INTERNATIONAL STANDARD

ISO/IEC 9506-3

First edition
1991-08-01

Industrial automation systems — Manufacturing message specification —

Part 3: Companion standard for robotics

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Systèmes d'automatisation industrielle — Système de messagerie industrielle —

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Partie 3: Norme d'accompagnement pour la robotique

Reference number
ISO/IEC 9506-3:1991(E)

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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International Standard ISO/IEC 9506-3 was prepared by Joint Technical Committee ISO/TC 184, *Industrial automation systems and integration.*

ISO/IEC 9506-3:1991

ISO/IEC 9506 consists of the following parts, under the general title *Industrial automation systems — Manufacturing message specification*:

— *Part 1: Service definition*

— *Part 2: Protocol specification*

— *Part 3: Companion standard for robotics*

Annexes A and B are for information only.

Introduction

This part of ISO/IEC 9506 is intended to be used in an open communication system employing robots and robotic systems connected to a communication network conforming to the OSI model (ISO 7498). This part of ISO/IEC 9506 also recognizes that the robot can act as a controller (client) to devices connected to it such as vision systems and grippers. Client conformance for communication to such devices is not defined by this part of ISO/IEC 9506. Conformance requirements for communication to such devices are defined by the companion Standard appropriate to that device or by ISO/IEC 9506-1 and ISO/IEC 9506-2.

This part of ISO/IEC 9506 does define conformance requirements for the robot when used in a network with multiple clients. The messages are described using the method defined in ISO 8824.

This part of ISO/IEC 9506 provides a description of several conformance classes including a base class. This base class is considered as the minimum conformance for robots connected as a "slave" or server to a host computer or client device on the network. The base class forms the "kernel" of conformance for robots in these types of networks. All other conformance classes will be additions to the base class. This part of ISO/IEC 9506 also provides the robot specific services and protocol including the abstract syntax notation for protocol elements which are undefined in the MMS-General-Module.

This part of ISO/IEC 9506 also recognizes that the robot can act as a controller to devices connected to it such as vision systems and grippers. This part of ISO/IEC 9506 identifies the requirements for communications in such a manner but does not identify MMS service and protocol conformance requirements for the robot when acting in a client role. These requirements are identified by the companion standard covering the device to which the robot intends to communicate.

MMS is intended to be used with yet other standards designed to achieve a systematic and uniform approach to Open Systems Interconnection of Information Processing Systems as defined in ISO 7498. As such, MMS is positioned within the application layer of the OSI model. It defines the Application Service Element and the protocol required to extend information systems networks to the programmable control devices of the automated factory environment. The services defined by MMS are generic and intended to be referenced by the companion standards, each of which is oriented towards a more specific class of application.

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This part of ISO/IEC 9506 recognizes that safe operation of robots is required at all times. Safety requirements for robots are specified in ISO DIS 10218. All robot actions delineated in this part of ISO/IEC 9506 are permissible under the safety standard.

Implementation of this part of ISO/IEC 9506 requires a minimum implementation of MMS. This is covered in Clause 9 which references the conformance requirements of ISO/IEC 9506-1 and 2. Implementers of MMS for robots and robotic systems should have a thorough understanding of MMS for proper implementation of this part of ISO/IEC 9506. Implementers should also have a thorough understanding of the modeling, services and protocol defined in this part of ISO/IEC 9506. Users of robots and robotic systems are directed to the clauses on modeling and services found in this document.

For the purpose of this part of ISO/IEC 9506, the term "robot" means "manipulating industrial robot" as defined in ISO/TR 8373. As used in this part of ISO/IEC 9506, a robot will generally refer to the manipulator together with its control system and any ancillary equipment, devices, sensors, or communications links, necessary for the robot to perform its task. Figure 1 illustrates the elements of the robot system as described in this part of ISO/IEC 9506. Since the definitions of ISO/TR 8373 only describe robot systems with a single arm and this part of ISO/IEC 9506 anticipates robots with multiple arms operating in a coordinated fashion, these definitions have been generalized. The term "robot system controller" will refer to the (single) task program operating with the (possible multiple) control program of the robot arm(s) of the system.

