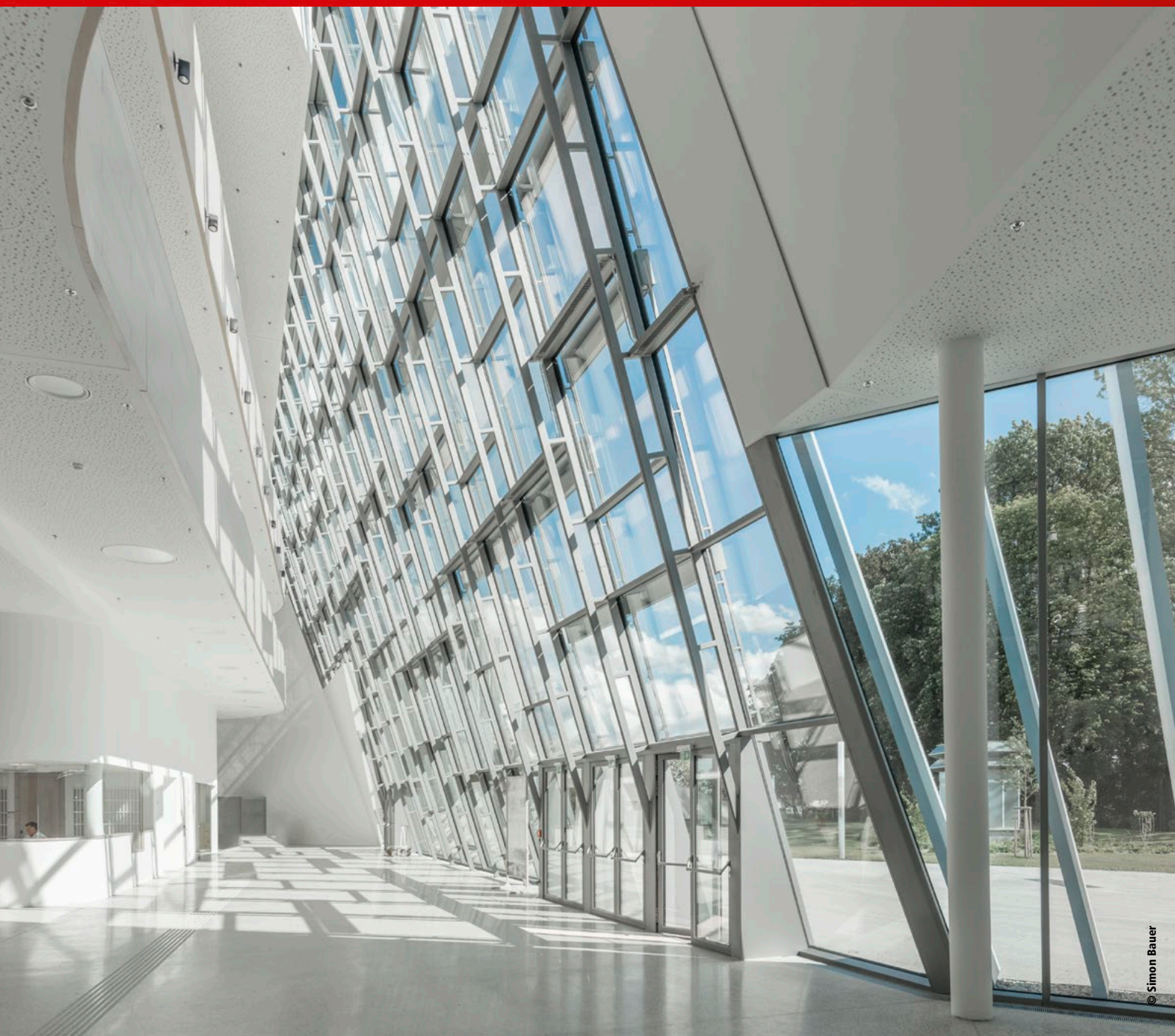
BECKHOFF New Automation Technology

Integrated Building Automation Solutions

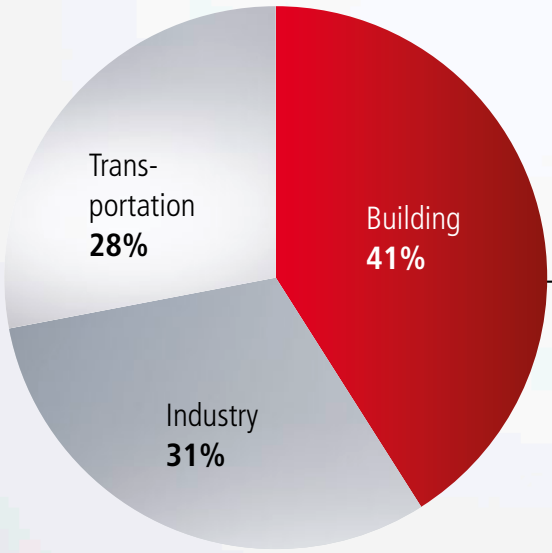
Leading edge for investors, planners and technicians



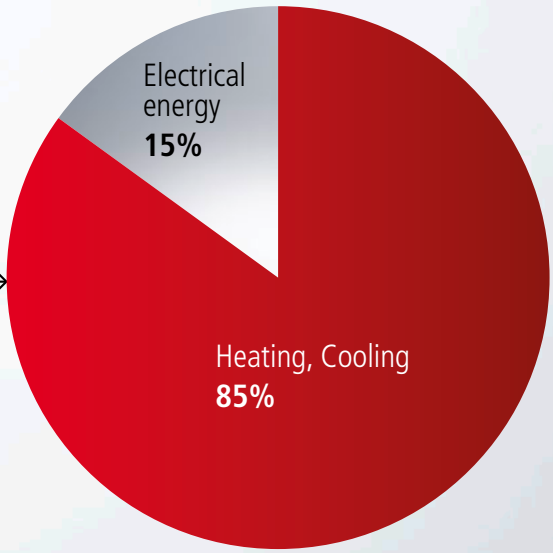
Integrated building automation

With this catalog we would like to provide investors, planners and technicians with solutions to enable them to make future-proof decisions both for new buildings and for modernisation projects. We explain intelligent building automation concepts in-depth that cater to the current global and demographic developments: increasing population figures, increasing urbanisation, increasing environmental pollution and at the same time increasingly scarce energy resources, which necessitate an urgent rethink.

Energy consumption worldwide



Energy consumption in buildings



Source: Arbeitsgemeinschaft für sparsamen und umweltfreundlichen Energieverbrauch e. V.

Future-proof buildings with automation

41% of the total worldwide primary energy requirement is consumed by buildings. About 85% of that is used for heating and cooling rooms and 15% for lighting. It is therefore immediately obvious that the question of investment in new buildings or modernisation projects is above all a question of optimising energy efficiency. And there are several reasons for that. Assessing demands at an early stage when planning a building from the ecological perspective determines whether it already fulfils the desired energy efficiency class. From the economic perspective: by choosing a highly efficient building automation system from Beckhoff, you tap into an energy-saving potential of up to 30%, which directly affects the profitability of your investment.

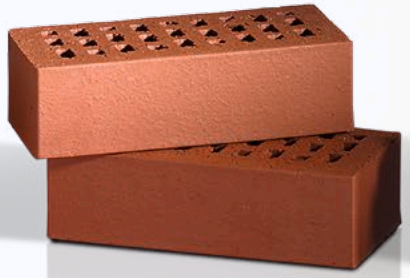
How can this be achieved? The answer is: with a system-spanning, holistic automation solution that has all information from all building systems at its disposal at all times and uses this information specifically to optimise efficiency. Whether lighting or facade, air conditioning or access control is concerned, the intelligent automation solution from Beckhoff allows all building systems to be coordinated and finely adjusted. Moreover, the option to continually optimise the system ensures maximum reduction in energy consumption over the entire life cycle of the building. Combined

with an inexpensive implementation, two key benefits can be derived: on one hand the possibility of an especially fast return on investment (ROI) in building automation in comparison with other energy efficiency investments. And on the other hand, future-proof buildings. With a building automation solution from Beckhoff, not only can you rely on the technology, rather also on the long-term availability of the components.

Area	Measures	Savings potential in %	ROI in years
Operation	User behaviour, saving of energy, **"active energy management"**	5–20	0–5
Plant technology	HVAC, cooling, lighting, control, motors, actuators, trigeneration	10–60	2–10
Building envelope	Insulation, windows, thermal bridges, building physics	>50	10–60

Source: VDMA

How to build flexibly:
with concrete.



How to build traditionally:
with bricks.

How to build safely:
with steel.

How to build intelligently:
with automation components from Beckhoff.

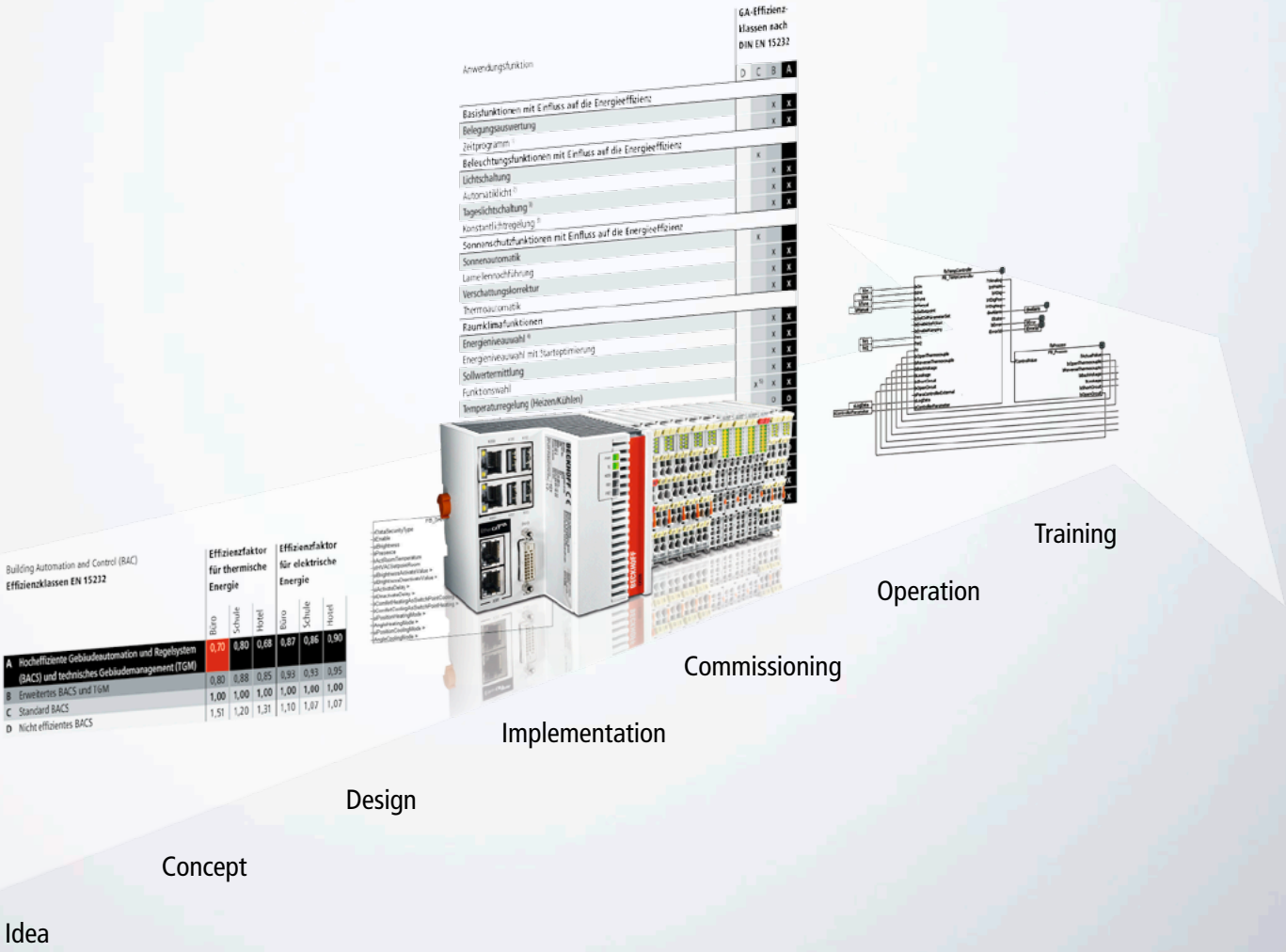
Energy efficiency is the no. 1 criterion

The ecological demands on a modern building are always identical. It has to deliver maximum energy conservation, reduce emissions of gases that are harmful to the climate and, in addition to meeting legal requirements, comply with various certifications for sustainable building (DGNB, LEED, BREEAM, Green Building, etc.). However this is where the similarities end, because the demands on a building's automation solution are defined by three individual parameters: its location, the way it is used and its specific design. No two buildings are identical in this respect.

Each Beckhoff control solution is therefore tailor-made to meet the specific requirements of the building. But that is not all: extensions or changes to functions can be completed easily – at a later stage too – on account of the modular design of the Beckhoff solution. Beckhoff covers all technical building systems with its TwinCAT 3 Building Automation software tool: from heating, ventilation and air conditioning through to shading, lighting and energy data collection. IoT products in software and hardware ensure that the seamless acquisition of building data in synchronisation with cycle times and its cloud-based analysis can be integrated directly into the control system. Manufacturers, system integrators and operators benefit from this level of integration with fast engineering, optimised energy management and increased fail-safe reliability.

With a control solution from Beckhoff, not only will you achieve maximum energy efficiency, but also:

- **Economic efficiency:** the Beckhoff control platform meets all technical and economic requirements and is also vendor-independent due to its open system architecture.
- **Availability:** the Beckhoff technology components are available on a long-term basis and offer investment security.
- **Universality:** With Beckhoff, all data points are integrated into a single system.
- **Flexibility:** Software modules that can be flexibly combined ensure optimum individual adaptability.



The high-performance Beckhoff automation system

System-spanning building automation from Beckhoff brings with it all the characteristics that are required for an energy-efficient building:

- A broadly diversified mix of inputs and outputs are available to connect all sensors and actuators in buildings.
- A comprehensive portfolio of scalable, high-performance controllers meets any requirements for computationally intensive building automation functions such as shading correction and blinds adjustment for sun tracking control for example.
- Features such as load optimisation for energy providers, integration with a building management system and transmission of central data, such as from a weather station, are all implemented on the basis of fast and open communication.
- As the interoperability of the system increases, inter-disciplinary knowledge is required of all areas of the building's technical equipment: our specialists have this know-how and convey their knowledge in hands-on trainings on building automation.
- TwinCAT 3 Building Automation enables consistent structuring of TwinCAT project

files and is thus the basis for proper system maintenance. The central underlying idea is our component identification system, which assigns a name to each data point and program module in accordance with defined rules.

Beckhoff Building Automation fulfils the requirements of all various partners involved in a building project:

- Investors can safeguard their investment with forward-looking building automation.
- Architects enjoy maximum freedom in planning in order to implement changes of use flexibly.
- Specialist engineers gain planning certainty through the openness and flexibility of the Beckhoff building automation platform.
- System integrators benefit from simplified engineering, since all building functions are executed with a universal software solution.
- Building operators are supported optimally in operating their technical facilities through central system monitoring, preventive maintenance and continuous energy optimisation.

Components for intelligent building automation

Modular I/O automation components
The Beckhoff bus terminal system for connection of data points features 400 different I/O terminals and supports all common sensors and actuators. The fine granularity of the system allows only as many inputs or outputs to be plugged in as the project requires. Subsequent system enhancements can be implemented effortlessly. The fine granularity of the Bus Terminals also enables bit-precise composition of the required I/O channels.

Scalable control technology
Owing to its scalability and modularity, the PC-based control system from Beckhoff offers a suitable solution for every task: from high-performance Industrial PCs for the higher management and control level to Embedded PCs for the automation level through to BC9191 room controllers for the field level. The excellent computing performance of PC-based control technology along with the high industrial quality standard of all components has been proven in numerous building automation projects. The required computing power for building automation applications is often underestimated, such as for example for synchronously positioning all blinds on a facade. PC-based control offers sufficient performance even for the fastest response times demanded in building applications.

Open communication systems
Beckhoff supports all of the communication protocols commonly used in building automation, for example BACnet, OPC UA, Modbus TCP (automation level), DALI, DMX, EnOcean, LON, EIB/KNX, SMI, MP-Bus, M-Bus, Modbus RTU (field level), enabling seamless integration of the controllers into existing automation topologies. The bus terminal controllers and PCs communicate right up to room automation level via an Ethernet network. This way, lower-level fieldbus technology is not necessary in many projects. Additional gateways for mapping the data from lower-level fieldbuses are therefore not required. All common cloud systems are supported via the IoT protocols AMQP, MQTT and OPC UA (over AMQP): Microsoft Azure™, Amazon Web Services™ (AWS) as well as private cloud systems in company networks.

TwinCAT 3 Building Automation: Efficient engineering for all building systems
TwinCAT 3 automation software is used universally for programming and parametrising the PLC in compliance with the IEC 61131-3 standard. Use of this globally accepted programming standard ensures that adequately qualified technicians are available for maintenance and servicing activities. The function blocks of the building automation library, or templates as they are known, can be programmed in the same language and enable simple recognition of control logic and long-term reusability. Life cycle costs are reduced, because the expenditure for maintenance is focused on a single programming software.

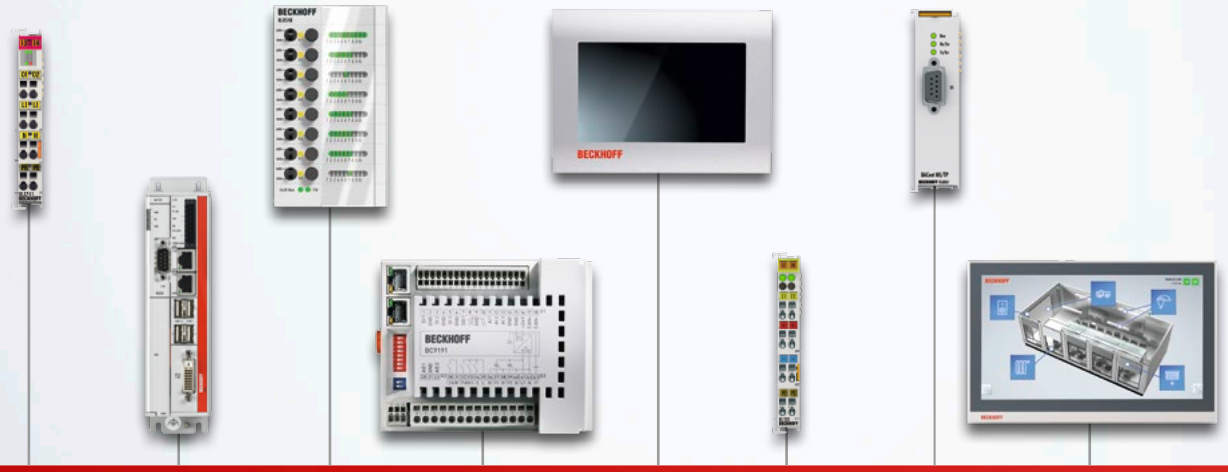
1980	1986	1995	1996	1999	2000	2002	2004	2006
Foundation of the company	**First PC-based machine controller**	**Bus Terminal** fieldbus technology in terminal block format	**TwinCAT** real-time software PLC	**BC9000** Ethernet Bus Terminal Controller	**KL2722** sunblinds terminal	**CX10xx** Embedded PC **KL6811** DALI terminal **KL3403** 3-phase power measurement terminal	**KL6023** EnOcean wireless adapter **KL6301** EIB/KNX terminal	**KL6771** MP-Bus terminal **KL6401** LON terminal

Milestones in building automation

Sustainability in terms of resource efficiency is one of the core features of any building automation system. Beckhoff extends the term even further by applying it to the actual components, because all new Industrial PCs (IPCs) from Beckhoff use only the latest and most powerful processors from well-known manufacturers. And since our product portfolio is subject to continuous innovation processes, our customers receive a solution that is not only state-of-the-art, but future-ready.

IPC technology from Beckhoff also delivers great benefits for renovation and expansion projects of existing buildings because all our IPCs are backwards-compatible with older models. This makes it easy to replace older units, and existing programs can be migrated to the newest models without having to be modified. Installed Bus Terminals and/or I/O systems can stay in place.

The needs of building operators may frequently change over the life of a building automation system. For example, they might want to add the standardized BACnet communication protocol to an existing system. However, with many classic DDC (direct digital control) systems, this is not possible. The open design of PC-based control technology from Beckhoff, on the other hand, permits the installation of new features like



2007

TwinCAT HVAC library

KL2751, KL2761
dimmer terminal

2009

C6915
compact control cabinet IPC

CX50xx, CX90xx
Embedded PC

EL6851
DMX terminal

KL6781
M-Bus terminal

2012

KL85xx
manual operating modules

CX8090
Embedded PC in Bus Coupler format

TwinCAT BACnet/IP

CP2xxx
built-in multi-touch Control Panel

2013

BC9191
BA Room Controller

CX9020
Embedded PC

2014

TwinCAT Building Automation

KL6831, KL6841
SMI terminal

CP6606
built-in Panel PC

CX8091
Embedded PC for BACnet/OPC UA

2015

KL2602
2-channel relay output terminal

KL1704
4-channel digital input terminal 120/230 V AC

2017

EK9160
IoT Bus Coupler

EL6861
BACnet MS/TP terminal

EL/KL26x2-0010
switching at the zero voltage crossing

KL6821
DALI/DALI 2 terminal

2018

TwinCAT 3 Building Automation
Microsoft Visual Studio Integration
TwinCAT HMI BA
TwinCAT Scope

the BACnet protocol even years after the system's initial commissioning without having to install a new Industrial PC.

The modular building automation portfolio consisting of processors available in a range of performance classes, Windows operating systems and TwinCAT software libraries makes it possible to adapt Industrial PCs to changing building requirements for many years to come. Another sustainability feature of the Beckhoff solution is the long-term availability of the Bus Terminal system. It has been on the market for almost 20 years, and with now more than 400 signal types it has become one of the world's most successful and comprehensive I/O systems. Its modular design also makes it easy to replace individual Bus Terminals or to make add-ins.

The wide range of available fieldbus couplers lets you link Bus Terminals to DDC or control systems from other manufacturers via Modbus, PROFIBUS or other protocols. Thus, customers can combine Beckhoff components with products from any vendor and enjoy a high degree of investment protection for existing I/O units.

