EPLAN

efficient engineering.

Functional Engineering

Design function-orientated schematics

PROCESS CONSULTING | ENGINEERING SOFTWARE | IMPLEMENTATION | GLOBAL SUPPORT

FRIEDHELM LOH GROUP

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Do you want to speed up schematic designs?

SWITCH TO FUNCTIONAL DESIGN

Electrical engineers are tasked with the challenge of creating schematics that are easy to read for everyone. However, a panel builder requires different information as compared to a service technician or maintenance engineer. So how do you make sure that you design schematics efficiently so that they contain all the required information for different end users? Switching to a functional design method allows you to design better, more practical schematics that take less time to create.

What is Functional Engineering?

In traditional schematics, components are grouped together on one page in their entirety. For example, PLC input cards are grouped on one page and output cards are grouped on another page. It may seem that grouping components like this makes for easy engineering, but actually the opposite is true. An engineer is interested in the connections between each component, which then determines their function. The more pages an engineer needs to read, the harder it becomes and the more time it takes to figure out the correlation.

Increasingly, engineers are switching from traditional, production-oriented schematics to functional-orientated schematics. Functional schematics allow engineers to be more efficient, and the schematics more practical for end users and service technicians who oversee the maintenance of control cabinets and machines. In functional engineering, the components that belong together functionally are all part of one schematic diagram. Changes are made easier as are adding or deleting components.

Standards

The ISO/IEC 81346 standard helps create schematics that everyone can read.

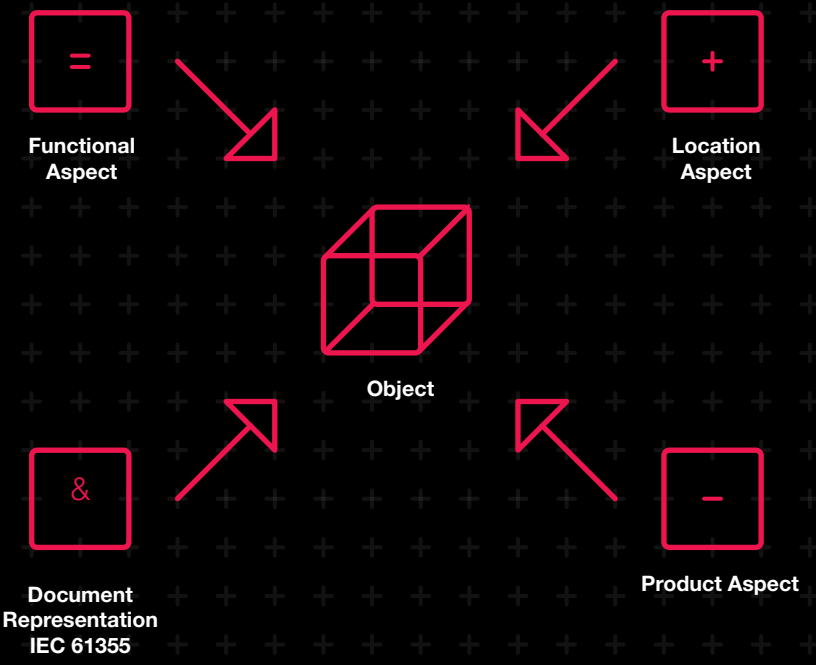
On this page, you see an object with different aspects. The aspects of an object describe how the object will be seen or viewed:

'=' symbol: this indicates a function.
What does this object do? What is its purpose?

'+' symbol: this indicates a location.
Where will this object be placed?

'-' symbol: this indicates a product.
How will this be built? What does it consist of?

When you create functional-oriented schematics, you can find all these aspects in your schematic diagram. The fourth aspect determines how the information is represented: What is the objective of the document or what type of document is it? This is determined by a different standard: the **IEC 61355 standard**.



