the control interface and project specific extensions.

This document defines three conformance classes and dedicated conformance options. Classes and options consist of a number of signals to simultaneously:

— allow a flexible adaptation of the interface(s) to a project-specific scope of functions;

— tie sets of signals tight enough to avoid unnecessary coordination efforts between suppliers of the machine tending devices and machines.

ISO 21919 concentrates on the control-related and safety-related connections. It does not describe the mechanical connections, it does not determine the transfer physics, a pin assignment, the hardware of the interfaces or measure of communication, e.g. protocol, and it is not intended to be used for communication to a MES (Manufacturing Execution System).

NOTE ISO 21919-2 deals with the safety interface and control interface, allocating signals to a conformance class and/or conformance option, describing the detailed functions of each signal, describing and displaying the timing interactions between signals in flow charts and showing examples for safety matrices and safety-related functional relationships.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
part
physical entity with its digital description [*data* (3.19)] that is transported into and out of the *machine* (3.4) by the *machine tending system* (3.3)

EXAMPLE Workpieces, sets of workpieces on workpiece carriers, tools, sets of tools in tool carriers.

3.2
functional unit
device or system which transports, receives or renders *parts* (3.1)

EXAMPLE *Machines* (3.4) and *automated machine tending* (3.5) systems.

3.3
machine tending system
functional unit (3.2) transporting *parts* (3.1) without changing their physical properties

EXAMPLE Robots, conveyors, gantries, bar feed systems, handling systems.

Note 1 to entry: See Figure A.1.

3.4
machine
functional unit (3.2) changing the physical properties of *parts* (3.1)

EXAMPLE Machine tools, measuring machines, washing machines and assembly systems.

Note 1 to entry: See Figure A.1.

3.5
automated machine tending
process of transporting *parts* (3.1) into or out of a *machine* (3.4) by a *machine tending system* (3.3)

Note 1 to entry: See Figure A.1.

3.6
interface
shared boundary between two *functional units* (3.2), defined by various characteristics pertaining to the functions, physical interconnections, *signal* (3.7) exchanges, and other characteristics, as appropriate

[SOURCE: ISO/IEC 2382:2015, 2121308, modified — Notes to entry have been removed.]

3.7
signal
information transferred between *functional units* (3.2) via the *interface* (3.6)

3.8
interference area
shared work area between *functional units* (3.2)

Note 1 to entry: See Figure A.2.

3.9
interference area preposition
interference area (3.8) without the area of the transfer station (device)

Note 1 to entry: See Figure A.2.

3.10
coherent transfer
transfer of *parts* (3.1) where one *functional unit* (3.2) keeps the part form-locked until the other functional unit has it securely clamped

Note 1 to entry: A distinction between coherent and non-coherent transfer can be made for loading and unloading operations.

EXAMPLE When a robot loads a part to a machine tool and keeps its grippers closed until the machine tool has clamped the part. After the machine tool has clamped the part, the robot opens its grippers.

3.11
function mode
status of a *functional unit* (3.2) indicating if *signals* (3.7) are valid/executed

3.12
conformance class
predefined subset of *signals* (3.7) selected to achieve a specified set of functions, for which conformance can be claimed

Note 1 to entry: Predefined sets of functions are conformance class 1 "Minimum set of signals", conformance class 2 "Extended scope" and conformance class 3 "Extended scope with process optimization".

3.13
conformance option
predefined subset of *signals* (3.7) that can be selected to add a set of functions to a *conformance class* (3.12), for which conformance can be claimed

3.14
loading access
interlocking guard which separates the *machine* (3.4) from the *machine tending system* (3.3) for exchanging *parts* (3.1)

EXAMPLE Loading hatches and loading doors.

Note 1 to entry: See Figures A.3 and A.4.

3.15
PFHD value
probability of a dangerours failure per hour

3.16
pulse 1 Hz
signal (3.7) of the format boolean alternating in an interval of 0,5s

3.17
handshake
interaction between *functional units* (3.2) with a request as trigger and an acknowledge or *state* (3.18) *signal* (3.7) as answer

3.18
state
signal (3.7) describing a condition

3.19
data
signal (3.7) containing information relevant to a *part* (3.1)

3.20
interlinked operation
intdOp
function mode (3.11) indicating that a *functional unit* (3.2) participates in the *automated machine tending* (3.5)

3.21
single operation
SOp
function mode (3.11) indicating that a *functional unit* (3.2) is processing/handling a *part* (3.1) but is not in *interlinked operation* (3.20)

3.22
single step
SSp
function mode (3.11) indicating that a *functional unit* (3.2) is traversed in sequential movements where each movement is initiated by an operator

3.23
setup operation
SetOp
function mode (3.11) indicating that an operator can manually execute any movement of a *functional unit* (3.2)

4 Description of the interfaces

4.1 General

For an extensive description of the interfaces for automated machine tending, the following interfaces shall be defined:

— safety interface;

— control interface.

4.2 Structure, range and standards of the interface

4.2.1 General

To transfer the signals, either a hardware interface (parallel wiring) or transmission via a bus system is available.

The function equipotential bonding between the automated machine tending system and the machine shall be implemented. In principle, this is not used as a protective conductor.

For any specific project, it shall be decided whether the power supply (e.g. 0 V and 24 V potential) of the automated machine tending system and/or the machine shall be made available.

NOTE If the power supply is provided by both functional units, safety-relevant devices are supplied even if one functional unit is shut down.

The pin assignment and connector format shall be agreed upon according to the project for the design of the hardware technology as parallel wiring for one or both interfaces.

4.2.2 Characteristics of the interface

The signals are grouped in conformance classes and conformance options for a flexible adaptation of the interface to the project-specific sets of functions. Grouping allows individual characterization of the interface while simultaneously meeting the requirements of this document.

Users of this document shall decide one conformance class and can select all desired conformance options and can define a project specific extension, if necessary.

The signals assigned to the relevant conformance class or the relevant conformance option shall be made available at the interface if the characteristics on this conformance class/conformance option are selected.

When realizing the interface, the signal correlates as shown in the relevant flow charts in ISO 21919-2.

4.2.3 Conformance class

4.2.3.1 Conformance class 1: Minimum set of signals

At conformance class 1, the following functions can be realized:

— safety of people;

— simple unloading;

— simple loading;

— simple combined unloading and loading.

The word "simple" indicates that there is no distinction between coherent and non-coherent transfer and that clamping functions are not handled via the interface.

NOTE Conformance class 1 is not applicable for machines that need coherent transfer.

4.2.3.2 Conformance class 2: Extended set of signals

At conformance class 2, all functions of conformance class 1 and the following can be realized:

— unloading with non-coherent transfer, with/without clamping function;

— unloading with coherent transfer;

— loading with non-coherent transfer, with/without clamping function;

— loading with coherent transfer;

— combined unloading and loading with non-coherent transfer, with/without clamping function;

— combined unloading and loading with coherent transfer;

— preparation of the part;

— emptying;

— functions of guard doors;

— further status information.

NOTE Conformance class 2 and conformance class 3 are typically implemented as bus interface as many signals are handled.

4.2.3.3 Conformance class 3: Extended set of signals with process optimization

At conformance class 3, all functions of conformance class 2 and the following can be realized:

— process optimizations at the combined unloading and loading with coherent transfer;

— process optimizations at the combined unloading and loading with non-coherent transfer, with/without clamping function;