Guide to Building Automation

Quality assurance in planning and integration

Industrie Service

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Work Guide

TÜV SÜD Industrie Service GmbH

TÜV®

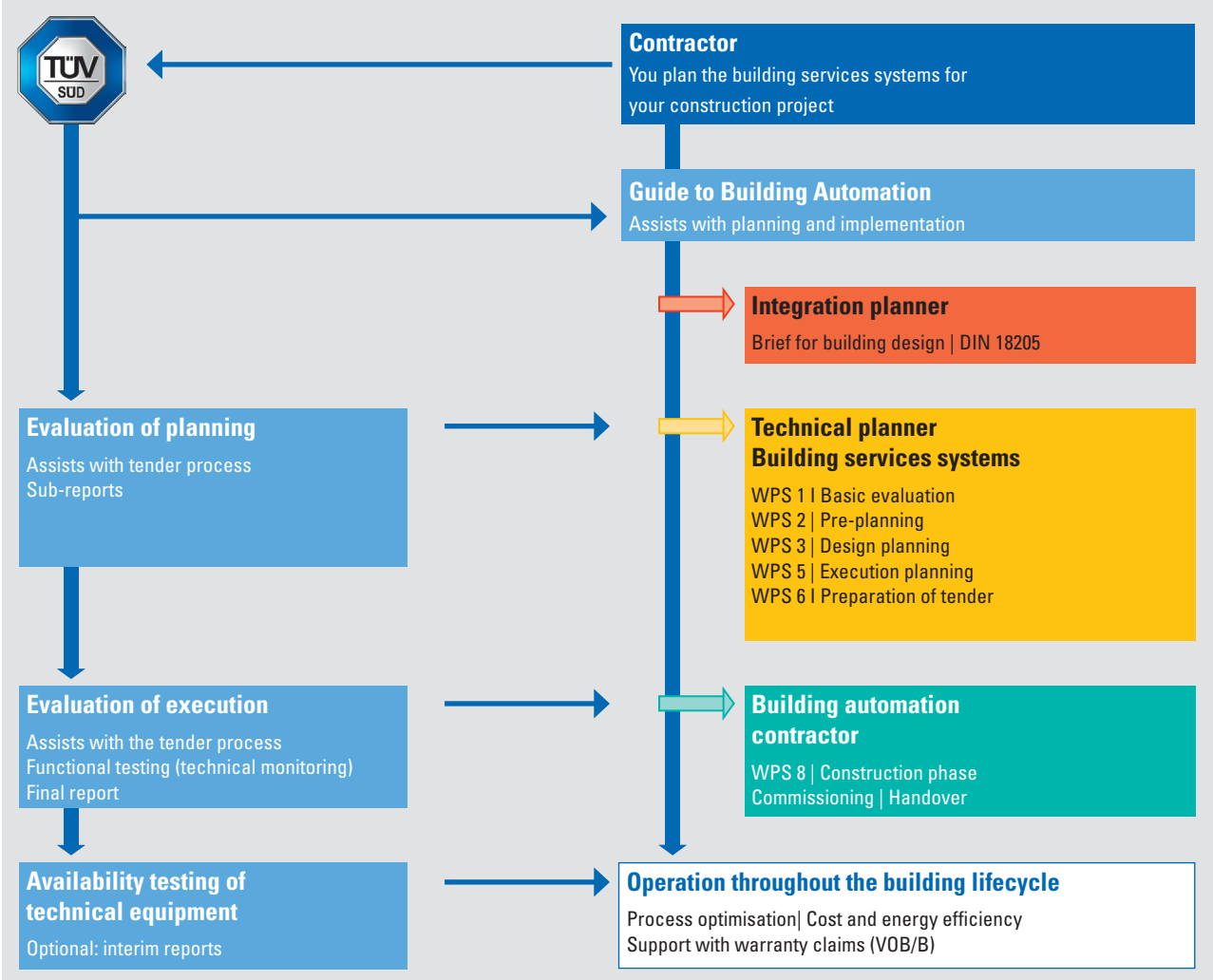
Get your building automation system fit for the future!

