



BSI Standards Publication

**Smart manufacturing —
Reference architecture model
industry 4.0 (RAMM 4.0)**

National foreword

This Published Document is the UK implementation of IEC/PAS 63088:2017.

The UK participation in its preparation was entrusted to Technical Committee GEL/65, Measurement and control.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2017.

Published by BSI Standards Limited 2017

ISBN 978 0 580 96168 7

ICS 25.040.01; 35.080; 35.240.50

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 March 2017.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------



PUBLICLY AVAILABLE SPECIFICATION

PRE-STANDARD



Smart manufacturing – Reference architecture model Industry 4.0 (RAMI4.0)

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 25.040.01; 35.080; 35.240.50

ISBN 978-2-8322-4053-3

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	9
2 Normative references	9
3 Terms and definitions	9
4 Assets in Industry 4.0	11
4.1 The object world	11
4.2 Information carriers.....	12
4.3 Assets and the information world	12
4.4 Life (“vita”) and characterization of an asset	13
4.5 Means by which an asset is actively presented, or made known, in the information system.....	14
4.5.1 General	14
4.5.2 Unknown assets	15
4.5.3 Anonymously known assets	15
4.5.4 Individually known assets	15
4.5.5 Assets administered as entities	15
4.6 State in an asset’s lifetime (“vita”).....	16
4.6.1 General	16
4.6.2 Type	16
4.6.3 Instance	16
4.7 Communication capability	17
4.7.1 Communication capability of assets in the physical world	17
4.7.2 Communication capability of assets in the information world	18
4.8 Classification of assets in terms of presentation and communication capability	18
4.9 Representation by means of information and technical functionality	19
5 Reference Architecture Model Industry 4.0 (RAMI4.0).....	20
5.1 General.....	20
5.2 Architecture axis (“Layers”).....	21
5.2.1 Overview	21
5.2.2 Business layer.....	21
5.2.3 Functional layer.....	21
5.2.4 Information layer.....	22
5.2.5 Communication layer	22
5.2.6 Integration layer	22
5.2.7 Asset layer	23
5.3 Life cycle & value stream axis	23
5.4 Hierarchy axis	23
6 Industry 4.0 components.....	24
6.1 General.....	24
6.1.1 Overview	24
6.1.2 Properties of I4.0 components	25
6.1.3 Identifiability	25
6.1.4 State in the lifetime (“vita”)	25
6.1.5 Secure I4.0-compliant communication, services and quality of service.....	26
6.1.6 Representation by information with I4.0-compliant semantics	26

6.1.7	I4.0 system consisting of I4.0 components.....	27
6.1.8	Nestability	27
6.1.9	Encapsulability	28
6.1.10	Domain specific functionality and state model.....	29
6.2	Administration shell of I4.0 components	29
6.2.1	General	29
6.2.2	Basic structure of the administration shell.....	30
6.2.3	DF header and DF body.....	30
6.2.4	Partial models and views	31
6.2.5	Properties.....	32
6.2.6	Managing the administration shell.....	34
6.2.7	Fundamental requirements for the administration shell	36
6.3	Forms of I4.0 components.....	36
6.3.1	Different assets with administration shells	36
6.3.2	Asset with multiple administration shells	37
6.3.3	Administration shell for multiple assets	38
	Bibliography.....	39
	Figure 1 – Structure of the object worlds with examples.....	12
	Figure 2 – Assets in the information world and their physical counterparts	12
	Figure 3 – Life (“vita”) of an asset	13
	Figure 4 – Concepts of an asset	14
	Figure 5 – Component manager for administering entities.....	16
	Figure 6 – Active presentation of an asset in the information system and its communication capability.....	19
	Figure 7 – CP notation system for classifying according to communication capability and presentation (“publicity”)	19
	Figure 8 – Reference architecture model Industry 4.0 (RAMI4.0)	20
	Figure 9 – Hierarchical levels of I4.0	24
	Figure 10 – An I4.0 component as a necessary connection between the asset and the administration shell.....	25
	Figure 11 – Nestability of I4.0 components	28
	Figure 12 – Encapsulability of I4.0-compliant and deterministic real-time communication.....	29
	Figure 13 – Diagram of an I4.0 administration shell	30
	Figure 14 – Examples of domain specific models	31
	Figure 15 – Diagram of how views are created.....	32
	Figure 16 – Availability of administration shells via repository or directly via the represented assets	35
	Figure 17 – Different assets that become I4.0 components by adding the administration shell.....	37
	Figure 18 – Representation of an asset by means of multiple administration shells.....	37
	Figure 19 – Representation of multiple assets.....	38

Table 1 – Basic views of a partial model	32
Table 2 – Property classes.....	33

Currently in preview, click buy full version

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SMART MANUFACTURING –
REFERENCE ARCHITECTURE MODEL INDUSTRY 4.0 (RAMI4.0)**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

A PAS is a technical specification not fulfilling the requirements for a standard, but made available to the public.