A conversation with

UWE HARDER

Head of Consulting at Eplan

Functional Engineering vs. A Production-Oriented Approach

Generally speaking, both types of schematic representations of circuit diagrams are justified. With production- and location-oriented representations, it is easy to manufacture control cabinets based on the schematics. However, a lot of patience is required during commissioning and servicing. The diagrams are distributed throughout the schematics, necessitating a lot of scrolling and jumping back and forth from page to page.

“Functional planning” includes all the components of an electro-mechanical design that are linked to each other technically. For example, a motorised system in a control cabinet with cables, terminals, relays, contactors, safety components, PLC inputs, PLC outputs and so on is responsible for controlling the same function. The complete functionality is shown on just a few pages in the schematics. The requirements for production can still be covered quite well by location-based reports. Combining the two is the solution.

At the moment, many control cabinet manufacturers use the components as a guideline for their engineering, but not their respective functions. For instance, groups of identical components are viewed in a page-oriented way. This approach is ideal for production, since component after component can be displayed in the schematics and installed directly into the control cabinet on a step-by-step basis. This type of grouping simplifies the cabling of control cabinets and devices. Control cabinet production thus provides the guidelines for engineering.

In a schematics-oriented environment, this traditional approach is the easier solution, particularly at the production stage. However, it takes a lot of time when the systems are up and running since the functions are scattered across many pages in the schematics and functional relationships can only be understood by leafing or scrolling through many schematics pages, which is time consuming.

For maintenance, then, it would be much easier if the control cabinet were organised according to the control functions it performs. Over a control cabinet's operational life, functional engineering can provide your customers with a lot of added value and save valuable time when maintenance is performed or in the event of malfunctions.

Quick and Easy Assembly

Are the arguments for production-oriented design still valid? As Eplan Head of Consulting Uwe Harder explains: "In the paper-based approach, service engineers must first leaf through numerous pages and schematics before they can understand a function-oriented design in the control cabinet. This is no longer necessary with the support of intelligent engineering software. The software automatically generates comprehensive lists for installation. Today, the two can be combined very well and the requirements of the engineering and production departments can ideally both be covered in equal measure."

In practice, many electrical engineers believes that service engineers would prefer to work with production-oriented designs. Harder believes otherwise: "I have spoken with people in installation departments at many companies. In most cases, it's just a habit because that is how it has always been done. I can only recommend spending the time to take a good look at the methods for functional structuring offerings and then simply try them out. I am certain that the engineering will be made even simpler in most cases because the connections are also shown in a coherent way in the schematics."

Connecting the Dots

Harder also believes that changing over to functional engineering is an investment in the future: “Converting a production-oriented library into a functional database requires time. However, the result is worth the effort since the design engineering becomes much faster and more efficient. Many functions, options and variants can be saved as templates that engineers can then insert anywhere into their designs. The templates can and should be utilised all across a company, which leads to a standardisation of the engineering and higher project quality.”

According to Harder, the biggest challenge is rethinking electrical engineering design:

“This isn’t just a task for the engineering department, as control cabinet production must also be involved in this process. Together they can develop an understanding for why functions are important for engineering and how every work step in production can be perfectly supported by way of clever assembly-related and automated reports, even without the schematics.”

In this context, functional engineering ends up connecting all the dots. As Harder says, it allows a company to achieve functional consistency from sales to engineering, production, commissioning and even on to service and maintenance. “We’re no longer talking about a number of components, such as twenty contactors, ten isolators and x-number of sensors and motors, but rather about a combination of functions. A functional range consisting of a power supply, processing functions one through four, monitoring, emergency stop circuits, PLC and operating functions, for instance, is much easier for everyone to understand.”

Standards and Functions

Several standards support functional engineering. IEC 81346 offers electrical engineers and control cabinet manufacturers guidelines for structuring their designs. This standard combines letters with “objects.” There are three possibilities for representing a design: What is it? (The contactor “K” for example, as a product with a device number.) What does it do? (The safety control “F” for instance.) And where is it located? The letter is the connection between these three objects. The designation “C” relates to energy storage, so this function is always associated with the letter C.

