BS EN ISO 52120-1:2022
Incorporating corrigendum September 2022

BSI Standards Publication

Energy performance of buildings — Contribution of building automation, controls and building management

Part 1: General framework and procedures

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National foreword

This British Standard is the UK implementation of EN ISO 52120-1:2022. It is identical to ISO 52120-1:2021, incorporating corrigendum September 2022. It supersedes BS EN 15232-1:2017 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RHE/16, Performance requirements for control systems.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Published by BSI Standards Limited 2022

ISBN 978 0 539 24761 9

ICS 91.120.10; 97.120

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2022.

Amendments/corrigenda issued since publication

Date	Text affected
30 November 2022	Implementation of ISO corrigendum September 2022: See ISO foreword for details

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 52120-1

March 2022

ICS 91.120.10

Supersedes EN 15232-1:2017

English Version

Energy performance of buildings - Contribution of building automation, controls and building management - Part 1: General framework and procedures (ISO 52120-1:2021, Corrected version 2022-09)

Performance énergétique des bâtiments - Contribution de l'automatisation, de la régulation et de la gestion technique des bâtiments - Partie 1: Cadre général et procédures (ISO 52120-1:2021, Version corrigée 2022-09)

Energieeffizienz von Gebäuden - Einfluss von Gebäudeautomation und Gebäudemanagement - Teil 1: Allgemeiner Rahmen und Verfahren (ISO 52120-1:2021, korrigierte Fassung 2022-09)

This European Standard was approved by CEN on 3 December 2021.

This European Standard was corrected and reissued by the CEN-CENELEC Management Centre on 28 September 2022.

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European foreword

This document (EN ISO 52120-1:2022) has been prepared by Technical Committee ISO/TC 205 "Building environment design" in collaboration with Technical Committee CEN/TC 247 “Building Automation, Controls and Building Management” the secretariat of which is held by SNV.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2022, and conflicting national standards shall be withdrawn at the latest by September 2022.

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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 documents 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).

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This corrected version of ISO 52120-1:2021 incorporates the following corrections:

— Figure C.12 has been replaced.

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Introduction

This document belongs to the family of standards aimed at international harmonization of the methodology for the assessment of the energy performance of buildings. Throughout, this group of standards is referred to as a set of called “EPB set of standards”.

All EPB standards follow specific rules to ensure overall consistency, unambiguity and transparency. This document is clearly identified in the modular structure developed to ensure a transparent and coherent set of EPB standards, as set out in ISO 52000-1, the overarching EPB standard. BAC (building automation and control) is identified in the modular structure as technical building system M10. However, other International Standards issued by ISO TC 205 deal with control accuracy, control functions and control strategies using standards communications protocol (these last standards do not belong to the set of EPB standards).

To avoid a duplication of calculation due to the BAC (avoid double impact), no calculation is done in a BAC EPB standard set, but in each underlying standard of the set of EPB standards (from M1 to M9 in the modular structure), an identifier developed and present in the M10 covered by this document is used where appropriate. This way of interaction is described in detail in ISO/TR 52000-2, the Technical Report accompanying ISO 52000-1. As consequence, the concept of a normative template for specific (national) choices in Annex A, and Annex B with informative default choices, as commonly used in the set of EPB standards is not applicable for this document.

The main target groups of this document are all the users of the set of EPB set of standards (e.g. architects, engineers, regulators).

Further target groups are parties wanting to motivate their assumptions by classifying the building energy performance for a dedicated building stock.

More information is provided in the Technical Report accompanying this document (ISO/TR 52120-2[5]).

NOTE 1 Table 1 shows the relative position of this document within the set of EPB standards in the context of the modular structure as set out in ISO 52000-1.

NOTE 2 In ISO/TR 52000-2 the same table can be found, with, for each module, the numbers of the relevant EPB standards and accompanying technical reports that are published or in preparation.

NOTE 3 The modules represent EPB standards, although one EPB standard can cover more than one module and one module can be covered by more than one EPB standard, for instance a simplified and a detailed method respectively. See also Clause 2 and Tables A.1 and B.1.

Table 1 — Position of this document (in casu M10–4,5,6,7,8,9,10), within the modular structure of the set of EPB standards

	Over-arching	Building (as such)	Technical building system									
Submodule	Descriptions	Descriptions	Descriptions	Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic hot waters	Lighting	Building automa-tion and control	PV, wind, etc.
sub1	M1	M2		M3	M4	M5	M6	M7	M8	M9	M10	M11
1	General	General	General									

[a] The shaded modules are not applicable.

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Table 1 *(continued)*

	Over-arching	Building (as such)	Technical building system									
Submodule	**Descriptions**	**Descriptions**	**Descriptions**	**Heating**	**Cooling**	**Ventilation**	**Humidification**	**Dehumidification**	**Domestic hot waters**	**Lighting**	**Building automation and control**	**PV, wind, etc.**
sub1	**M1**	**M2**		**M3**	**M4**	**M5**	**M6**	**M7**	**M8**	**M9**	**M10**	**M11**
2	Common terms and definitions; symbols, units and subscripts	Building energy needs	Needs									
3	Application	(Free) indoor conditions without systems	Maximum load and power									
4	Ways to express energy performance	Ways to express energy performance	Ways to express energy performance								x	
5	Building functions and building boundaries	Heat transfer by transmission	Emission and control								x	
6	Building occupancy and operating conditions	Heat transfer by infiltration and ventilation	Distribution and control								x	
7	Aggregation of energy services and energy carriers	Internal heat gains	Storage and control								x	
8	Building partitioning	Solar heat gains	Generation and control								x	
9	Calculated energy performance	Building dynamics (thermal mass)	Load dispatching and operating conditions								x	
10	Measured energy performance	Measured energy performance	Measured energy performance								x	
11	Inspection	Inspection	Inspection									
12	Ways to express indoor comfort		BMS									
13	External environment conditions											
14[a]	Economic calculation											

[a] The shaded modules are not applicable.

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Energy performance of buildings — Contribution of building automation, controls and building management —

Part 1: General framework and procedures

1 Scope

This document specifies:

— a structured list of control, building automation and technical building management functions which contribute to the energy performance of buildings; functions have been categorized and structured according to building disciplines and building automation and control (BAC);

— a method to define minimum requirements or any specification regarding the control, building automation and technical building management functions contributing to energy efficiency of a building to be implemented in building of different complexities;

— a factor-based method to get a first estimation of the effect of these functions on typical buildings types and use profiles;

— detailed methods to assess the effect of these functions on a given building.

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.

ISO 50001:2018, *Energy management systems — Requirements with guidance for use*

ISO 52000-1:2017, *Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures*

ISO 7345:2018, *Thermal performance of buildings and building components — Physical quantities and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7345:2018, ISO 52000-1:2017 and the following apply.

ISO and IEC maintain terminological 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/

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3.1
auxiliary energy
electrical energy used by *technical building systems* (3.14) to support energy transformation to satisfy energy needs

Note 1 to entry: This includes energy for fans, pumps, electronics, etc. Electrical energy input to the ventilation system for air transport and heat recovery is not considered as auxiliary energy, but as energy used for ventilation.

Note 2 to entry: In ISO 9488 the energy used for pumps and valves is called "parasitic energy".

[SOURCE: ISO 13612-2:2014, 3.3, modified — Note 3 to entry was removed.]

3.2
building automation and control
BAC
products, software, and engineering services for automatic controls, monitoring and optimization, human intervention and management to achieve energy-efficient, economical, and safe operation of building services equipment

[SOURCE: ISO 52000-1:2017, 3.4.4, modified — The term BAC was added.]

3.3
building automation and control system
BACS
system, comprising all products, software and engineering services for automatic controls (including interlocks), monitoring, optimization, for operation, human intervention, and management to achieve energy-efficient, economical, and safe operation of building services

Note 1 to entry: BACS is also referred to as BMS (building management system).