"MMS services" refers to the abstract services defined in ISO/IEC 9506-1 and "MMS protocol" refers to the protocol defined in ISO/IEC 9506-2.

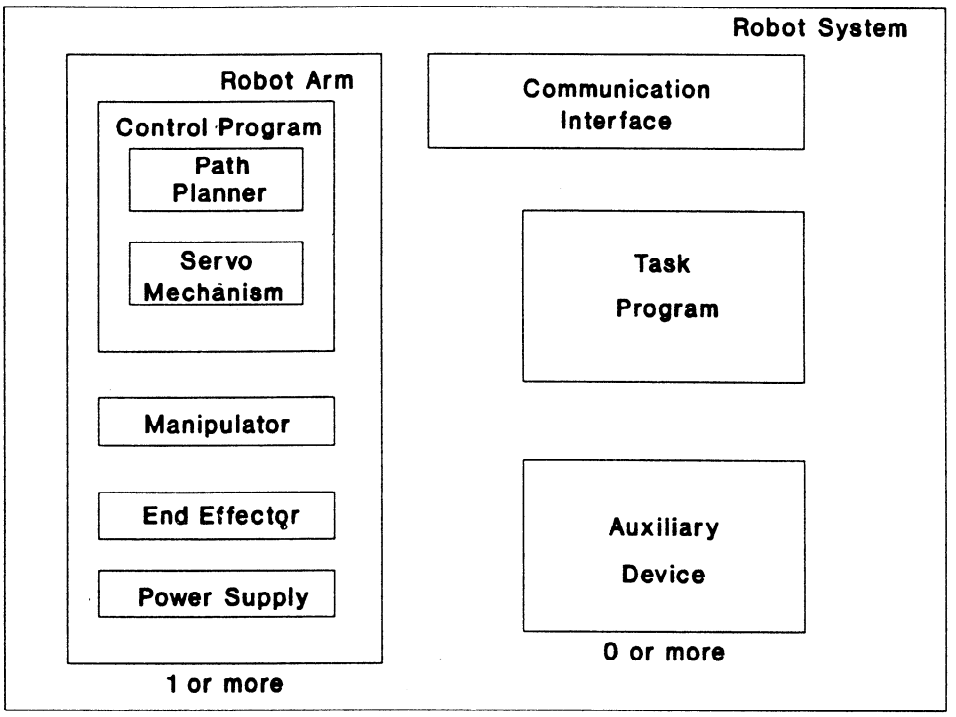

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Figure 1 Robot system

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Industrial automation systems — Manufacturing message specification —

Part 3:
Companion standard for robotics

1 Scope

This part of ISO/IEC 9506:

a) describes the model of a robot and how the attributes of the robot are mapped onto the attributes of a Virtual Manufacturing Device (VMD),

b) defines the robot specific services and protocol including the abstract syntax notation for protocol elements requiring companion standard specification by MMS,

c) defines robot specific standardized objects,

d) provides a description of conformance classes including a base class and several enhanced classes.

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Definitions are provided of the services and protocol of robots operating as a server in the abstract syntax defined in this part of ISO/IEC 9506. The semantics of MMS services performed by robots while communicating under other abstract syntaxes are not defined by this part of ISO/IEC 9506. This part of ISO/IEC 9506 does not identify MMS service and protocol conformance requirements for a robot acting in a client role. These requirements are intended to be identified by the companion standard covering the device to which the robot intends to communicate.

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2 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC 9506. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO/IEC 9506 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of ISO and IEC maintain registers of currently valid international standards.