Open communication platforms

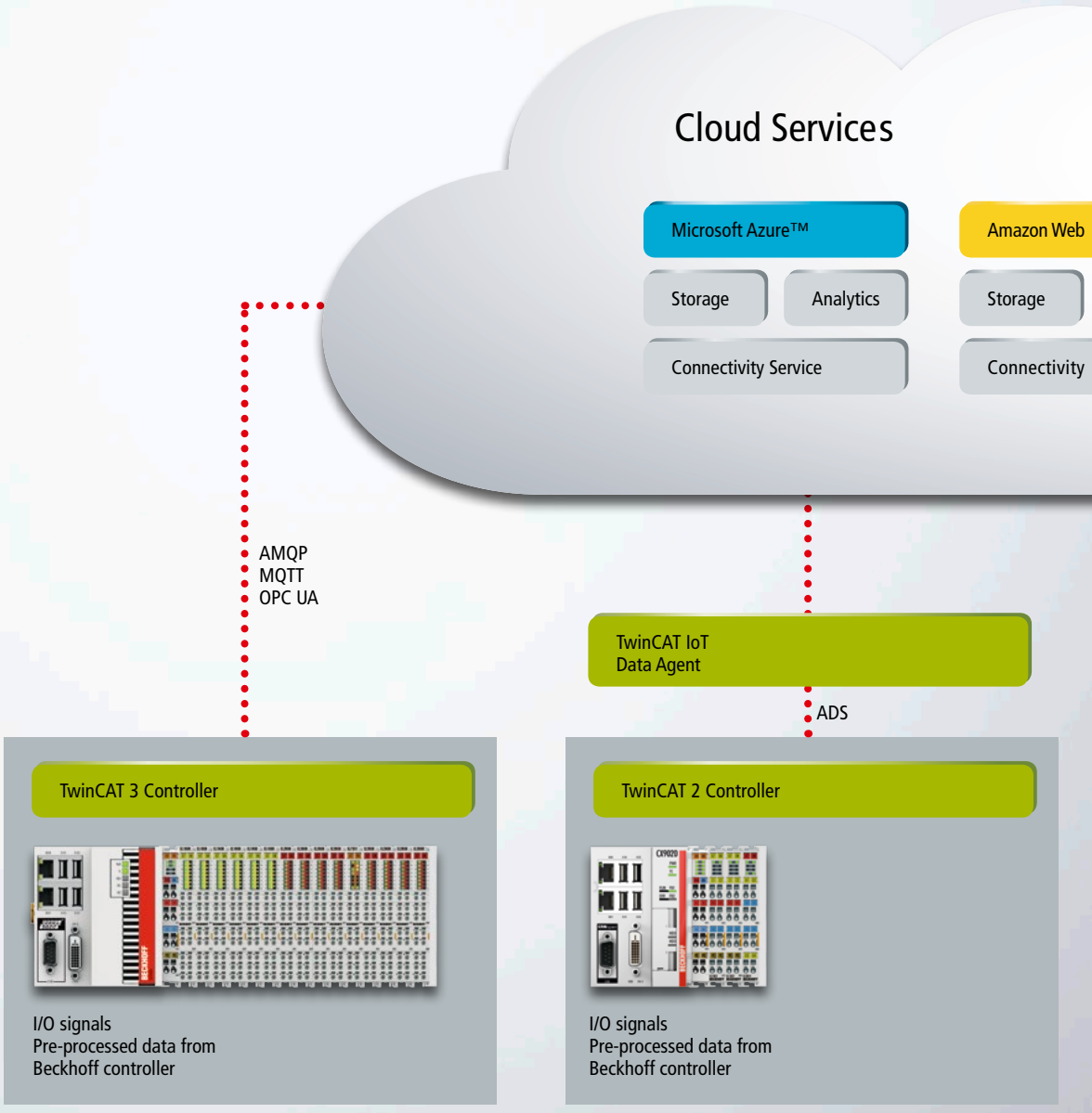
The PC-based automation platform handles control, data processing, connectivity, visualisation and remote maintenance. The open interfaces of its hardware and software components make it ideal for centralised or decentralised control of all building systems: from heating, ventilation and air conditioning to room automation and media control through to operating and monitoring. The TwinCAT Database Server can be integrated into a building project configuration to enable the building automation system to connect to standard databases.

Support of Ethernet communication through to the field level provides a transparent network for commissioning and maintenance in which, depending on requirements, the relevant IP-based protocol can be used for communication.

Integration of the BACnet/IP and OPC UA protocol standards ensures vendor neutrality and thus high investment protection.

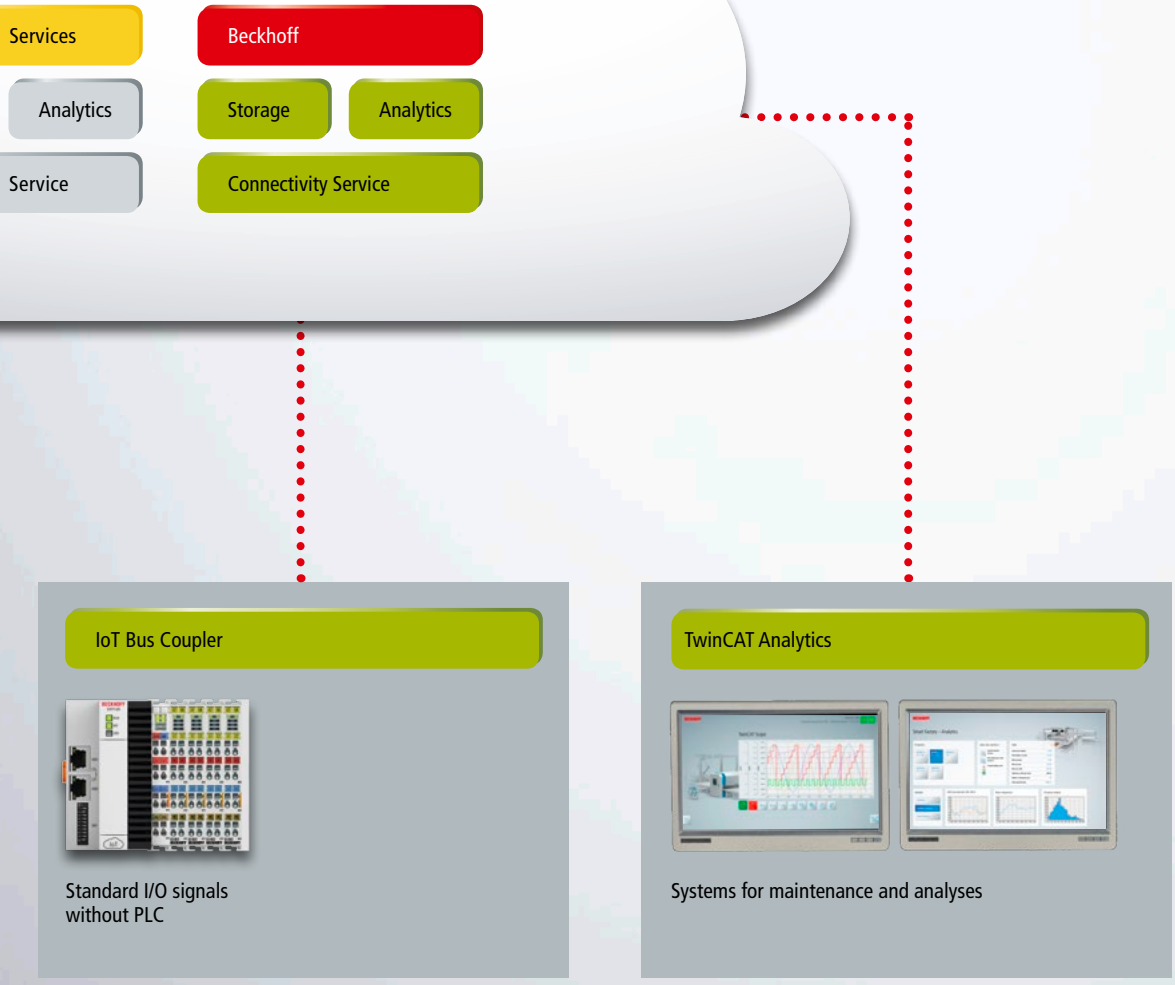
- **BACnet/IP**
  The international BACnet standard, which ensures that building automation devices from different manufacturers can communicate with each other, is steadily gaining in importance with new features being added all the time. As a universal Ethernet protocol, BACnet/IP can be used on all PC-based hardware platforms from Beckhoff through to the field level.

- **OPC Unified Architecture (UA)**
  OPC UA has its origin in automation technology, but its industry-neutral design makes it increasingly popular as a universal communication platform in building automation and smart metering applications. OPC UA offers platform independence from the operating system and the programming language as well as scalability from the sensor to the ERP/cloud level.



Cloud-based analysis of building data with TwinCAT IoT and Analytics

Beckhoff developed the TwinCAT IoT software library for communication between building control system and cloud-based services. It supports the standardised protocols OPC UA, AMQP and MQTT for communication with common cloud systems, such as Microsoft Azure™, Amazon Web Services and private cloud systems in company networks. Integrated security mechanisms prevent misuse of data as a result of unauthorised access and protect the intellectual property of a company. Systems based on TwinCAT 3 to provide their PLC variables using TwinCAT 3 IoT Communication directly to the cloud platforms without further conversion. Existing systems with TwinCAT 2 or third-party systems can be activated without changes in the application program using the gateway functionality of the TwinCAT 3 IoT Data Agent. Input and output signals can be

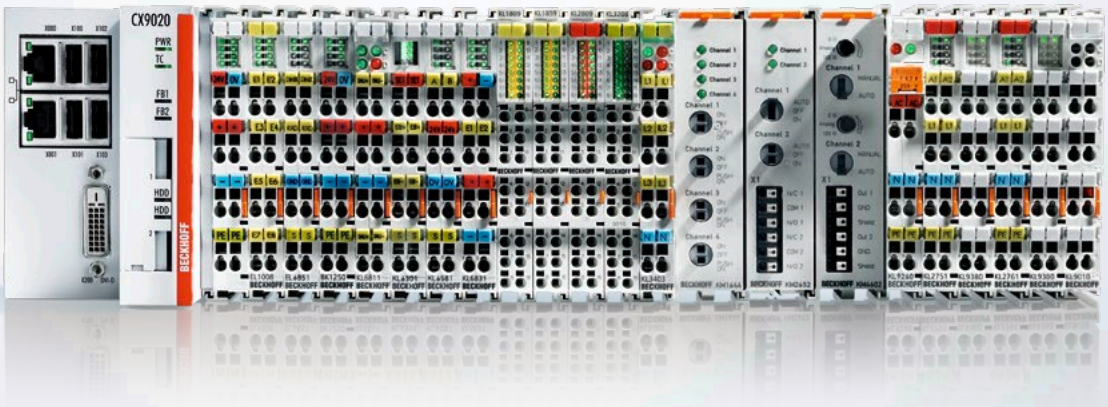


connected conveniently to cloud systems with the EK9160 IoT Bus Coupler. Configuration is carried out conveniently without the need for actual programming; the I/O data is parametrised in a simple configuration dialog of the integrated web server using any browser.

The resulting data is then made available in the cloud in the form of energy reports, for example for analysis purposes. Buildings of similar size and usage can therefore be compared with each other in a performance benchmarking. The systems can be accessed from anywhere in the world using any devices, such as smartphones, tablets, notebook or desktop PCs.

Exceptional occurrences in the operating procedure, such as an abrupt increase in water consumption, for example, can be reported as an alarm to the operator, thus allowing a burst pipe, for example, to be detected early on and consequential damages avoided.

BACnet
OPC UA
DALI/DALI 2
SMI
EnOcean
Modbus
M-Bus, MP-Bus
LON, EIB/KNX
DMX
FIAS
Crestron



Integration of external systems

Beckhoff offers a range of different software libraries that enable optimum networking with external components and systems. This allows systems such as hotel reservation systems, for example, to be integrated into a building automation system. Moreover, the PC platform supports different interfaces for controlling multimedia components and thus allows a variety of applications to be implemented in the areas of media, stage and show technology.

FIAS – for hotel applications

The Fidelio FIAS (Fidelio Interface and Application Specification) is one of the world's leading hotel management software. Since there is a constantly growing demand for networked systems and room automations in hotels, the TwinCAT FIAS server provides a direct FIAS interface that facilitates smooth communication between the hotel management system and PLC.

Crestron – for controlling AV and multimedia equipment

Crestron Electronics is a market leader in media management systems. In addition to the management of audio and video systems, building services components can also be integrated. The data between the Crestron management system and Beckhoff hardware is exchanged via Ethernet.

For the Crestron control systems, software modules (user modules) are available for the Crestron control systems. The Crestron controller can access read and write commands; the Beckhoff controller can use the TwinCAT Crestron server to write data to the Crestron control system or extract data from it.

Interfaces to stage and show technology systems

Various Bus Terminals and software libraries are available for connecting the PC control platform with devices and systems from the area of stage and event technology. The automation software can therefore be integrated very easily in the stage technology, for example, using the EtherCAT Terminals EL6851 (DMX master) and EL6851-0010 (DMX slave). All of the devices and systems relevant for media and stage technology can be controlled with the Beckhoff automation platform over interfaces to AES70 (OCA), PJLink, DMX, SMPTE TimeCode, Art-Net™, Streaming ACN (sACN) and PosiStageNet. Stage control, lighting, sound and video effects, kinetic installations or animated figures as well as interactions can therefore be run on a universal platform.

Integration of further systems

In collaboration with innovative suppliers, more and more systems and devices can be integrated into the Beckhoff control platform, for example to implement operating, fire protection and access control systems as well as the whole range of sensors and actuators.


Anton Bruckner Privatuniversität, Austria

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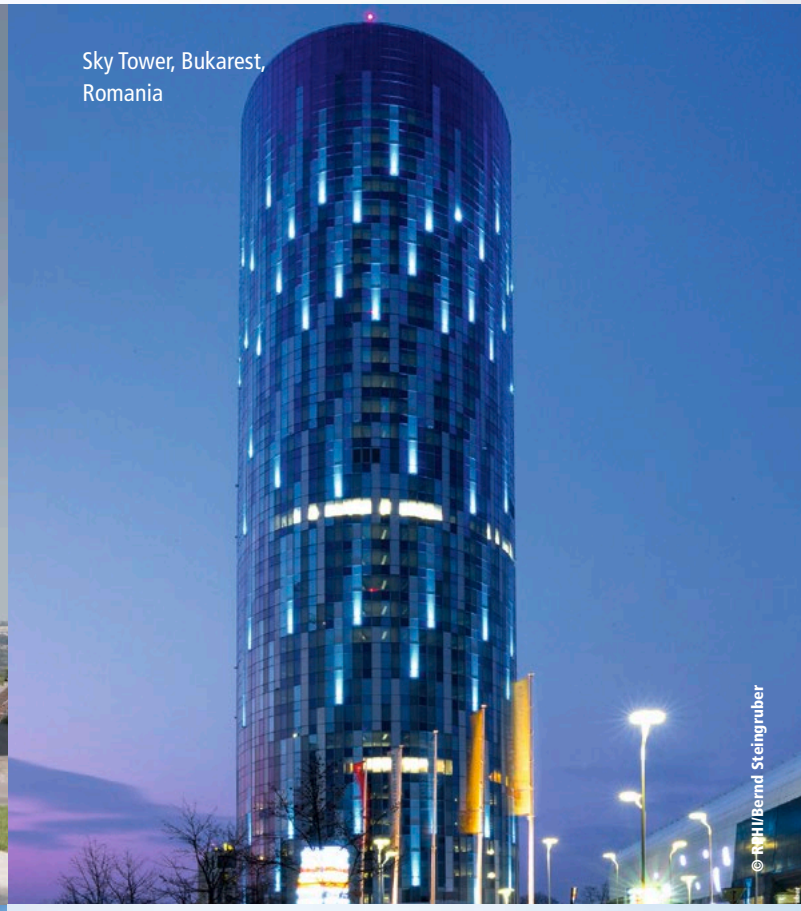
Sky Tower, Bukarest, Romania

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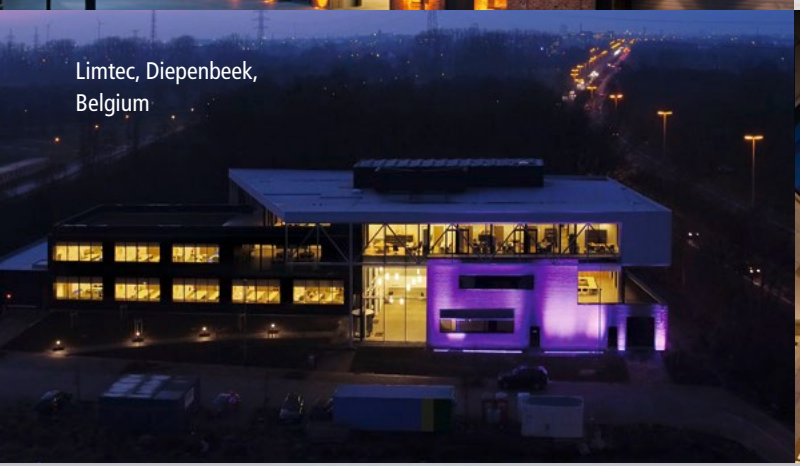
Karolkowa Business Park, Poland


Zayed University, Abu Dhabi, UAE


Limtec, Diepenbeek, Belgium


Tower 185, Frankfurt am Main, Germany

Microsoft, Cologne, Germany

References for office buildings and educational institutions, selection

Office buildings

- Allianz head office, Stuttgart, Germany
- BNP Paribas Fortis, Hasselt, Belgium
- BSH Bosch und Siemens Hausgeräte GmbH at "Aviva", Munich, Germany
- Campus Dornbirn, Dornbirn, Austria
- Center for Virtual Engineering ZVE, Fraunhofer IAO, Stuttgart, Germany
- Diamant Software, Bielefeld, Germany
- Etech-Center/AMS Engineering, Linz, Austria
- Euro Plaza, Vienna, Austria
- Eurotheum (European Central Bank), Frankfurt am Main, Germany
- Fifth Light Technology, Oakville, Canada
- Internorm, Traun, Austria
- Karolkowa Business Park, Warsaw, Poland
- KölnTriangle, Cologne, Germany
- Microsoft, Cologne, Germany
- Microsoft, Munich, Germany
- Miele innovation centre for electronics development, Gütersloh, Germany
- MOE A/S, Søborg, Denmark
- Nardini, Bassano, Italy
- New Energy Research Institute, Beijing, China
- Nordea Bank, Oslo, Norway
- Office building "Esplanade" Theresienhöhe, Munich, Germany
- One BKC, Mumbai, India
- Schüco Technology Center, Bielefeld, Germany
- Sky Tower, Bukarest, Romania
- Tower 185, Frankfurt am Main, Germany
- WesBank, Johannesburg, South Africa
- Westpac Headquarters, Sydney, Australia
- Widex A/S, Lynge, Denmark
- Zukunftsmeile Fürstenallee, Paderborn, Germany

Educational institutions

- Anton Bruckner Private University, Linz, Austria
- AUA Training Center, Schwechat, Austria
- Collegio San Giuseppe Istituto De Merode, Rome, Italy
- Kea Copenhagen School of Design and Technology, Denmark
- Leuphana University of Lüneburg, Germany
- Limtec+, Training Center, Diepenbeek, Belgium
- Lufthansa Training Center, Schwechat, Austria
- State Fire Academy Würzburg, Germany
- Stelzhamer school, Linz, Austria
- Unipark Nonntal, Universität Salzburg, Austria
- University of Antwerp, Belgium
- Zayed University, Abu Dhabi, UAE

► www.beckhoff.com/building

References for business and industry buildings, selection

- AEC Pole Division, Italy
- Algorab, Lavis, Italy
  - Eurospin Grocery Stores, Italy
- AMAG Automotive, Buch, Switzerland
- Bank of Communication, Shanghai, China
- Broschek Tiefdruck, Hamburg, Germany
- Carheal+, Støvring, Denmark
- Cummins India Ltd., Pune, India
- Daimler, Stuttgart, Germany
- dSPACE, Paderborn, Germany
- F-eins, Vienna, Austria
- Friedrich Wenner, Versmold, Germany
- Heroal, Verl, Germany
- Holzwerke Weinzierl, Vilshofen, Germany
- Internorm, Traun, Austria
- Liebherr Werk, Nenzig, Austria
- Miele innovation centre for electronics development, Gütersloh, Germany
- nobilia-Werke J. Stickling GmbH & Co. KG, Verl, Germany
- Pirelli Deutschland GmbH, Breuberg, Germany
- Philip Morris International, Lausanne, Switzerland
- Sensirion, Stäfa, Switzerland
- SOLON SE, Berlin, Germany
- Stahlwerke Bremen, Germany
- Tekloth GmbH, Bocholt, Germany
- ZF-Lemförder Fahrwerk technik, Dielingen, Germany

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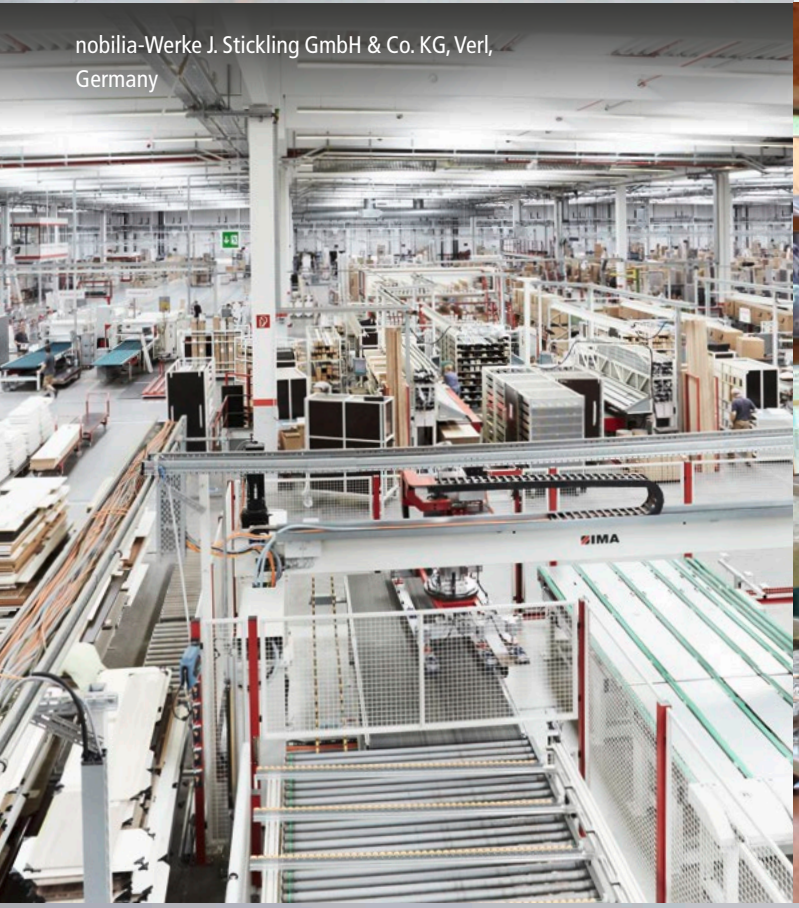
Tekloth GmbH, Bocholt, Germany