Note 2 to entry: The use of the word 'control' does not imply that the system or device is restricted to *control functions* (3.5). Processing of data and information is possible.

Note 3 to entry: If a building control system, *building management* (3.4) system, or building energy management system complies with the requirements of the ISO 16484 series, it should be designated as a building automation and control system (BACS).

Note 4 to entry: Building services are divided in technical, infrastructural and financial building services and energy management is part of *technical building management* (3.13).

Note 5 to entry: Building energy management system is part of a BMS.

Note 6 to entry: The building energy management system comprises data collection, logging, alarming, reporting, and analysis of energy usage, etc. The system is designed to reduce the energy consumption, improve the utilization, increase the reliability, and predict the performance of the *technical building systems* (3.14), as well as optimize energy usage and reducing its cost.

[SOURCE: ISO 16484-2:2004, 3.31, modified — Notes to entry 1, 4, 5 and 6 have been added.]

3.4
building management
BM
totality of services involved in the management operation and monitoring of buildings (including plants and installations)

Note 1 to entry: Building management can be assigned as part of facility management.

[SOURCE: CEN/TS 15379:2009, 3.4, modified – Second part of the definition became Note 1 to entry.]

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3.5
control function
BAC (3.2) effect of programs and parameters

Note 1 to entry: BAC functions are referred to as control functions, I/O, processing, optimization, management and operator functions. They are listed in the BAC FL (function list) for a specification of work.

Note 2 to entry: Function is a program unit that delivers exactly one data element, which can be a multiple value (i.e. an array or a structure). Functions can be an operand in a program as described in EN 61131–3.

3.6
delivered energy
energy, expressed per *energy carrier* (3.7), supplied to the *technical building systems* (3.14) through the assessment boundary, to satisfy the uses taken into account or to produce the exported energy

Note 1 to entry: Delivered energy can be calculated for defined energy uses or it can be measured.

[SOURCE: ISO 52000-1:2017, 3.4.6]

3.7
energy carrier
substance or phenomenon that can be used to produce mechanical work or heat or to operate chemical or physical processes

[SOURCE: ISO 52000-1:2017, 3.4.9]

3.8
energy need for heating and cooling
heat to be delivered to or extracted from a thermally conditioned space to maintain the intended space temperature conditions during a given period of time

Note 1 to entry: The energy need can include additional heat transfer resulting from non-uniform temperature distribution and non-ideal temperature control, if they are taken into account by increasing (decreasing) the effective temperature for heating (cooling) and not included in the heat transfer due to the heating (cooling) system.

[SOURCE: ISO 52000-1:2017, 3.4.13, modified — Note 1 to entry added and the term was originally "energy need for heating or cooling".]

3.9
energy efficiency
ratio or other quantitative relationship between an output of performance, service, goods or energy, and an input of energy

EXAMPLE Efficiency conversion; energy required/energy used; output/input; theoretical energy used to operate/energy used to operate.

Note 1 to entry: Both input and output need to be clearly specified in quantity and quality, and be measurable.

[SOURCE: ISO 50001:2018, 3.5.3, modified — "commodities" was removed from the definition and the example has been modified.]

3.10
integrated function
BAC (3.2) effect of programs, shared data points and parameters for multi-discipline interrelationships between various building services and technologies

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3.11
measured energy performance
energy performance based on measured amounts of delivered and exported energy

Note 1 to entry: The measured rating is the weighted sum of all *energy carriers* (3.7) used by the building, as measured by meters or derived from measured energy by other means. It is a measure of the in-use performance of the building after correction or extrapolation. This is particularly relevant to certification of actual energy performance.

Note 2 to entry: Also known as “operational rating”.

[SOURCE: ISO 52000-1:2017, 3.5.16, modified — "weighted measured amounts" has been replaced by "measured amounts" in the definition and "energy performance" has been replaced by "rating".]

3.12
thermally activated building system
TABS
massive building fabric actively heated or cooled by integrated air- or water-based systems

3.13
technical building management
TBM
process(es) and services related to operation and management of buildings and *technical building system* (3.14) through the interrelationships between the different disciplines and trades

Note 1 to entry: The disciplines and trades comprise all technical building services for the purpose of optimized maintenance and energy consumption.

EXAMPLE Optimization of buildings through interrelationships ranging from heating, ventilation and air conditioning (HVAC), to lighting and day lighting, to life safety and security, to electric power systems and energy monitoring and metering, to services, including communications and maintenance and to management.

[SOURCE: ISO 52127-1:2021, 3.2]

3.14
technical building system
technical equipment for heating, cooling, ventilation, humidification, dehumidification, domestic hot water, lighting and electricity production

Note 1 to entry: A technical building system can refer to one or to several building services (e.g. heating, heating and DHW).

Note 2 to entry: A technical building system is composed of different subsystems.

Note 3 to entry: Electricity production can include cogeneration and photovoltaic systems.

[SOURCE: ISO 52000-1:2017, 3.3.13, modified — The phrase "building automation and control" was deleted from the definition.]

3.15
EPB standard
standard that complies with the requirements given in ISO 52000-1, CEN/TS 16628 and CEN/TS 16629

Note 1 to entry: These three basic EPB documents were developed under a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/480), and support essential requirements of EU Directive 2010/31/EC on the energy performance of buildings (EPBD). Several EPB standards and related documents are developed or revised under the same mandate. CEN/TS 16628[5] and CEN/TS 16629[6] are available as N-documents in ISO/TC 163 and ISO/TC 205.

[SOURCE: ISO 52000-1:2017, 3.5.14, modified — The last sentence of the Note 1 to entry has been added.]

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4 Symbols, subscripts and abbreviated terms

4.1 Symbols

For the purposes of this document, the symbols given in ISO 52000-1 and Table 2 apply.

Table 2 — Symbols

Symbol	Quantity	Unit
a	normalized level, e.g. occupancy or gains	-
$\bar{\beta}$	mean part load	-
Φ	heat flow rate, thermal power	kW

4.2 Subscripts

For the purposes of this document, the subscript given in ISO 52000-1:2017, Clause 4 and Annex C and the specific subscripts listed in Table 3 apply.

NOTE Relevant subscripts already given in ISO 52000-1 are included if necessary for the understanding of this document.

Table 3 — Subscripts

Subscript	Term	Subscript	Term	Subscript	Term
amb	ambient	end	end	th	thermal
BAC	building automation and control	r	room	trans	transfer
cor	correction	ref	reference		
ctr	control	set	setpoint		
DHW	domestic hot water	sta	start		

4.3 Abbreviated terms

For the purposes of this document, the abbreviated terms given in ISO 52000-1 and Table 4 apply.

Table 4 — Abbreviated terms

AHU	air handling unit
BAC	building automation and control
BM	building management
COP	coefficient of performance
DHW	domestic hot water
HVAC	heating, ventilation and air conditioning
TABS	thermally activated building systems
TBM	technical building management
VFD	variable flow dependant
VRF	variable room flow

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5 Description of the method

5.1 Output of the method

This document describes two methods of how to calculate the contribution of building automation and controls to the energy performance of buildings. The two methods are the following.

— The detailed method: output of the detailed method is a list of automation, control and management function types that is used to run a detailed calculation of building energy performance based on other EPB standards. In addition, the detailed method would also allow classification of a building automation and control system according to a set of criteria defined in this document. There is no limitation regarding the time interval.

— The factor-based method: output of the factor-based method is the energy demand of a building according to a given building automation and control classification. The time interval of the output is a yearly step.

