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Building automation and control systems (BACS) —

Part 2: Hardware

Systèmes d'automatisation et de contrôle des bâtiments (BACS) —

Partie 2: Matériel

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 205, *Building environment design*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 247, *Building Automation, Controls and Building Management,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 16484-2:2004), which has been technically revised.

The main changes are as follows:

— overall structure of document has been updated;

— Clause 1, Clause 2 and Clause 3 have been revised;

— technical content throughout the document has been modified and updated.

A list of all parts in the ISO 16484 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Building automation and control systems (BACS) —

Part 2:
Hardware

1 Scope

This document specifies the hardware requirements needed to carry out building automation tasks.

This document is applicable to physical devices, i.e.:

— devices that require human interaction, such as management stations or operator panels;

— devices for data storage and analysis, such as edge or cloud servers;

— devices for control applications, such as automation stations;

— devices for physical quantities acquisition, such as sensors and actuators.

This document provides a generic system topology based on a building network infrastructure, which includes both the devices inside the building envelope and those outside the building envelope.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60529, *Degrees of protection provided by enclosures (IP code)*

IEC/TR 62443-3-1, *Industrial communication networks — Network and system security — Part 3-1: Security technologies for industrial automation and control systems*

IEC 62443-3-3, *Industrial communication networks — Network and system security — Part 3-3: System security requirements and security levels*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
access control system
dedicated security system, that includes the automatic checking of access rights under organizational measures, barrier and door control for buildings and rooms, and registration of events

3.2
alarm
warning given by the system either:

a) indicating the presence of a hazard to property, the environment, or to life

b) a condition detected by a device or controller regarded as abnormal, that implements a rule or logic specifically designed to look for that condition, e.g. "frost alarm"

Note 1 to entry: An alarm can be an annunciation that is either audible, visual or both that alerts an operator to an abnormal condition, which can require corrective action.

3.3
analogue input
part of the hardware pertaining to a control device for measuring

3.4
analogue output
part of the hardware pertaining to a control device for positioning

3.5
application
set of user information processing requirements or functions that together form a logical unit supporting a process

Note 1 to entry: A building automation and control system can support many different applications.

3.6
binary input
hardware pertaining to control devices for state processing

Note 1 to entry: The function is also referred to as binary input state.

3.7
binary output
hardware pertaining to control devices for switching

Note 1 to entry: The function is also referred to as output switching.

3.8
building
large volume separate fixed structures, i.e. commercial or residential premises, however excluding industrial structures

Note 1 to entry: Building automation and control system can also be employed for other structures, such as houses, tunnels, railways, and ships.

3.9
building automation and control system
system, comprising all products, software and engineering services for automatic controls (including interlocks), monitoring, optimization, operation, human intervention, and management to achieve energy-efficient, economical, and safe operation of building services

Note 1 to entry: The trade designation and the industry branch are also referred to as either building automation or building control, or both.

[SOURCE: ISO 52120-1:2021, 3.2, modified — Note 1 has been added.]

Note 2 to entry: Building automation and control system (BACS) is also referred to as building management system (BMS), of which building energy management is part.

Note 3 to entry: The use of the word "control" does not imply that either the system or the device or both are restricted to control functions. Processing of data and information is also possible.

Note 4 to entry: If a building automation and control system, or building energy management system, conforms to the requirements of the ISO 16484 series, it may be designated as a BACS.

Note 5 to entry: Building services are divided into technical, infrastructural and financial building services and energy management is part of technical building management.

3.10
building management
totality of services involved in the management, operation and monitoring of buildings (including plants and installations)

Note 1 to entry: Building management is divided into technical building management, infrastructural building management and commercial building management and has interfaces to area and facility management.

[SOURCE: ISO 52120-1:2021, 3.4, modified — Note 1 has been added.]

3.11
building network infrastructure
communication infrastructure next to the traditional electrical and sanitary installations in modern buildings

Note 1 to entry: The network is optimally set up for the needs of the building and its use and ensures that cyber security needs are met, taking IEC 62443 series into consideration.

3.12
building services
utilities and installations supplied and distributed within a building, such as electricity, gas, heating, water, waste, and communications

3.13
cabling
system of cables and connecting hardware that supports the wired connection of the building automation and control system and other equipment

3.14
cloud
servers located in data centres all over the world that are accessed over the internet, as well as the software and databases that run on those servers

Note 1 to entry: By using cloud computing, users and companies do not need to manage physical servers themselves or run software applications on their own machines.