Building automation is an essential part of office buildings, shopping malls and other infrastructure facilities in our modern world. The market dominance of concepts like BIM, smart home, smart grid and smart buildings shows that modern building automation systems need smart connectivity and agility to master the challenges of the future. In addition to offering user convenience and functionality, these systems also significantly impact on total cost of operation. They are thus a key parameter for the long-term value of a building, and a major criterion for rental and sale.

We aim to make sure that your planning and integration of this important control centre of a building is successful, and have developed this guide to support you in this task. Our experience has shown that in spite of all planning requirements, many new building or building rehabilitation projects do not achieve the desired result.

Realise your goals with our Guide to Building Automation

- Quality assurance of your building services systems
- Reliable planning for the implementation/achievement of your goals
- Avoidance of schedule and budget overruns caused by rectification of faults and defects



Three good arguments for relying on TÜV SÜD:

- Comprehensive expertise in all areas of building automation
- Long-standing and comprehensive project experience
- Confirmation of equipment functionality in a standardised report

Interested? Contact us for a free initial meeting at **+49 (0)8142 4461-400** or **buildingautomation@tuvsud.com**

Quality starts with correct contracting

Correct contracting can minimise quality risks.

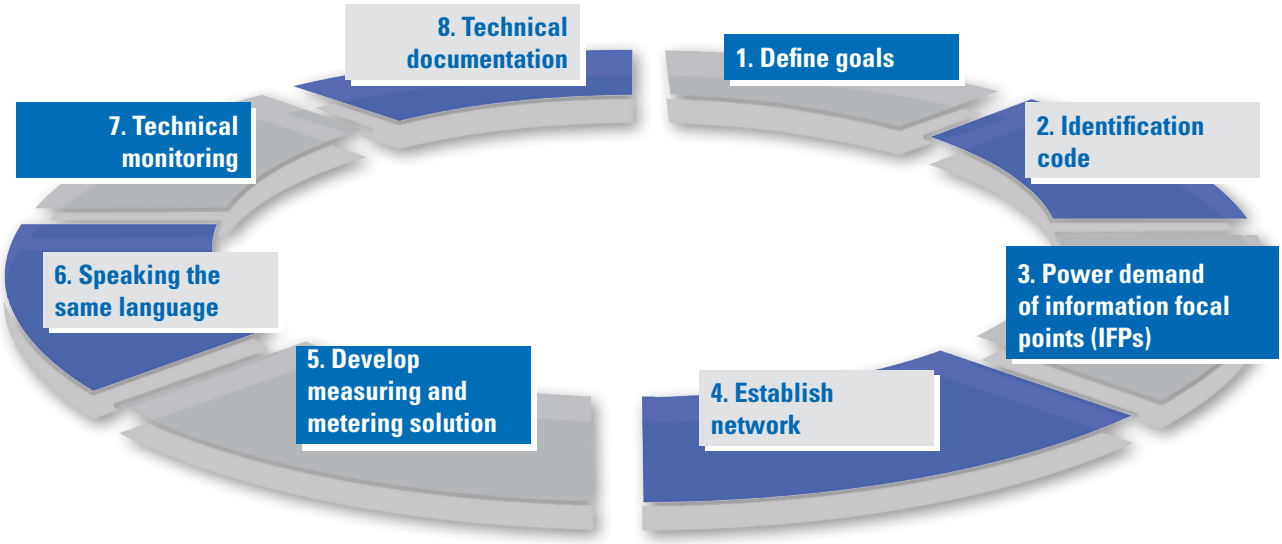
Exact specification of the services to be provided is critical in contracting the planner and in the subsequent tender process. In Germany some services fall under the scope of HOAI (German Fee Scales for Architects and Engineers). However, others do not, and in these cases pricing is up to the supplier.

But which services require a contract to be placed?

What are the key success factors to ensure optimum coordination of building automation across trades and systems?