5.2 General description of the method(s)

Two methods are given:

— method 1, defined in Clause 6, is meant for a detailed energy performance analysis of a building in case detailed information about the building, the HVAC systems and especially the type of automation, control and management functions are available that can be applied in a holistic EPB calculation method;

— method 2, defined in Clause 7, is intended for easily calculating a rough estimate of the impact of building automation, control and management on the energy performance of a building based on a given energy performance (either a consumption metered, or a demand calculated) correlated to a certain BAC efficiency classification of the building.

In this document, “factor-based method” is exemplified by “BAC factor method”.

5.3 Selection criteria between the methods

For the calculation of the impact of building automation, control and management functions on the building energy performance the detailed method is method 1 in this document. Figure 1 illustrates how to use the detailed method compared to the simplified BAC factor method.

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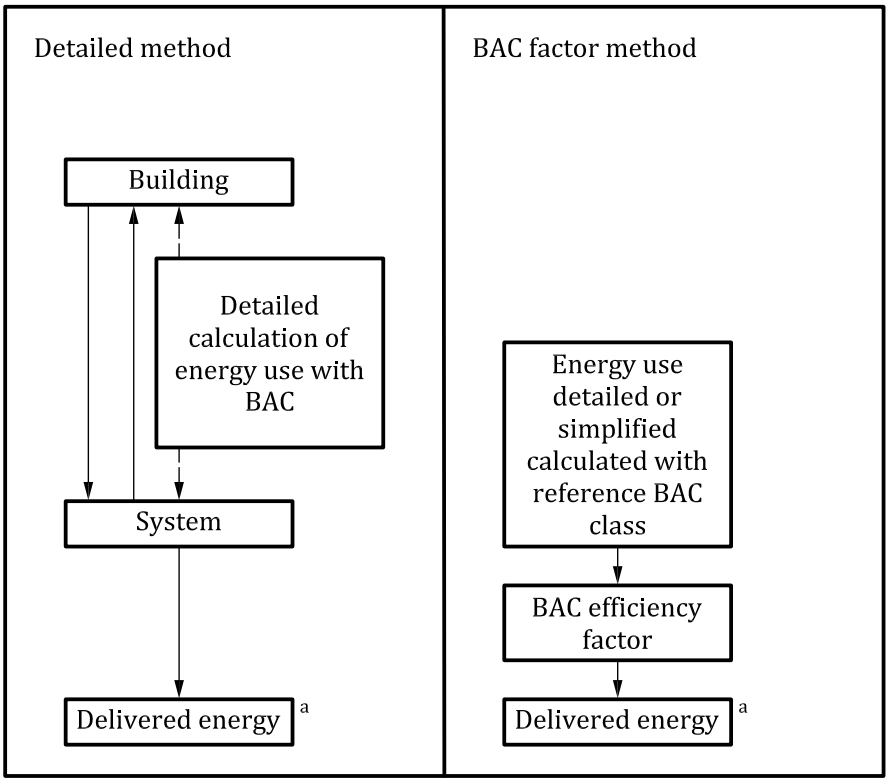

[a] Delivered energy is the total energy, expressed per energy carrier (gas, oil, electricity etc.) used for heating, cooling, ventilation, domestic hot water or lighting.

NOTE Arrows illustrate only the calculation process and do not represent energy and/or mass flows.

Figure 1 — Detailed method in comparison with BAC factor method

The detailed method should be used only when a sufficient knowledge about automation, control and management functions used for the building and the energy systems is available. The application of the detailed calculation procedure implies that all automation, control and management functions that have to be accounted for the operation of a building and its energy systems are known. Clause 6 gives a general survey of those functions and describes how to use them in the context of energy performance calculations.

5.4 BAC and TBM functions having an impact on the energy performance of buildings

Building automation and control (BAC) provide effective control functions for any building energy system, for example, heating, ventilating, cooling, hot water and lighting appliances, that lead to improve operational and energy efficiencies. Complex and integrated energy saving functions and routines can be configured based on the actual use of a building, depending on real user needs, to avoid unnecessary energy use and CO_2 emissions.

Technical building management (TBM) functions as part of building management (BM) and provides information about operation, maintenance, services and management of buildings, especially for energy management, e.g. measurement, recording trending, and alarming capabilities and diagnosis of unnecessary energy use. Energy management provides requirements for documentation, controlling, monitoring, optimization, determination and to support corrective action and preventive action to improve the energy performance of buildings. This document can be used to evaluate the contribution of these building management functions to the energy performance of buildings.

The BAC functions described in Table 5 are based on the energy demand and supply model for a building in Figure 2.

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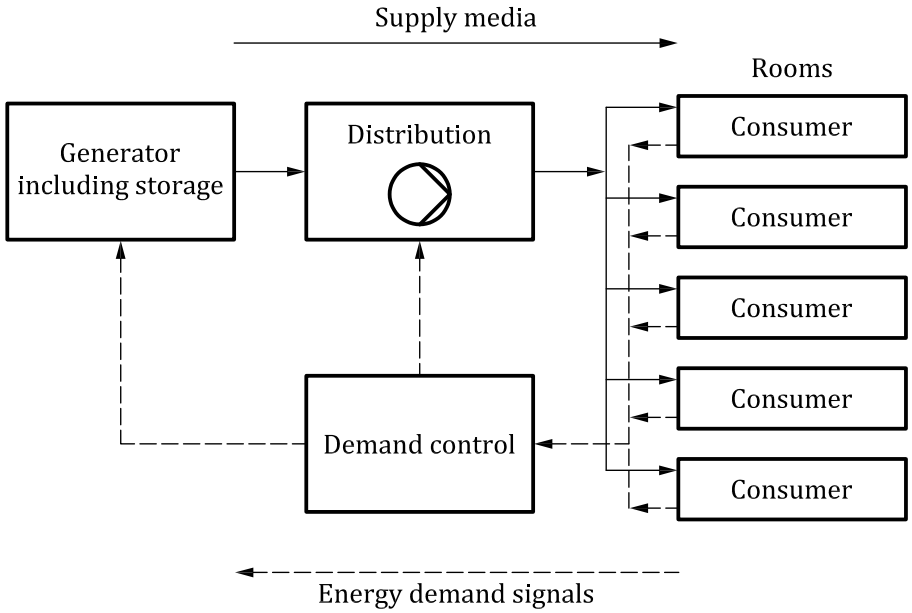

Figure 2 — Energy demand and supply model (example: heating plant)

Rooms represent the source of the energy demand. Suitable equipment should ensure comfortable conditions in the rooms with regard to temperature, humidity, air quality and light as needed. Local regulations can specify minimum or maximum requirements.

Supply media is provided to the consumer according to energy demand keeping losses in distribution and generation to an absolute minimum.

The building automation and control functions described in Table 5 are aligned in accordance with the energy demand and supply model. The relevant energy-efficiency functions are handled starting with the room, via distribution up through generation.

The most common BAC and TBM functions having an impact on the energy performance of buildings have been described and summarized in Table 5.

Figures 3 to 7 illustrate basic system designs for heating, domestic hot water, cooling, ventilation and air conditioning purposes. The numbers refer to the control functions summarized in Table 5. These basic elements can be combined to more or less complex systems that also account for local, regional or national specifics. The building automation and control functions defined in Table 5 are according to these basic system designs. Air side system control of HVAC shall be treated as ventilation and air-conditioning control, separately from heat generators, chillers, terminal units and water and refrigerant side controls.

Annex D provides examples of how to use the BAC function list of ISO 16484-3 to describe functions from this document. In addition, Annex G gives informative control accuracy requirements.