3.15
communication
act of conveying meaning from one entity or group to another through the use of mutually understood signs, symbols, and semiotic rules

3.16
communication interface
physical and electrical requirements for the connection of components of communicating products

3.17
configuration
site-specific information related to physical and functional units, entered during system engineering resulting in the system configuration

Note 1 to entry: Generally, the configuration does not change once the system is functioning.

3.18
controller
automation station
device for either regulation or logic control, or both, as well as the monitoring and processing of information such as temperature, humidity and pressure

Note 1 to entry: The use of the words "automation" and "control" does not imply that the device or system is restricted to control functions only. Monitoring and processing of other information is possible.

Note 2 to entry: In IT, a device that controls the transfer of data between a computer and a peripheral device is also referred to as a controller.

3.19
counter input
hardware pertaining to a control device for pulse counting

3.20
data
representation of information in a formalized manner suitable for human or automatic processing

Note 1 to entry: Processing includes communication and interpretation.

3.21
data interface unit
functional or physical unit for communication between the devices of a BACS, as well as devices and systems in other networks

Note 1 to entry: Different types of DIUs can exist, such as routers or gateways.

Note 2 to entry: A DIU may be used to conform to the relevant national standards if connected via public data networks.

3.22
data-point
input and output function consisting of all assigned information describing the point's meaning entirely

Note 1 to entry: There are physical and virtual data-points. A physical data-point is related to a direct or remotely connected input/output device. A virtual data-point can be derived from the result of a processing function, or is related to another device as a shared data-point.

Note 2 to entry: Historically, the term "data-point" described only a physical value or state.

Note 3 to entry: A collection of virtual data-points is usually identified as the digital twin of the controller owning the physical data-point counterparts.

3.23
data security
framework conditions to protect data from direct or indirect manipulation or unauthorized use

Note 1 to entry: Data manipulation includes loss of data, destruction or falsification of data.

Note 2 to entry: Data security means are the measures and equipment to secure and maintain the safety of data.

3.24
device
physical product designed and implemented to perform specified or programmable functions, in operational, electrotechnology equipment

Note 1 to entry: For the purposes of this document, a device forms a self-contained physical unit.

3.25
digital twin
virtual representation of real-world entities and processes, synchronized at a specified frequency and fidelity

3.26
electromagnetic compatibility
ability of equipment or a system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

[SOURCE: IEC 60050-161:2018]

3.27
edge device
piece of hardware that controls data flow at the boundary between two networks, fulfilling a variety of roles depending on what type of device they are, but essentially serving as network entries or exit points

Note 1 to entry: Some common functions of edge devices include the transmission, routing, processing, monitoring, filtering, translation and storage of the data passing between networks.

Note 2 to entry: There can be multiple edge devices in a building automation network devoted to different purposes, such as for different portions of the network or for different application requirements.

3.28
engineering
project and system-specific services for the system planning process, configuration, and commissioning of the various parts of a building automation and control system

Note 1 to entry: The services that can be performed as part of engineering include configuration of the physical and logical connections and relationships between all items of a system to achieve the required application.

3.29
facility management
services performed before, during, and after the use of real estate and infrastructure that are based on a holistic (integral) strategy

3.30
historical data
data that is recorded on a storage medium for an undefined time

Note 1 to entry: The data logging performed by storing historical data is referred to as a "historical database function".

3.31
input/output
function that includes either the processing of a signal from a sensor or a signal for an actuator of the system to be controlled

Note 1 to entry: The I/O also provides system users with the specific status and value information for a data-point.

3.32
information
knowledge concerning objects, facts, events, things, processes, or ideas (including concepts), which, within a certain context, has a particular meaning

3.33
interface
functional or physical unit as a defined interconnection between a device or system to another device or system, or to a person

3.34
logbook
record book or its electronic equivalent, where all relevant details of an operation, a system, its performance, and its maintenance can be entered in a secure manner for subsequent retrieval

Note 1 to entry: A logbook can consist of one or more record books.

Note 2 to entry: A logbook can be kept in a centralized or distributed manner.

3.35
maintenance
combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in or restore it to a state in which it can perform the required function

3.36
monitoring
activity of the system, intended to observe the actual state of an item, identify a defined deviation from the normal state, and transmit a message about the observed state

3.37
operating system
software to control program operation and to provide services for resource allocation, task scheduling, input/output control, and data management

3.38
room control unit
interface enabling users to interact with the building automation system in order to influence room conditions

Note 1 to entry: Room control units can either be permanently installed on the wall of a room or they can be available as an application on a room user's mobile device.

