

Fluid Power



## Fluid Power 4.0 – digitize, connect, communicate



## Foreword

Industrie 4.0 is the most pressing topic for our industry. Digitalized value chains require products and components that can communicate with each other reliably in all kinds of applications. This universal digital communication is a key task to successfully implementing Industrie 4.0. It can only be achieved with an integrated standardization. That is why the VDMA Fluid Power Association, together with its member companies, has developed a standardization strategy, which it implements through a number of activities at both the national and international level.

In this strategy, standardized descriptions and specifications for fluid engineering products play a central role. In order for fluid power product data to be digitally transmitted and received correctly and clearly, it needs to be available in a standardized format. Therefore, a formalized definition of specifications or rather technical properties is necessary. This makes interoperability possible, in that elements with the same meaning are defined with the same specifications irrespective of sector or communication partner.

The standardization must occur “bottom up” – from individual components through to complete products. Every fluid power component must be described using standardized specifications, so that the product is compatible with Industrie 4.0. The series of standards ISO 18582 and the industry standard eCI@ss form the starting point for the standardization. The activities of the VDMA Fluid Power association aim to combine the particular strengths of these standards and to add any missing specifications.

The fact sheet “Fluid Power 4.0 – digitize, connect, communicate” provides you with an overview of our activities. It should also serve as an information and implementation guide, assisting you to profitably implement “Fluid Power 4.0” in your company.

We wish you an interesting read and welcome your ideas and comments.

**Industrie 4.0 needs a non-proprietary  
“language”; Fluid Power is writing the global  
dictionary of the future.**

Dr. Steffen Haack, Bosch Rexroth AG,  
Member of the Board of the Fluid Power  
Association within VDMA

# 1 Industrie 4.0: Challenges and opportunities



With Industrie 4.0 a fundamental paradigm shift is taking place in industry: Production is becoming more customized, faster and more flexible. This process is associated with changes at all company levels and throughout the entire value chain. Fluid power too must respond and develop into “Fluid Power 4.0”.

## **Better products and new services**

Fluid power products are known for their low acquisition cost, high reliability and great power density. With the help of more innovative digital solutions, operating costs can be reduced and precision increased. In addition, digitized, connected and intelligently controlled fluid power products make it possible for new products and services to be developed in user industries. These include for example predictive maintenance or new forms of collaboration between man and machine. New business models based on product-service systems – the bundling of products and corresponding services, e.g. in the form of a use-based settlement – and on data analysis will play an even more important role in company portfolios in the long run.

## **Handling data will be a success factor**

With intelligent data analysis it is possible to better monitor and steer processes and to control and to guarantee product quality. In this way, economic and ecological advantages arise which can be attributed to increased energy efficiency (e.g. through reducing the pressure level) as well as the optimal and flexible utilization of

machines and plants, for example. In order to avoid unnecessary and huge amounts of data, edge computing – the analysis of data at the place where it is generated – functions as a complement to cloud solutions. With edge computing, manufacturers of products can also make optimal use of their specific know-how in that they can disclose and pass along data that is relevant and useful for operators.

## **Standardization is crucial**

In Industrie 4.0, fluid power must be capable of communicating in a digital network and of generating, processing and sharing data. Furthermore, this data must be compatible with all the different technologies and controls used in various industries. That is why standardizing the communication – from the description of the technical specifications through to data exchange all the way to interfaces – is essential for successfully implementing Industrie 4.0. The sheer number of different fluid power products and their applications presents a special challenge – there are only a few standard scenarios or rather functional units.

## 2 Action fields for standardization

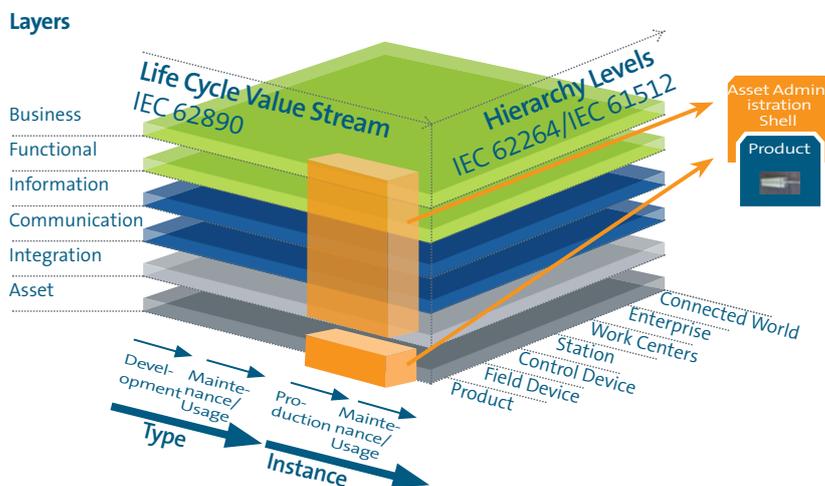
To enable universal data exchange, the physical fluid power products must exist digitally as a so-called Digital Twin. The Digital Twin is a virtual image of the product and contains all relevant information necessary at different application levels over the entire lifecycle.