How to assure quality in planning, construction and operation?

This guide takes you through the steps shown in the figure below and explains which points you need to consider. Are your specific questions not answered in this guide? You can contact us at any time.



1. Define goals

Contracting of an integration planner to design your system architecture

In general, the amount of equipment and functions you need to implement grows in step with the size of your project. Building contractors can choose to call in an integration planner at an early stage to take over responsibility for precise and well-structured specifications of all project requirements.

Starting from the brief for building design, integration planners define the project goal (in compliance with construction contract law under the German Civil Code) and perform the technical planning for all relevant trades, focusing on the building lifecycle. Management of the interfaces between the individual trades is critical for the smooth functioning of building services systems, in particular within the scope of building automation.

The brief for building design falls under the responsibility of the building contractor and is not a basic service covered by HOAI. The brief for building design must be contracted separately. Guidance for building automation is provided by the regulatory acts and standards.

Compliance with the defined goals is finally verified during technical monitoring (see Section 7).

An integration planner offers support with the following tasks:

- **Definition of requirements (in consultation with you)**
  in general requirements specifications; “what” and “what for”
- **Control of the further development of requirements up to an applicable description of the function**
  in a functional specification; “how” and “with what”
- **Interface management**
  Clear coordination/definition of interfaces in planning and execution

2. Identification code

To ensure every component can be clearly identified

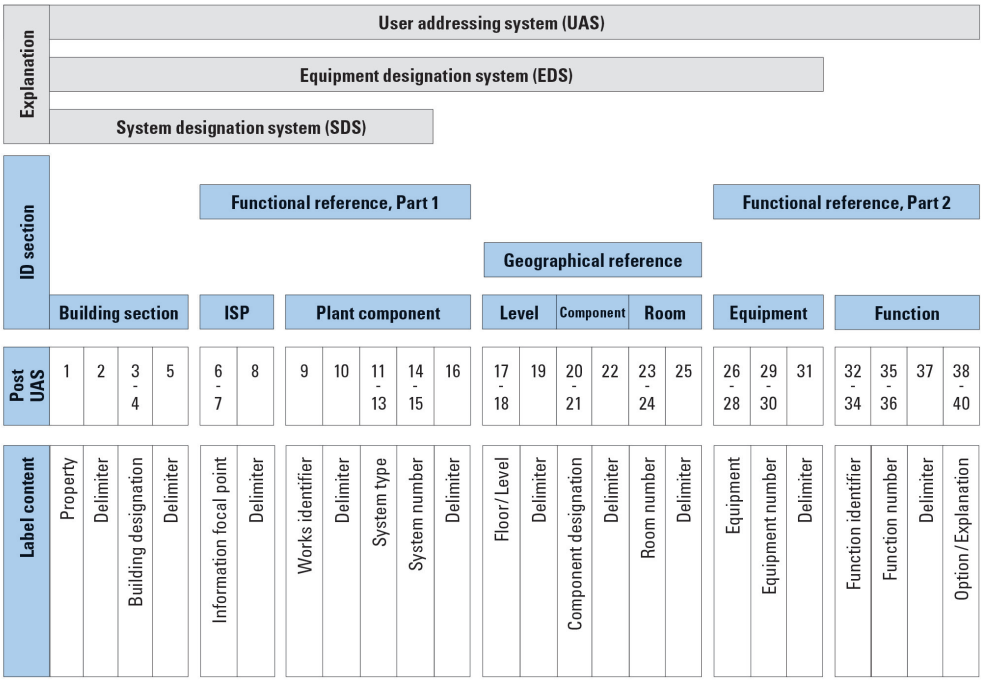
IT systems have become increasingly popular in larger construction projects. They enable control of air-conditioning, lighting, sunshading, shutters, heating and other building services systems to be automated to such an extent that all functions of the building can be remote-controlled.

In major construction projects, IT is actually imperative for controlling automatic opening and closing of doors and fire and ventilation shutters.

