Bundesministerium
für Verkehr, Bau
und Stadtentwicklung

Arbeitskreis Maschinen- und Elektrotechnik staatlicher und kommunaler Verwaltungen

AMEV

BACnet 2017 en

BACnet
in public buildings

Brochure No. 136 en

AMEV

Mechanical and Electrical Engineering Working Party of National, Regional and Local Authorities

BACnet
in public buildings

(BACnet 2017 en)

Brochure No. **136 en**

Established and published by
the Mechanical and Electrical Engineering Working Party
of National, Regional and Local Authorities (AMEV)
Berlin 2017

AMEV office at
Federal Ministry for the Environment, Nature Conservation,
Building and Nuclear Safety (BMUB); Ref. B I 32
Krausenstrasse 17-20, 10117 Berlin
Telefon: +49 30 18 305 7136
Computerfax: +49 30 18 10 305 7136
E-Mail:amev@bmub.bund.de

Information on new publications is available at www.amev-online.de or the AMEV office.

Contents

Contents		**5**
Prologue		**8**
Editorial		**9**
1	**Scope and application**	**10**
2	**Introduction**	**12**
2.1	***STANDARDIZATION***	**12**
2.2	***BASIC INTENT OF THE BACNET PROTOCOL***	**13**
2.3	***BACNET SYSTEM STRUCTURE***	**14**
3	**Basic principles**	**15**
3.1	***BACNET®***	**15**
3.2	***OBJECTS***	**15**
3.3	***PROPERTIES***	**16**
3.4	***SERVICES***	**16**
3.5	***CLIENT-SERVER PRINCIPLE***	**17**
3.6	***INTEROPERABILITY AREAS***	**18**
3.7	***BIBBS***	**18**
3.8	***STANDARD DEVICE PROFILES***	**19**
3.9	***PICS*** **19**	
3.10	***EPICS***	**20**
3.11	***CONFORMANCE TESTS***	**20**
3.12	***AMEV ATTESTATIONS***	**21**
3.13	***INTEROPERABILITY TESTS***	**21**
3.14	***EDE LISTS***	**22**
4	**Implementing BACnet systems**	**24**
4.1	***PLANNING AND EXECUTION***	**24**
4.2	***RECOMMENDED BACNET FUNCTIONS AND AMEV PROFILES***	**26**
4.3	***ALLOCATION OF BAC FUNCTIONS TO BACNET OBJECT TYPES***	**30**
4.4	***ADDRESSING SYSTEM***	**33**

5	Management and operating unit (MOU)	34
5.1	*GENERAL*	34
5.2	*HARDWARE*	35
5.3	*OPERATING SYSTEM*	35
5.4	*MONITOR AND OPERATE*	35
5.5	*FAULT MANAGEMENT*	36
5.6	*SCHEDULING*	37
5.7	*TREND AND HISTORICAL DATA*	37
6	Automation stations (AS)	38
6.1	*GENERAL*	38
6.2	*ALARM AND EVENT MANAGEMENT*	38
6.3	*NOTIFICATION CLASSES*	42
6.4	*I/O OBJECTS*	43
6.5	*RUNTIME TOTALIZATION*	45
6.6	*SCHEDULING*	45
6.7	*TIME SYNCHRONIZATION*	48
6.8	*TREND LOGGING*	49
6.9	*LOOP* 50	
6.10	*MANUAL INTERVENTION*	50
6.11	*SYSTEM FAULTS*	51
6.12	*POWER FAILURE AND RETURN*	51
7	BACnet networks	52
7.1	*NETWORK PROTOCOLS*	52
7.2	*BACNET/IP*	52
7.3	*BACNET MS/TP*	53
7.4	*BACNET LONTALK*	53
7.5	*BACNET/PTP*	54
7.6	*BACNET ADDRESSING*	54
7.7	*CONNECTION TO UNIVERSAL DATA NETWORKS*	55
7.8	*SECURITY CONCEPT AGAINST UNAUTHORIZED MANIPULATION*	55
8	Implementation concepts	56
8.1	*ISSUES AND APPLICATION NOTES*	56
8.2	*SYSTEM-ORIENTED SOLUTIONS CONCEPT*	57
8.3	*BACNET REQUIREMENT SPECIFICATION (OVERVIEW)*	58
8.4	*BACNET MIGRATION CONCEPT (OVERVIEW)*	60

Appendix 62

APPENDIX 1 OBJECT TYPES: OVERVIEW 62

APPENDIX 2 PLANNING AIDS FOR BAC FUNCTIONS LISTS 64
Appendix 2.1 Key for BAC functions list 64
Appendix 2.2 Dynamic displays in the MOU 64
Appendix 2.3 Plant diagram (example: AHU) 65
Appendix 2.4 Explanation of BAC functions and BACnet objects (example: AHU) 68