### RAMI 4.0: Structure for standardization

The Reference Architecture Model Industrie 4.0 (RAMI 4.0) has proven itself for visualizing the different information and levels. RAMI 4.0 is a three-dimensional layer model that contrasts the lifecycle of products, factories, machines or orders with Industrie 4.0 hierarchy levels. With the help of this model, existing norms and standards can be ordered into straightforward segments.

Fluid power activities largely can be assigned to “Product” and “Field Device” as well as “Information Layer”. At these levels all information necessary for creating a Digital Twin must be available. As a counterpart to the real product (Asset) is the digital data, which describes the product, filed on a so-called “Asset Administration Shell”. This data comprises defined attributes, which are assigned specific values.

### RAMI 4.0 creates transparency throughout all facets of Industrie 4.0

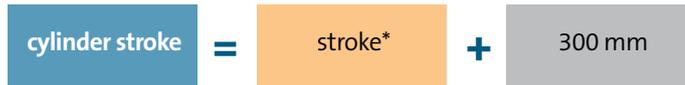


Sources: Plattform Industrie 4.0 and VDMA

## Example (cylinder stroke) for a standardized data description



example:



\* ISO 5598:2008, section 3.2.181:

**stroke**, m

distance travelled externally by the moveable element from one extreme position to another

Source: VDMA

### Interoperability through uniform interfaces and semantics

Standardization aims at manufacturer-independent interoperability or rather a formalized exchange of data and its value. This interoperability requires a uniform, technology neutral description of attributes as well as standardized data exchange formats and interfaces.

The uniform description of attributes occurs with a shared language, which uses standardized terms and characteristic definitions and

generates a semantics. This semantics enables the readability of the data in a standardized digital form and ensures it can be processed – thus ensuring networking and communication. Interface standards such as OPC UA (Open Platform Communications Unified Architecture) and standardized data exchange formats such as Automation ML (Markup Language) guarantee the uniform communication of this data.



### 3 Requirements on “Fluid Power 4.0”

The scope of “Fluid Power 4.0” extends far beyond online communication. It refers to the entire lifecycle, from development, production, commissioning, operations, service all the way through to end of life/recycling. Appropriate attributes must exist for each phase of the lifecycle. If one considers the attributes that currently exist in standardized form in ISO and eCl@ss for fluid power products, two different types of attributes arise:

- classical technical attributes, e.g. stroke, pressure, dimensions or switching time
- commercial attributes, e.g. manufacturer or GTIN (Global Trade Item Number)

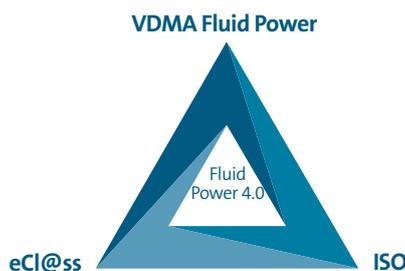
With a view to Industrie 4.0, additional attributes are also relevant: especially operating data (actual values) and other data necessary for development (e.g. simulation models), commissioning (e.g. firmware) and service (e.g. GPS location). The VDMA Fluid Power Association set itself the goal to introduce these Industrie 4.0

relevant attributes into the international standardization process and thus to drive forward the standardization in line with “Fluid Power 4.0”.

#### Central role of ISO

The VDMA Fluid Power Association is active in the International Standardization Organization ISO, and forms part of its technical committee ISO/TC 131, Fluid power systems ([www.iso.org/committee/52232.html](http://www.iso.org/committee/52232.html)). VDMA employees lead the secretariats of important work groups and subcommittees. German industry experts are also active as convenors, chairpersons and project leaders. The most important fluid power ISO standards for Industrie 4.0 are ISO 5598 and the ISO 18582 series of standards. ISO 5598:2008, Fluid power systems and components – Vocabulary, defines the vocabulary necessary for a standardized semantics – meaning of linguistic signs and character sequences as well as linkage rules (see example cylinder stroke on page 4). The standard is currently being revised and should be released later in 2019.

#### Fluid Power 4.0 standards arise in the Interaction of ISO, eCl@ss and VDMA



Source: VDMA

## eCl@ss standard for information exchange

eCl@ss is a German association whose purpose is to develop a standard for information exchange between suppliers and customers. This eCl@ss standard is a hierarchical system for grouping products and services. It comprises four hierarchy levels or classes. The lower the class level, the more detailed the description of the product.