To address these complex terms of reference, all components and data points in the building automation system must be clearly identifiable. Organisation of building automation thus depends on the establishment of a **standardised identification system.**

This identification system must apply **to the entire property** or to a complete building automation system.

The identification system must be **defined in writing** and agreed **in the runup to the project**.



Example of the structure of an identification system according to VDI 3814 (Part 4.1)

3. Power demand of information focal points (IFPs)

To ensure secure power supply down to the smallest unit

Building automation systems distribute electricity throughout the building. Electricity is fed into the building and the energy then routed to the individual consumers.

Given this, the building automation system, with its switching cabinets, cables and wiring, forms part of the electrical installations of a building. Its coordination with electrical engineering systems is essential.

Technical planning of building automation must include the production of a power footprint incorporating all electricity data of the equipment to be connected to each IFP.

4. Network planning

Essential for component interactions in your technical systems

Network topology (also: BA topology) describes the architecture or structure of communication units in a project.

In smaller projects, building automation can use the transmission networks of the technical IT infrastructure, whereas in large projects it is advisable to establish a separate building automation network. There are individual solutions for all types of challenges (new buildings, modification, rehabilitation).

Detailed coordination of the **interfaces between electrical engineering and building automation** is important in this context.

Network topology requires thorough network planning and documentation including the re-quested and available fieldbus protocols. It must be presented at the start of all measures (new building, modification, rehabilitation) planned for the automation of your property. Before the project is executed, network topology is completed by the addition of:

- quantitative information concerning active and passive components
- segment lengths
- distances between components

Preparation of the network topology for building automation is a basic service. It is essential for all project-related actions.

IT security
Against the backdrop of growing threats stemming from damage scenarios such as sabotage, espionage and malware, special attention should be paid to IT security in network design. Safety precautions must be aligned to the type and use of the building in question and the associated risks. Project-specific risk assessment is indispensable in every case.

Our experts will be happy to assist you with this task.

At the following link, BACnet Interest Group Europe (BIG-EU) offers a helpful free Excel tool for network planning ("BACnet Project Address Table" under documents): http://www.big-eu.org/service/downloads/

5. Develop measuring and metering solution

Ensuring effective energy management

To ensure correct recording and systematic evaluation of the consumption of individual utilities (heat, cooling, electricity, water etc.), BA experts are required to develop a sophisticated measuring and metering solution **at an early stage of the project**.

This task involves identification of the areas and applications for which continuous energy flows shall be recorded. The requisite measuring and metering devices can be integrated into the overall building automation system by means of bus communication (e.g. M-bus). Once this has been done, you have laid the foundations for **energy controlling** throughout the lifecycle of the building.

Energy controlling summarises the flood of data in key indicators. Continuous monitoring of these key indicators allows sustainable energy savings to be assigned to power consumers and lays the foundation for lawful and as complete as possible allocation of operating costs to tenants and users.

To establish transparency of energy consumption, the following points must be included in planning of the measuring and metering solution:

- Assignment of meters to type of energy / energy carrier
- Demarcated areas in the measuring and metering solution
- Intervals of consumption data recording and evaluation
- Topological presentation of the measuring and metering solution

6. Speaking the same language

We recommend the BACnet® standard for vendor-independent actions

An international standard defined in ASHRAE/ANSI 135-1 and integrated into the ISO 16484 standard.

BACnet® stands for Building Automation and Control networks. It is a **vendor-independent communication protocol** for building automation systems. BACnet describes the form and framework conditions for data transmission in the communication between building-automation devices.

Like "http", the vital communication protocol for the World Wide Web, BACnet is the leading communication protocol for building automation.

Ensuring vendor-independent communication and a standardised view among all building automation stakeholders, the BACnet protocol **lays the foundations for transparent** and **cost-effective planning and projecting** in building automation.

Although BACnet is an international standard, its implementation and projecting depend on building automation specialists with a broad basis of knowledge and experience.
We are happy to assist you with professional advisory services.