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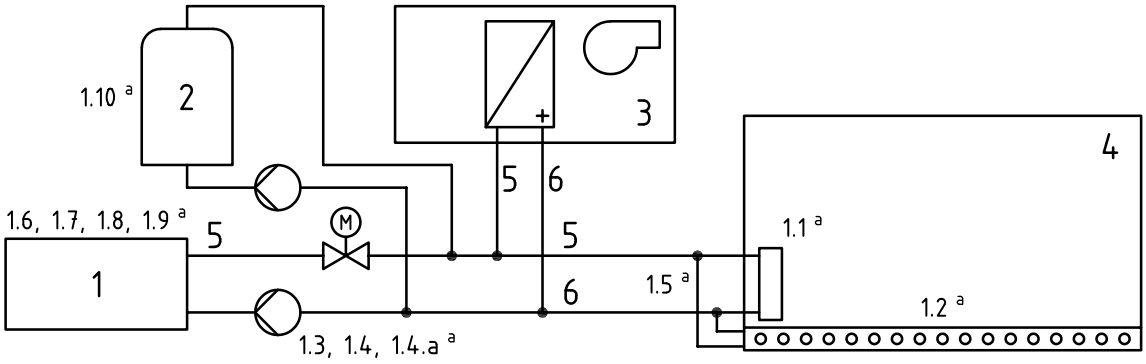
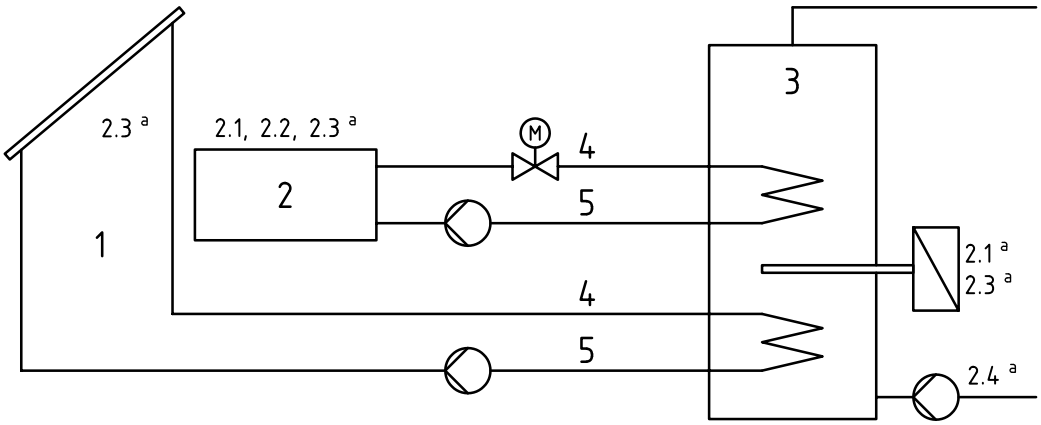


Key

1 heat generator
2 thermal energy storage
3 air handling unit
4 room
5 heating water supply
6 heating water return
a These numbers refer to the numbers in Table 5.

Figure 3 — Space heating system



Key

1 solar collector
2 boiler/district heating heat pump
3 domestic hot water storage
4 heating water supply
5 heating water return
a These numbers refer to the numbers in Table 5.

Figure 4 — Domestic hot water heating system

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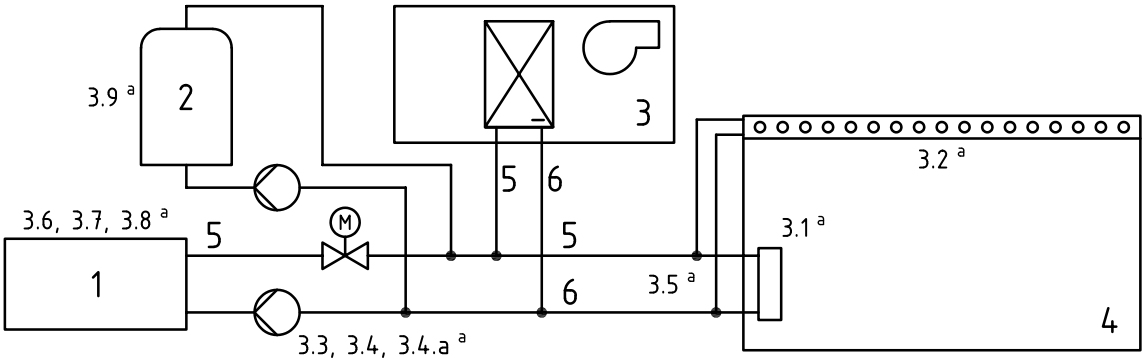
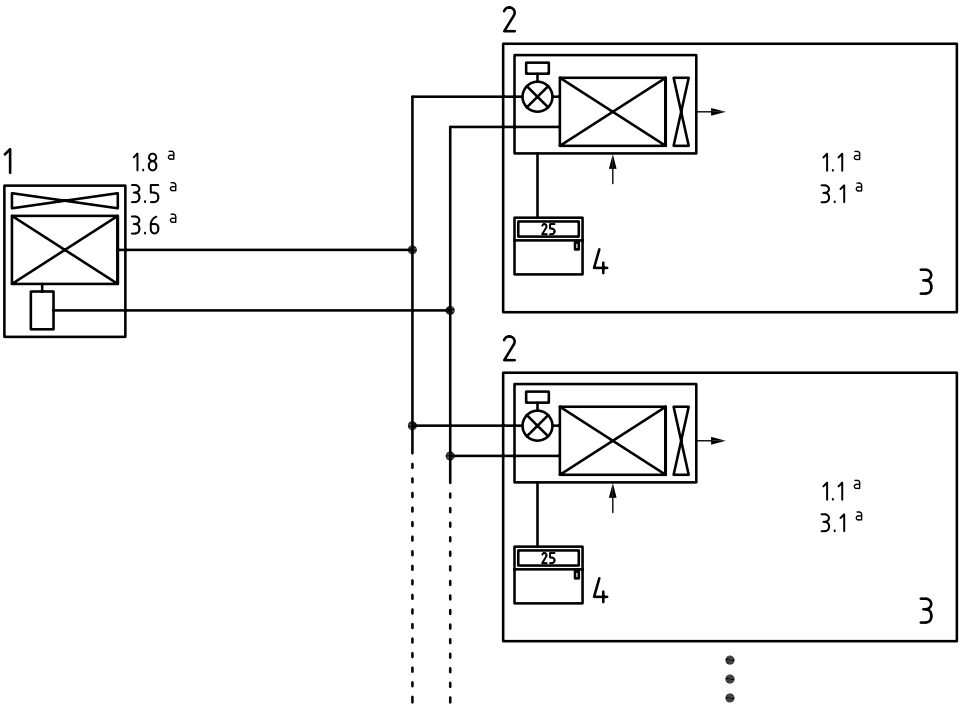


Key

1 chiller
2 thermal energy storage
3 air handling unit
4 room
5 chilled water supply
6 chilled water return
a These numbers refer to the numbers in Table 5.

Figure 5 — Cooling system



Key

1 outdoor unit
2 indoor unit
3 room
4 controller
a These numbers refer to the numbers in Table 5.

Figure 6 — Split system/VRF (heating and/or cooling)

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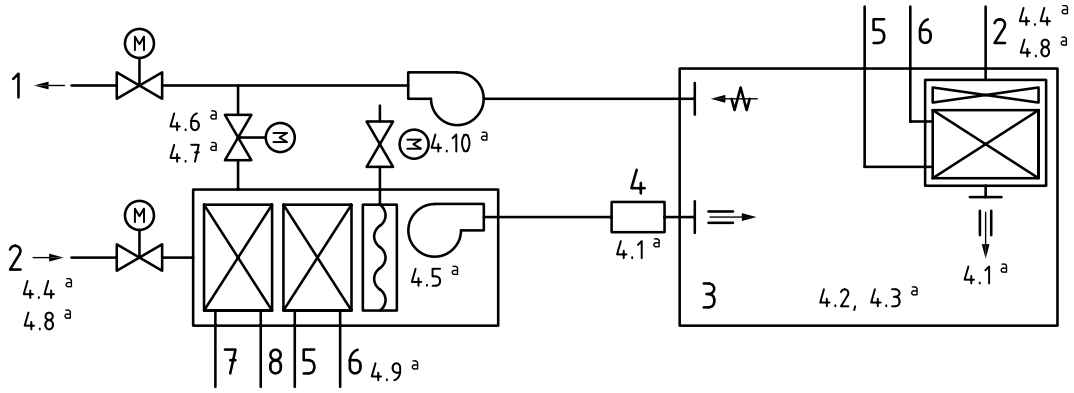

Key

1 exhaust air
2 outside air
3 room
4 variable air volume
5 chilled water supply
6 chilled water return
7 heating water supply
8 heating water return
a These numbers refer to the numbers in Table 5.