3.39
cyber security
security
protection of networks, devices, programs and data from attacks, damage and unauthorized access

3.40
sensor
device designed to detect or measure a variable

3.41
topology
way in which the links and nodes of a network are arranged so that they relate to each other

Note 1 to entry: Topologies are categorized as either a physical network topology, which is the physical medium of signalling, or a logical network topology, which refers to the way in which data is transferred between devices regardless of the physical connection of the devices through the network.

4 Abbreviated terms

Abbreviated term	Description
AI	analogue input
AO	analogue output
BACS	building automaton control systems
BI	binary input
BO	binary output
CI	counter input
DIU	data interface unit
EMC	electromagnetic compatibility
GUI	graphical user interface
I/O	input/output
HMI	human-machine interface

5 BACS features catalogue

5.1 BACS components

5.1.1 Hardware components

A building automation system can consist of the following hardware:

— sensors and actuators;

— automation control devices;

— cabling and wireless access points;

— either dedicated management stations or computing devices or both;

— edge devices and connections to the cloud.

NOTE Power and communication cabling requirements are not part of this document.

Each BACS can be designed, in an individual way, by combining:

— standard computer hardware (data processing devices);

— manufacturer specific hardware;

— standard software (e.g. operating system, database management system);

— manufacturer specific application software (e.g. programs and engineering tools);

— project specific application software (e.g. functions that have been engineered);

— cloud resources.

If a building network infrastructure is missing or the BACS needs to be operated in a separate network, the following additional hardware can be needed:

— standard data communications hardware;

— network infrastructure.

5.1.2 System configuration

Functionality shall be specified before the project-specific hardware components of a building automation system are determined. There can be several ways to achieve the required functionality.

The building automation-related functions performed by software and engineering are specified in ISO 16484-3, which also includes a method for determining the required functionality of the system hardware.

5.1.3 Basic hardware performance criteria

For all components of building automation systems, the following mechanical, electrical and environmental performance criteria shall be specified depending on the requirements of the project:

a) power consumption;

b) mains voltage;

c) heat dissipation;

d) acoustic noise emission;

e) environmental conditions, such as temperature, relative humidity, pressure and dust;

f) data throughput, bandwidth and network speed requirements;

g) degrees of protection provided by enclosures and the IP-code protection class in accordance with IEC 60529;

h) protection against physical shock and vibration;

i) electrical safety class (e.g. protection against electric shock);

j) EMC (EMI) conformance and environment class;

k) cyber security requirements in accordance with IEC 62443-3-3.

5.2 Building management

5.2.1 General

The typical tasks of a management station can be distributed across a wide variety of devices in the building automation system.

Computational and storage resources can be distributed across the whole system without limitation in magnitude and distance. Data can be stored locally in the edge, the cloud or a combination of both. This also applies to the outcomes of analytic processes.

A management station provides a visual interface to monitor the systems and adjust the system configuration. These changes are recorded and are, therefore, traceable.

NOTE In many cases, the management station no longer requires an extremely powerful computer on site, but can also be run on a wide variety of devices, for example a web browser or an app. In this way, all relevant data is more easily accessible on site or from any other location around the world, at any time.

The following information about the building automation system can be helpful when designing management functions:

a) How big is the system (number of devices, number of data-points)?

b) What response times are to be guaranteed?

c) What level of cyber security needs to be observed?

d) Which other systems should be integrated (fire, e-charging, smart grid, etc.)?

By taking this information into account, fundamental questions about the design of the system as well as the performance and segmentation of the network or additional network load for an existing building network can be answered. However, since these boundary conditions can change at any time during operation, modularization, scalability, communication interface standardization and on-demand resource allocation shall always be taken into account.

5.2.2 Devices for data processing, storage and archiving

When deciding which combination of local hardware resources or cloud-based computing will be implemented, the following aspects shall be taken into account:

a) performance of the selected hardware;

b) network speed, bandwidth and data throughput;

c) high-speed internet connection;

d) available memory and storage capacity;

e) cyber security requirements of the system;

f) redundancy requirements.

5.2.3 Management stations and operating units

The HMI may be used for monitoring, alarm function and operation.

The GUI may be used for operator functions, such as presentation of point information, graphics, alarm handling, scheduling and display of trend curves.