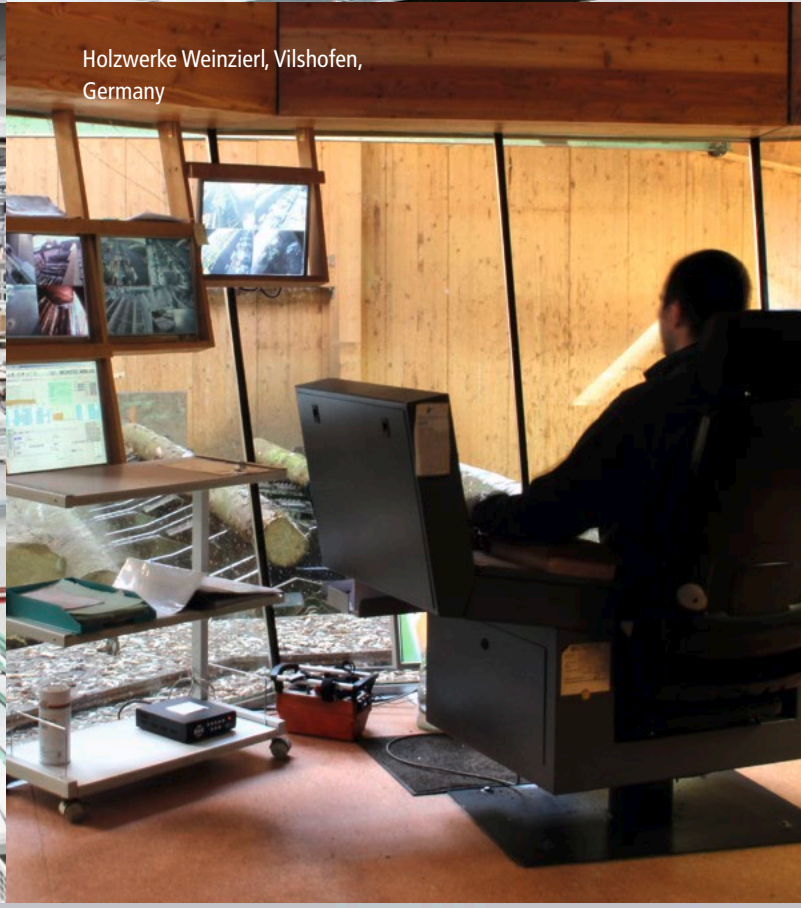
AEC Pole Division, Subbiano, Italy

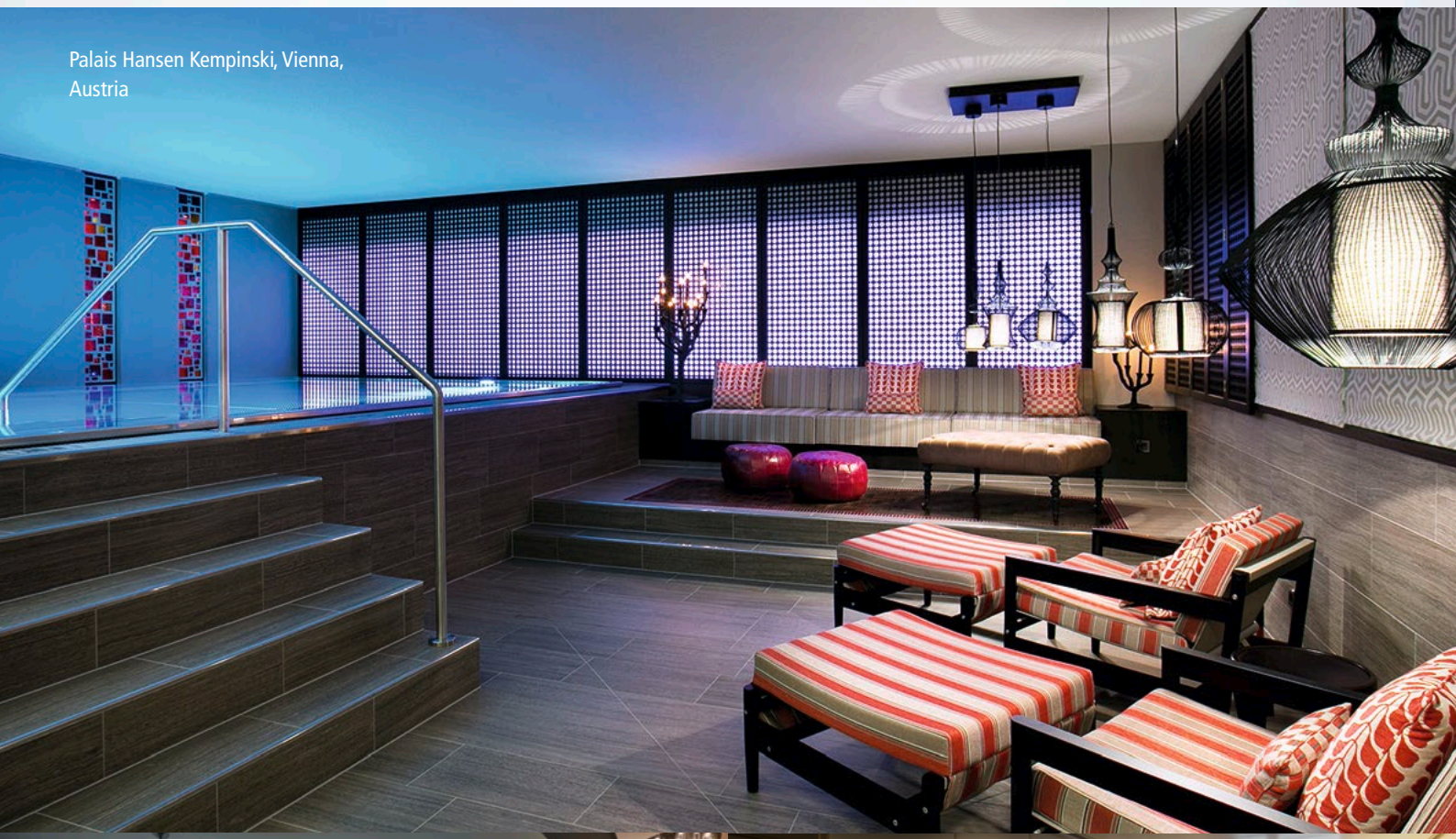
Sensirion, Stäfa, Switzerland

nobilia-Werke J. Stickling GmbH & Co. KG, Verl, Germany

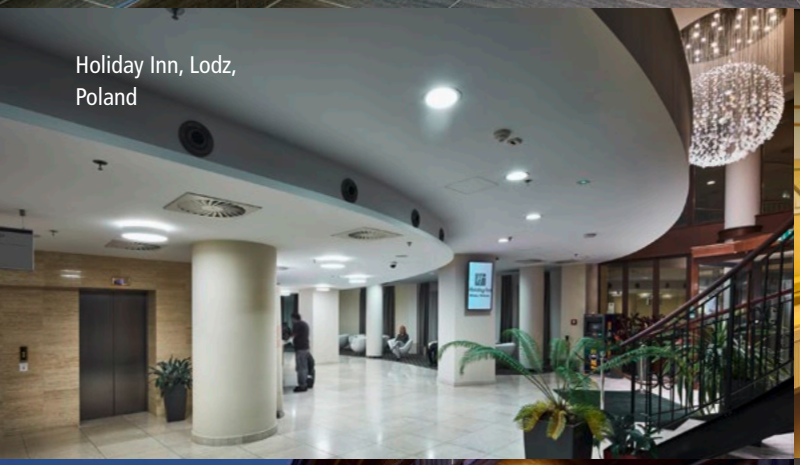


Holzwerke Weinzierl, Vilshofen, Germany



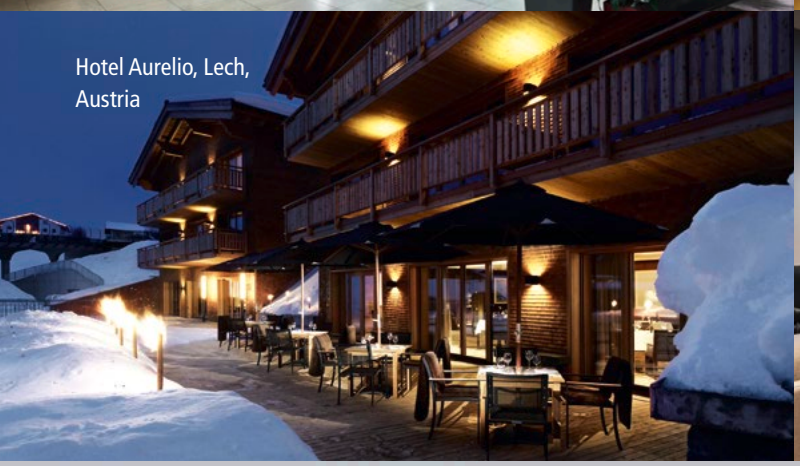


Palais Hansen Kempinski, Vienna, Austria

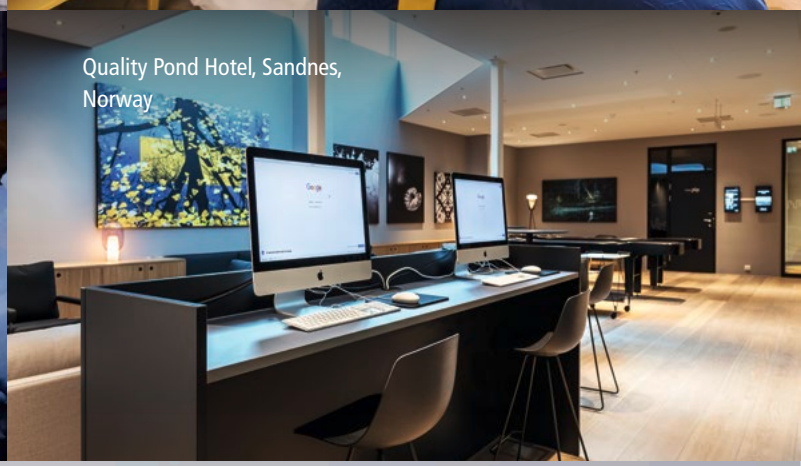


Holiday Inn, Lodz, Poland

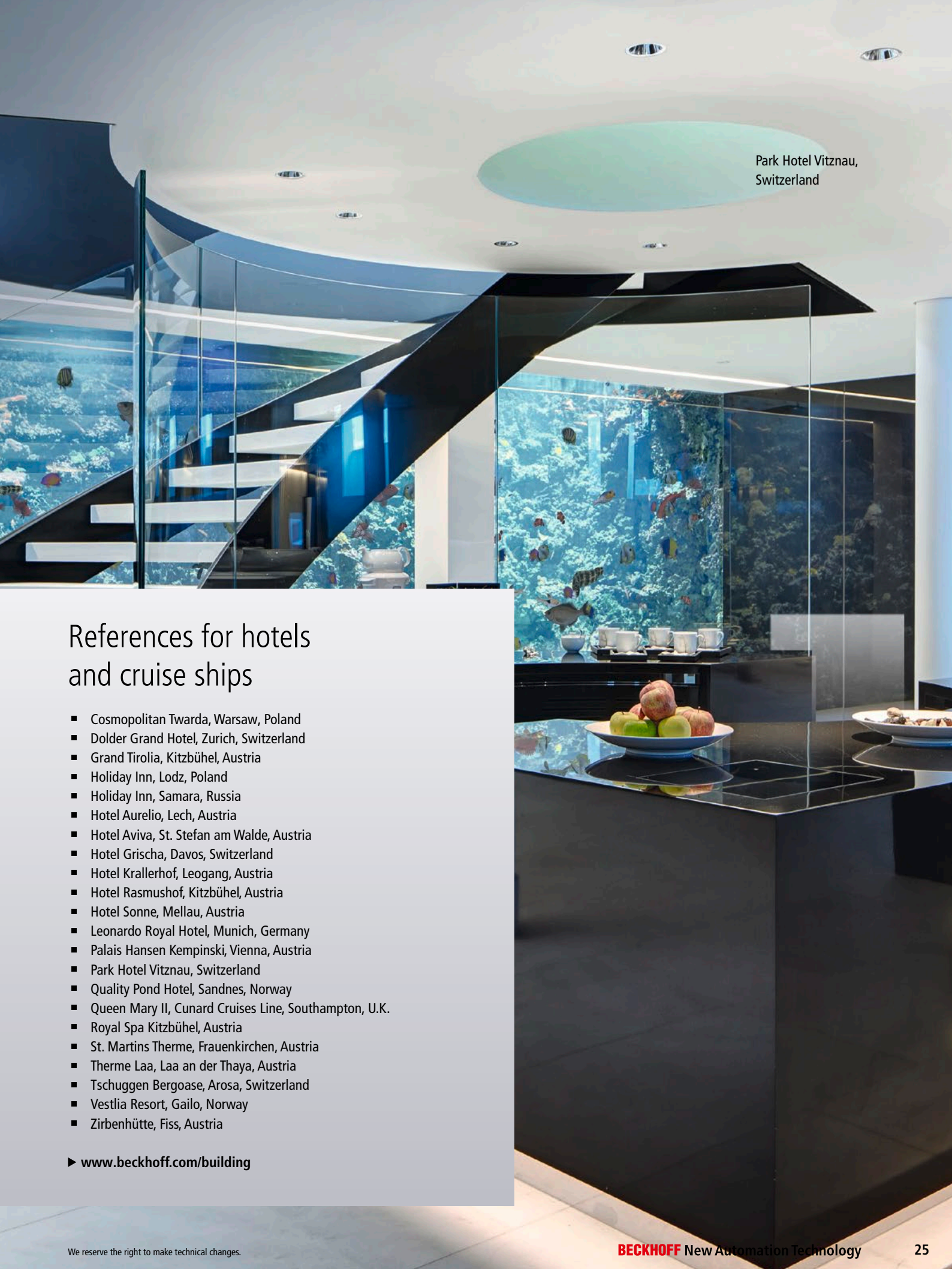
Queen Mary II, Cunard Cruises Line, Southampton, UK



Hotel Aurelio, Lech, Austria



Quality Pond Hotel, Sandnes, Norway



Park Hotel Vitznau, Switzerland

References for hotels and cruise ships

- Cosmopolitan Twarda, Warsaw, Poland
- Dolder Grand Hotel, Zurich, Switzerland
- Grand Tirolia, Kitzbühel, Austria
- Holiday Inn, Lodz, Poland
- Holiday Inn, Samara, Russia
- Hotel Aurelio, Lech, Austria
- Hotel Aviva, St. Stefan am Walde, Austria
- Hotel Grischa, Davos, Switzerland
- Hotel Krallerhof, Leogang, Austria
- Hotel Rasmushof, Kitzbühel, Austria
- Hotel Sonne, Mellau, Austria
- Leonardo Royal Hotel, Munich, Germany
- Palais Hansen Kempinski, Vienna, Austria
- Park Hotel Vitznau, Switzerland
- Quality Pond Hotel, Sandnes, Norway
- Queen Mary II, Cunard Cruises Line, Southampton, U.K.
- Royal Spa Kitzbühel, Austria
- St. Martins Therme, Frauenkirchen, Austria
- Therme Laa, Laa an der Thaya, Austria
- Tschuggen Bergoase, Arosa, Switzerland
- Vestlia Resort, Gailo, Norway
- Zirbenhütte, Fiss, Austria

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Switzerland

Frankfurt Airport,
Germany

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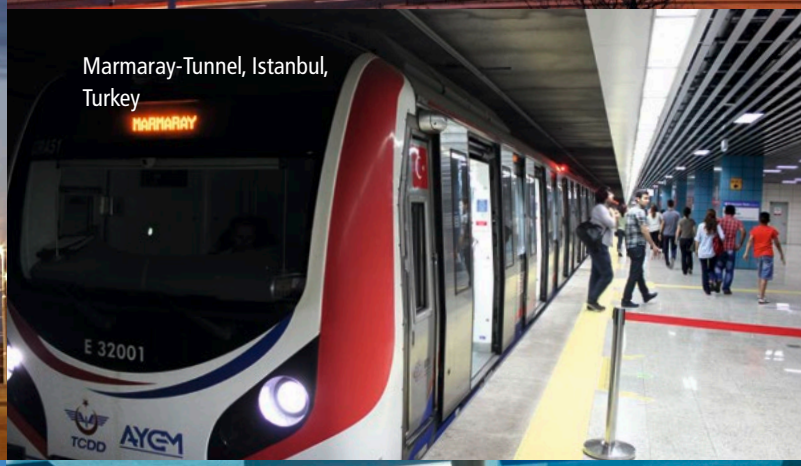


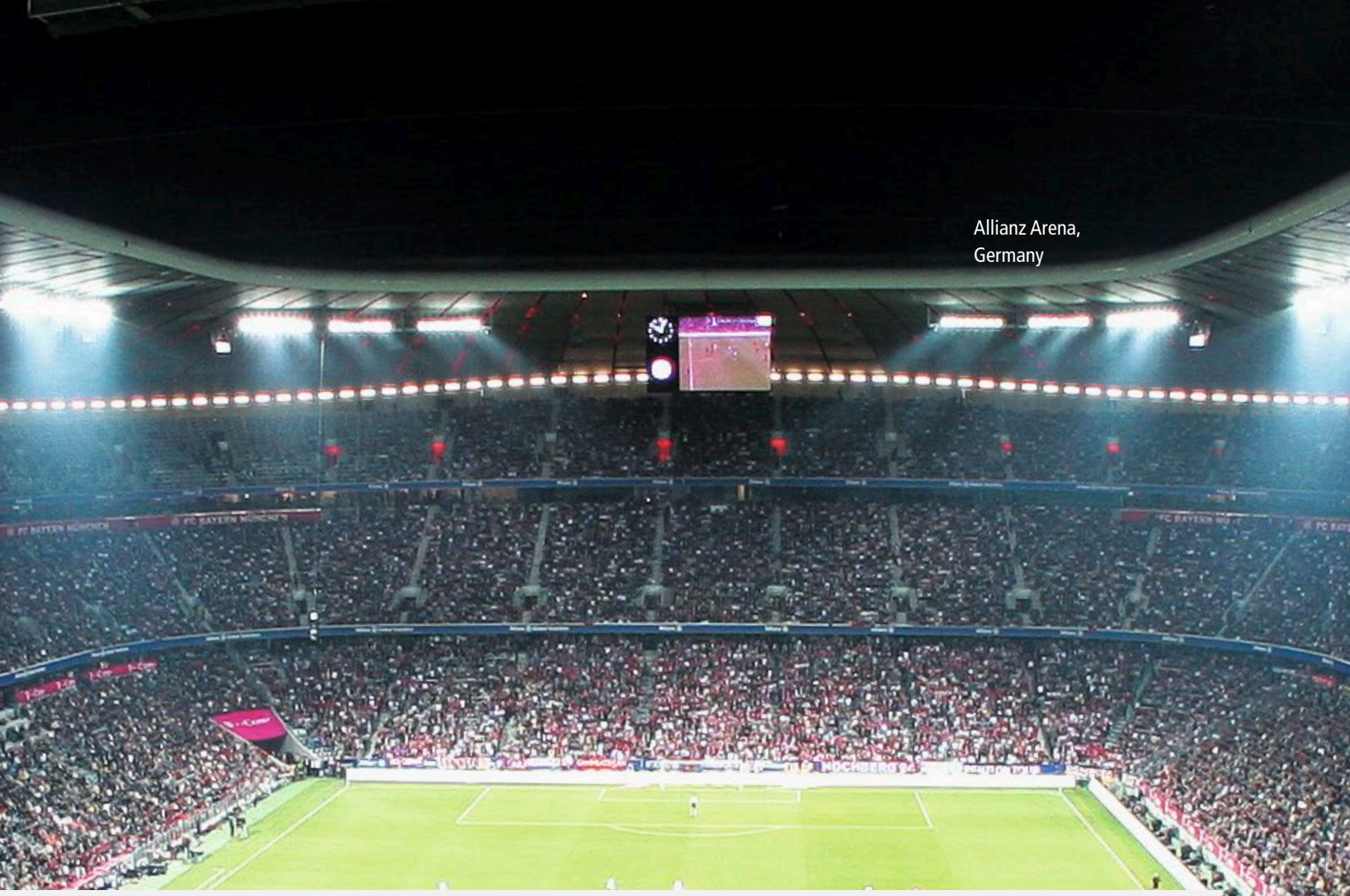
Marmaray-Tunnel, Istanbul,
Turkey

Nürnberg Messe, Hall 3A,
Nuremberg, Germany

Therme Wien, Vienna,
Austria

©Cathrine Stukhard/Therme Wien

KLIA 2 Control Tower, Sepang,
Malaysia



Allianz Arena,
Germany

References for technical and social infrastructure, selection

Technical infrastructure

- Acciona S.A., Spain
- Aparcaments i Mercats de Reus, Reus, Spain
- Envac Optibag, Stockholm, Sweden
- e2watch, Regio IT, Aachen, Germany
- Frankfurt Airport, Germany
- Gatwick Airport, London, U.K.
- Hydro-Systemtechnik, Germany
- KLIA 2 Control Tower, Sepang, Malaysia
- Marmaray-Tunnel, Istanbul, Turkey
- Metro M2, Lausanne, Switzerland
- Nordtangente, Basel, Switzerland
- Offis, Institut for Information Technology, Oldenburg, Germany
- Stadtwerke Konstanz, Germany
- Stadtwerke Lingen, Germany
- Vitrociset, Rome, Italy
  - Aqueduct automation, Maghnia, Algeria
  - Brenner motor way, Italy
  - ENAV, air traffic control, Rome, Italy
  - Italian Air Defence, remote monitoring of radar towers
  - Italian Ministry of Interior, unmanned remote control of radio site
  - SNAM, electric grid security, Milan, Italy
  - Terna, electric grid security, Rome, Italy
- Zweckverband Wasser und Abwasser Vogtland, Germany

Social infrastructure

- Akrykarium, Zoo Wroclaw, Poland
- Allianz Arena, Munich, Germany
- Anima Care retirement homes, Belgium
- Armonea retirement homes, Mechelen, Belgium
- ESPRIT arena, Düsseldorf, Germany
- Gran Casino Aranjuez, Madrid, Spain
- Grundfos Kollegiet, Aarhus, Denmark
- Messe Basel, Hall 2, Basel, Switzerland
- Nürnberg Messe, Hall 3A, Nuremberg, Germany
- Oncological Centre, Samara, Russia
- Oslo City Hall, Norway
- Ryhov Hospital, Jönköping, Sweden
- Therme Wien,Vienna, Austria
- Vitrociset, Rome, Italy
  - EXPO 2015, access control system, Milan, Italy

▶ **www.beckhoff.com/building**

Bregenz Festival, "Seebühne", 2015-16, "Turandot", Austria

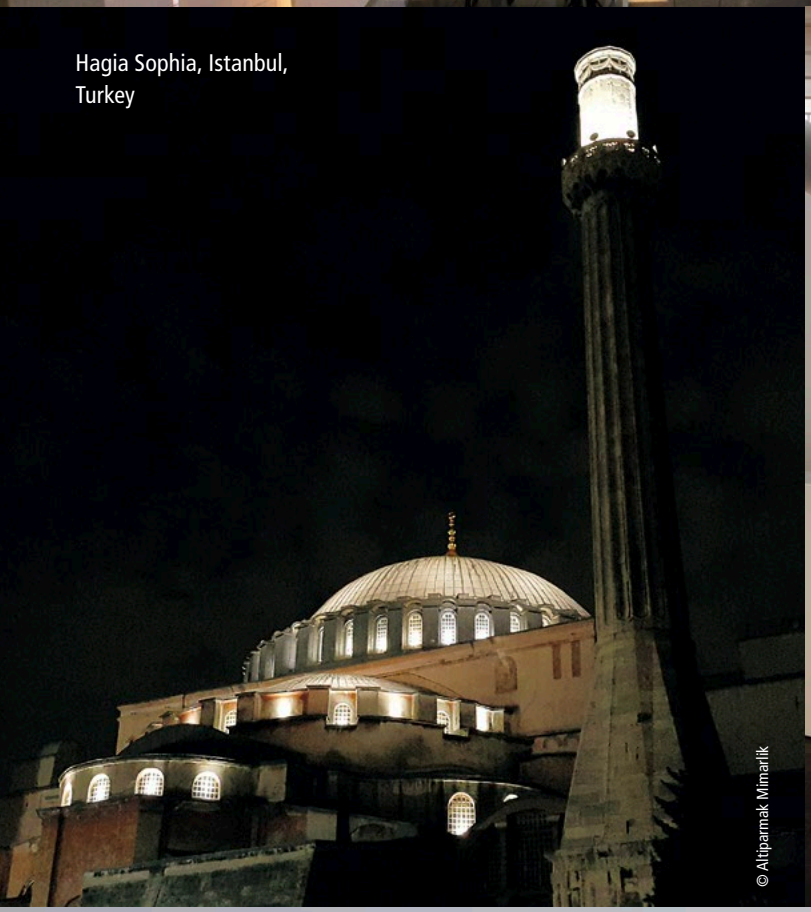
References for theaters, congress halls and museums, selection