The Consortium Data Standard classifies products and services using standardized attributes whose definite allocation is guaranteed by the International Registration Data Identifier (IRDI). It is ISO/IEC (International Electrotechnical Commission) compliant and available in many languages. As a result, the eCl@ss standard enables product data to be digitally shared over sectors, countries, languages or organizations. Already since 2016 activities have been taking place to standardize fluid power attributes. [www.eclass.eu](http://www.eclass.eu)

With its classes and definitions of characteristics, the ISO 18582 series of standards, Fluid power – Specification of reference dictionary, forms the basis for classification and unequivocal descriptions of products. Part 1 of the series defines the formation rules for classifications and specifications of fluid power products; part 2 contains the specifications for pneumatics.

### Updating of eCl@ss standard in 2019

Employees of VDMA Fluid Power member companies and the association manage and are actively involved in the eCl@ss expert groups for Hydraulics and Pneumatics. When the eCl@ss standard is revised in summer 2019, the two eCl@ss main groups for Pneumatics and Hydraulics – which up to now were subordinated under the subject area “Electric engineering, automation, process control engineering” – will be amalgamated in one segment “Fluid power”. This update also entails a new structuring of the main groups and other groups. eCl@ss automatically assigns the products (“classes”) at the lowest level with certain specifications such as name of manufacturer, manufacturer product designation, GTIN or name of supplier. In subsequent revisions, additional specifications will be assigned to fluid power components and systems in the eCl@ss

expert groups Pneumatics and Hydraulics. In the group Pneumatics, specifications are assigned to the classes or products using ISO 18582-2:2018, Fluid power – Specification of reference dictionary – Part 2: Definitions of classes and properties of pneumatics.

### VDMA is driver, moderator and catalyst

The VDMA Fluid Power Association acts as a coordinator between the organizations ISO and eCl@ss. The taskforce “Industrie 4.0 – Fluid Power”, in which 14 VDMA member companies and also eCl@ss representatives work, has identified more than 100 attributes that are relevant for Industrie 4.0 which go beyond pure product specifications. GPS for example is important information for mobile machines. Fluid quality and reached service life are specifications that are relevant for predictive maintenance. File format, file location and versioning of simulation models are – just like standardized characteristics and diagrams – specifications that must be available in the development phase. VDMA informs the appropriate eCl@ss expert groups of its recommendations on Industrie 4.0 relevant specifications, so as to gradually consolidate these and integrate them into the eCl@ss standard in the next update.

VDMA activities play a decisive role in ensuring that ISO and eCl@ss standards are further developed in sync and consideration is given to the needs of “Fluid Power 4.0”. It is proposed that

new eCl@ss specifications are integrated into ISO standards and that changes in ISO standards result in changes in the eCl@ss standard, too.

## Example of specifications from different standardization committees

### Attributes from ISO – ISO/TC 131 “Fluid power systems”

- Ports and connections
- $B_{10D}$ ,  $MTTF_D$
- Pressure: operating pressure et al. (according to ISO 5598, ISO 18582; nom, min, max, is)
- Parameters
- Medium number of particles
- Shifting time
- Flow
- ...

### Attributes from eCl@ss – Expert groups Hydraulics and Pneumatics

- GTIN (Global Trade Item Number)
- Manufacturer product designation
- Brand
- Serial number
- Part number
- Time stamp
- Customs tariff number
- Approval / compliance
- ...

### Attributes from VDMA – Industrie 4.0 – Fluid power

- Number of operating states outside specification
- Documentation (type, version, hyperlink/URL)
- Electric power consumption
- Reached operating time
- Reached switching cycles
- Characteristic diagram
- Simulation model (type/format, version, hyperlink/URL)
- Location according to geodetic data; GPS
- Maintenance interval
- ...