Standards and Documentation

As Harder explains, this consistency supports functional engineering: “Design engineers know that a motor always requires protection, so they add an ‘F’ to their basic designs without having to link it to a specific device until the detailed engineering phase. This means that the basic and detailed designs are better connected to one another. This also provides another useful link to the sales department, as a quote can be generated based on the basic designs. Customers receive a better impression of the functions that the quote offers. The products and device numbers required for the functions are determined at a later stage.”

Standard IEC 61355 offers a database for all types of documentation that are relevant for projects. This can include tables of contents, multi-line schematics, planning documents, terminal diagrams, cable lists, and so on. The advantage of this is that the document types are clearly organised using (digital) tabs and stored in a (digital) folder.

“When designing using the production-oriented approach, you have a folder for this,” Harder says. “However, if you apply the standard to functional engineering, then each functional subgroup in the entire project has its own subfolder. It’s the same setup, the same project, but with more subfolders in the documentation.” The advantage of this is that it is much easier to search for a specific component in a functional group. “If you use these standards, there is no need for rigid page numbering.” Each document type contains its own tag: EFS for multi-line schematics, for instance. Filtering the product-oriented information is now just as easy as displaying the complete overview.

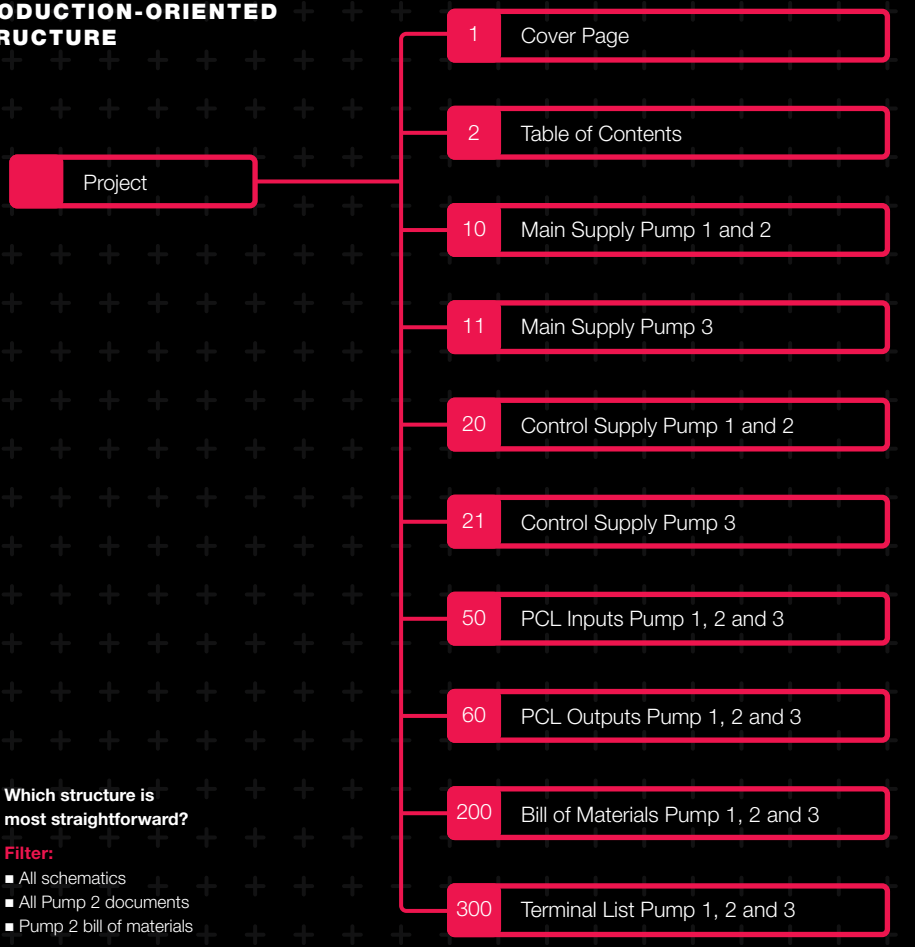
Just Get Started

In general, functional engineering offers numerous benefits. But where do you start? Harder has an answer: “It’s best to simply get started with the knowledge that the documents aren’t there just for production.” If this approach is accepted, it makes sense to focus on the functional groups right from the start, during the sales phase, and then derive them 1:1 via engineering for production. “For example, each function requires a motor, sensor and actuator. Ask yourself what else is needed so that the function can be carried out safely and reliably. This also includes infrastructure components. Think of the cabling, fasteners, protection, a contactor, PLC output, feedback security for the PLC and a sensor that switches the motor on and off. Bring everything together that belongs together to perform a function.” In Harder’s experience, this approach is more reliable in engineering: “First you design the complete functions and only in the second step do you select the necessary components.”

Tip

Uwe Harder’s tip: “Just get started and try out something new!” He adds, “After the familiarisation period, when the processes are much more structured and the first step towards automated schematic generation has been taken, most customers ask themselves the question: *Why didn’t we start doing this a lot sooner?*”

PRODUCTION-ORIENTED STRUCTURE



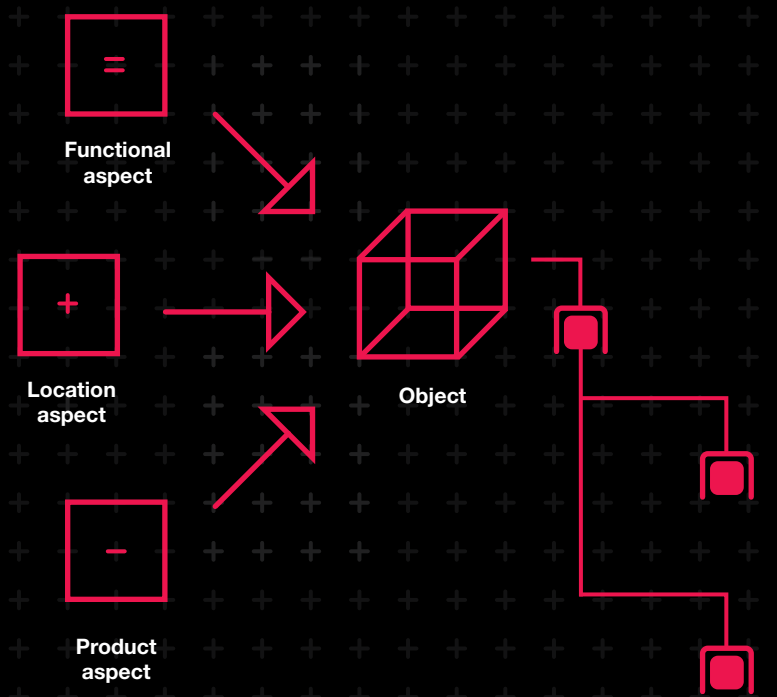
Which structure is most straightforward?

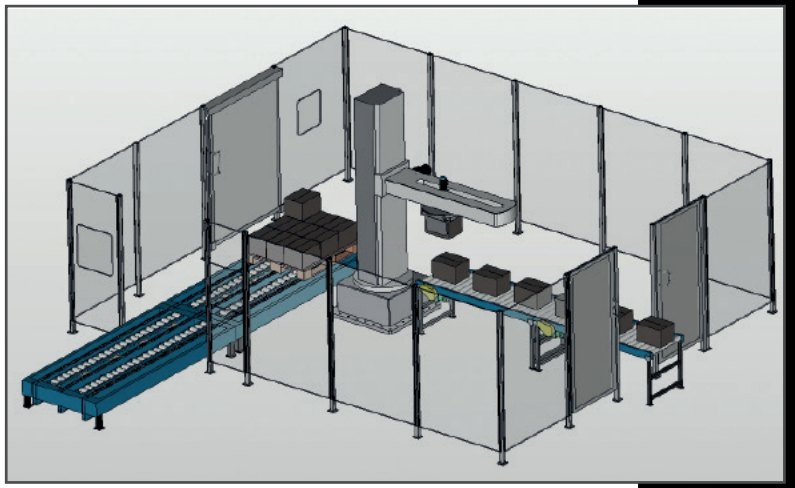
Filter:

- All schematics
- All Pump 2 documents
- Pump 2 bill of materials

ISO/IEC 81346-1

Structuring principles and reference designations



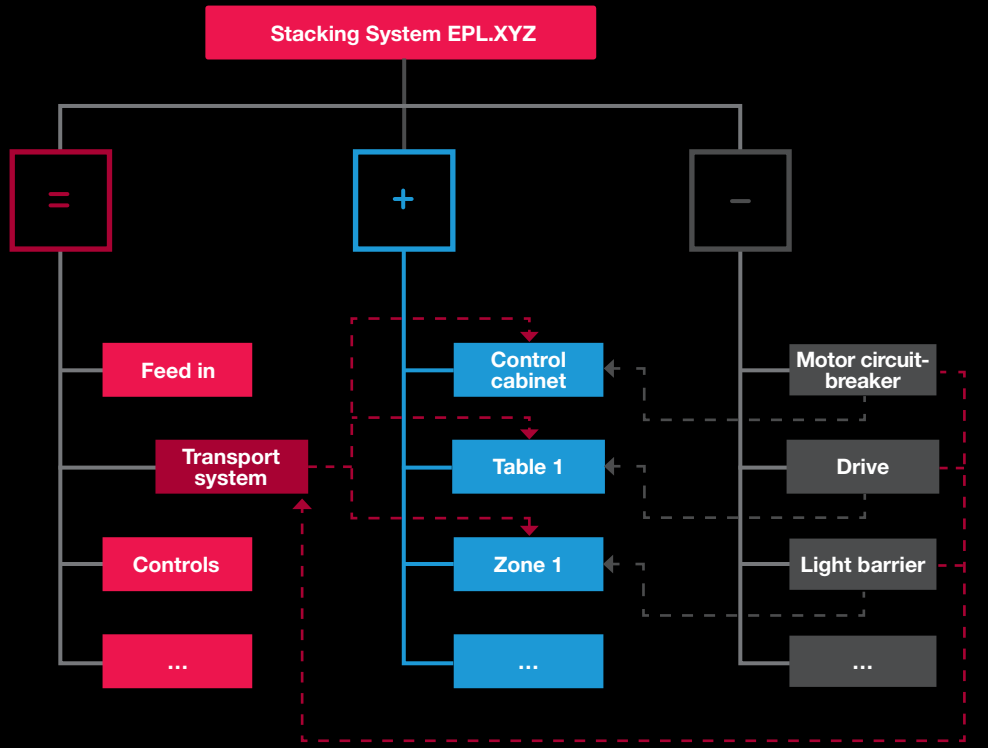


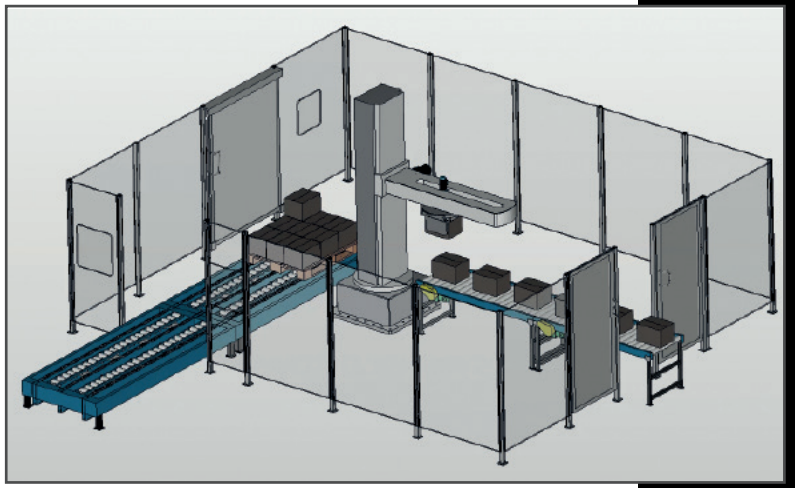
Eplan Engineering Standard, Industry Sample - “Stacking System - IEC”