ISO/IEC 9506-1:1990	*Industrial automation systems - Manufacturing Message Specification - Part 1 - Service definition*
ISO/IEC 9506-2:1990	*Industrial automation systems - Manufacturing Message Specification - Part 2 - Protocol specification*
ISO 7498:1984	*Information processing systems - Open Systems Interconnection - Basic Reference Model*

ISO/TR 8509:1985	*Information processing systems - Open Systems Interconnection - Service Conventions*
ISO 8824:1987	*Information processing systems - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1)*
ISO 8571:1988	*Information processing systems - Open Systems Interconnection - File Transfer, Access and Management*
ISO 8649:1988	*Information processing systems - Open Systems Interconnection - Service definition for the Association Control Service Element*
ISO 8650:1988	*Information processing systems - Open Systems Interconnection - Protocol specification for the Association Control Service Element*
ISO DIS 10218[1]	*Manipulating Industrial Robots - Standard for Safety*
ISO/TR 8373:1988	*Manipulating Industrial Robots -Vocabulary*
ISO 9787:1990	*Manipulating Industrial Robots - Coordinate Systems and Motions*

[1] To be published

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3 Definitions

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3.1 General definitions

Clause 3 of ISO/IEC 9506-1:1990 and clause 3 of ISO/IEC 9506-2:1990 list a number of terms defined in ISO 7498, in ISO/TR 8509, and in ISO 8824, as well as its own definitions. ISO/TR 8373 and ISO 9787 also define a number of terms used in this part of ISO/IEC 9506. These definitions are included in this part of ISO/IEC 9506 by reference.

3.2 Specific definitions

3.2.1 control program:

The inherent set of control instructions which defines the capabilities, actions, and responses of a robot system. This type of program is fixed and usually not modifiable by the user.

3.2.2 cycle:

A single execution of a task program.

3.2.3 local control:

A boolean value which indicates whether or not it is possible for remote operations to effect changes in the state of the MMS server. If local control is true, remote operations cannot change the state of the server.

Note: This definition is appropriate to MMS Companion Standards and is different from that contained in ISO DIS 10218.

3.2.4 manipulating industrial robot [robot]:

An automatically controlled, reprogrammable, multi-purpose, manipulative machine with several degrees of freedom, which can be either fixed in place or mobile for use in industrial automation applications.

Note: For the purposes of the remaining clauses of this part of ISO/IEC 9506, the term "robot" will mean "manipulating industrial robot".

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3.2.5 manipulator:

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A machine, the mechanism of which usually consists of a series of segments jointed or sliding relative to one another, for the purpose of grasping and/or moving objects (pieces or tools) usually in several degrees of freedom. It may be controlled by an operator, a programmable electronic controller, or any logic system (for example cam device, wired, etc.).

3.2.6 motion enabled:

A boolean value which if TRUE indicates that a valid command presented to the control program of a robot arm will result in motion of the arm.

3.2.7 pose:

Combination of position and orientation of a part of a robot (for example its mechanical interface) or of a workpiece in a coordinate system.

3.2.8 remote operation:

An operation involving data acquisition or control operating over an OSI communication network using MMS services.

3.2.9 robot arm:

As used in this part of ISO/IEC 9506, a manipulator, an end effector, its power supply, and the control program which controls the manipulator.

3.2.10 robot system:

A robot system includes:

- the robot (hardware and software) consisting of the manipulator whether mobile or not; power supply and control system;
- the end-effector(s);
- any equipment, devices, or sensors required for the robot to perform its task;
- any communication interface that is operating and monitoring the robot, equipment, or sensors, as far as these peripheral devices are supervised by the robot control system.

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3.2.11 robot system controller:

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The entire control system of the robot, consisting of the (single) task program and the control program(s) for the robot arm(s) and the auxiliary device(s).

3.2.12 step:

An atomic element of task program execution. It may or may not involve robot motion.

Note: The concept of a step is dependent on the robotic programming language.

3.2.13 task program:

The set of motion and auxiliary function instructions which define the specific intended task of the robot system; this type of program is normally generated by the user.

Note: an application is a general area of work, a task is specific within the application.

4 Abbreviations

The following abbreviations are used in the text of this part of ISO/IEC 9506.