- Bregenzer Festspiele, Opera on the Lake, 2015-16, Austria
- Carré Theatre, Amsterdam, Netherlands
- Design Center Linz, Austria
- Deutsches Museum, Munich, Germany
- Ferry Porsche Congress Center, Austria
- Hagia Sophia, Istanbul, Turkey
- Helsinki City Theatre, Helsinki, Finland
- Helsinki Music Center, Helsinki, Finland
- Imatra Theatre, Imatra, Finland
- Janacek Theatre, Bruno, Czech Republik
- Kuopio City Theatre, Kuopio, Finland
- Magical Production, Dubai, UAE
- People's Grand Theatre, Jilin City, China
- Ronacher-Theatre, Vienna, Austria
- Rovaniemi Theatre, Finland
- Royal Danish Theatre, Copenhagen, Denmark
- Scala di Milano, Milan, Italy
- Schauspielhaus Nuremberg, Germany
- Schloss Charlottenburg, Berlin, Germany
- Serlachius Museum, Mänttä, Finland
- Sibelius Hall, Lahti, Finland
- Sisi-Museum, Vienna Hofburg, Vienna, Austria
- Staatliches Museum für Archäologie, Chemnitz, Germany
- Stadtmuseum Dresden, Germany
- Stage Theater an der Elbe, "Das Wunder von Bern", Hamburg, Germany
- Tampere Hall, Tampere, Finland

▶ **www.beckhoff.com/building**

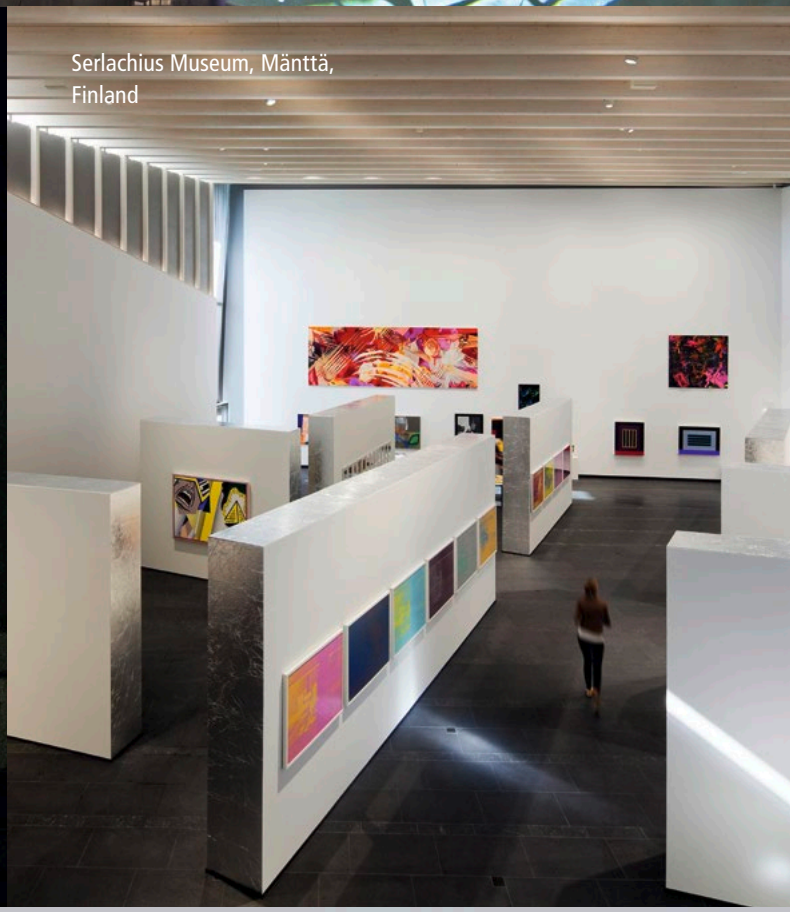
Staatliches Museum für Archäologie, Chemnitz, Germany

© ATELIER BRÜCKNER/Michael Jungblut



Hagia Sophia, Istanbul, Turkey

© Altiparmak Mimarlik



Serlachius Museum, Mänttä, Finland

Planning, building systems and solutions for planners and technicians

Application of the latest norms and standards gives rise to new possibilities for the planning of new buildings and the renovation of existing stock. Good cooperation between the different fields represented by specialist planners, architects, builders, commissioning engineers and operators can considerably improve the ecological and commercial value of a building. An energy efficient, integrated building automation system can only be implemented with the use of one control system for all technical building systems.

Basic principles and standards of building automation

In recent years, standards for building and room automation have been set by international committees to make the functionalities of building automation measurable and to be able to implement them efficiently. The energy efficiency of a building describes the relationship between the energy used and the resulting benefit. The latter must always be seen in relation to the function of a building and is an important factor in the evaluation of energy efficiency.

DIN EN 15232: energy efficiency of buildings

European norm EN 15232 describes the effect of building automation and building management on energy efficiency and enables standardised representation for the first time. It includes a structured list of all building automation functions that can affect the energy efficiency of a building. It also offers systematic support for the definition of minimum requirements concerning building automation. The following can be stated as a basic principle: the higher the level of automation, the greater the energy savings.

Equivalent to highly energy-efficient BAC systems and TBM	A
Equivalent to more advanced BAC systems and some special TBM functions	B
Equivalent to standard BAC systems	C
Equivalent to BAC systems that are not energy-efficient. Buildings with such systems must be modernised. New buildings must not be constructed using systems such as these.	D

Building Automation and Control System (BAC), Technical Building Management (TBM)

Exemplary application of EN 15232

	Automatic control and regulation of the heating system	Definition of classes							
		Residential building				Non-residential building			
		D	C	B	A	D	C	B	A
Control of transfer									
	The controller is installed at transfer level or room level; in the former case, one controller can regulate a number of different rooms.								
0	No automatic control	x				x			
1	Central automatic regulation	x	x			x			
2	Automatic individual room control using thermostatic valves or electronic control devices	x	x			x	x		
3	Individual room control with communication between control devices and BACs	x	x	x		x	x	x	
4	Integrated individual room control including needs-based regulation (occupancy, air quality, etc.)	x	x	x	x	x	x	x	x
Regulation of hot water temperature in distribution network (flow or return)									
	Comparable functions can be used to control networks for direct electrical heating.								
0	No automatic control	x				x			
1	Weather-based control	x	x			x	x		
2	Control of inside temperature	x	x	x	x	x	x	x	x
Control of circulation pumps									
	The controlled pumps can be installed in the network at different levels.								
0	No control	x				x			
1	On/off control	x	x			x			
2	Control of variable pump speed according to a constant Δp	x	x	x	x	x	x	x	x
3	Control of variable pump speed according to proportional Δp	x	x	x	x	x	x	x	x
Control of transfer and/or distribution during intermittent operation									
	One controller can regulate different rooms/zones with the same occupancy pattern.								
0	No automatic control	x				x			
1	Automatic control with fixed time program	x	x			x			
2	Automatic control with optimised on/off switching	x	x	x	x	x	x	x	x
Control of generators									
0	Constant temperature	x				x			
1	Variable temperature dependent on the outside temperature	x	x	x	x	x	x	x	x
2	Variable temperature dependent on the load	x	x	x	x	x	x	x	x
Operating sequence of different generators									
0	Priority setting based solely on the load	x	x			x	x		
1	Priority setting based on the load and on the generator performance	x	x	x		x	x	x	
2	Priority setting based on the level of generator usage (check other norms)	x	x	x	x	x	x	x	x

Source: DIN EN 15232

The table illustrates the relationship between building automation functions and energy efficiency classes for control of the heating system.

Application of EN 15232 gives rise to different energy efficiency factors for different building types, with regard to the use of thermal and electrical energy. In the evaluation of buildings, the energy efficiency class C is the reference class for the implementation of measures for energy optimisation.

The red field in the table on the right-hand side shows how the thermal energy consumption of a building with efficiency class A with a factor of 0.7 can be reduced by up to 30%.

Building Automation and Control (BAC) **Efficiency classes EN 15232**	**Efficiency factor for thermal energy**			**Efficiency factor for electrical energy**		
	Office	School	Hotel	Office	School	Hotel
A Highly efficient Building Automation and Control System (BACS) and Technical Building Management (TBM)	0.70	0.80	0.68	0.87	0.86	0.90
B Advanced BACS and TBM	0.80	0.88	0.85	0.93	0.93	0.95
C Standard BACS	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
D Non-efficient BACS	1.51	1.20	1.31	1.10	1.07	1.07

Source: DIN EN 15232, table 9, table 11

Use in room automation

VDI 3813 – room automation

VDI 3813 describes the integrated room automation with special consideration for interoperability of different building systems, based on usage requirements. To provide a uniform assessment basis for owners, planners and system integrators, clear terms and functions are defined in the norm.

The current difficulty is that in invitations to tender, room automation functions are dealt with separately from the building systems connected with technical development. In practice, this often means that existing potential for saving energy remains unused.

The VDI 3813 supplements the EN 15232 by providing a precise description of the room automation functions described there. It is important that EN 15232 and VDI 3813 are applied as early as the basic evaluation and pre-planning stage.

The table on the right-hand side shows the room automation functions of the VDI 3813, relating to the energy efficiency classes of EN 15232.

Application function	**BAC efficiency classes in accordance with DIN EN 15232**			
	D	C	B	A
Basic functions affecting energy efficiency				
Occupancy control			x	x
Time program			x	x
Illumination functions which influence energy efficiency				
Light switching		x		
Automatic lighting			x	x
Daylight switching			x	x
Constant light control			x	x
Solar shading functions which influence energy efficiency				
Automatic solar shading		x		
Louvre adjustment			x	x
Shading correction			x	x
Thermo-automatic control			x	x
Air conditioning functions				
Energy level selection			x	x
Energy level selection with start optimisation			x	x
Target value calculation			x	x
Function selection			x	x
Temperature control (heating/cooling)		x	x	x
Room/intake air temperature cascade control			x	x
Ventilator control			x	x
Sequence control			x	x
Setpoint control			x	x
Air quality control/regulation				x
Night cooling			x	x
Load optimisation			x	x

Source: VDI 3813 part 2

In room automation, sensors are implemented depending on their function and not on the individual building system. This saves on hardware and cabling costs as early as in the system installation phase. The reduction in cabling also has a positive spin-off effect on fire loads and building statics.

To achieve energy efficiency class A in accordance with EN 15232, Beckhoff offers a software library based on room automation guideline VDI 3813.

Comprehensive room automation exploits the interdependencies of facade control, illumination and climate control to create a pleasant room climate. At the same time, efficient room and zone control also affects the primary systems: the heating and cooling requirements and the air quantities are regulated according to need. When designing the heating, cooling, ventilation and air conditioning systems, the needs arising from the specific use of the building must be taken into account. A further benefit lies in the way in which a majority of the optimisation functions can be realised within the software on a single system during commissioning and ongoing operations. As a result, no reconstruction work impedes operation and the time required for software adjustment also remains within reasonable limits. In certain cases, many modifications can be made by accessing the system remotely, without the need for a service technician to attend in person.

The adjacent matrix shows the interplay of the individual building systems with regard to the sensors used. For energy efficient automation, all individual building systems must be controlled and managed from a single system.

Interaction of building systems	**Sensor system**					
	HVAC	Lighting	Solar shading	Security	Global	Monitoring
Light intensity	x	x	x			
Room temperature	x		x			x
Occupancy	x	x	x	x		x
Window contact	x		x	x	x	
Room operating device	x	x	x			
Weather (wind/rain)			x		x	
Outside temperature	x		x		x	
Solar radiation	x	x	x		x	

Offices according to energy efficiency class A

For a better illustration of what lies behind building automation functions and how energy can be saved, examples of building automation functions in an office with energy efficiency class A are described below.

Technical equipment of an office

Illumination consists of one lighting strip on the corridor side and one on the window side. The lights are held at a constant room brightness level via DALI (constant light control), depending on the amount of daylight. A room brightness sensor is mounted in the ceiling. An occupancy sensor is installed for needs-dependent management and control of the entire room.

The office is shaded by means of two electrically operated, externally mounted louvre blinds. Two buttons are installed for manual control of the blinds.

To heat the room, a radiator is present. The office is cooled via a cooling ceiling. An actuator is located on the radiator and on the cooling ceiling respectively. The room temperature is monitored and the desired room temperature is adjusted locally using EnOcean radio technology.

For ventilation, the office is connected to an air-conditioning installation. Volume flow is variable. The open state of the window is captured via a digital input; so too is the dew point sensor on the cooling ceiling.

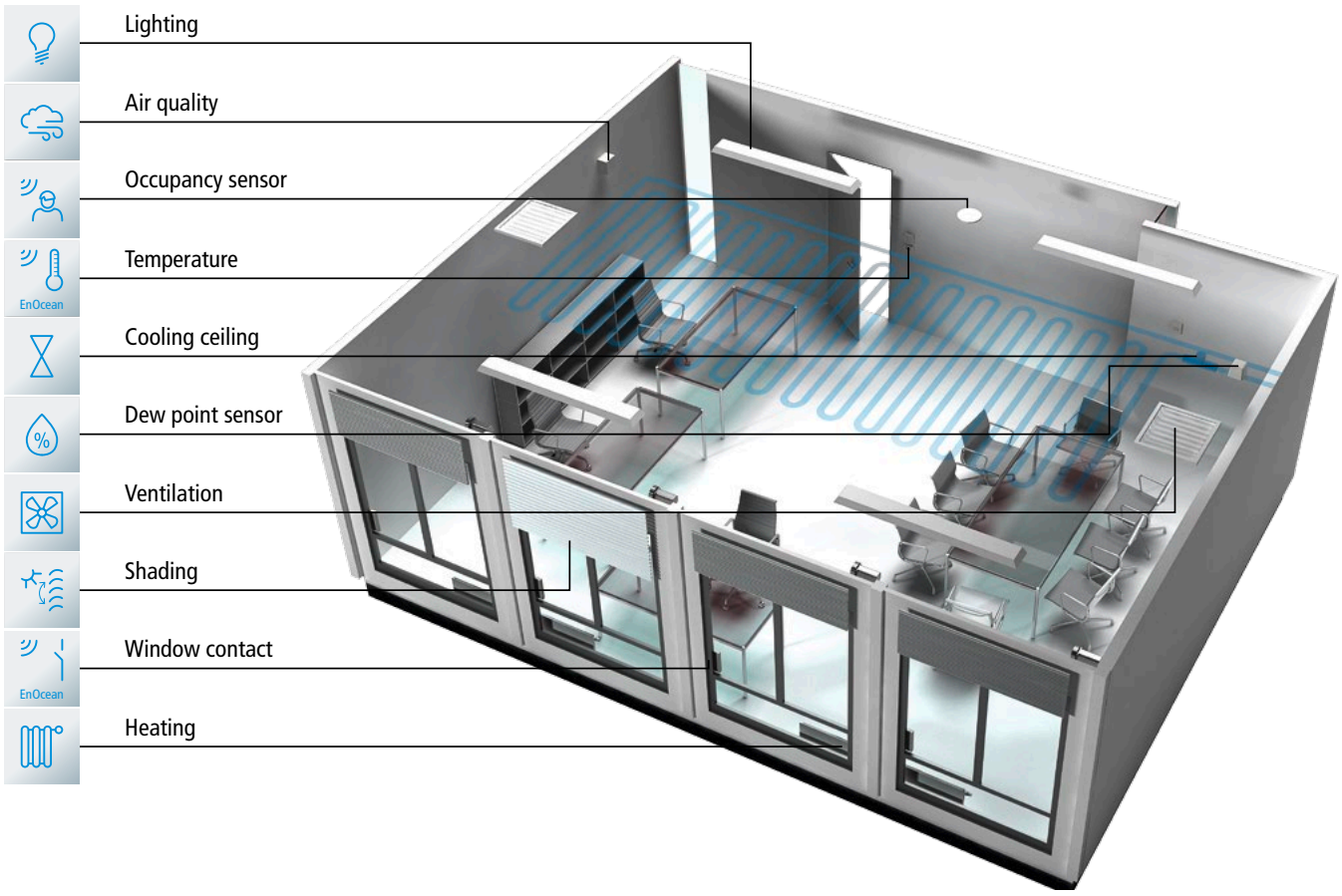
Heating/cooling function

To minimise energy use for room heating and cooling, the desired room temperature is determined via a scheduler-dependent energy level selector (see fig. 1, page 30, and fig. 2, page 31). In the case of long absences, e.g. during shut-down periods, the office is switched to "Protection", the lowest energy level, to prevent damage caused by frost or overheating. For brief absences, e.g. at night or on weekends, the office is set to "Economy" mode. Only at the start of core working time is the energy level raised to the level "Pre-Comfort". The room temperature is now almost up to the comfort target value. Only when persons are detected in the room is "Comfort" mode activated and the appropriate set value reached in a short time.

The system switches from "Economy" to "Pre-Comfort" mode as late as possible via the energy level selector with start optimisation. The optimum activation time is calculated by the building automation system.

The opening of the window is monitored by a window contact. If the window is open, the system automatically switches to the "Protection" energy level. This automatically stops unnecessary energy consumption due to a window being opened.

The room temperature set values for all four energy levels are provided by the room climate function set value calculation for heating and cooling.



The "Function Selection" regulates the controller for heating and cooling and compares the current room temperature against the set value. If the current value is lower than the target value for the energy level "Comfort" heating, the heating controller is activated. If the current room temperature is higher than the set value for the energy level "Comfort" cooling, the cooling controller is activated. Simultaneous heating and cooling is not possible.

Ventilation

In summer, natural cooling at night helps reduce energy consumption: The night cooling program switches on the room ventilation system and ventilates the offices using cool external air. This removes heat from the building at night so that less energy is required to cool the room the following day. For electrically operated windows, these can also be used for automatic night cooling in summer.

Load optimisation

Communication between systems for automation of energy centres and systems for the generation and distribution of heating and cooling water enables needs-based adjustment of the flow temperatures. This allows transfer losses to be minimised and the overall effectiveness of the systems to be increased.

Air quality regulation

Depending on the measured air quality, the volume flow controller is used to introduce more or less fresh air into the room. If the air quality is good, air intake is reduced to a minimum volume flow. The central air conditioning unit for ventilation automatically adjusts the level of ventilation based on the data communicated between the room automation system and the primary systems. This reduces the energy consumption of the fans by up to 45 %. In the event of zero occupancy, the volume flow is reduced to a minimum.

Shading: thermo-automatic control and shading correction

Constant light control

If a minimum light strength in the room is not reached but the room is occupied, the constant light control function switches on automatically. Conversely, if the amount of external light increases, the proportion of artificial light automatically reduces or is switched off once a suitable lighting strength is reached. If the occupancy detector identifies that the room is empty, the constant light control function switches itself off on a time-delay basis.

Shading

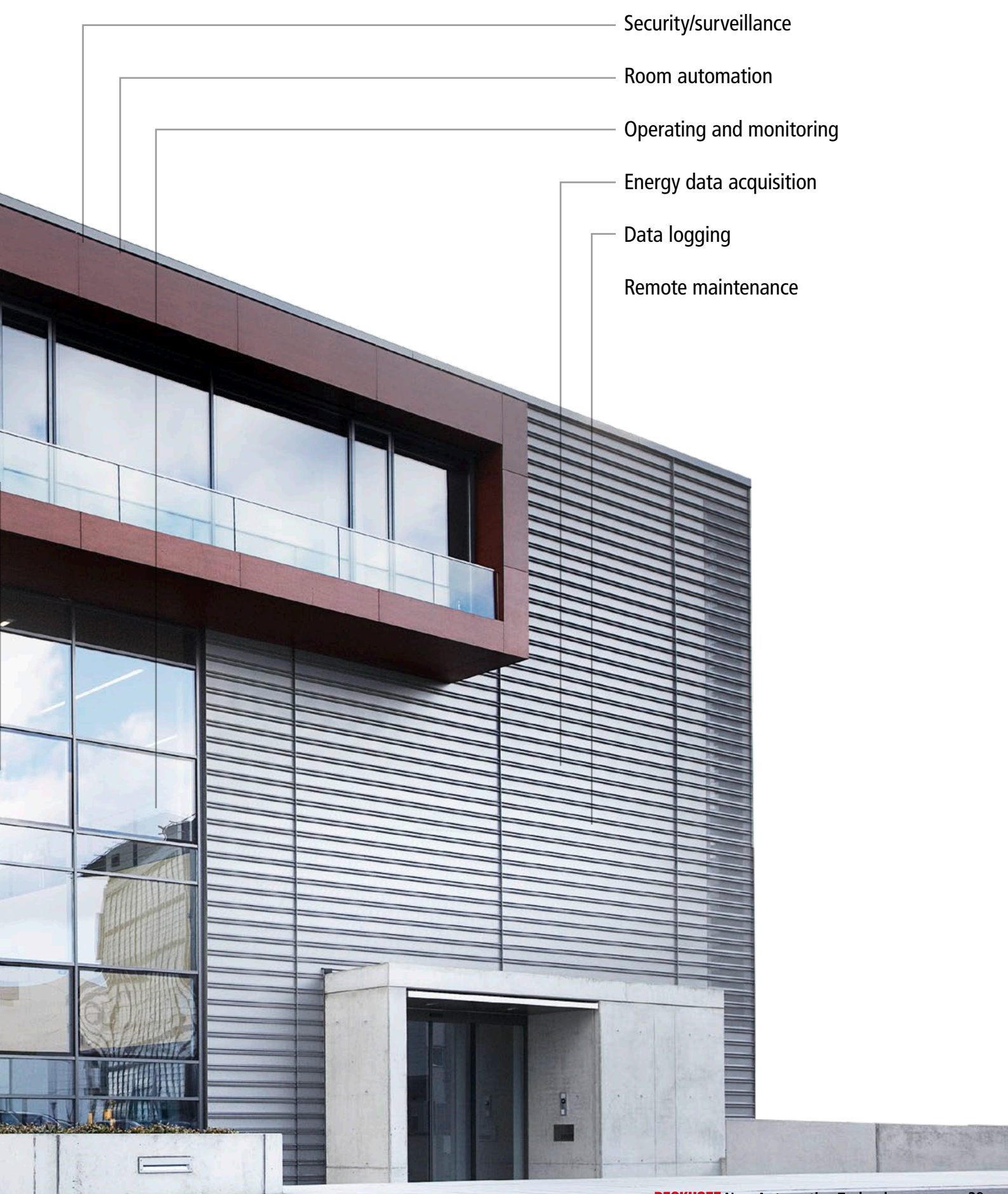
Control of solar shading is integrated directly into the room automation system. The "thermo-automatic" function supports the heating and cooling function of the room if it is not occupied. To benefit from sun light in winter, solar shading is raised to help heat the space using the sun's rays. In summer, the solar shading is automatically activated to reduce the energy yield from the sun and to assist cooling.