ISO/IEC 81346-1

Structuring principles and reference designations

(basic rules)

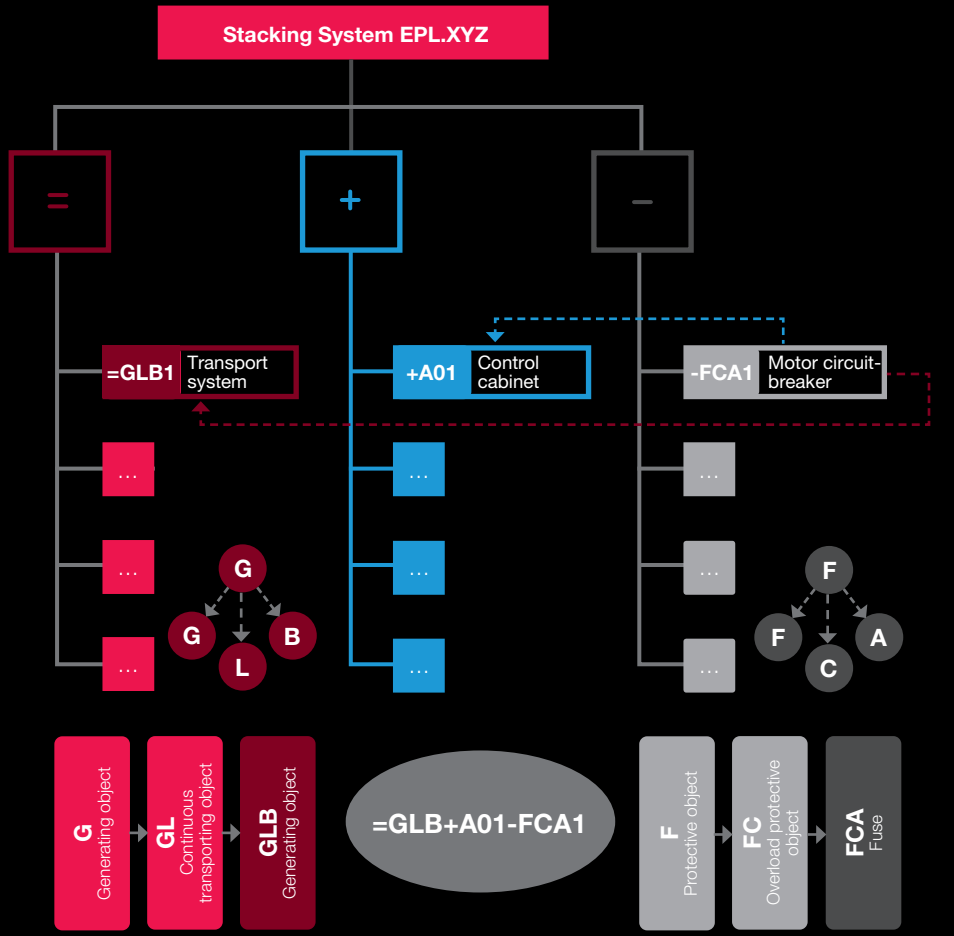




Eplan Engineering Standard, Industry Sample - “Stacking System - IEC”