Figure 7 — Ventilation and air-conditioning system

Table 5 — BAC and TBM functions having an impact on the energy performance of buildings

Automatic control				
1	Heating control			
1.1	Emission control		HEAT_EMIS_CTRL_DEF	M3–5
		The control function is applied to the heat emitter (radiators, underfloor heating, fan-coil unit, indoor unit) at room level; for type 1, one function can control several rooms.		
	0	No automatic control of the room temperature		
	1	Central automatic control: there is only central automatic control acting either on the distribution or on the generation. Function is to be integrated in a system.		
	2	Individual room control: by thermostatic valves or electronic controller		
	3	Individual modulating room control with communication: between controllers and BACS (e.g. scheduler, room temperature setpoint)		
	4	Individual modulating room control with communication and occupancy detection: between controllers and BACS; demand control/occupancy detection (this function level is usually not applied to any slow reacting heat emission systems with relevant thermal mass, e.g. floor heating, wall heating)		
1.2	Emission control for TABS (heating mode)		HEAT_EMIS_CTRL_TABS	M3–5
	0	No automatic control of the room temperature		
	1	Central automatic control: the central automatic control for a TABS zone (which comprises all rooms which get the same supply water temperature) typically is a supply water temperature control loop whose set-point is dependent on the filtered outside temperature, e.g. the average of the previous 24 h.		

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Table 5 *(continued)*

Automatic control				
	2	Advanced central automatic control: this is a central automatic control of the TABS zone that is designed and tuned to achieve an optimal self-regulating of the room temperature within the required comfort range (specified by the room temperature heating set-point). “Optimal” means that the room temperatures of all rooms of the TABS zone remain during operation periods in the comfort range to meet comfort requirements, but also the temperatures are as low as possible to reduce the energy demand for heating.		
	3	Advanced central automatic control with intermittent operation and/or room temperature feedback control: a) Advanced central automatic control with intermittent operation: this is an advanced central automatic control according to 2) with the following supplement. The pump is switched off regularly to save electrical energy, either with a fast frequency - typically 6 h on/off cycle time - or with a slow frequency, corresponding to 24 h on/off cycle time. If the TABS is used for cooling, intermittent operation with 24 h on/off cycle time can also be used to reject the heat to the outside air if the outside air is cold. b) Advanced central automatic control with room temperature feedback control: this is an advanced central automatic control according to 2) with the following supplement. The supply water temperature set-point is corrected by the output of a room temperature feedback controller, to adapt the set-point to non-predictable day-to-day variation of the heat gain. Since TABS reacts slowly, only day-to-day room temperature correction is applied, an instant correction cannot be achieved with TABS. The room temperature that is fed back is the temperature of a reference room or another temperature representative for the zone. c) Advanced central automatic control with intermittent operation and room temperature feedback control		
1.3	Control of distribution network hot water temperature (supply or return)	HEAT_DISTR_CTRL_TMP	M3–6	
		A similar function can be applied to the control of direct electric heating networks.		
	0	No automatic control		
	1	Outside temperature compensated control: actions generally lower the mean flow temperature.		
	2	Demand based control: for example. based on indoor temperature control variable, actions generally lower the mean flow temperature.		
1.4	Control of distribution pumps in networks	HEAT_DISTR_CTRL_PMP	M3–6	
		The controlled pumps can be installed at different levels in the network. Control means to reduce the auxiliary energy demand of the pumps.		
	0	No automatic control		
	1	On/off control: switch on and off automatically, pumps run with no control at maximum speed.		
	2	Multi-stage control: speed of pumps is controlled by a multi-step control.		
	3	Variable speed pump control: constant or variable Δp based on pump unit (internal) estimations.		
	4	Variable speed pump control: variable Δp following an external demand signal, e.g. hydraulic requirements.		
1.4.a	Hydronic balancing heating distribution (including contribution to the balancing to the emission side)	HEAT_DISTR_CTRL _HYDR	M3–6	
		Hydronic balancing is applied to an emitter or a group of heat emitters greater than 10.		
	0	No balancing		

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Table 5 *(continued)*

Automatic control			
	1	Balanced statically per emitter, without group balance	
	2	Balanced statically per emitter, and a static group balance (e.g. with balancing valve)	
	3	Balanced statically per emitter and dynamic group balance (e.g. with differential pressure control)	
	4	Balanced dynamically per emitter (e.g. differential pressure controllers)	
1.5	Intermittent control of emission and/or distribution	HEAT_DISTR_CTRL	M3–5 / M3–6
		One controller can control different rooms/zones having same occupancy patterns.	
	0	No automatic control	
	1	Automatic control with fixed time program: to lower the operation time	
	2	Automatic control with optimum start/stop: to lower the operation time NOTE This can be achieved, for example, by an outside-temperature compensated controller conforming to EN 12098–1, EN 12098–3 or by an optimized start-stop scheduler conforming to EN 12098-5; one system can control several rooms.	
	3	Automatic control with demand evaluation: to lower the operation time	
1.6	Heat generator control for combustion and district heating	HEAT_GEN_CTRL_CD	M3–8
		The goal consists generally in minimizing the heat generator operation temperature.	
	0	Constant temperature control	
	1	Variable temperature control depending on outside temperature	
	2	Variable temperature control depending on the load: e.g. depending on supply water temperature setpoint	
1.7	Heat generator control (heat pump)	HEAT_GEN_CTRL_HP	M3–8
		The goal consists generally in minimizing the heat generator operation temperature and by doing this maximizing the heat generator efficiency.	
	0	Constant temperature control	
	1	Variable temperature control depending on outside temperature.	
	2	Variable temperature control depending on the load: e.g. depending on supply water temperature setpoint	
1.8	Heat generator control (outdoor unit)	HEAT_GEN_CTRL_OU	M3–8
		The goal consists generally in maximizing the heat generator efficiency.	
	0	On/off-control of heat generator	
	1	Multi-stage control of heat generator capacity depending on the load or demand (e.g. on/off of several compressors)	
	2	Variable control of heat generator capacity depending on the load or demand (e.g. hot gas bypass, inverter frequency control)	
1.9	Sequencing of different heat generators	HEAT_GEN_CTRL_SEQ	M3–8
		This control function only applies to a system with a set of different heat generator sizes or types including renewable energy sources.	
	0	Priorities are only based on running time.	
	1	Control according to fixed priority list: e.g. heat pump prior to hot water boiler	
	2	Control according to dynamic priority list (based on current efficiency and capacity of generators, e.g. solar, geothermal heat, cogeneration plant, fossil fuels).	
	3	Control according to prediction based dynamic priority list (based on current efficiency and capacity of generators, e.g. solar, geothermal heat, cogeneration plant, fossil fuels)	