AMEV recommendation BACnet 2017

Further detailed information on how to use BACnet according to ISO 16484-5 can be found on the website of the Mechanical and Electrical Engineering Working Party of National, Regional and Local Authorities (AMEV):
https://www.amev-online.de/AMEVInhalt/Planen/Gebaeudeautomation/BACnet%202017/2017-08-01_AMEV-BACnet-2017_en.pdf

BACnet® is a registered trademark of ASHRAE.

7. Technical Monitoring

To ensure equipment permanently works as planned

Appropriate **monitoring of functions and efficiency** is based on comparison of target values with the actual values of the technical equipment – a process known as technical monitoring. It is based on the goals defined at the start of the project (see Section 1).

Technical monitoring reveals that technical equipment often does not work as expected in many buildings, especially at the beginning. Energy costs and operating costs may be significantly higher than planned. In the first years of operation of a building, facility management is kept busy attending to numerous emergency operations. In spite of building automation, regular operation is frequently a manual procedure.

To ensure **equipment operates in an optimum manner right from the start,** a digital test plan is developed. The requested functions and applications of individual equipment or systems are specified in writing and in a verifiable manner during planning and installation.

One suitable method for specification of equipment functions is to use state graphs and/or state charts. "Digital functional descriptions" expand this specification approach and transform it into a digital specification and test solution.

Digital functional descriptions provide structured specifications of the planned equipment functions in individual operating states and rules. Subsequently, the operational data recorded at short intervals by the building automation systems is used to verify that functions in actual operation are in compliance with the specification.

The degree of compliance between planning and operation is described by the **key performance indicator** of **"operational quality"** which has been introduced for this purpose. It allows equip-ment evaluation and comparison of the different quality levels of equipment. Operational quality is measured by the number of callup points at which an equipment complies with all applicable operational rules in relation to the total number of callup points within the test period.

The procedure can be applied to control variables, switching commands and other functional requirements, as well as to various key performance indicators (KPIs) of the specified system.

Specification and test results are digitally generated and/or provided. They are actively and continuously monitored online from the commissioning stage onwards, using KPIs and, if necessary, carrying out detailed analysis. They are a mandatory acceptance criterion for new buildings and facilitate monitoring and improvement of the functions of ding services systems and building automation in later operation.

Digital test solution
The benefits at a glance:

- Assure BA quality from planning to operation
- Guaranteed identification of potential measures energy-saving opportunities
- Ensure indoor air quality and sustainable value of your equipment
- Fast breakeven thanks to non-investment
- Short project terms/easy implementation
- Future-focused application of big-data

8. Technical documentation

Ensure the transparency required for subsequent operation

General technical terms and conditions are applicable in cases where the Regulation on the Award of Public Contracts and Agreements in the Construction Sector has been agreed in the construction contract.

They define the minimum documentation of building automation that must be handed over to you at acceptance at the latest. To **enable safe and efficient operation**, operators require complete documents for building automation systems.

We have prepared a checklist for you summarising the minimum scope of documentation.

Checklist

	Document	YES	NO
1.	Automation diagram		
2.	Circuit diagrams		
3.	Automation station layout planning including addressing		
4.	Connection diagrams		
5.	Block diagram including the locations of operation equipment / information focal points (IFP)		
6.	Bills of materials		
7.	Functional descriptions		
8.	Commissioning and initial adjustment records		
9.	All operating instructions/maintenance information required for safe/efficient operation		
10.	Spare parts lists		
11.	Project-specific software and data on data carriers		
12.	Records of instruction of operators		
13.	Required manufacturer and test certificates		
14.	Target values, limits and operation periods		
15.	System diagrams		
16.	Function lists		
17.	Cable lists including function assignment and power rating		

Space for your notes

Glossary

General terms

EDS – **Equipment designation system**
Clear, well-structured method for the identification of data points with the purpose of supplying addresses for the information in a BA system. Composed of a structure and definitions of the various elements.