ACSE:	Association Control Service Element
ASE:	Application Service Element
ASN.1:	Abstract Syntax Notation One
C:	conditional parameter
CBB:	conformance building block
Cnf:	confirm
CS:	companion standard
DIS:	Draft International Standard
FTAM:	File Transfer, Access, and Management
Ind:	indication
I/O:	input/output
IS:	International Standard
M:	mandatory
MICS:	Mechanical Interface Coordinate System
MMS:	Manufacturing Message Specification
OSI:	Open System Interconnection
PDU:	protocol data unit
PICS:	Protocol implementation conformance statement
Req:	request
Rsp:	response
S:	Selection
TR:	Technical Report
U:	user option parameter
VMD:	Virtual Manufacturing Device

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5 Robot application description

5.1 Manufacturing configurations

5.1.1 General considerations

The conformance classes which are defined in clause 9 of this part of ISO/IEC 9506 are described independently of the configurations in which they are used. The configurations described in this subclause are tutorial in nature, and are included to give insight into the rationale which underlies this part of ISO/IEC 9506. Actual configurations can exhibit characteristics of several of these configurations simultaneously.

In a remote communication environment, one node is referred to as the client, the other node is referred to as the server. A host connected to a robot is considered to be a client of the robot. The host generally gives commands to, and monitors functions of, the robot. The robot is considered the server to the host. In the case of the robot connected through an OSI communication channel to intelligent peripherals, e.g., such devices as grippers, vision

systems, or other robots, the robot is viewed as a client with respect to such devices. The connections between devices described in this part of this Standard are considered to be logical connections.

Although operator panels and teach pendants can be used to direct operation of a robot, they are not considered clients in the present sense since they are not connected to the robot through OSI communication channels. Rather, they are considered part of the robot server.

This part of ISO/IEC 9506 does not impose any requirements on the client configurations when the client communicates with a robot. It requires only that the client has the capability to send the appropriate requests to the robot and to receive responses from the robot.

5.1.2 Configuration one: Robot server, single client

This configuration consists of one client (e.g., host computer) controlling, or in communication with, one robot (see Figure 2). The client, or host, sends requests to the robot, or server, to which the robot should respond. The robot can include its own subsystems such as vision and gripper controls. These subsystems will not be directly controlled via MMS and are outside the scope of Configuration one.

In simple implementations of Configuration one, there need be only one MMS association. In more sophisticated implementations, there can be multiple concurrent MMS associations.

An example is the case where two MMS associations are used between the host and the robot for increased throughput.

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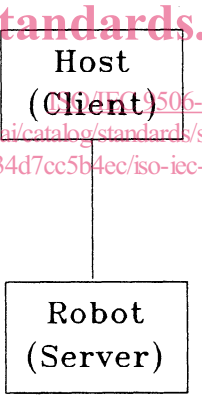

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Figure 2 Robot server/single client

5.1.3 Configuration two: Robot server, many clients

In configuration two, the robot is a server, but there are many clients (host computers). See Figure 3. Support for multiple concurrent associations is now required on the part of the robot server, since any of the client hosts can initiate an association.

A multiple client configuration requires a mechanism for taking and relinquishing control of the robot. Without this capability, there is no means for preventing two or more clients from attempting to control the robot simultaneously.

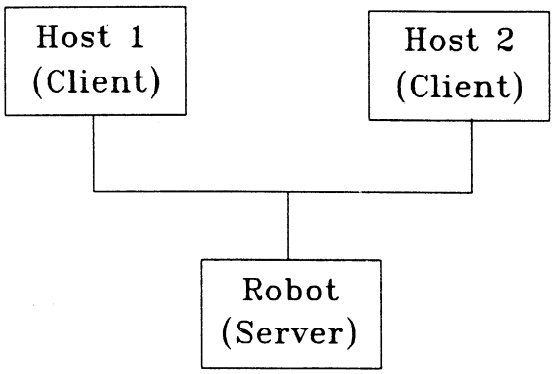

Figure 3 Robot server/many clients

An example of this configuration is a host performing robot control and a second host monitoring the robot as part of a larger system.

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5.1.4 Configuration three: Robot client

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In configuration three, the robot is a client to one or more devices (see Figure 4). It is also possible that the robot is simultaneously a server to one or more host clients as in configurations one and two respectively. The robot in a client capacity requires the ability to act as an initiator of requests, rather than just as a responder.

This part of ISO/IEC 9506 addresses only the interactions between a system acting as a client and robots acting as servers, and does not define the interactions with other devices such as vision systems, grippers, etc.. These interactions can only be defined based on the requirements of those devices.

An example of this configuration is a robot acting as a client to another system acting as a file server.