Graphic control units are mostly part of management stations. The user's preference should be made available to them, whether permanently mounted, portable or wearable, whether PC, notebook, tablet, or augmented reality glasses.

5.2.4 Data interface unit (DIU)

DIU functionality is covered by virtualized software functions that run locally on automation stations, edge devices or the cloud, executing such services.

DIUs can be used as separate hardware whenever network segments need to be interconnected.

5.3 Control devices

5.3.1 General

The typical automation tasks may be distributed across a large number of devices in the building automation system.

For example, time-critical functions may be carried out on the intelligent actuators and sensors that are wired or wirelessly connected to the network. The intelligence, which is further distributed as a result, relieves the network and ensures that the function itself is still available and executed locally even if an automation station fails or if there is a partial network interruption.

All these devices on which the automation and control functions are carried out provide the environment for the following main tasks of a building automation system:

a) direct digital control automation;

b) energy and operational optimization;

c) plant operation monitoring;

d) alarm, fault, maintenance and operations information;

e) automatic and manual control;

f) data for statistics and analysis of values and states;

g) information exchange between processing functions with any other device of the building automation system.

5.3.2 Edge device — Tasks

In principle, an edge device can perform all of the tasks of an automation station, but it can also take on some of the tasks of the cloud.

An edge device belongs to the building and can be used for a wide variety of tasks. In the next few years, the range of tasks is likely to grow.

NOTE 1 In case the connection to the cloud fails, an edge device can take over the cloud tasks until the cloud connection is available again.

NOTE 2 An edge device can also typically provide the staggered and time-controlled distribution of important software updates to several connected devices in the system.

NOTE 3 In order to reduce the network load between the building and the cloud, the edge is often used as a buffer for historical data, which is then transferred from the edge to the cloud at night when data lines are not too busy.

5.3.3 Automation station

5.3.3.1 Tasks and structures

Automation stations automatically operate the system equipment and offer efficient operation and high system availability by implementing the project-specific functions described in ISO 16484-3.

An automation station can either consist of a compact module with a fixed number of I/O or a group of modules, for example, a base module to which either expansion modules or I/O modules, or both can be connected directly or remotely. A combination of both is also possible.

General performance criteria for the used controller:

a) number and type of physical I/O points of each device or module;

b) number and type of each function described in ISO 16484-3;

c) number of accessible and possible addresses for data-points, alarms, schedules and information;

d) capacity for historical data;

e) resources available for each function described in ISO 16484-3.

5.3.3.2 Power supply

Automation stations can be equipped with their own power supplies, or groups of automation stations may be supplied by a common power supply.

The power supply unit shall take regional legal compliance into consideration in order to meet project-specific performance and safety requirements. The usable voltage and whether alternating current or direct current need to be used shall be specified.

5.3.3.3 Processing unit

The processing unit of a controller works with its physical and virtual data-points in order to operate all peripheral devices connected directly or remotely.

In order to process this information and perform the desired functions, the controller shall be equipped with the necessary software. This software can be pre-installed or imported at any time.

When a controller is not supplied by an uninterruptible power supply, in the case of a power failure:

— the programs, parameters and data shall remain stored;

— the system internal clock (time and calendar function) shall continue working for a specified time, depending on the application. The necessary value shall be specified with each project.

On resumption of power, the embedded functions of the controller shall restart automatically without the manual intervention of an operator. The behaviour of the following specific applications shall be specified:

a) maximum number of points for the different physical and virtual point types to be processed;

b) minimum cycle time for scanning a maximum number of data-points within each processing unit;

c) maximum number of control loops available within each processing unit;

d) minimum cycle time for closed loop control;

e) minimum buffering time for programs and data during power failure.

5.3.3.4 Input/output interfaces

5.3.3.4.1 General

An I/O module can either:

— be an integral part of a compact automation station;

— consist of modules, for example a base module to which expansion modules can be connected directly or remotely;

— be connected directly to the network via a built-in communication interface (either wired or wireless).

Any combination of the above is also possible.

The connections of the I/O interface shall be easily accessible. They shall also be legible and permanently marked. The I/O interfaces should provide a display device (e.g. LED, LCD) to make the status of the signals visible.

Physical I/O shall be specified according to the following:

— over voltage and EMC protection limits;

— galvanic separation of signals.

Signal interchange between field devices for operational plant and controllers shall be done via the I/O functions given in subclauses 5.3.3.4.2 to 5.3.3.4.6.