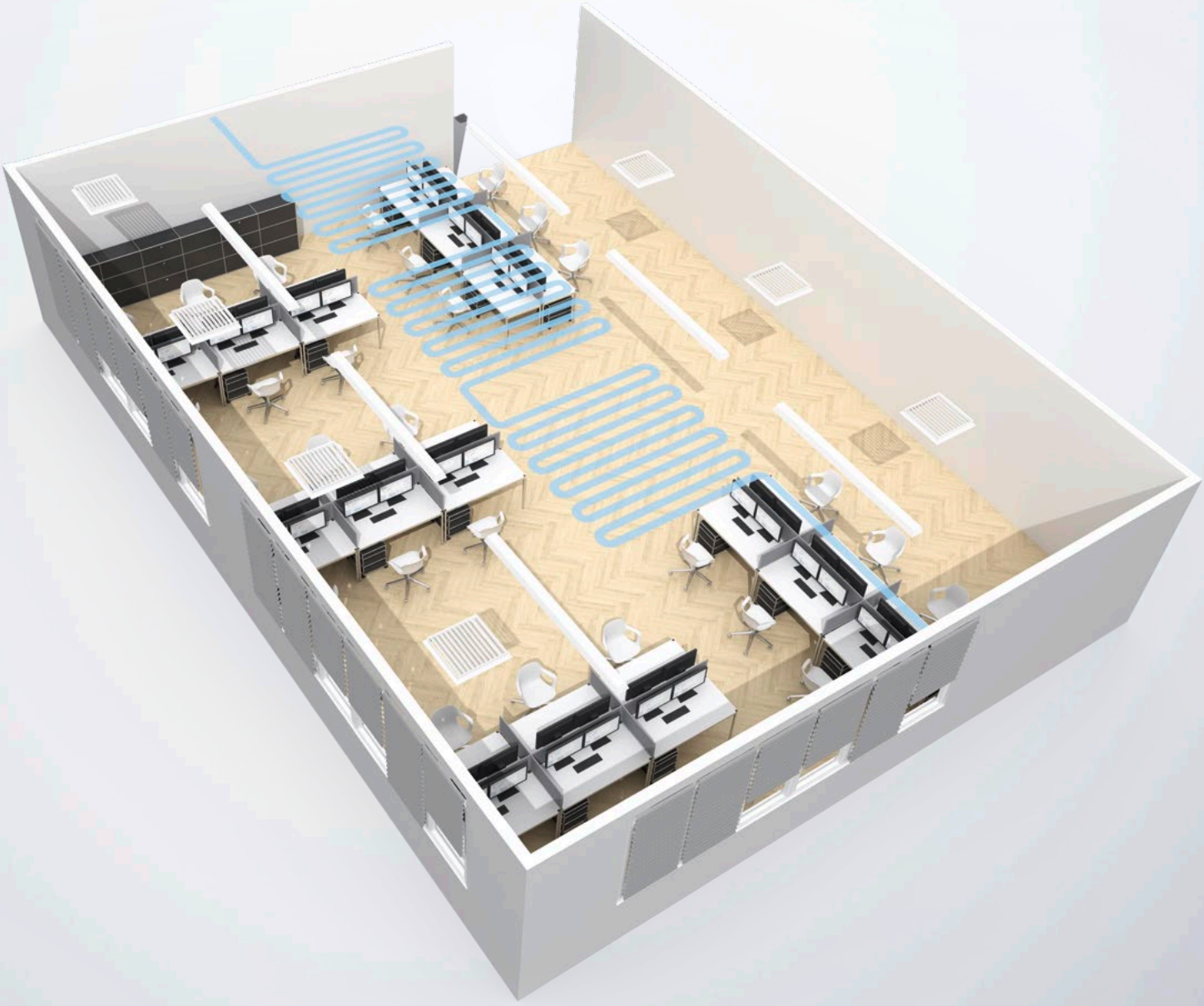
If the room is occupied and the sun is shining in strongly, the solar shading is automatically activated. The louvre adjustment optimises the angle of the louvre according to the position of the sun. The blades are positioned in such a way as to prevent blinding from direct sunlight while keeping the need for artificial lighting to a minimum in order to reduce energy consumption.

The shading correction function calculates the shadow movement on the facades of the building, depending on the position of the sun, the facade orientation and the position and coordinates of the surrounding buildings that provide shade. This prevents unnecessary activation of the solar shading and increased energy consumption due to the use of artificial light within the building.

Integrated building automation in detail

For the implementation of building automation solutions, Beckhoff offers a comprehensive range of hardware and software modules that can be used both in individual building systems and across different systems. The following pages contain examples to illustrate the use of individual components in different building systems.

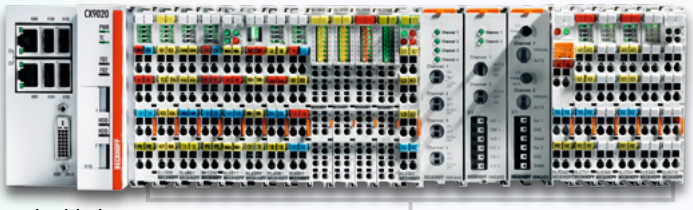

Security/surveillance
Room automation
Operating and monitoring
Energy data acquisition
Data logging
Remote maintenance



Room automation, offices

Having building systems that work together intelligently saves money not only during the construction of an office building, but also over the long term through increased energy efficiency. Heating, ventilation and air conditioning systems run only when needed. Lighting is controlled based on demand, daylight, occupancy, and even season. Blinds and shades are controlled based on wind speed and the position of the sun. Media systems in conference, training and seminar rooms are integrated into the existing building automation platform.

Communication between the individual automation stations takes place via Ethernet TCP/IP. The level of automation in a room can be individually adjusted through free configuration of individual Bus Terminals. Alternatively, the BC9191 room controller integrates these functions within a single module. Rooms and/or areas with repeat requirements need only be programmed once and can be replicated. With features like these, an efficient, multi-component room automation system can be implemented that meets energy efficiency class A.



Embedded PC,
Bus Terminals

HVAC

- Mechanical ventilation
- Ventilation
- Air quality
- Heating
- Cooling
- Temperature
- Humidity

Lighting

- Automatic dimmer system
- Occupancy sensor
- Constant light regulation
- DALI
- Light switch

Facade/door

- Thermo-automatic control
- Shading
- Access

Operating and monitoring

- Control panel
- Mobile controller

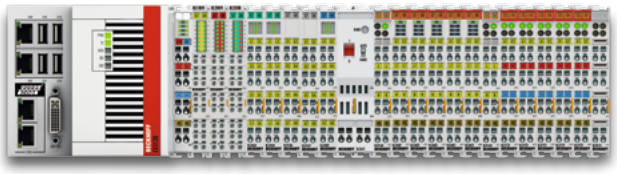
The TwinCAT PLC HVAC Libraries contain comprehensive room automation functions.
By coupling a daylight-dependent control unit with glare protection as well as heating and cooling functions, significant synergies can be generated. Using object orientation, various functions can be represented as PLC function blocks:

- Occupancy sensor
- Time program
- Automatic lighting
- Human centric lighting
- Constant light control
- Slat adjustment
- Shading correction
- Automatic temperature control
- Energy level selection with start optimisation
- Target point determination
- Function selection
- Temperature control (heating/cooling)
- Sequence control
- Target value limiter
- Air quality control
- Night cooling

Sample configuration room automation, offices

Traditional floor and room | standard room automation

Product	Description
CX5010-1111	TwinCAT PLC

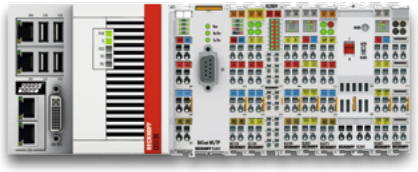


KL1809	16-channel digital input 24 V DC
	Dew point monitor
	Window contact
	Occupancy sensor
	Light switch for floor lamps
	Light switch for ceiling lights
	Shutter switch UP
	Shutter switch DOWN
KL2809	16-channel digital output 24 V DC
	Actuator for heating
	Actuator for cooling
KL3208-0010	8-channel analog input terminal PT1000,
	Ni1000 (RTD); NTC sensors, potentiometers
	Room temperature sensor
	Temperature setpoint
KL3468	8-channel analog input 0…10 V
	Air quality sensor
	Light sensor

KL9186	Potential distribution terminal 24 V DV
KL9187	Potential distribution terminal 0 V DV
KL4408	8-channel analog output 0…10 V
	Volume flow controller
KL2641	1-channel relay output terminal 230 V AC, 16 A
	Switchable floor lamp power outlet
KL9160	Potential feed terminal with diagnostics, 230 V AC
KL2602-0010	2-channel relay output terminal 230 V AC,
	5 A, make contacts
	contact-protecting switching of LED lamps
	at zero voltage crossing
KL9160	Potential feed terminal 120…230 V AC, with diagnostics
KL2722	2-channel triac output terminal 230 V AC
	Sunshade actuator UP
	Sunshade actuator DOWN
KL9010	End terminal

Floor and room with fieldbus | Room automation with DALI, SMI, EnOcean and BACnet MS/TP

Product	Description
CX5010-1111	TwinCAT PLC



EL6861	1-channel BACnet MS/TP interface RS485,
	D-sub connection
	connection of BACnet MS/TP field devices
BK1250	"Compact" coupler between E-bus and K-bus terminals
	conversion from E-bus to K-bus
KL1104	4-channel digital input terminals 24 V DC
	Dew point monitor
KL6581	EnOcean master terminal
KL6583	EnOcean transmitter and receiver
	Air quality sensor
	Temperature setpoint
	Light switch for floor lamps/ceiling lights
	Shutter switch UP/DOWN
	Window contact
	Room temperature sensor

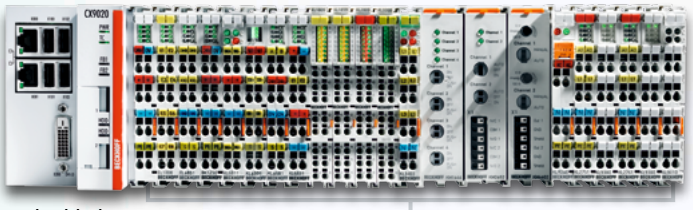
KL6821	DALI/DALI 2 multi-master and power supply terminal
	Connection of DALI/DALI 2 actors and sensors
KL6771	MP bus master terminal, 8 drives max.
	Volume flow control
KL2641	1-channel relay output terminal 230 V AC, 16 A
	Switchable floor lamp power outlet
KL6841	SMI master terminal 230 V AC, 16 drives max.
	Sunshade actuator UP
	Sunshade actuator DOWN
KL9010	End terminal

The BK9000, BK9050 or BK9100 Bus Coupler makes it easy to expand the decentralized room automation system.
You simply replace the CX controller with one of these Bus Couplers. The terminals are the same.

Room automation, hotels

To keep costs under control, hotels must pay especially close attention to their energy efficiency. Without affecting their guests' well-being, they can save energy by intelligently controlling the heating and cooling of hotel rooms. Various illumination scenarios in the lounge, restaurant and spa areas can set the mood based on usage and time of day. For cost-sensitive hotel room applications, the compact BC9191 Room Controller delivers all the features for a standard room in a compact housing.

With the CX9020 Embedded Controller or the BC9191 Bus Terminal Controller a decentralised room automation can easily be realised. This setup offers maximum modularity because every zone has a decentralized control system for which the parameters can be freely defined. An embedded controller communicates with the building management system in the respective zone in order to transfer all the data. For a more upscale setup, each room or suite can be equipped with a CX9020 Embedded PC for maximum flexibility.



Embedded PC,
Bus Terminals

HVAC

- Cooling
- Humidity
- Ventilation
- Temperature
- Heating

Lighting

- Constant light control
- Motion detector
- Switchable power outlets

Operating and monitoring

- Mobile controller
- FIAS Server
- Control panel

Facade/door

- Shading
- Access

A central floor or building controller is recommended for general functions such as floor or staircase lighting, the FIAS server link, and higher-level functions based on weather data, for example.

A hotel reservation system can be integrated via the TwinCAT FIAS Server. Media devices and systems for meeting or seminar rooms can also be easily integrated into the room automation system:

- Automatic occupancy registration
- Timer program
- Automatic lighting
- Human centric lighting
- Automatic temperature control
- Energy level selection with start optimisation
- Setpoint determination
- Function selection
- Temperature control (heating/cooling)
- Sequence control

Sample configuration room automation, hotels

Floor controller

Product	Description
CX9020-0111	TwinCAT PLC
- TS8035	TwinCAT FIAS Server

KL1809	16-channel digital input 24 V DC
	Window contact
	Light switch for secondary rooms
KL6821	DALI/DALI 2 multi-master and power supply terminal
	Connection of DALI/DALI 2 actors and sensors
KL9160	Potential feed terminal 120…230 V AC, with diagnostics

KL1722	2-channel digital input terminal 120/230 V AC
	Occupancy sensor
KL2602-0010	2-channel relay output terminal 230 V AC, 5 A,
	make contacts
	contact-protecting switching of LED lamps
	at zero voltage crossing
KL9010	End terminal

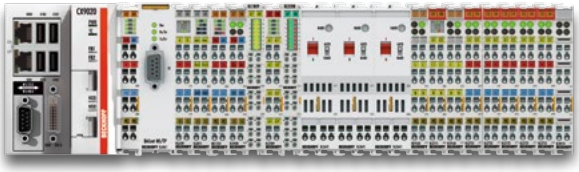
Standard hotel room

Digital inputs
Dew point monitor
Window contact
Occupancy sensor
Analog inputs
Room temperature sensor
Temperature setpoint

Digital outputs
3-stage fan coil
Air heater
Analog outputs
Actuator for heating
Actuator for cooling
Serial communication

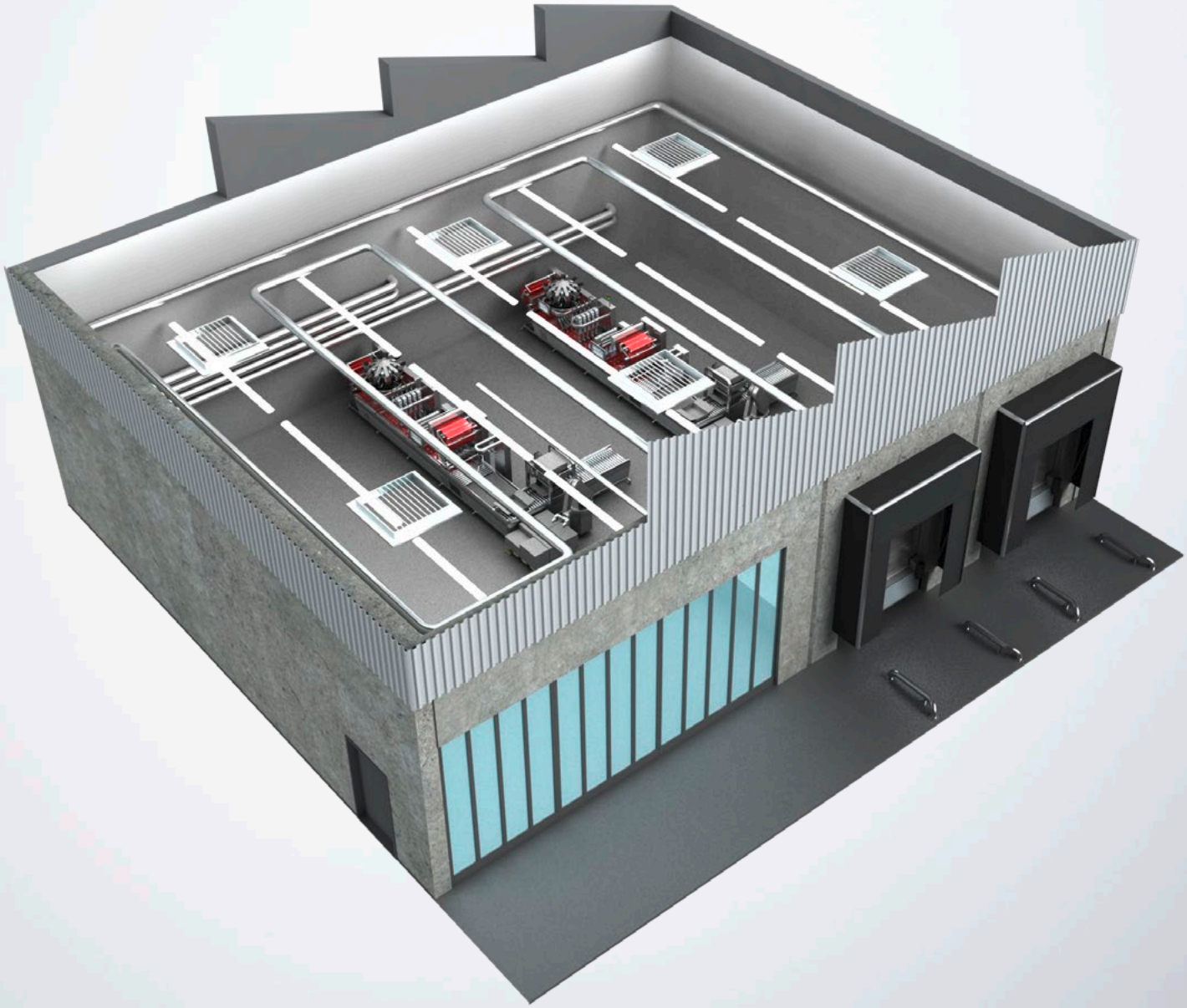
Deluxe hotel room

Product	Description
CX9020-0111	TwinCAT PLC



EL6861	1-channel BACnet MS/TP interface RS485,
	D-sub connection
	connection of BACnet MS/TP field devices
EL6851	DMX master terminal
	Lighting
BK1250	Coupler between E-bus and K-bus terminals
KL9400	Power supply terminal to refresh K-bus
KL1809	16-channel digital input 24 V DC
	Dew point monitor
	Window contact
	Occupancy sensor
	Light switch for floor lamps
	Light switch for ceiling lamps
	Curtain switch OPEN/CLOSED
	Shutter switch UP/DOWN

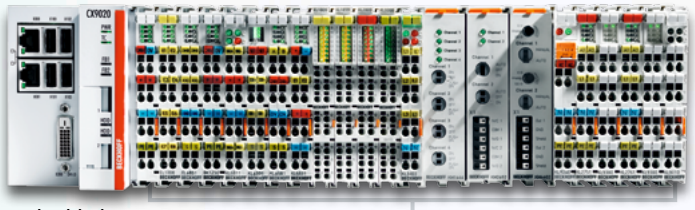
KL2284	4-channel digital output terminal 24 V DC, 2 A, reversible
	Curtains CLOSED/OPEN
KL3208-0010	8-channel analog input terminal PT1000,
	Ni1000 (RTD); NTC sensors, potentiometers
	Room temperature sensor
	Temperature setpoint
KL2641	1-channel relay output terminal 230 V AC, 16 A
	Switchable floor lamp power outlet
KL9160	Potential feed terminal 120…230 V AC, with diagnostics
KL2751	1-channel universal dimmer terminal 230 V AC
	Lighting
KL9160	Potential feed terminal 120…230 V AC, with diagnostics
KL2722	2-channel triac output terminal 230 V AC
	Shutters UP/DOWN
KL9010	End terminal



Automation of industrial buildings

More and more industrial buildings employ intelligent building automation systems, because seamless interaction of all components reduces costs both during construction and operation. The building automation system measures, controls, regulates and optimises the complex operations of the different systems depending on the building's utilisation, thus ensuring that everything works efficiently. For example, The building automation system controls the lighting in storage areas, production areas and on roadways based on need, time of day, season, and the presence of people. Heating, ventilation and air conditioning systems run only when needed as well. Using smart-grid functions, the systems can even be switched on or off depending on the power grid load.

The extensive Beckhoff Bus Terminal portfolio features I/O modules for a wide spectrum of applications and functions. Mechanical ventilation systems with automated roof vents can be controlled via the Beckhoff KL2722 Bus Terminal. The KM3702 monitors product media such as compressed air. For reading and analysing the consumption of heat, water and gas as well as power meters, the KL6781 M-Bus master terminal is available. The KL3403



Embedded PC,
Bus Terminals

HVAC

- Temperature
- Cooling
- Ventilation
- Air quality control
- Heating
- Humidity

Facade/door

- Rolling shutter gate
- Mechanical ventilation via roof vents
- Access

Lighting

- Constant light regulation
- DALI
- Occupancy sensor
- Daylight sensor

Operating and monitoring

- Remote maintenance
- Control panel
- Energy data measurement
- Pressurised air monitoring
- Timer

power monitoring terminal is used for the direct metering of electricity. Even highly sensitive clean-room applications can be controlled with high precision measurement technology from Beckhoff.

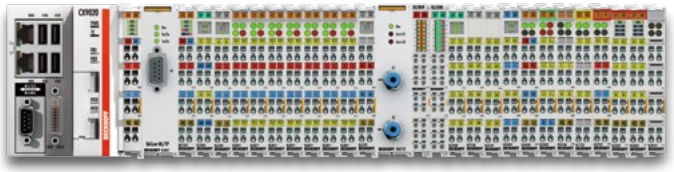
The TwinCAT 3 BA Libraries coordinate the operation of measurement, open-loop and closed-loop controllers for an optimised, energy-efficient interaction.