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Table 5 *(continued)*

Automatic control				
1.10	Control of thermal energy storage (TES) charging		HEAT_TES_CTRL	M3–7
		The TES is part of the heating system.		
	0	Continuous storage operation		
	1	2-sensor charging of storage		
	2	Load-prediction based storage operation		
2	Domestic hot water supply control			
2.1	Control of DHW storage charging with direct electric heating or integrated electric heat pump		DHW_STRG_CTRL_EL	M8–7 / M8–8
	0	Automatic on/off control		
	1	Automatic on/off control and scheduled charging enable		
	2	Automatic on/off control and scheduled charging enable and multi-sensor storage management		
2.2	Control of DHW storage charging using hot water generation		DHW_STRG_CTRL_HG	M8–7 / M8–8
	0	Automatic on/off control		
	1	Automatic on/off control and scheduled charging enable		
	2	Automatic on/off control, scheduled charging enable and demand-based supply temperature control or multi-sensor storage management		
2.3	Control of DHW storage charging with solar collector and supplementary heat generation		DHW_STRG_CTRL_SOL	M8–7 / M8–8
	0	Manual control		
	1	Automatic control of solar storage charge (Prio. 1) and supplementary storage charge (Prio. 2)		
	2	Automatic control of solar storage charge (Prio. 1) and supplementary storage charge (Prio. 2) plus demand-based supply temperature control or multi-sensor storage management		
2.4	Control of DHW circulation pump		DHW_CIRC_CTRL	M8–6
	0	No control, continuous operation		
	1	With time program		
3	Cooling control			
3.1	Emission control		CLG_EMIS_CTRL_DEF	M4–5
		The control function is applied to the emitter (cooling panel, fan-coil unit or indoor unit) at room level; for type 1, one function can control several rooms.		
	0	No automatic control of the room temperature		
	1	Central automatic control: there is only the central automatic control acting either on the distribution or on the generation. .		
	2	Individual room control: by thermostatic valves or electronic controller		
	3	Individual modulating room control with communication: between controllers and BACS (e.g. scheduler, room temperature setpoint)		
	4	Individual modulating room control with communication and occupancy detection: between controllers and BACS; demand control/occupancy detection (this function level is usually not applied to any slow reacting cool emission systems with relevant thermal mass, e.g. floor cooling).		
3.2	Emission control for TABS (cooling mode)		CLG_EMIS_CTRL_TABS	M4–5

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Table 5 *(continued)*

Automatic control			
	0	No automatic control of the room temperature	
	1	Central automatic control: the central automatic control for a TABS zone (which comprises all rooms which get the same supply water temperature) typically is a supply water temperature control loop whose set-point is dependent on the filtered outside temperature, e.g. the average of the previous 24 h.	
	2	Advanced central automatic control: this is a central automatic control of the TABS zone that is designed and tuned to achieve an optimal self-regulating of the room temperature within the required comfort range (specified by the room temperature cooling set-point). "Optimal" means that the room temperatures of all rooms of the TABS zone remain during operation periods in the comfort range, to meet comfort requirements, but also is as high as possible to reduce the energy demand for cooling.	
	3	Advanced central automatic control with intermittent operation and/or room temperature feedback control: a) Advanced central automatic control with intermittent operation: this is an advanced central automatic control according to 2) with the following supplement. The pump is switched off regularly to save electrical energy, either with a fast frequency - typically 6 h on/off cycle time - or with a slow frequency, corresponding to 24 h on/off cycle time. If the TABS is used for cooling, intermittent operation with 24 h on/off cycle time can also be used to reject the heat to the outside air if the outside air is cold. b) Advanced central automatic control with room temperature feedback control: this is an advanced central automatic control according to 2) with the following supplement. The supply water temperature set-point is corrected by the output of a room temperature feedback controller, to adapt the set-point to non-predictable day-to-day variation of the heat gain. Since TABS reacts slowly, only day-to-day room temperature correction is applied, an instant correction cannot be achieved with TABS. The room temperature that is fed back is the temperature of a reference room or another temperature representative for the zone. c) Advanced central automatic control with intermittent operation and room temperature feedback control	
3.3	Control of distribution network chilled water temperature (supply or return)	CLG_DISTR_CTRL_TMP	M4–6
		A similar function can be applied to the control of direct electric cooling (e.g. compact cooling units, split units) for individual rooms.	
	0	Constant temperature control	
	1	Outside-temperature compensated control: actions generally raise the mean flow temperature.	
	2	Demand-based control: e.g. based on indoor temperature control variable, actions generally raise the mean flow temperature.	
3.4	Control of distribution pumps in hydraulic networks	CLG_DISTR_CTRL_PMP	M4–6
		The controlled pumps can be installed at different levels in the network.	
	0	No automatic control	
	1	On off control: to reduce the auxiliary energy demand of the pumps	
	2	Multi-stage control: to reduce the auxiliary energy demand of the pumps	
	3	Variable speed pump control: constant or variable Δp based on pump unit (internal) estimations to reduce the auxiliary energy demand of the pumps	
	4	Variable speed pump control: variable Δp following an external demand signal, e.g. hydraulic requirements, ΔT, energy optimization to reduce the auxiliary energy demand of the pumps	

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Table 5 *(continued)*

Automatic control				
3.4.a	Hydronic balancing cooling distribution (including contribution to the balancing on the emission side)		CLG_DISTR _CTRL _HYDR	M4–6
		Hydronic balancing is applied to a group of cooling emitters (cooling panel, fan-coil unit or indoor unit) greater than 10.		
	0	No balancing		
	1	Balanced statically per emitter, without group balance		
	2	Balanced statically per emitter, and a static group balance (e.g. with balancing valve)		
	3	Balanced statically per emitter and dynamic group balance (e.g. with differential pressure controller)		
	4	Balanced dynamically per emitter (e.g. differential pressure control)		
3.5	Intermittent control of emission and/or distribution		CLG_DISTR_CTRL	M4–5 / M4–6
		One controller can control different rooms/zones having same occupancy patterns.		
	0	No automatic control		
	1	Automatic control with fixed time program: to lower the operation time		
	2	Automatic control with optimum start/stop: to lower the operation time		
	3	Automatic control with demand evaluation: to lower the operation time		
3.6	Interlock between heating and cooling control of emission and/or distribution		CLG_GEN_CTRL	M4–8
		To avoid at the same time heating and cooling in the same room depends on the system principle (e.g. cooling panel/heat emitter, TABS/ventilation, several indoor units)		
	0	No interlock: the two systems are controlled independently and can provide simultaneously heating and cooling.		
	1	Partial interlock (depending on the HVAC system): the control function is set up in order to minimize the possibility of simultaneous heating and cooling. This is generally done by defining a sliding setpoint for the supply temperature of the centrally controlled system.		
	2	Total interlock: the control function enables to guarantee that there will be no simultaneous heating and cooling.		
3.7	Generator control for cooling		CLG_GEN_CTRL	M4–8
		The goal consists generally in maximizing the chiller water temperature.		
	0	Constant temperature control		
	1	Variable temperature control depending on the outside temperature		
	2	Variable temperature control depending on the load: this includes control according to room temperature.		
3.8	Sequencing of different chillers (generators for chilled water)		CLG_GEN_CTRL_SEQ	M4–8
		This control function only applies to a system with a set of different chiller sizes or chilled water generator types including free cooling and/or renewable energy sources.		
	0	Priorities are only based on running time.		
	1	Fixed sequencing based on loads only: for example, depending on the generator's characteristics, e.g. absorption chiller vs. centrifugal chiller.		
	2	Priorities based on generator efficiency and characteristics: the generator operational control is set individually to available generators so that they operate with an overall high degree of efficiency (e.g. outside air, river water, geothermic heat, refrigeration machines).		