## 4 “Fluid Power 4.0” in practice

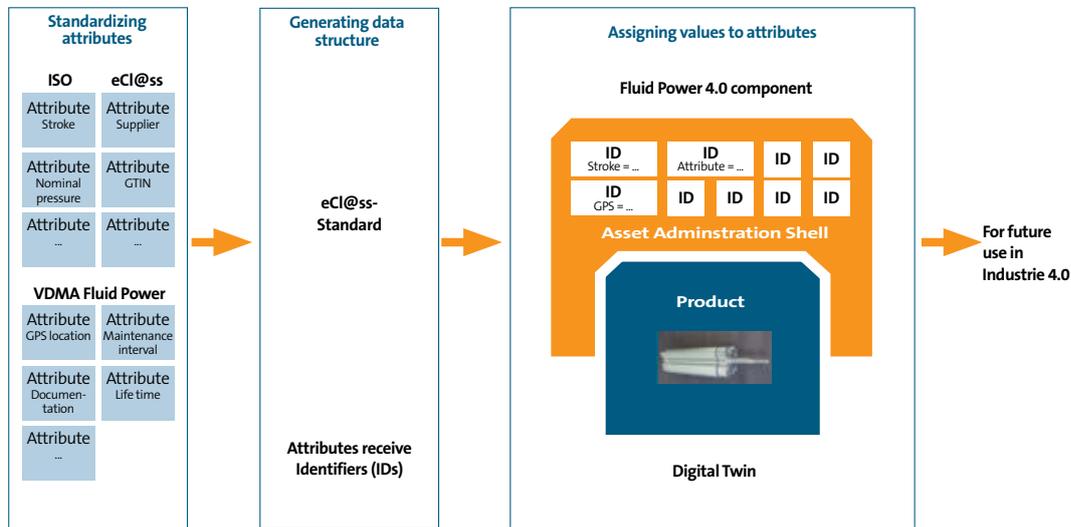
To image a component digitally, it must be described with the attributes of ISO or eCI@ss. The graph illustrates how – originating from the description and identification of specifications – the specifications can be channeled and filled with values. With data generated in this way it is possible to create the Asset Administration Shell or rather the Digital Twin.

### The way to a Digital Twin

The specifications of fluid power products are standardized using attributes in eCI@ss and ISO and a unique identifier in eCI@ss.

eCI@ss users can export and download the standard with structure and specifications in different languages in both XML or SCV file formats.

### From the generation of an attribute to the Digital Twin (Asset Administration Shell)



Source: VDMA Fluid Power



The manufacturer or user can then furnish the relevant specifications with fixed values or leave fields blank in the case of actual values. This generated data record describes the product (Asset) digitally and completely – the Digital Twin is generated.

This data record of attributes with values can be transmitted, stored on a product or offered as a download, which also enables the attributes to be used when linking products or developing OPC UA Companion Specifications – the common shared cross-sector language between machines and plants within OPC UA.

#### **OPC UA: Important standardization building block**

The standard OPC UA helps manufacturers to prepare their products for Industrie 4.0 applications. It is thus an important technical prerequisite for new Industrie 4.0 business models as well. The standardized description of fluid power components and systems enables compatibility at all levels of industrial automation. In applications in which no OPC UA Companion Specifications exist, but which should be linked with OPC UA, the attributes can be directly used.

The attributes can be universally applied for every type of protocol and interface. When manufacturers provide eCl@ss compliant data, the described fluid power product can be connected and communicate digitally. The integrated components and (sub-)systems and their Digital Twins are then Industrie 4.0 compatible: the path for “Fluid Power 4.0” has been paved.

## 5 Summary and outlook

Industrie 4.0 is a central challenge for all companies in the engineering business. The interoperability of future value-added networks presents an important enabler for implementing Industrie 4.0 successfully. In order to actively shape the technical frameworks, the VDMA Fluid Power Association, together with its member companies, has developed an integrated standardization strategy.

**This strategy is to generate the Digital Twin or rather the Asset Administrative Shell of fluid power products on the basis of a sectoral standardization of attributes and their standardized descriptions.**

The Digital Twin enables compatibility at all levels of industrial automation – to machine manufacturers and integrators, but also to interfaces and protocols such as OPC UA. It thus creates the perfect digital link between product and user or rather between components and machine.

### **Greater efficiency in engineering and the commissioning and operating of plants**

The benefits for machine manufacturers are obvious: Using the Digital Twin of components, engineering times can drastically be shortened. In addition, virtual machines can be built up much faster and commissioning times can be reduced through virtual commissioning. Moreover, in operation, service approaches can be planned and monitored in a preventative and targeted fashion, and operating information from machines can be better assigned. But it is not just customers who can immediately benefit from the Digital Twin, so can the fluid power industry itself, e.g. through new business models in the form of maintenance and service concepts.

This can occur only through the regular exchange and sharing of information of all parties involved.

**The VDMA Fluid Power Association represents the interests of industry in the processes of ISO and eCl@ss, in which the standards for the standardization of properties and attributes and the semantic description are set.**

Interested companies are cordially invited to participate in future activities involving “Fluid Power 4.0”.

## Our partners

The following partners are involved in the VDMA Fluid Power Association's Industrie 4.0 activities:



Fluid Power

# Imprint

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VDMA DesignStudio, Frankfurt am Main

## **Production**

h. reuffurth gmbh, digital media & print  
Mühlheim am Main  
[www.reuffurth.net](http://www.reuffurth.net)

## **Picture credits:**

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