ISO/IEC 81346-2

Classification of objects and coding of classes



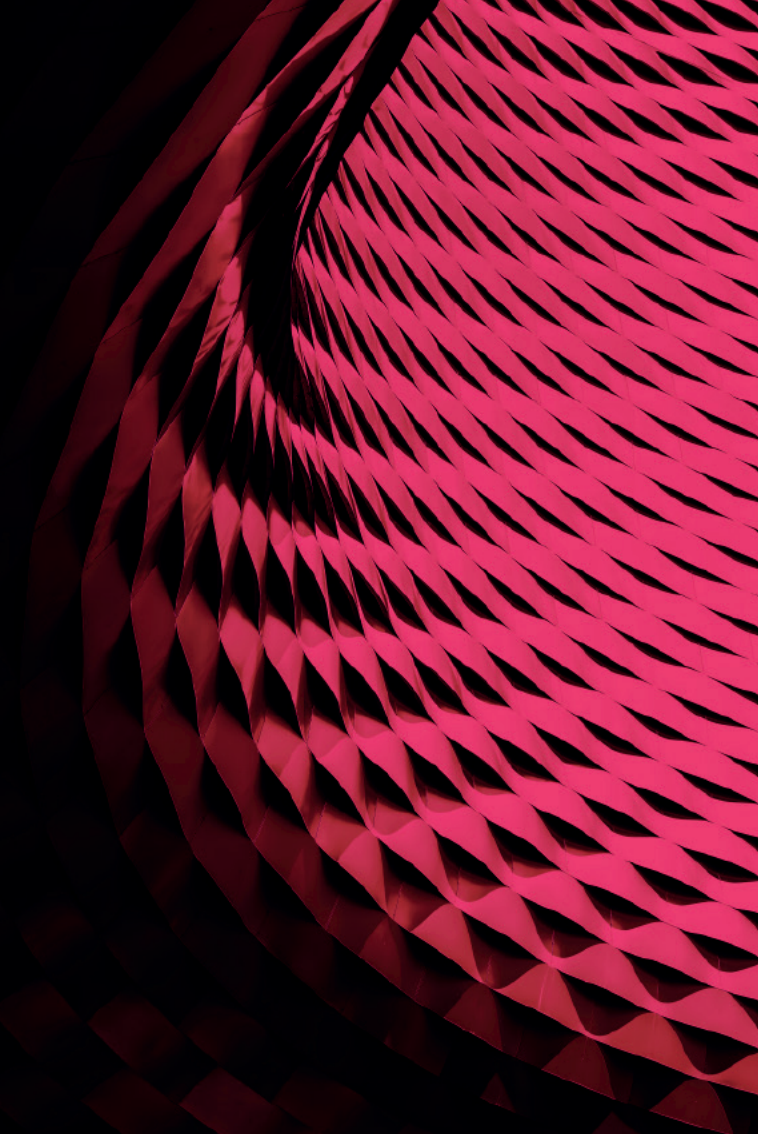
*Classification according to Appendix D – up to three letters