- Occupancy sensor
- Timer program
- Automatic lighting
- Human centric lighting
- Constant light regulation
- Slat control
- Shading correction
- Automatic temperature control
- Energy level selection
- Energy level selection with start optimisation
- Setpoint determination
- Function selection
- Temperature control (heating/cooling)
- Cascade control for air supply temperature
- Fan control
- Sequence control
- Setpoint limiter
- Air quality control
- Night cooling
- Load optimisation

Sample configuration automation of industrial buildings

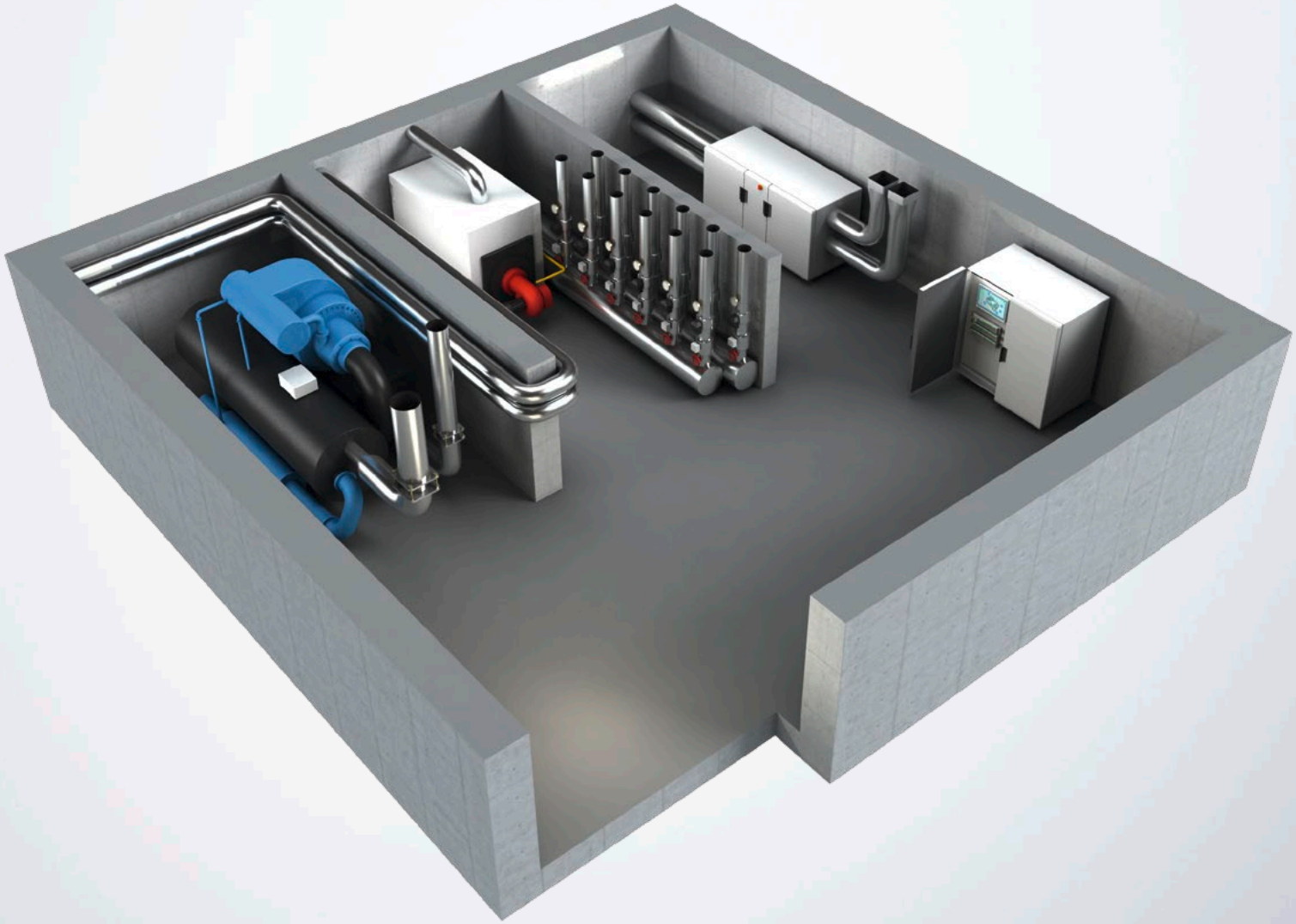
Standard automation of industrial buildings

Product	Description
CX9020-0111	TwinCAT PLC



EL6861	1-channel BACnet MS/TP interface RS485,
	D-sub connection
	connection of BACnet MS/TP field devices
BK1250	Coupler between E-bus and K-bus terminals
	conversion from E-bus to K-bus
KL1809	16-channel digital input 24 V DC
	Door contact
	Window contact
	Light switch
	Precipitation sensor
	Rolling shutter gate UP
	Rolling shutter gate DOWN
	Roof vent OPEN
	Roof vent CLOSED
KL6581	EnOcean terminal
KL6583	EnOcean transmitter and receiver
	Light switch
	Roof vent OPEN
	Roof vent CLOSED
	Room temperature sensor
KL6821	DALI/DALI 2 multi-master and power supply terminal
	Connection of DALI/DALI 2 actors and sensors
KL6781	M-Bus master terminal
	M-Bus gas meter
	M-Bus power meter
	M-Bus water meter
KM3702	2-channel absolute pressure measuring terminal
	7,500 hPa (7.5 bar)
	Pressurised air monitor
KL2809	16-channel digital output 24 V DC
	Ventilation level 1
	Ventilation level 2
	Ventilation level 3

KL3208-0010	8-channel analog input terminal PT1000,
	Ni1000 (RTD); NTC sensors, potentiometers
	Room temperature sensor
	Temperature setpoint
KL3468	8-channel analog input 0…10 V
	Air quality sensor
	Light sensor
KL9186	Potential distribution terminal 24 V DV
KL9187	Potential distribution terminal 0 V DV
KL3454	4-channel analog output terminal 4…20 mA
	Wind sensor
	Daylight sensor
	Outside temperature
KL9400	Power supply terminal to refresh K-bus, 24 V DC, 2A
KL3403	3-phase power monitoring terminal
	System power metering
KL9160	Potential feed terminal with diagnostics, 230 V AC
KL2722	2-channel triac output terminal 230 V AC
	Roof vent OPEN
	Roof vent CLOSED
KL2622	2-channel relay output terminal 230 V AC, 2 A,
	potential-free relay contacts
	Rolling shutter gate UP
	Rolling shutter gate DOWN
KL2622	2-channel relay output terminal 230 V AC, 2 A,
	potential-free relay contacts
	Ventilation ON
KL9010	End terminal



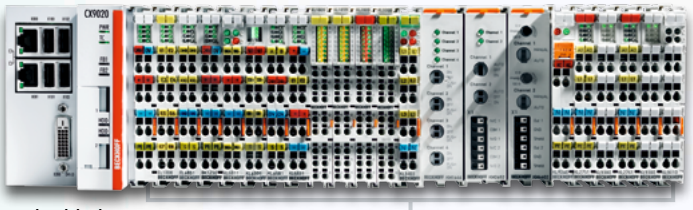
Central HVAC systems

The control of heating, ventilation and air conditioning systems is very important in building automation, both concerning the well-being of the user and the reduction of energy consumption. Alongside the standard hardware portfolio for integration of all data points, Beckhoff provides a software tool that covers the entire scope of functions of an intelligent HVAC control system. The TwinCAT PLC HVAC software library offers programmers and users the following benefits:

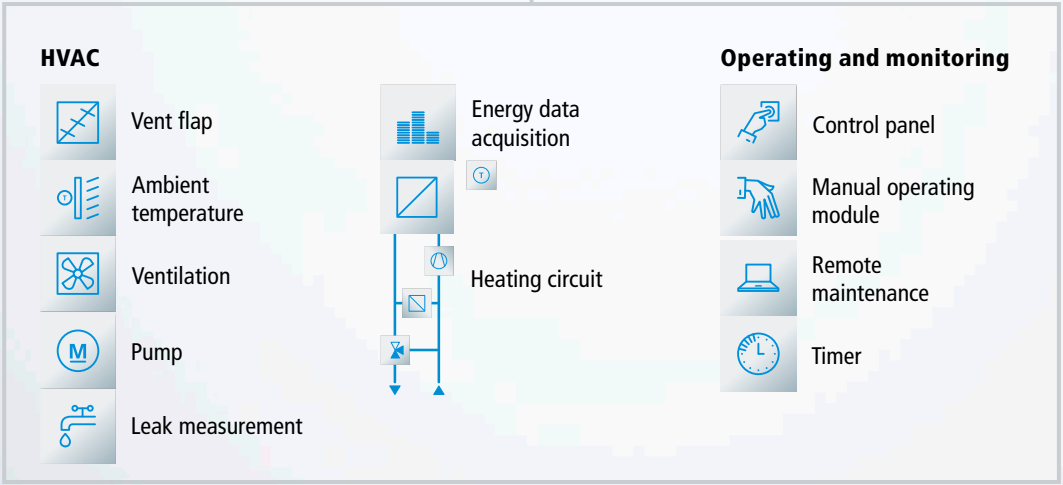
- Efficient parametrisation and commissioning,
- Consistently high level of system functionality,
- Flexible expandability of programs,
- Improved reusability of templates for systems or system modules,
- Easy training of service personnel,
- Definition of a clear object oriented program structure,
- Good documentability of programs.

The system is rounded off by KL85xx manual operating modules for integration into control cabinet doors. These allow monitoring and operation of the system without having to open electrical cabinets.

Running a HVAC-system efficiently requires a lot of measurement technology. Besides its standard portfolio of hardware and software,



Embedded PC,
Bus Terminals



Beckhoff offers as part of its TwinCAT Building Automation Library function blocks that simplify using the KL3403 Power Measurement Terminal considerably.

These function blocks provide effective and peak values for current, voltage and power. In addition, the free M-Bus library offers many options for reading data from M-Bus slaves with the KL6781 and processing it directly in the PLC. In combination with the multi-meter terminal, TwinCAT Scope 2 provides an easy-to-use tool for collecting data and analysing signals graphically.

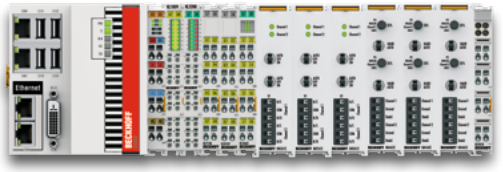
TwinCAT PLC HVAC Libraries provides users with software modules to represent actuators, analog modules, controllers, set point modules, clocks, and other functions. They allow, for example, the straightforward scaling of an analog value or the implementation of energy saving functions such as:

- Summer night cooling
- Summer compensation
- Sequence control
- Time schedulers
- Enthalpy calculation
- Pressure control
- Motor control
- Hot water production

Sample configuration central HVAC systems

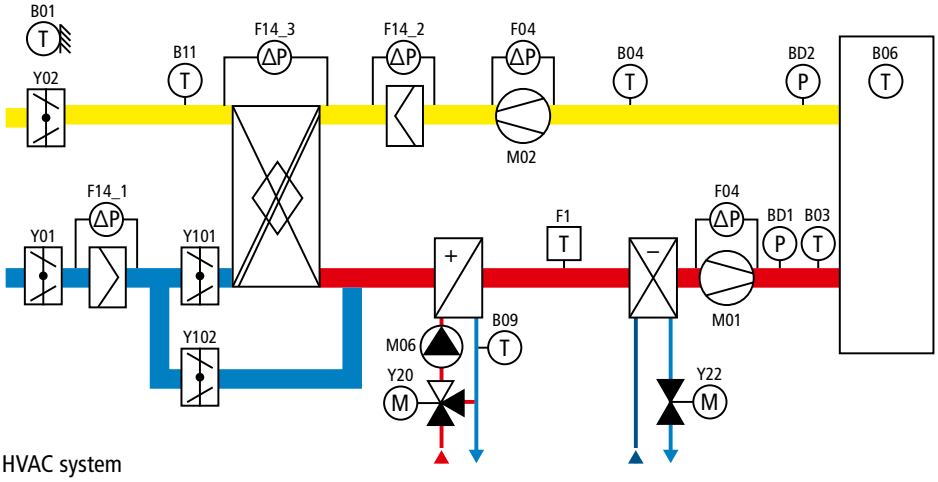
HVAC system

Product	Description
CX5010-1111	TwinCAT PLC



KL1809	16-channel digital input 24 V DC
M01_2	Supply air frequency converter fault signal
M01_3	Supply air frequency converter operating signal
M01_5	Supply air repair switch
M02_2	Exhaust air frequency converter fault signal
M02_3	Exhaust air frequency converter operating signal
M02_5	Exhaust air repair switch
M06_2	Preheating pump operating signal
M06_3	Preheating pump fault signal
Y01_2	Ambient air gate stop position OPEN
Y02_2	Exhaust air gate stop position OPEN
Y102_2	Heat recovery bypass gates stop position OPEN
F1	Antifrost thermostat
KL3208-0010	8-channel analog input terminal PT1000, Ni1000 (RTD); NTC sensors, potentiometers
B01	Ambient air temperature
B03	Supply air temperature
B04	Exhaust air temperature
B06	Room temperature
B09	Preheater return temperature
B000	Exhaust air temperature
KL9186	Potential distribution terminal 24 V DV
KL9187	Potential distribution terminal 0 V DV

KL3468	8-channel analog input 0…10 V
F03	Supply air differential pressure sensor
F04	Exhaust air differential pressure sensor
F14_1	Ambient air filter differential pressure sensor
F14_2	Exhaust air filter differential pressure sensor
F14_3	Heat recovery differential pressure sensor
BD1	Supply air pressure
BD2	Exhaust air pressure
KM2652	2-channel relay module 230 V AC, 6 A, manual/automatic operation
M01_1	Supply air frequency converter clearance
M02_1	Exhaust air frequency converter clearance
M06_1	Preheating pump clearance
Y01_1	Ambient air gate
Y02_1	Exhaust air gate
KM4602	2-channel analog output 0…10 V, manual/automatic operation
M01_4	Supply air VFD target setting
M02_4	Exhaust air VFD target setting
Y102_1	Heat recovery bypass gates
Y20	Preheater control valve
Y22	Cooling control valve
KL9010	End terminal



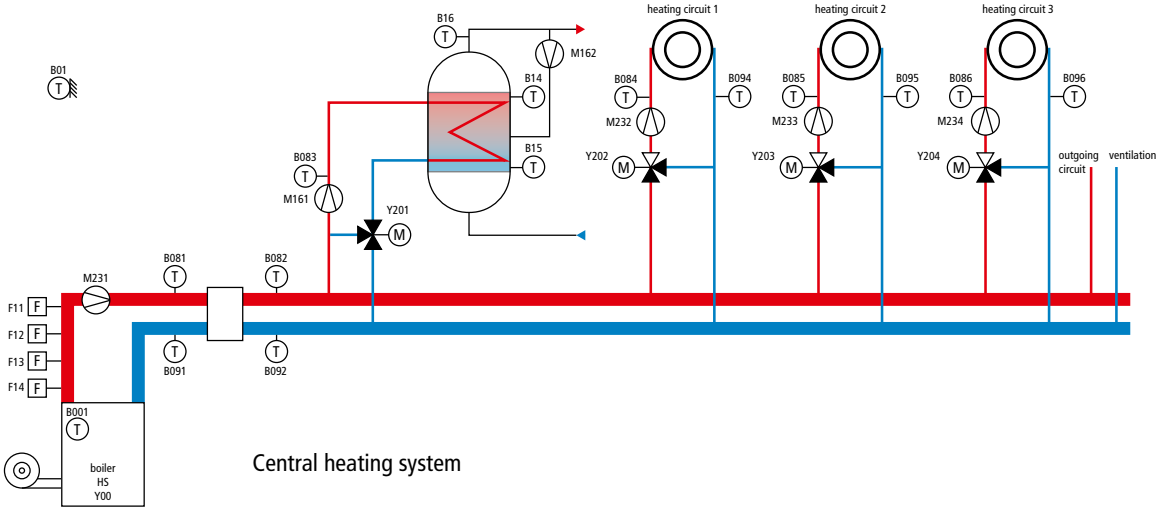
HVAC system

Central heating system

Product	Description
CX9020-0111	TwinCAT PLC

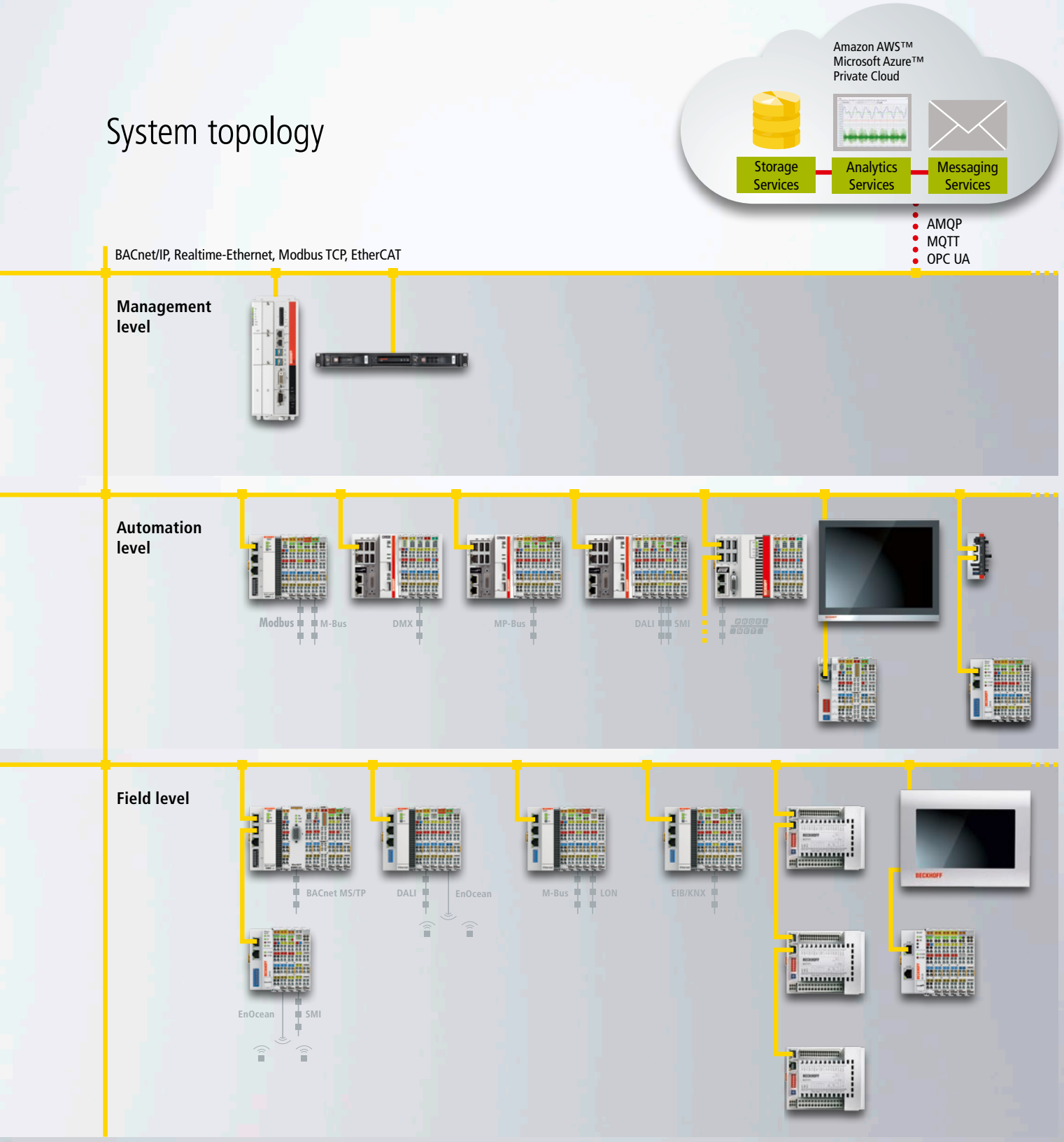
KL1809	16-channel digital input 24 V DC
F12	Maximum boiler pressure
F13	Minimum boiler pressure
F14	Boiler temperature safety limiter
M231_2	Primary pump fault
M231_3	Primary pump operation
M232_2	Heating circuit 1 pump fault
M232_3	Heating circuit 1 pump operation
M233_2	Heating circuit 2 pump fault
M233_3	Heating circuit 2 pump operation
M234_2	Heating circuit 3 pump fault
M234_3	Heating circuit 3 pump operation
M161_2	Storage charge pump fault
M161_3	Storage charge pump operation
M162_2	Circulation pump fault
M162_3	Circulation pump operation
KL6781	M-Bus master terminal
Z1	Heat meter
Z2	Service water meter
Z3	Gas meter
Z4	Power meter
KL3208-0010	8-channel analog input terminal PT1000, Ni1000 (RTD); NTC sensors, potentiometers
B001	Boiler temperature
B081	Primary hydraulic gate flow temperature
B091	Primary hydraulic gate return temperature
B082	Secondary hydraulic gate flow temperature
B092	Secondary hydraulic gate return temperature
B083	Hot water flow temperature
B094	Heating circuit 1 return temperature
B084	Heating circuit 1 flow temperature

KL3208-0010	8-channel analog input terminal PT1000, Ni1000 (RTD); NTC sensors, potentiometers
B095	Heating circuit 2 return temperature
B085	Heating circuit 2 flow temperature
B096	Heating circuit 3 return temperature
B086	Heating circuit 3 flow temperature
B14	Hot water boiler, top
B15	Hot water boiler, bottom
B16	Hot water service water temperature
B01	Ambient temperature
KM2652	2-channel relay module 230 V AC, 6 A, manual/automatic operation
Y00	Boiler clearance
HBU2	Boiler operation
M231_1	Primary pump clearance
M232_1	Heating circuit 1 pump clearance
M233_1	Heating circuit 2 pump clearance
M234_1	Heating circuit 3 pump clearance
M161_1	Storage charge pump
M162_1	Circulation pump
KM4602	2-channel analog output 0…10 V, manual/automatic operation
Y00	Boiler modulation
Y201	WWB control valve
Y202	Heating circuit 1 control valve
Y203	Heating circuit 2 control valve
Y204	Heating circuit 3 control valve
KL9010	End terminal