IFP – **Information focal point** refers to switching cabinets accommodating the instrumentation and control units (direct digital control (DDC) stations). HVAC (heating, ventilation and air-conditioning) systems are controlled by IFPs. IFPs are connected via BACnet with each other and the building automation system (BAS).

Gateway – A gateway is an active network component which translates various transmission protocols, e. g. M-bus to BACnet.

UAS – **User address system** is used to visualise and operate the technical equipment from a PC workstation. Reports of malfunctions and alarms are received here. It forms the interface with technical staff.

KPI – **Key performance indicator** refers to a quantifiable measure in business administration which is used to evaluate or determine the progress or degree of achievement of important objectives or critical success factors within an organisation.

M-BUS – The **M**eter-**B**us is a fieldbus system that transmits consumption data from meters, such as heat, cooling, water, gas and electricity. The M-Bus can transmit the consumption values to BACnet via a gateway.

VOB – Die **Vergabe- und Vertragsordnung für Bauleistungen**, the German Construction Contract Procedures, is a three-part contractual document governing the award and terms and conditions of construction contracts. It was developed by the German Committee for Construction Contract Procedures.

BACnet terms

BACnet – **B**uilding **A**utomation and **C**ontrol **net**works is the standardised building-automation network protocol according to ISO 16484-5.

BACnet objects – examples of BACnet objects are "Analogue Input", "Binary Output" and "Device". They exist on the device and are described in detail by their properties.

COV – Subscribe to changes of value
Change_Of_Value (COV) bedeutet, means that data will not be transmitted continuously, but only when changes in the ACTUAL temperature exceed a pre-set delta. BACnet participants can subscribe to COV using the COV notification service.

Description property – In the Description property, the name of the data point must be indicated in line with the identification system.

Device object – automation station identification
The **Device_Object** is a special BACnet object. It includes properties which represent the externally visible characteristics of the device. There may only be a single Device_Object for every device. The Device_Object is identified by its Object_Identifier property. The Object_ Identifier of the Device_Object in the BACnet network must be unique. The ObjectName of the Device_Object in the BACnet network must be unique.

EDE file – The **EDE** (Engineering Data Exchange) file includes the actual configuration of a device, i. e. the objects projected in the device. These can be exchanged with other partner companies in a project in the form of a specified Excel table (EDE format). In addition to the identification code (ObjectName property), a conclusive description (Description property) of the data points must be saved.

Location property – The location of the device, e.g. room or IFP (switching cabinet), must be saved in the Location property.

NotificationClass object – Transmit alarms
The notification channel is formed by the **NotificationClass** (NC) object. All relevant transmission properties are saved in this NC object. The NC object has a list of recipients (e. g. BAS) which are notified of the alarms.

ObjectName property – In an object for a data point, the identification code (IC) must be saved in the “Object_Name” property.

PriorityArray property – Prioritisation of switching commands
All writable BACnet objects have a 16-stage priority control, the **PriorityArray** (property).

Specification of building automation

The planning and execution of building automation must be in conformity with the generally accepted codes of practice and current standards. The international standard **ISO 16484** applies to all parties involved in the individual project stages. **Further standards and regulations**, including VDI 3814, EN 15232, VDI 3810-5 and DIN 18386, provide optimum guidance for the planning and execution of future-proof building automation.

AMEV BACnet – BACnet recommendation for public buildings.

AMEV TMon – Recommendation of technical monitoring as an instrument of quality assurance (No. 135).

VDI 3810-5 – Operation and maintenance of building services – building automation.

VDI 3814 – Building automation (BA).

VDI 6041 – Technical monitoring of buildings and building services.

EN 15232 – Energy efficiency of buildings – impact of building automation, controls and building management.

ISO 16484 – Building automation and control systems.

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We will be happy to provide further, more detailed information. Contact us.

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TÜV SÜD Industrie Service GmbH provides engineering and testing services and technical support for investors, developers, planners, owners/operators and manufacturers of plants, buildings and infrastructure facilities –throughout the world. From drawing board to demolition, our experts offer support at every stage of a project, helping you to minimise risks and assure quality.

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