5.3.3.4.2 Binary input (BI)

A BI shall be used for entering one binary input signal. Bounce free and voltage free contacts are recommended.

5.3.3.4.3 Binary output (BO)

A BO shall be used for commanding an actuator, or to energize a contactor for switching an electric motor (e.g. fan, pump).

5.3.3.4.4 Analogue input (AI)

An AI shall be used for measuring the magnitude of a value (i.e. voltage, current).

5.3.3.4.5 Analogue output (AO)

An AO shall be short-circuit proof. Actuators can be connected to analogue outputs either directly or via coupling modules.

5.3.3.4.6 Counter input (CI)

A CI shall be used for counting pulsed signals.

5.4 Sensors and actuators

The type of connection of sensors and actuators to the building automation system is less important.

5.5 Local override/indication device — Task and use

Devices for local manual override of outputs are used to enable manual switching or positioning for emergency operation of heating, ventilation, and air conditioning or other systems in the event of a defect.

System components can be switched on and off or positioned directly by the user independently of the processing unit, and the status is displayed locally.

Manual interventions may be displayed system-wide and recorded in the system logbook.

5.6 Room control device

A room control unit shall enable the user to interact with automated services as part of the building automation system, for instance the climate parameters of the room in which it is located. Depending on the project's requirements, other user interactions such as lighting control and blind control are also possible.

The building automation system can use room control units to check the presence of the user.

6 Topology

6.1 Topology

An overview of the topology is given in Figure 1.

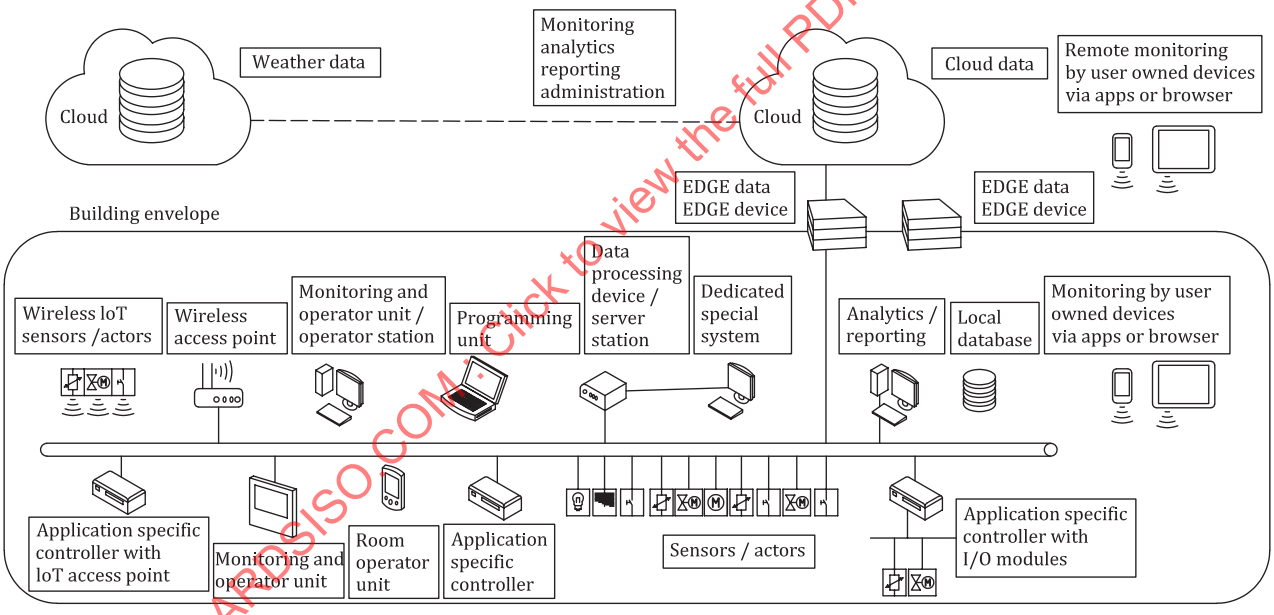

Figure 1 — Overview of the topology

6.2 System communication

6.2.1 General

The information network infrastructure is part of the building itself and is essential to ensuring that all connected devices are either supplied with the necessary data or that they themselves make data available in the network.

To ensure that the requirements for every data service and protocol are met, a network connection shall be available:

a) inside and outside the building;