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Table 5 *(continued)*

Automatic control				
	3	Load prediction-based sequencing: the sequence is based on, e.g. COP and available power of a device and the predicted required power.		
3.9	Control of thermal energy storage (TES) charging		CLG_TES_CTRL	M4–7
		The TES is part of the cooling/chilled water system.		
	0	Continuous storage operation		
	1	Time-scheduled storage operation		
	2	Load prediction-based storage operation		
4	Ventilation and air-conditioning control			
	This section is for building energy systems that bring air into the building: both ventilation and air conditioning systems. Heating and cooling of air requires additional heating and cooling devices. Control functions related to heating/cooling systems are defined in sections 1 and 3 of this table respectively.			
4.1	Supply air flow control at the room level (e.g. fan on/off)		VENT_RMFLOW_CTRL	M5–5
	Control of supply air flow related to occupancy (availability of air flow, i.e. fan on/off control)			
	0	No automatic control: the system runs constantly (e.g. manual controlled switch).		
	1	Time control: the system runs according to a given time schedule.		
	2	Occupancy based control: the system runs dependent on the occupancy (presence, light switch, infrared sensors etc.).		
	3	Demand based control: the system runs dependent on the air quality demand (measurement of CO_2, VOC, etc.).		
4.2	Room air temperature control by the ventilation system (all-air systems; combination with static systems as cooling ceiling, radiators, etc.)		VENT_RTEMP_CTRL	M5–5 / M5–6
	Room air temperature depends on air flow (4.1, 4.5) as well as supply air temperature (4.9). This control function is related to a closed-loop controller for the room air temperature acting on the air flow or supply air temperature. It can work with or without an additional static heating system (radiators etc.). Minimum air flow rates are maintained.			
	0	On-off control: fixed air flow rate and fixed supply air temperature at the room level, room temperature setpoints are set individually.		
	1	Continuous control: either air flow rate or supply air temperature at the room level can be varied continuously; room temperature setpoint s are set individually.		
	2	Optimized control: minimum energy demand by optimized control. Both air flow rate as well as supply air temperature at the room level are controlled dependent on heating/cooling load.		
4.3	Coordination of room air temperature control by ventilation and by static system		VENT_RTEMP_COORD	M5–5 / M5–6
	Interaction of the different systems shall be coordinated.			
	0	Interaction is not coordinated, e.g. closed loop controllers are dedicated to each system to maintain the room air temperature independently.		
	1	Interaction is coordinated, i.e. only one system is controlled by a closed loop controller for the room air temperature and the other system conditions the room only to the extent that allows the closed loop controller to benefit from internal and external heat gains.		
4.4	Outside air (OA) flow control		VENT_OAFLOW_CTRL	M5–6 / M5–8
	This control function is applied to ventilation systems that allow varying the OA ratio or flow respectively.			

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Table 5 *(continued)*

Automatic control				
	0	Fixed OA ratio or OA flow: the system runs according to a given OA ratio, e.g. modified manually.		
	1	Staged (low/high) OA ratio or OA flow: depending on a given time schedule		
	2	Staged (low/high) OA ratio or OA flow: depending on the occupancy, e.g. light switch, infrared sensors, etc.		
	3	Variable control: the system is controlled by sensors which detect the number of people or indoor air parameters or adapted criteria (e.g. CO_2, mixed gas or VOC sensors). The used parameters shall be adapted to the kind of activity in the space.		
4.5	Air flow or pressure control at the air handler level		VENT_AHUFLOW_CTRL	M5–6 / M5–8
	0	No automatic control: continuously supplies air flow for a maximum load of all rooms.		
	1	On off time control: continuously supplies air flow for a maximum load of all rooms during nominal occupancy time.		
	2	Multi-stage control: to reduce the auxiliary energy demand of the fan		
	3	Automatic flow or pressure control without pressure reset: load dependent supplies of air flow for the demand of all connected rooms		
	4	Automatic flow or pressure control with pressure reset: load dependent supplies of air flow for the demand of all connected rooms (for variable air volume systems with VFD)		
4.6	Heat recovery control: icing protection		VENT_HRICE_CTRL	M5–5
	This control function is to avoid icing of the heat exchanger.			
	0	Without icing protection control: there is no specific action to avoid icing of the heat exchanger.		
	1	With icing protection control: a control loop enables to guarantee that the exhaust air temperature leaving the heat exchanger is not too low, to avoid frosting.		
4.7	Heat recovery control: prevention of overheating		VENT_HRHEAT_CTRL	M5–5
	This control function is to avoid overheating at the heat recovery unit.			
	0	Without overheating control: there is no specific action to avoid overheating.		
	1	With overheating control: during periods when the effect of the heat exchanger will no longer be positive, a control loop will switch between the “off”, “modulation” or bypass states of the heat exchanger.		
4.8	Free mechanical cooling		VENT_FREECOOL_CTRL	M5–8
	0	No automatic control		
	1	Night cooling: the amount of outside air is set to its maximum during the unoccupied period provided that firstly the room temperature is above the setpoint for the comfort period, and secondly the difference between the room temperature and the outside temperature is above a given limit. If free night cooling will be realized by automatically opening windows there is no air flow control.		
	2	Free cooling: both the amount of outside air and recirculation air are modulated during all periods of time to minimize the amount of mechanical cooling. Calculation is performed on the basis of temperatures.		
	3	Enthalpy based control: the amount of outside air and recirculation air are modulated during all periods of time to minimize the amount of mechanical cooling. Calculation is performed on the basis of temperatures and humidity (enthalpy).		
4.9	Supply air temperature control at the Air Handling Unit (AHU) level		VENT_AHUSAT_CTRL	M5–5

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Table 5 *(continued)*

Automatic control				
	There might be several supply air temperatures in an air conditioning system: the supply air temperature at the outlet of the AHU, the supply air temperature at the outlet of central re-heaters as well as the supply air temperature at the room level (terminal re-heat boxes). This control function allows to determine the supply air temperature setpoint (in case there is one) at the air handler level and not to control the temperature (e.g. enthalpy-based control).			
	0	No automatic control: no control loop enables to act on the supply air temperature.		
	1	Constant setpoint: a control loop enables to control the supply air temperature, the setpoint is constant and can only be modified by a manual action.		
	2	Variable setpoint with outside temperature compensation: a control loop enables to control the supply air temperature. The setpoint is a simple function of the outside temperature (e.g. linear function).		
	3	Variable setpoint with load dependent compensation: a control loop enables to control the supply air temperature. The setpoint is defined as a function of the loads in the room. This can normally only be achieved with an integrated control system enabling to collect the temperatures or actuator position in the different rooms.		
4.10	Humidity control		VENT_HUM_CTRL	M6–5 / M7–5
	The control of the air humidity can include humidification and/or dehumidification. Controllers can be applied as “humidity limitation control” or “constant control”.			
	0	No automatic control: no control loop enables to act on the air humidity.		
	1	Dew point control: supply air or room air humidity is expressed with the dew point temperature and reheat of the supply air to bring the relative humidity to the setpoint.		
	2	Direct humidity control: supply air or room air humidity, a control loop enables the supply air or room air humidity at a given setpoint. The setpoint is either fixed and predefined by the user or a fluctuating optimal value at a minimum energy but within min./max. limits of room air condition.		
5	Lighting control			
5.1	Occupancy control		LIGHT_OCC_CTRL	M9–5
	0	Manual on/off switch: the luminaire is switched on and off with a manual switch in the room.		
	1	Manual on/off switch plus additional sweeping extinction signal: the luminaire is switched on and off with a manual switch in the room. In addition, an automatic signal automatically switches off the luminaire at least once a day, typically in the evening to avoid needless operation during the night.		
	2	Automatic detection Auto on/dimmed off: the control system switches the luminaire(s) automatically on whenever the illuminated area is occupied, and automatically switches them to a state with dimmed status after the last occupancy in the illuminated area. Auto on/auto off: the control system switches the luminaire(s) automatically on whenever the illuminated area is occupied, and automatically switches them entirely off.		
	3	Automatic detection Manual on/ partial auto on /dimmed off: the luminaire(s) can only be switched on by means of a manual switch or automatically by occupancy detection sensor located in (or very close to) the area illuminated by the luminaire(s), and, if not switched off manually, is/are automatically switched to a state with dimmed status after the last occupancy in the illuminated area. Manual on/ partial auto on /auto off: the luminaire(s) can only be switched on by means of a manual switch or automatically by occupancy detection sensor.		
5.2	Light level/daylight control (daylight harvesting)		LIGHT_LEVEL_CTRL	M9–5
	0	Manual central: luminaires are controlled centrally, there is no manual switch in the room/zone.		