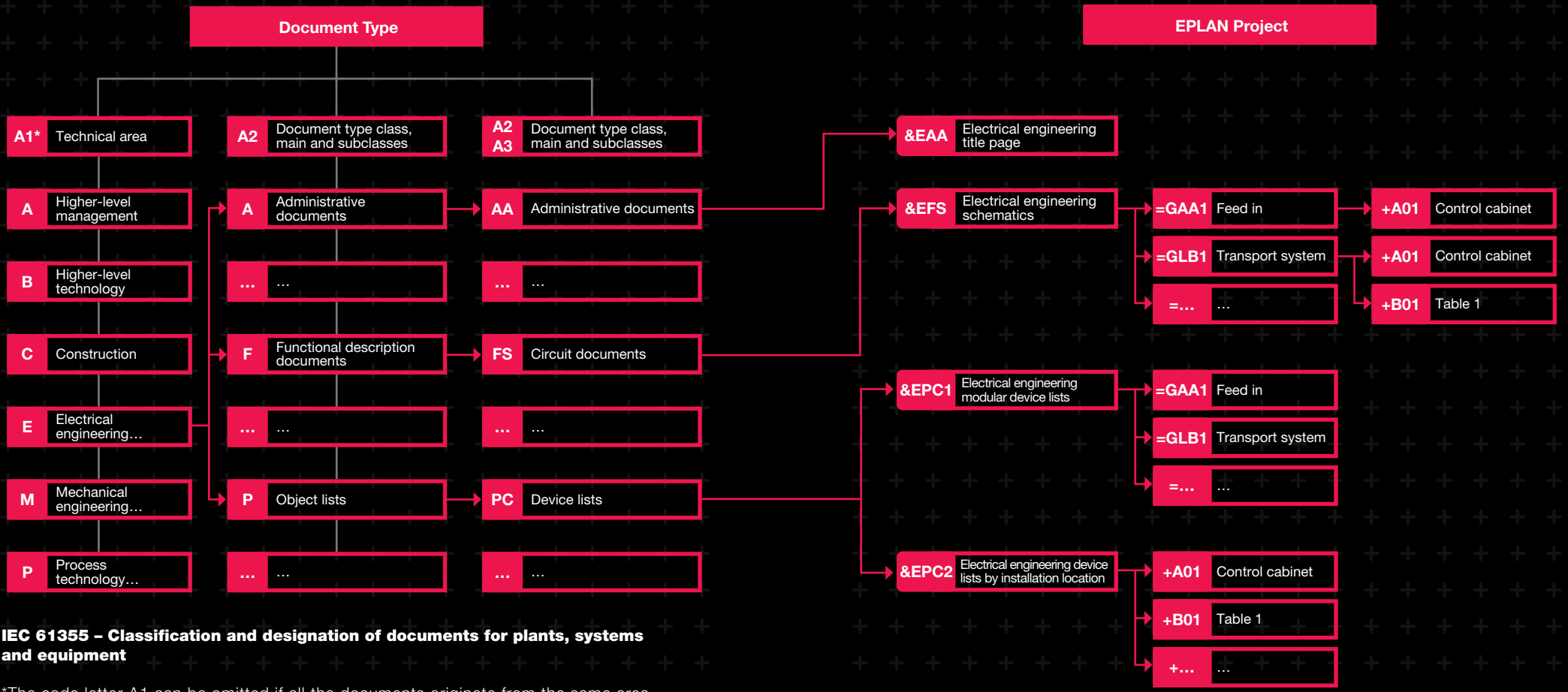
ISO/IEC 81346-2

Source: RDS 81346 Technique ApS/www.81346.com

CLASS CODE	CLASS DEFINITION	CLASS NAME
B	Object for **picking up information and providing a representation**	Sensing object
C	Object for **storing for subsequent retrieval**	Storing object
E	Object for **emitting**	Emitting object
F	Object for **protecting against the effects of dangerous or undesirable conditions**	Protecting object
G	Object for **providing a controllable flow**	Generating object
H	Object for **treating matter**	Matter processing object
K	Object for **treating input signals and providing an appropriate output**	Information processing object
M	Object for **providing mechanical movement or force**	Driving object
N	Object for **partly or fully enclosing another object**	Covering object

CLASS CODE	CLASS DEFINITION	CLASS NAME
P	Object for **providing perceptible information**	Presenting object
Q	Object for **controlling access or flow**	Controlling object
R	Object for **restricting or stabilising**	Restricing object
S	Object for **detecting a human action and providing an appropriate response**	Human interacting object
T	Object for **transforming**	Transforming object
U	Object for **localising other objects**	Holding object
W	Object for **leading from one place to another**	Guiding object
X	Object for **interfacing an object**	Interfacing object





IEC 61355 – Classification and designation of documents for plants, systems and equipment

*The code letter A1 can be omitted if all the documents originate from the same area.

ADDITIONAL INFORMATION

can be found at the following websites, amongst other places:

www.eplan.help
- Eplan Online Help
- Functional description of the products on the Eplan Platform

www.eplan.com
- Installation guide
- Standardisation templates
- Application and industry examples

www.eplan-software.com/services/consulting-portfolio
- Overview of Eplan Consulting services

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