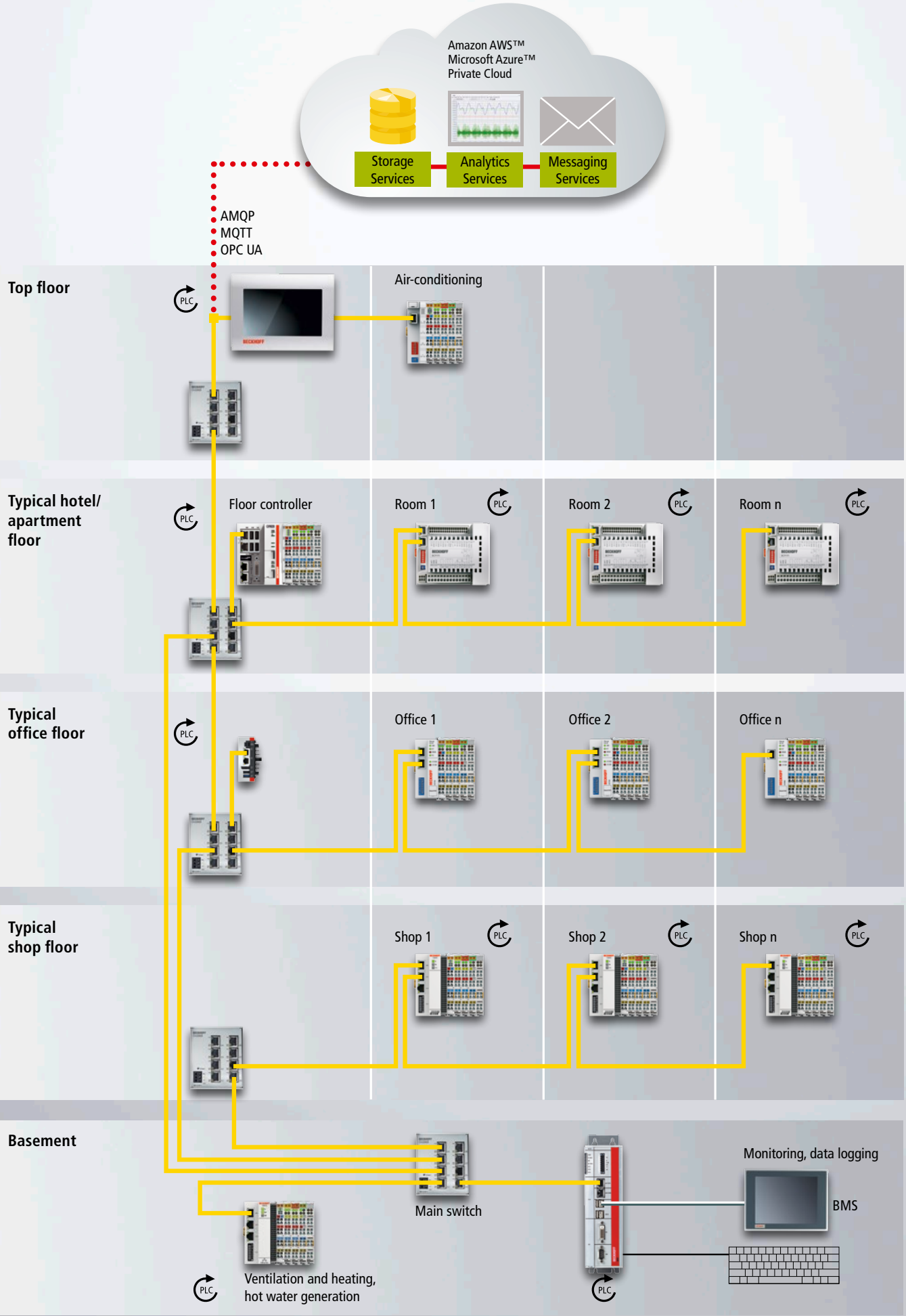


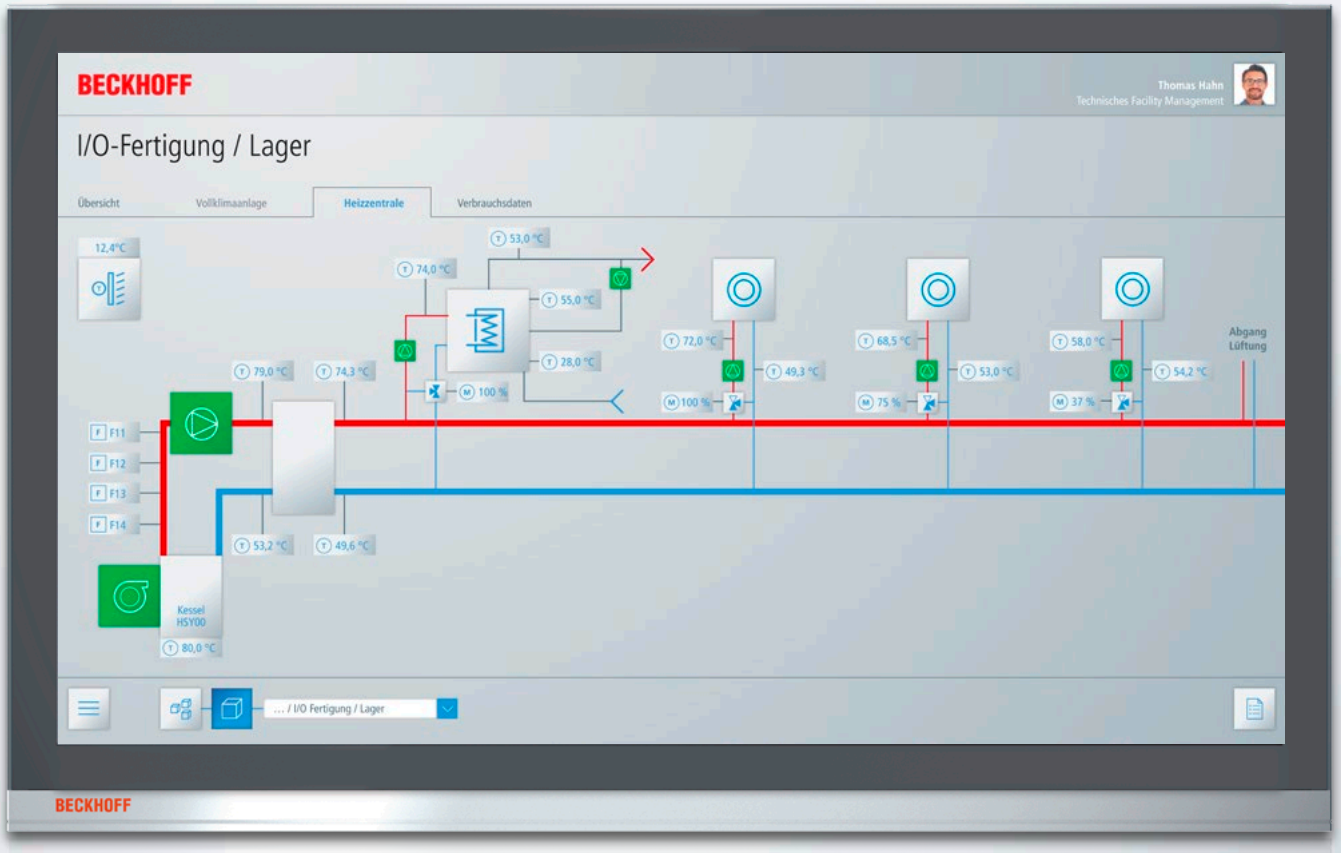
Central heating system

System topology



Depending on the way they are being used, buildings have different levels of control requirements. To meet these requirements, the range of automation components from Beckhoff includes "head stations" in various performance classes, which allow scaling of the control platform in line with the respective performance requirements. All controls are freely programmable. This gives users the option to develop a uniform control concept for the different requirements of the individual system components. And if you need to extend the system, you can simply replace the head station without having to make major changes in the application program. The use of decentralised web servers on Industrial PCs and Embedded PCs also allows easy access to different system components. Room controllers are available as compact solutions for room automation across different building systems.


Amazon AWS™
Microsoft Azure™
Private Cloud
Storage Services
Analytics Services
Messaging Services
AMQP
MQTT
OPC UA
Top floor
Air-conditioning
Typical hotel/ apartment floor
Floor controller
Room 1
Room 2
Room n
Typical office floor
Office 1
Office 2
Office n
Typical shop floor
Shop 1
Shop 2
Shop n
Basement
Main switch
Monitoring, data logging
BMS
Ventilation and heating, hot water generation
PLC

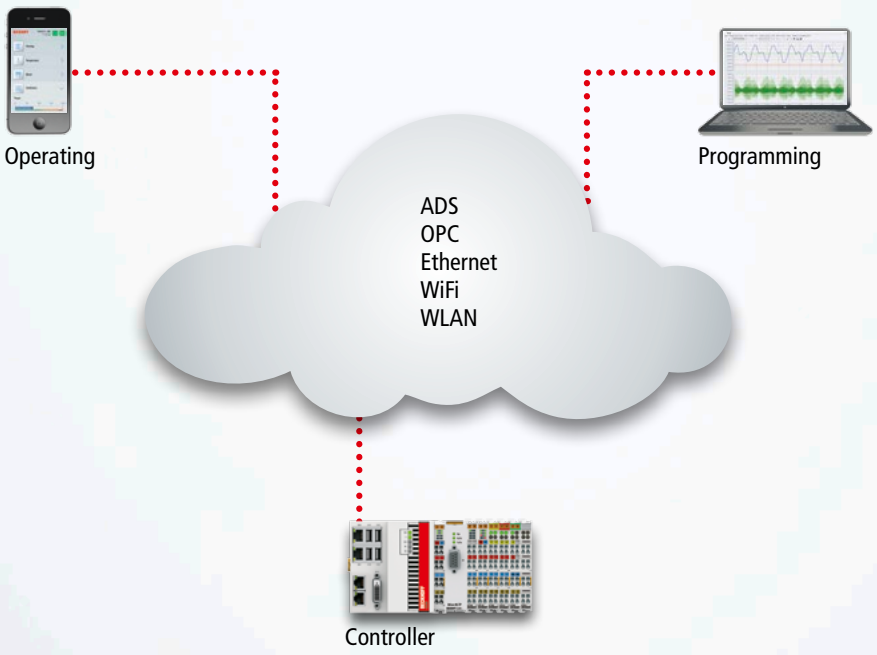


Operating and monitoring

Due to complexity, the automation of buildings and real estate requires access using remote diagnostics, remote maintenance and remote control. To avoid unnecessary costs caused by system failures, rapid support by specialists is required for error diagnosis, software maintenance, and for the import of updates.

- Networking via cable (e.g. ISDN, DSL) or using mobile radio (e.g. GSM, EDGE, UMTS)
- Availability of known Internet technologies such as FTP, HTML, SOAP, WCF, REST, WebService, through the use of PC-based automation technology
- Use of cloud services directly from the PLC, such as e.g. data logging, TwinCAT IoT, TwinCAT Analytics and other IoT-based services
- Connectivity to mobile devices, such as smartphones and tablet PCs
- Support of communication protocols BACnet/IP, OPC UA, IEC 61850 (extension of IEC 61850-7-420), IEC 60870-5-102, IEC 60870-5-103 and IEC 60870-5-104
- Use of TwinCAT Scope 2 for logging of trend data on the Scope server

Landline, DSL, mobile communications



Remote control

- Use of cloud-based services
- Sending of text messages and e-mails directly from the control unit for notification of service personnel
- Remote Desktop, Lync or Team Viewer enable operation of the entire PC controller via Internet/Intranet, including across long distances
- Operating and monitoring using HTML pages stored directly on the control unit
- Database link
- Diagnostics
- Data logging
- Online change
- Remote user access

Remote programming

- Full access to the control unit for modification of system configurations and control program by means of "online change"
- Central administration of Beckhoff CE controllers via the TwinCAT management server
- VPN router for secure access via Internet/ Intranet or mobile radio

Product data

Beckhoff offers modular automation components of finely grained I/Os, scalable controllers and modular software that enables implementation of all building automation requirements, with particular focus on energy efficiency and sustainability. In combination, they enable application-specific solutions for all building types and utilisation options.

Modular automation components from Beckhoff

For building automation applications Beckhoff offers a system consisting of software, controllers and Bus Terminals. The flexible application options of the three system components facilitate integration of the requirements for automation solutions. This section describes the core building automation components.

Scalable and open control technology

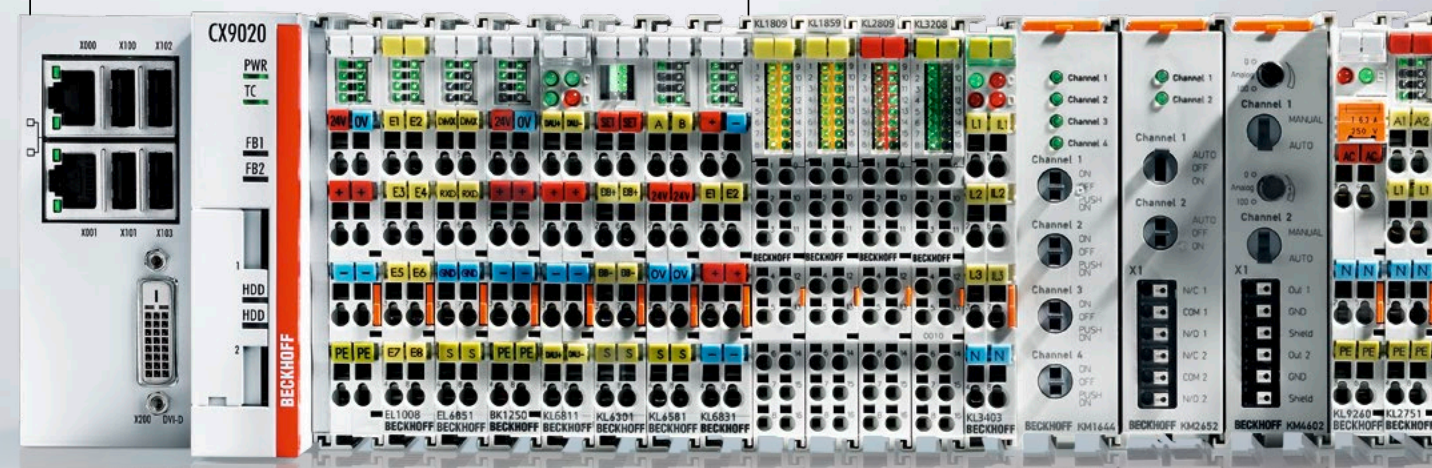
The right controller for each application
The scalable, modular control system from Beckhoff offers the right solution for any task, from the high-performance Industrial PC or Embedded PC as main building computer up to local Ethernet controllers.

Page 66

Bus Terminals – The complete I/O system

The I/O components
The Beckhoff Bus Terminal system for connection of data points features 400 different I/O terminals and supports all common sensors and actuators.

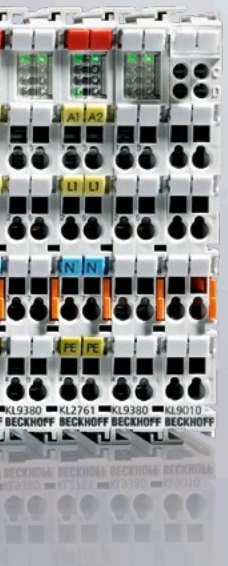
Page 72



TwinCAT 3 – The universal software platform for building automation

Maximum flexibility
PC-based control technology enables all building functions and function changes to be realised in software based on TwinCAT, which consists of a wide range of software modules and offers users maximum flexibility. The use of standard software components, which integrate all key building functions, reduces the engineering costs significantly.

Page 68



Open control architecture

AMQP
MQTT
OPC UA

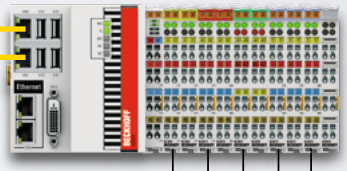
Management level

Higher-level control/server systems

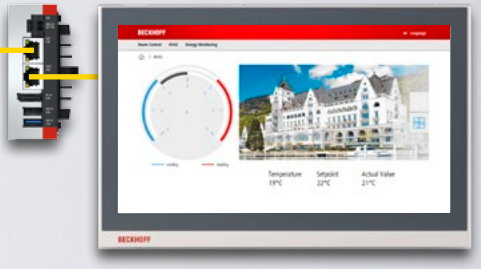
BMS

BACnet/IP, Real-time Ethernet, ADS, OPC UA, Modbus TCP, PROFINET

Automation level



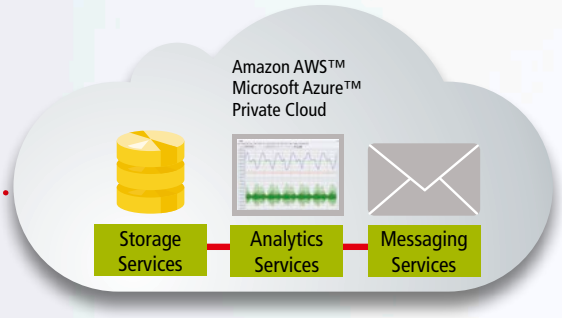
Digital Input
Digital Output
Analog Input
Analog Output
Sub-bus systems



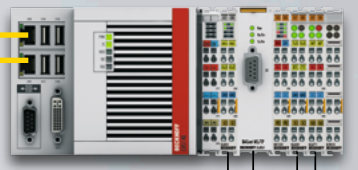
Embedded PC, Bus Terminals

Field level

Room Controller



ERP



DMX
BACnet MS/TP
Modbus RTU
MP Bus

Embedded PC, Bus Terminals

Digital I/O
Analog I/O
PROFIBUS
PROFINET
CANopen
DMX

Digital I/O
Analog I/O

Embedded PC, Bus Terminals

Panel PC

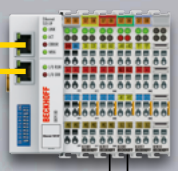
Bus Coupler,
Bus Terminals

Digital I/O
Analog I/O

Embedded PC, Bus Terminals

EnOcean
DALI
M Bus
LON
EIB/KNX

Embedded PC, Bus Terminals

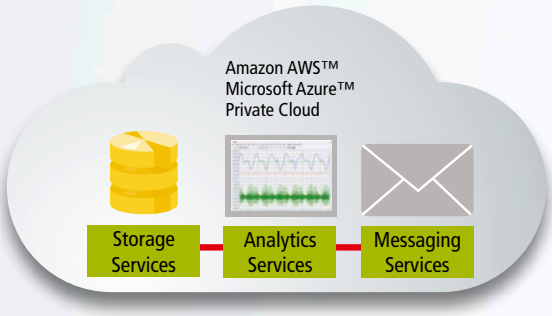


Digital I/O
Analog I/O

Bus Coupler, Bus Terminals

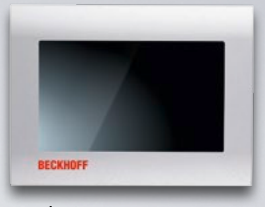
Scalable control technology

Plug and Cloud



Room automation
Zone control

System level automation
HVAC systems



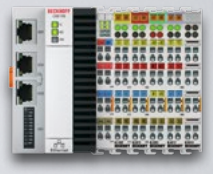
Panel PC
CP6606

Control cabinet PC
C6915

Embedded PC
CX5010/5020

Ultra compact IPC
C6015

Embedded PC CX8090, CX8091



Embedded PC CX8190

Embedded PC CX9020

EK9160

Room Controller
BC9191

PLC

Floor level automation

Multi-touch Panel PC
CP2215

Building automation

Multi-touch Panel PC
CP2224

Control cabinet PC
C6925

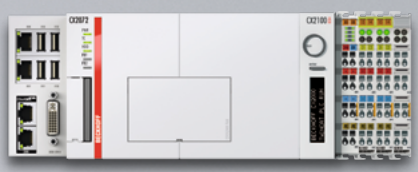
Building management system (BMS)

Control cabinet PC C5210

Control cabinet PC
C6930

Industrial PCs
Panel PCs

Embedded PC
CX5120 to CX5140



Embedded PC
CX2020 to CX2072

x86-based Embedded PCs

Embedded PC CX9020

ARM-based Embedded PCs

Scalable controller performance: from 16-bit CPU to x86 CPU with 2.1 GHz on 12 cores

TwinCAT 3 – The universal software platform for building automation

When Beckhoff introduced its PC-based control technology in 1986, the company also created a worldwide standard for automation. On the software side, the TwinCAT automation suite is at the heart of the controller. (TwinCAT stands for "the Windows control and automation technology".) TwinCAT converts nearly any PC-based system into a real-time controller with multiple PLC runtime systems. All building automation systems are programmed and parameterised with TwinCAT. The engineering environment has been designed for all popular programming standards in the IT and automation fields from IEC 61131 to C/C++. Predefined software modules simplify the engineering process, and functional enhancements or modifications are possible at any time.

High-end PLC

- Internationally-recognised IEC 61131-3 programming standard
- Reusable software modules
- Almost unlimited memory
- Unlimited number of function blocks and variables
- High-speed software solutions for controllers, etc.
- Up to four runtime systems per PC, up to four tasks per runtime system

Communication interface TwinCAT ADS

- Universal vertical and horizontal communication
- Cyclical/event-triggered
- Open protocol with documented examples for:
  - C/C++
  - .NET
  - Delphi
  - Java
  - JavaScript
  - WebService
  - WCF
- Available on Windows operating systems
- Access from the PLC via function blocks possible

TwinCAT 3 Building Automation – Efficient engineering for all building systems

To meet the strict demands on modern building automation, such as high levels of convenience, optimum energy savings and efficient building operation, a thoroughly coordinated solution is essential. The ideal scenario, in other words, is where all technical building systems are included in the planning from the outset and integrated in a single control platform.

However, integrating all of the relevant trade disciplines increases demands both on the automation system itself and on the know-how of the responsible system integrator. It requires knowledge of different communication protocols as well as expertise in operating all of the technical components of the building. Added to this, the execution times for building automation projects are becoming increasingly shorter. It is therefore all the more important to ease the workload on the executing companies in the building automation market as much as possible using appropriate tools and to provide optimum support for the engineering process. The cost aspect should also not be overlooked, however, since the costs involved in programming and commissioning the automation stations as well as the operation and management system are not insignificant. Yet the potential savings in this area are correspondingly high.

In order to simplify and accelerate the engineering process, Beckhoff developed TwinCAT Building Automation (TwinCAT BA). Extensive software libraries and supplements extend the concept of the modular range of automation components from Beckhoff to the software level.

The software suite essentially comprises three basic functions:

1. TwinCAT Engineering
2. TwinCAT BA PLC Libraries: Basic functions for all systems
3. TwinCAT BA PLC Templates: Functional templates for all systems

The TwinCAT BA PLC Libraries provide the system integrator with established and proven building blocks, such as basic functions in the areas of closed-loop control, signal processing, special mathematical functions, fault signal processing and general system functions.

The templates not only include finished applications for temperature sensors, pumps or flaps, rather also the BACnet objects that are required for operating and monitoring the systems at management level. The template portfolio extends from system automation with finished ventilation and air conditioning systems through to room automation, including room air-conditioning, solar protection and lighting.

All properties (parameters) of the BACnet objects are already predefined within the templates. The object name is derived automatically from the position of the template in the tree structure. This therefore minimises

the effort required to configure the BACnet and to parametrise all of the BACnet properties.

Tested, standardised templates ensure a high standard of quality and allow the system integrator to get to grips quickly and efficiently with the Beckhoff automation system. Comprehensive documentation of the templates supports this process of familiarisation with the system and allows subsequent maintenance and care.

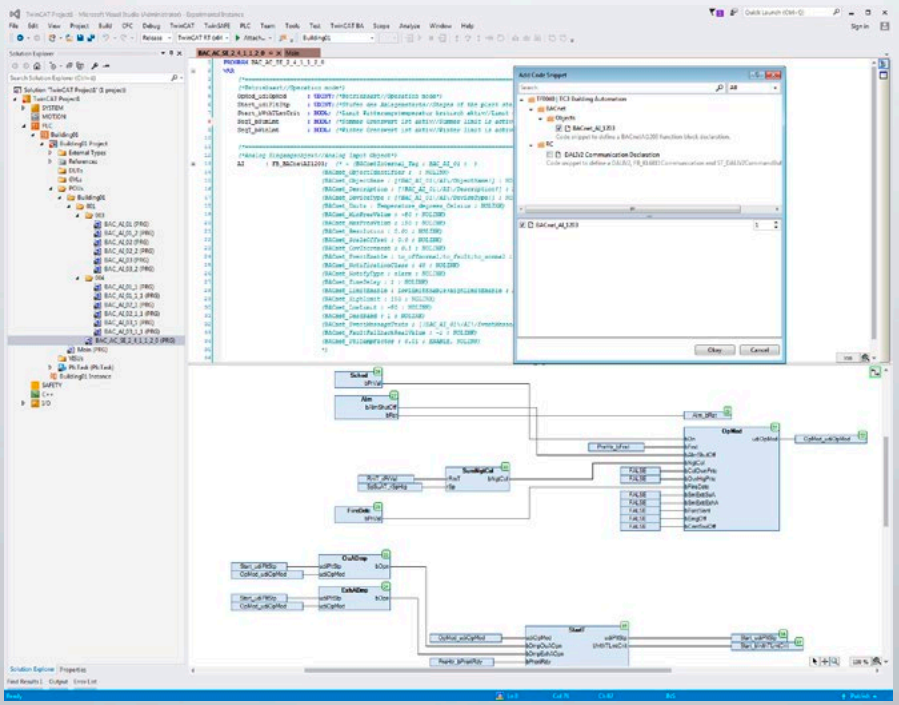
Creating applications efficiently

The TwinCAT BA PLC Templates allow system integrators to create their own templates and thus conveniently extend their systems. Customer or project-specific templates can also be created in accordance with the specific requirements of the system integrator or end customer. The templates are created within the TwinCAT standard IEC 61131 programming environment. The use of TwinCAT BA on one hand provides an efficient tool for simple standard applications in the field of building automation; on the other hand, the user still has the possibility to benefit from the openness and flexibility of free programming under IEC 61131. There are virtually no limits therefore to the use of TwinCAT BA.