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Table 5 *(continued)*

Automatic control			
	1	Manual: luminaires can be switched off with a manual switch in the room.	
	2	Automatic switching: the luminaires are automatically switched off when more than enough daylight is present to fully provide minimum illuminance required and switched on when there is not enough daylight.	
	3	Automatic dimming: the luminaires are dimmed down and finally fully switched off, e.g. when daylight is available or when scene based light level control is applied. The luminaires will be switched on again and dimmed up if the amount of daylight is decreasing or when scene based light level control is applied.	
6	Blind control		
6.1	Blind control	BLIND_CTRL	M2.5/M2.8/M9–5
	There are two different motivations for blind control: solar protection to avoid overheating and to avoid glaring.		
	0	Manual operation: mostly used only for manual shadowing, energy saving depends only on the user behaviour.	
	1	Motorized operation with manual control: mostly used only for easiest manual (motor supported) shadowing, energy saving depends only on the user behaviour.	
	2	Motorized operation with automatic control: automatic controlled dimming to reduce cooling energy.	
	3	Combined light/blind/HVAC control: to optimize energy use for HVAC, blind and lighting for occupied and non-occupied rooms.	
7	Technical home and building management		
	The technical home and building management enables to adapt easily the operation to the user needs. One shall check at regular intervals that the operation schedules of heating, cooling, ventilation and lighting is well adapted to the actual used schedules and that the setpoints are also adapted to the needs. — Attention shall be paid to the tuning of all controllers, this includes setpoints as well as control parameters such as PI controller coefficients. — Heating and cooling setpoints of the room controllers shall be checked at regular intervals. The users often modify these setpoints. A centralized system enables to detect and correct extreme values of setpoints due to misunderstanding of users. — If the interlock between heating and cooling control of emission and/or distribution is only a partial interlock, the setpoint shall be regularly modified to minimize the simultaneous use of heating and cooling. — Alarming and monitoring functions will support the adaptation of the operation to user needs and the optimization of the tuning of the different controllers. This will be achieved by providing easy tools to detect abnormal operation (alarming functions) and by providing easy way to log and plot information (monitoring functions).		
7.1	Setpoint management	BMS_SP	M10–12
	Management, set back and adaptation of BAC setpoints according to the room/zone operating modes		
	0	Manual setting room by room individually	
	1	Adaptation from distributed/decentralized plant rooms only	
	2	Adaptation from a central room (e.g. work station, web operation; room operating units are excluded)	
	3	Adaptation from a central room (e.g. work station, web operation; room operating units are excluded) with frequent set back of user inputs	
7.2	Runtime management	BMS_RT	M10–12
	Adaptation of system/plant operating hours according to given time schedule and/or calendar		
	0	Manual setting (plant enabling)	

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Table 5 *(continued)*

Automatic control				
	1	Individual setting following a predefined schedule including fixed preconditioning phases		
	2	Individual setting following a predefined schedule, adaptation from a central room (e.g. work station, web operation; room operating units are excluded), variable preconditioning phases		
7.3	Detecting faults of technical building systems and providing support to the diagnosis of these faults		BMS_FD	M10–12
	0	No central indication of detected faults and alarms		
	1	With central indication of detected faults and alarms		
	2	With central indication of detected faults and alarms including diagnosing functions		
7.4	Reporting information regarding energy consumption, indoor conditions		BMS_RPR	M10–12
	0	Indication of actual values only (e.g. temperatures, meter values)		
	1	Trending functions and consumption determination		
	2	Analysing, performance evaluation, benchmarking of indoor environment and energy		
7.5	Local energy production and renewable energies		BMS_RES	M10–12
	Managing local renewable energy sources and other local energy productions as CHP			
	0	Uncontrolled generation depending on the fluctuating availability of RES and or run time of CHP; overproduction will be fed into the grid.		
	1	Coordination of local RES and CHP with regard to local energy demand profile including energy storage management; optimization of own consumption		
7.6	Waste heat recovery and heat shifting		BMS_HRC	M10–12
	Using of waste heat recovery on the building level and heat shifting			
	0	Instantaneous use of waste heat or heat shifting		
	1	Managed use of waste heat or heat shifting (including charging/discharging TES)		
7.7	Smart grid integration		BMS_SG	M10–12
	Interactions between building and any smart grid including demand side management			
	0	No harmonization between grid and building energy systems; building is operated independently from the grid load.		
	1	Building energy systems are managed and operated depending on grid load; demand side management is used for load shifting.		

5.5 BAC efficiency class

Four different BAC efficiency classes (A, B, C, D) of functions are defined both for non-residential and residential buildings.

— Class D corresponds to non-energy efficient BAC. Building with such systems shall be retrofitted. New buildings shall not be built with such systems.

— Class C corresponds to standard BAC.

— Class B corresponds to advanced BAC and some specific TBM functions.

— Class A corresponds to high-energy performance BAC and TBM functions.

The BAC implementation is categorized as class D if the minimum functions to be in class C are not implemented.

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To be in class C: minimum functions defined in Table B.1 shall be implemented.

To be in class B: building automation function plus some specific functions defined in Table 5 shall be implemented in addition to class C. Room controllers shall be able to communicate with a building automation system.

To be in class A: technical building management function plus some specific functions defined in Table 5 shall be implemented in addition to class B. Room controllers shall be available for demand controlled HVAC (e.g. adaptive setpoint based on sensing of occupancy, air quality, etc.) including additional integrated functions for multi-discipline interrelationships between HVAC and various building services.

EXAMPLE Electricity, lighting, solar shading, etc.

5.6 BAC and TBM functions assigned to the BAC efficiency classes

BAC and TBM functions described and summarized in Table 5 are assigned to the BAC efficiency classes as defined in 5.5, depending on their use in residential or non-residential buildings. The assignment of functions to the BAC efficiency classes is listed in Table 6.

Table 5 and Table 6 should be applied in the following way.

a) For the definition of the building automation and controls (BAC) and technical building management (TBM) functions to be implemented for a new building or for the renovation of an existing building:

   1) building owners, architects or engineers can put a marker in front of each of the functions in Table 6 they want to be implemented. They will use the indicated boxes as a help tool to determine in which BAC class A, B, C, D the function they have specified is located;

      EXAMPLE To achieve BAC class B, the marker shall be in a line where indicated boxes cover classes D to B.

   2) it will be a simplified alternative to specify only the classes of function A, B, C, D, especially for specifications at an early stage of a project to help defining preliminary specifications of the functions and a certain function type to be implemented for a given new building or for the renovation of an existing building.

b) For the definition of minimum requirements for BAC and TBM functions for new buildings as well as for renovations of buildings:

   1) public authorities can define the minimum class to be achieved, unless differently specified this class is C.

c) For the definition of inspection procedures of technical systems as well as inspectors applying these procedures to check if the level of BAC and TBM functions implemented is appropriate:

   1) public authorities can request the use of the table to inspect the BAC functions in place;

   2) inspectors can put an X in front of each of the BAC functions in Table 6 which is implemented;

   3) they will then be able to determine the class A, B, C, D of functions already implemented. To be in a given class all the X in Table 6 shall correspond to the indicated boxes for this class.

d) For the definition and implementation of calculation methods which take into account the impact of BAC and TBM functions on the energy performance of buildings, as well as software developers implementing these calculation methods and designers using them:

   1) public authorities can request that the impact of the BAC and TBM functions defined in Table 5 is taken into account;

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