IEC PAS 63088 has been processed by IEC technical committee 65: Industrial-process measurement, control and automation.

The text of this PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

Draft PAS	Report on voting
65/645/PAS	65/655/RVDPAS

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned may transform it into an International Standard.

This PAS shall remain valid for an initial maximum period of 3 years starting from the publication date. The validity may be extended for a single period up to a maximum of 3 years, at the end of which it shall be published as another type of normative document, or shall be withdrawn.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Background

Industry requires constant attention on optimization, cost efficiency, energy efficiency, environmental concerns, quality, security, safety, time-to-market, inventory reduction, simulation, ease of maintenance, etc. Customers also want to satisfy new requirements and address new use cases now reachable given the availability of new technologies. Addressing these challenges, several projects in different countries were issued with similar names and aims, e.g. in Germany “Industrie 4.0”, in France “Industrie du Futur”, in China “Intelligent Manufacturing”, in Japan etc.

Manufacturers, customers, service providers are working in a more and more global market. The need of interoperability of products, open interfaces, etc. can only be achieved with International Standards. To cover these needs, IEC and ISO have activities related to Smart Manufacturing.

Objective

This specification defines a Reference Architecture Model to identify, structure, and illustrate the different areas where standards exist or standards are required. It allows setting standards in relation to different aspects, hierarchies and life cycles.

Life cycles are relevant to products, to assets in the factory or plant, to orders from planning to cash and to the supply chain covering the process from source to delivery.

In addition, this specification defines term and definitions generally for Smart Manufacturing. As Smart Manufacturing is covering different domains (batch, continuous, discrete, etc.), terms need to be harmonized and globally accepted.

The fundamental purpose of Industry 4.0 is to facilitate cooperation and collaboration between technical objects, which means they have to be virtually represented and connected. In this context, a technical object is an object that is of value to an organization, which therefore not only means physically tangible objects, but also intangible objects such as ideas, archives and software. The concept of industry 4.0 is intended to create digital description rules for a technical object throughout its entire lifetime, and for the associated changes in value, in the form of the Reference Architecture Model for Industry 4.0 “RAMI4.0”. The purpose of this model is to represent the technical object and all aspects relevant to it, from its development, production and use right through to its disposal. The Industry 4.0 component provides a digital description of the object, making it possible to represent that object virtually.

Technical objects are intentionally manufactured in order to fulfil a specific purpose. They possess common characteristics in terms of their lifetime and the associated changes in value. Technical objects for which a “change in value” or an “owner” are important aspects are also referred to as “technical assets”. Because this is almost always the case, the terms “technical object” and “technical asset” can be regarded as synonymous. In this document, the term “technical asset”, or simply “asset” is used.

This document describes two fundamental reference models for the Industry 4.0 concept:

- The reference architecture model RAMI4.0 is a reference model of Industry 4.0 reference architecture and gives a structured description of fundamental ideas. See Clause 5.
- The I4.0 component reference model provides digital access to this description. See Clause 6.

The central concept of Industry 4.0 is that assets can be combined in any way, and these assets are formally described in sufficient detail for use in the digital world. This methodology not only enables sufficient generic descriptions of a configuration, but through an increasing degree of detail also allows for very specific descriptions. This is a core concept regardless of the way in which the asset is used.

To virtually represent configurations of assets and the connections between them, the “principle of recursive description of assets” is used to characterize an asset as follows:

- the structural description is compliant with RAMI4.0;
- a configuration of two or more assets collectively forms a new asset, which is described using RAMI4.0;
- components of an asset can themselves represent separate assets that are described with RAMI4.0;
- the asset description is provided as structured information in the administration shell of the I4.0 component that acts as a virtual representation of an asset.

This means that any configuration can be digitally represented to any degree of granularity by describing structured assets, and combinations thereof, using RAMI4.0.

SMART MANUFACTURING – REFERENCE ARCHITECTURE MODEL INDUSTRY 4.0 (RAMI4.0)

1 Scope

This document, which is a PAS, describes a reference architecture model in the form of a cubic layer model, which shows technical objects (assets) in the form of layers, and allows them to be described, tracked over their entire lifetime (or “vita”) and assigned to technical and/or organizational hierarchies.

It also describes the structure and function of Industry 4.0 components as essential parts of the virtual representation of assets.

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.

IEC 61360-1, *Standard data element types with associated classification scheme for electric components – Part 1: Definitions – Principles and methods*

IEC 61360-2, *Standard data element types with associated classification scheme for electric components – Part 2: EXPRESS dictionary schema*

IEC TR 62794¹, *Industrial-process measurement, control and automation – Reference model for representation of production facilities (digital factory)*

IEC TS 62832-1, *Industrial-process measurement, control and automation – Digital factory framework – Part 1: General principles*

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:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

administration shell

virtual digital and active representation of an I4.0 component in the I4.0 system

Note 1 to entry: An administration shell contains the manifest and the component manager.

¹ Withdrawn.