Excel import

Many participants in a building automation project are involved with inputting data from the planning phase right through to approval and documentation: from the creation of building automation function lists, control logic diagrams, circuit diagrams as well as various other lists, ensuring that this data is consistent across all documents and updated throughout the documentation is often an enormous task. What generally happens is that the same data is input and updated multiple times. This effort can be reduced considerably with TwinCAT BA. Beckhoff offers an Excel import interface for this purpose that allows the data to be transferred from instrumentation and control planning tools or CAD software.

All in all, TwinCAT BA therefore offers excellent conditions for implementing cost-efficient programming and parametrisation of Beckhoff Industrial PCs for building automation.



Based on the component identification system in TwinCAT BA, a tree structure is generated in the PLC Explorer that depicts the building topology.

TwinCAT connectivity – Universal communication from the management level to the field level

Having a standards-based communication structure is the key to efficient building automation. Beckhoff provides this kind of control as a complete solution with optimally coordinated software and hardware components.

BACnet/IP
The international BACnet standard, which ensures that building automation devices from different manufacturers can communicate with each other, is steadily gaining in importance with new features being added all the time. As a universal Ethernet protocol, BACnet/IP can be used on all Beckhoff PC-based hardware platforms – through to the field level.

The BACnet controllers certified according to the BACnet ISO 16484-5 standard as well as the AMEV BACnet2011 guidelines with the AS-B application profile (extended BACnet functionality) offer a control platform with precisely scalable performance: from the CX8091 Embedded PC, which supports up to 250 BACnet objects, through to the CX5020, using which the data from several thousand BACnet objects can be collected and processed.

Through the integration of the BACnet protocol in the TwinCAT System Manager, the I/O Bus Terminals and the BACnet devices can be configured efficiently with a tool using the automapping function. Another convenient feature is the dynamic generation of BACnet objects, which among other things allows schedulers and trend objects to be created and configured.

The advanced alarm and event services, additional object types, improved device management features and increased execution performance of BACnet Rev. 12 are also implemented in TwinCAT BACnet/IP and enhance the user benefits. Since the Beckhoff solution was developed completely in-house, users can be confident that the company has plenty of expertise in the field.

OPC Unified Architecture (UA)
OPC UA is gaining acceptance at all levels of the automation pyramid. Its scalability ranges from small 15 kB footprint applications in embedded sensors to communication with ERP level and SAP systems right up into the cloud. OPC UA has its origin in automation technology, but its industry-neutral design makes it increasingly popular as a universal communication platform in building automation and smart metering applications. OPC UA enables platform independence from operating systems and languages as well as scalability from the sensor to the ERP/cloud level. Security-by-design provides security concepts with user authentication, message signing and encryption of transmitted data already integrated in the OPC UA stack.

Its specification of information models makes OPC UA particularly interesting for other organisations, who can organise their existing objects in the UA name space and define "What is being communicated", while OPC UA manages transport security and access rights by asking "How is it being communicated?".

Transparency via ADS, continuous routing via:
- UDP/TCP/serial/Bluetooth/fieldbus/EtherCAT/SOAP (HTTP)

TwinCAT network variables:
- publisher/subscriber variables via broadcast, multicast or unicast

Functions for Building Automation:
- TF8000 | TC3 BA Connectivity Library
- TF8040 | TC3 Building Automation
- TF8020 | TC3 BACnet/IP

Connectivity Functions:
- TF6000 | TC3 ADS Communication Library
- TF6100 | TC3 OPC UA
- TF6255 | TC3 Modbus RTU
- TF6340 | TC3 Serial Communication
- TF6310 | TC3 TCP/IP
- TF6350 | TC3 SMS/SMTP
- TF6420 | TC3 Database Server
- TF6421 | TC3 XML Server
- TF6500 | TC3 IEC 60870-5-10x
- TF6510 | TC3 IEC 61850/400-25

System Functions:
- TF1800 | TC3 PLC HMI
- TF1810 | TC3 PLC HMI Web

Cloud connectivity:
- TF6701 | TC3 IoT Communication (MQTT)
- TF6710 | TC3 IoT Functions
- TF6720 | TC3 IoT Data Agent
- TF6730 | TC3 IoT Communicator

Data analysis:
- TE3500 | TC3 Analytics Workbench
- TF3500 | TC3 Analytics Logger
- TF3510 | TC3 Analytics Library

Bus Terminals – The complete I/O system

BACnet IP, OPC UA, ADS, Real-time Ethernet, Modbus TCP, EtherCAT, Profinet, MQTT, AMQP

Bus Coupler series BK, the link between Bus Terminals and fieldbus

Bus Terminal Controller series BC with integrated IEC 61131-3 PLC

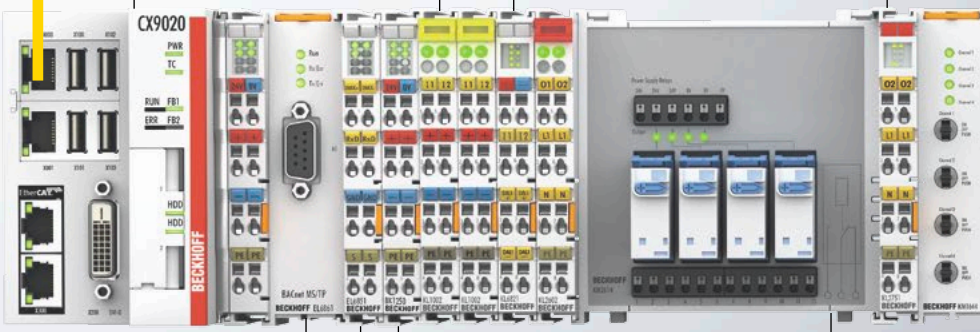
Embedded PC series CX with integrated IEC 61131-3 PLC and extended interfaces

Head station of the Bus Terminals: Bus Couplers, Bus Terminal Controllers or Embedded PCs

Free mix of signals: about 400 different Bus Terminals for connection to all common sensors and actuators

Universal dimmer terminal with automatic load detection for control of brightness values independent of the fieldbus

DALI/DALI 2 multi-master and power supply terminal



BACnet MS/TP

BK1250 "Compact" Coupler between E-bus and K-bus terminals

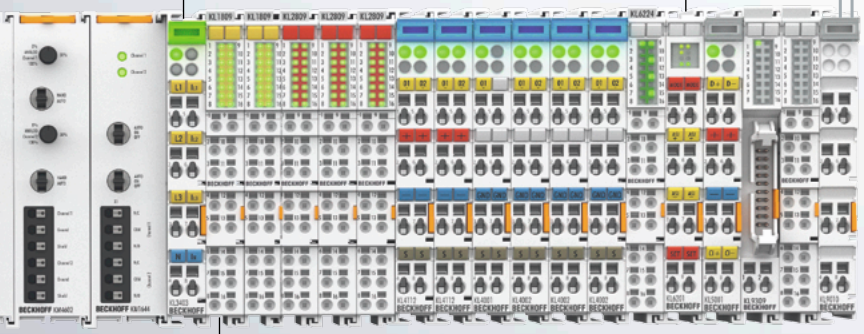
DMX master or slave terminal for integration of lighting, movable light elements or mixing consoles via EtherCAT

More efficient manual/emergency operation using Bus Terminals: switch or potentiometer in Bus Terminal format for process data change independent of the controller

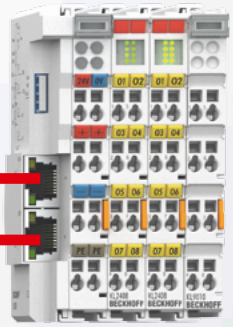
Bus end terminal

3-phase power measurement terminal for the measurement of all relevant electrical data of the supply network

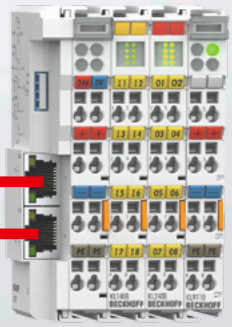
Communication terminals for the integration of subsystems such as EIB/KNX, MP-Bus, M-Bus, LON, DALI, SMI, EnOcean, RS232/RS485, Modbus and BACnet MS/TP.



K-bus



Terminal bus extension for the connection of up to 255 (instead of 64) Bus Terminals to a station.



Bus Terminals in 1-, 2-, 4-, 8- and 16-channel modularity with mixing of any signal type; HD (High-Density) Bus Terminals with 16 connection points in a 12 mm housing for reducing space requirements and costs

Manual operating modules enable switching, controlling and monitoring of digital and analog signals as well as setting and reading of data and values in the event of a controller failure.

Extract from the Beckhoff Bus Terminal I/O system

Digital input

Product	Description
KL1012	2-channel digital input 24 V DC
KL1362	2-channel digital input for break-in alarm
KL1404	4-channel digital input 24 V DC
KL1408	8-channel digital input 24 V DC
KL1501	Up/down counter 24 V DC, 100 kHz
KL1702	2-channel digital input terminal 120/230 V AC
KL1704	4-channel digital input terminal 120/230 V AC
KL1722	2-channel digital input terminal 120/230 V AC
KL1804	HD Bus Terminal, 4-channel digital input 24 V DC, 3-wire connection
KL1808	HD Bus Terminal, 8-channel digital input 24 V DC, 2-wire connection
KL1809	HD Bus Terminal, 16-channel digital input 24 V DC
KL1859	HD Bus Terminal, 8-channel digital input + 8-channel digital-output 24 V DC
KL1862	16-channel digital input 24 V DC, type 3, flat-ribbon cable connection
KM1644	4-channel manual operation

Digital output

Product	Description
KL2012	2-channel digital output 24 V DC
KL2284	4-channel digital output 24 V DC, 2 A, reverse switching
KL2404	4-channel digital output 24 V DC
KL2408	8-channel digital output 24 V DC
KL2512	2-channel pulse width output 24 V DC, 1.5 A
KL2602	2-channel relay output
KL2602-0010	2-channel relay output terminal 230 V AC, 5 A, make contacts, contact-protecting switching of LED lamps
KL2622	2-channel relay output
KL2641	1-channel relay output 230 V AC, 16 A, bistable, manual operation
KL2701	1-channel solid state load relay up to 230 V AC/DC, 3 A
KL2722	2-channel triac output 12…230 V AC
KL2732	2-channel triac output 12…230 V AC, without power contacts
KL2751	1-channel dimmer terminal 230 VAC, 300 VA (W)
KL2761	1-channel universal dimmer terminal 230 V AC, 600 VA (W)
KL2808	HD Bus Terminal, 8-channel digital output 24 V DC
KL2809	HD Bus Terminal, 16-channel digital output 24 V DC
KL2872	16-channel digital output 24 V DC, flat-ribbon cable connection
KM2614	4-channel relay module 230 V AC, 16 A
KM2652	2-channel relay module 230 V AC, 6 A, manual/automatic operation

Analog input

Product	Description
KL3061	1-channel analog input 0…10 V
KL3062	2-channel analog input 0…10 V
KL3064	4-channel analog input 0…10 V
KL3112	2-channel analog input 0…20 mA
KL3202	2-channel input PT100 (RTD)
KL3204	4-channel input PT100 (RTD)
KL3208-0010	HD 8-channel analog input terminal PT1000, Ni1000 (RTD); NTC sensors, potentiometers
KL3403	3-phase power measurement terminal
KL3444	4-channel analog input 0…20 mA
KL3458	8-channel analog input 4…20 mA
KL3468	8-channel analog input 0…10 V
KL3681	Digital multimeter terminal
KM3701	1-channel differential pressure measuring terminal -100…+100 hPa
KM3702	2-channel absolute pressure measuring terminal 7,500 hPa (7.5 bar)
KM3712	2-channel absolute pressure measuring terminal -1,000…+1,000 hPa (-1…+1 bar)

Analog output

Product	Description
KL4001	1-channel analog output 0…10 V
KL4002	2-channel analog output 0…10 V
KL4011	1-channel analog output 0…20 mA
KL4012	2-channel analog output 0…20 mA
KL4404	4-channel analog output 0…10 V
KL4408	8-channel analog output 0…10 V
KL4414	4-channel analog output 0…20 mA
KL4418	8-channel analog output 0…20 mA
KM4602	2-channel analog output 0…10 V, manual/automatic operation

Communication

Product	Description
KL6021-0023	Serial interface for processing signals from the KL6023 wireless adapter with EnOcean radio technology
KL6023	Wireless adapter for EnOcean radio technology
KL6031	Serial interface RS232
KL6041	Serial interface RS422/RS485
KL6301	EIB/KNX Bus Terminal
KL6401	LON Bus Terminal
KL6581	EnOcean master terminal
KL6583	EnOcean transmitter and receiver for the KL6581
KL6771	MP-Bus master terminal
KL6781	M-Bus master terminal
KL6811	DALI/DSI master and power supply terminal
KL6821	DALI/DALI 2 multi-master and power supply terminal
KL6831	SMI master terminal, LoVo
KL6841	SMI master terminal 230 V AC
BK1250	"Compact" coupler between E-bus and K-bus Terminals
EL6851	DMX master terminal
EL6851-0010	DMX slave terminal
EL6861	BACnet MS/TP RS485

Safety

Product	Description
KL1904	4-channel digital input, TwinSAFE, 24 V DC
KL2904	4-channel digital output, TwinSAFE, 24 V DC
KL6904	TwinSAFE Logic Bus Terminal

Manual operating modules

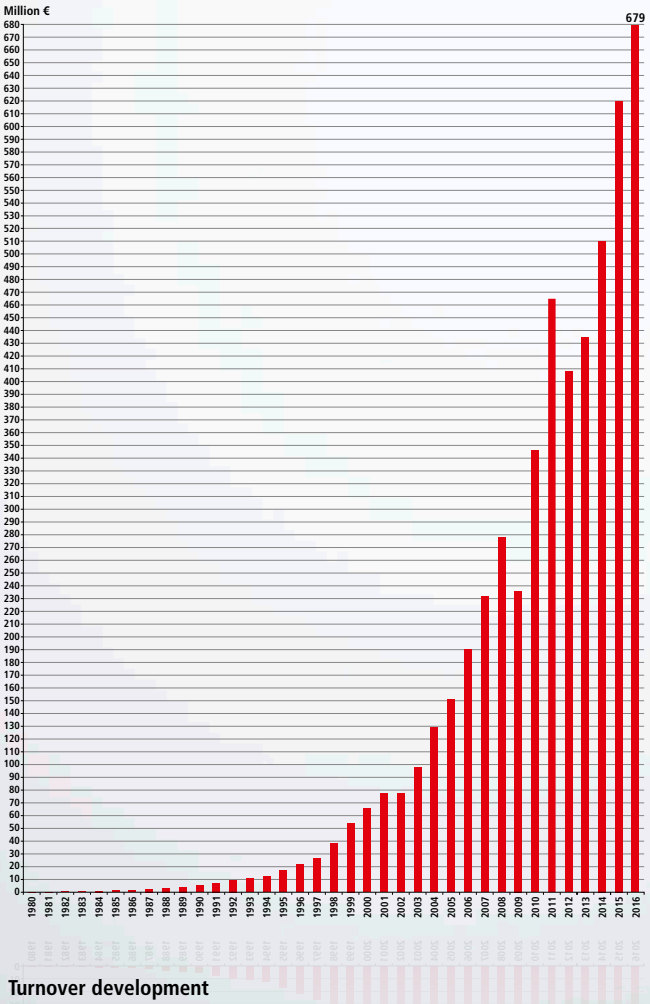
Product	Description
KL8500	Placeholder module
KL8519	16-channel digital input signal module
KL8524	4 x 2-channel digital output module
KL8528	8-channel digital output module
KL8548	8-channel analog output module 0…10 V

System terminals

Product	Description
KL9010	End terminal
KL9160	Potential supply terminal, 120…230 V AC, with diagnostics
KL9184	HD Bus Terminal, 16-channel potential distribution
KL9186	Potential distribution terminal, 8 x 24 V DC
KL9187	Potential distribution terminal, 8 x 0 V DC
KL9210	Potential supply terminal, 24 V DC, with diagnostics and fuse
KL9260	Potential supply terminal, 120…230 V AC, with diagnostics and fuse
KL9309	Adapter terminal for manual operating modules
KL9380	Potential distribution, 2 x 230 V AC, 2 x 0 V, 2 x PE, with X2 suppressor capacitor
KL9400	Power supply unit terminal for K-bus refresh

For our complete Bus Terminal portfolio please refer to

▶ **www.beckhoff.com/BusTerminal**



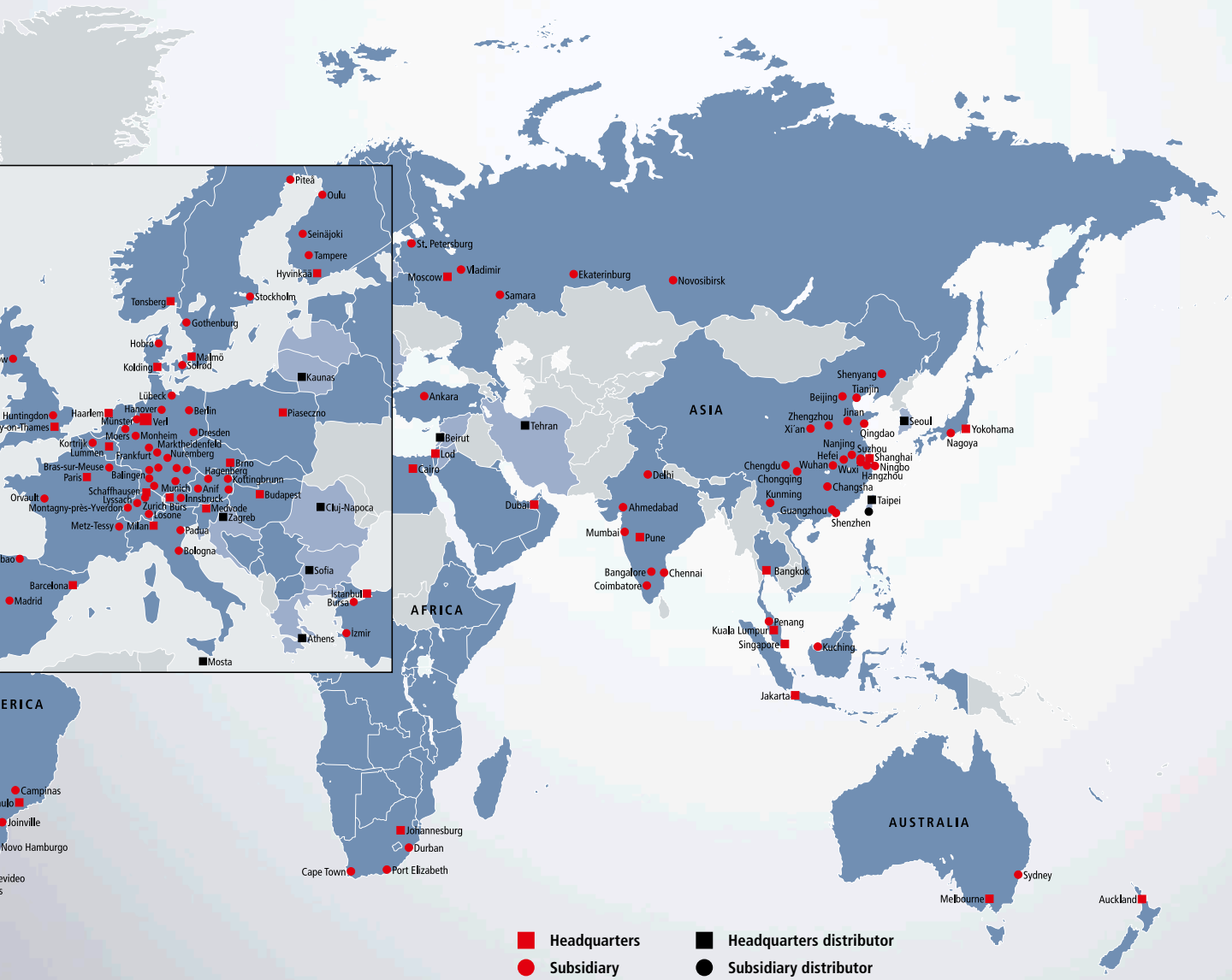
Turnover development

Beckhoff. Worldwide specialist for New Automation Technology

Beckhoff implements open automation systems based on PC Control technology. The product range covers Industrial PCs, I/O and Fieldbus Components, Drive Technology and automation software. Products that can be used as separate components or integrated into a complete and seamless control system are available for all industries.

The Beckhoff "New Automation Technology" philosophy represents universal and open control and automation solutions that are used worldwide in a wide variety of different applications, ranging from CNC-controlled machine tools to intelligent building automation.

▶ **www.beckhoff.com**

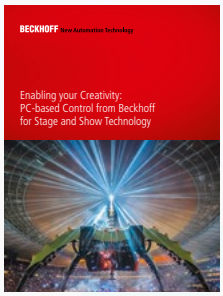


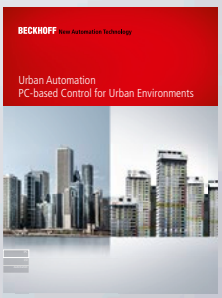
Worldwide presence on all continents
The worldwide presence of Beckhoff in more than 75 countries ensures fast service and support for globally operating customers in their local language. Moreover, geographical proximity helps us develop an in-depth understanding of the technical challenges our customers are faced with around the world.

- Headquarters: Verl, Germany
- Sales 2016: 679 Mio. € (+9.5 %)
- Staff worldwide: over 3,850
- Sales/Technical Offices Germany: 20
- Subsidiaries/Branch Offices worldwide: 34
- Distributors worldwide:
  in more than 75 countries

(as of 11/2017)

All in-depth information at a glance





Print media online
The Beckhoff catalogs and flyers are available for download on the Internet. Printed copies are available on request. Please use our online order form to specify your requirements.

▶ **www.beckhoff.com/media**

General information

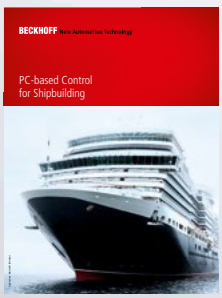
- Website
- Main Catalog: Volume 1 and 2
- Product Overview
- News Catalog

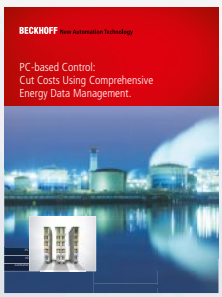
Specific information

- PC-based Control for
  - Integrated Building Automation
  - Media technology
  - Stage and Show
- Building Automation for
  - System Integrators
  - Specialist Engineers
  - Architects
  - Operators
  - Investors

Additional information

- PC-based Control for
  - Urban Environments
  - Wind 4.0
  - Shipbuilding
  - Energy Data Management





Company magazine

- PC Control Magazine
- Stage Technology Compendium
- Building Automation Compendium

DK3502-0218

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