APPENDIX 3 ALLOCATION OF BAC FUNCTIONS TO BACNET OBJECT TYPES 74

APPENDIX 4 OBJECT TYPES: RECOMMENDATIONS 76
Appendix 4.1 Object type device 76
Appendix 4.2 I/O object types 77
Appendix 4.3 Complex object types 82

APPENDIX 5 BIBBS: OVERVIEW AND RECOMMENDATIONS 85

APPENDIX 6 DOCUMENTS FOR BACNET DEVICES 90
Appendix 6.1 PICS (form) 90
Appendix 6.2 AMEV attestation (brief description) 92
Appendix 6.3 AMEV attestation (form) 93

APPENDIX 7 ENGINEERING AIDS FOR BACNET PROJECTS 94
Appendix 7.1 Object type code (overview) 95
Appendix 7.2 Status texts (overview) 96
Appendix 7.3 Engineering units (overview) 98
Appendix 7.4 Event types for Intrinsic Reporting (examples) 101
Appendix 7.5 Notification class matrix (example) 102
Appendix 7.6 Event and acknowledgement options (example) 103
Appendix 7.7 Sample Specification for MOU 104

APPENDIX 8 GLOSSARY 107

APPENDIX 9 LITERATURE (GERMAN) 110

Contributors 111

Revision history 113

Prologue

In building automation, the communication protocol BACnet standardized in ISO 18486-5 assumes a prominent position all over the world. The protocol is very complex and technically sophisticated. It is also continually being further developed to adapt to the requirements of further building installations and to take account of new technical developments.

In order to support building owners and planners in the application of BACnet in public buildings, AMEV Recommendation BACnet 2007 described the requirements of the public authorities on BACnet systems in detail for the first time. With the BACnet 2011 update, the AMEV-BACnet-attestation was introduced, that allows manufacturers to demonstrate compliance with the AMEV requirements for their automation stations. AMEV-attestations have proven themselves and simplified the public tendering procedure for BACnet systems.

This AMEV Recommendation BACnet 2017 updates version 1.2 of BACnet 2011. While core requirements on BACnet systems remained unchanged, the new worldwide BACnet certification procedure was taken into account as well as version 2.3 of the EDE-Table. Sample specifications for the management and operation unit (MOU), which describe the basic requirements of the AMEV for the MOU, was newly added. The performance specification is generated by supplementing the sample specification with project-specific requirements.

The English version is published in cooperation with BACnet-Interest Group Europe (BIG-EU) as AMEV BACnet 2017 en.

The new AMEV Recommendation BACnet 2017 replaces BACnet 2011, which is being withdrawn at the same time.

Berlin, July 2017

Torsten Wenisch
Chairman of AMEV

Bernhard Hall
AMEV chairman BACnet

Editorial

BACnet has developed into the leading open communication protocol for building automation. Other building specialties such as elevators and escalators have been added, opening up new possibilities. The number of BACnet manufacturers with a BACnet vendor ID is growing steadily and is now in the four-digits. Topics such as "cyber security" and "IT compliance" are becoming increasingly important through the sharing of networks and have already been submitted as proposals for new BACnet extensions in the ASHRAE SSPC 135 (Standing Standard Project Committee). In this way, BACnet will be prepared for the challenges of the coming years and will continue to inspire the professional world.

The cooperation between the BACnet Interest Group Europe (BIG-EU) and the AMEV has always been strong and I look forward to this spirit continuing for many years to come. As in all good relationships, there are ups and downs, however that just shows how serious and conscientious both partners are working on the matter and are aware of their mutual responsibility.

For its part, the AMEV has expanded its network in the area of building automation and maintains the best contacts in Switzerland and Austria. As a representative of the public sector in federal, state and local government, their expertise in this market is very much appreciated.

The intensive cooperation with GAEB (Common Committee for Electronic Tendering in Construction) and other experts indicates the importance of the AMEV and its recommendations. In my experience, the experts mentioned regularly attend meetings only when they feel they can successfully influence an update to an AMEV recommendation. There are only a very few associations with the ability to inspire as many people as the AMEV over such a long period of time.

For this reason, my hope is that the AMEV will continue in this same manner in the future and that together we will successfully promote BACnet. The BIG-EU is still available as a critical and constructive partner at any time.

Klaus Wächter

President of BIG-EU
Siemens Building Technologies

1 Scope and application

The following information applies to planning, execution and operation of vendor-neutral building automation and control systems based upon the BACnet communications protocol. The aim is to integrate various BACnet devices from one single vendor (single-vendor-system) or from multiple vendors (multi-vendor-system) in public buildings.

Basic principles of building automation and control, which deal not with communications protocols (e.g. profitability, energy savings, system integration, BAC concepts, user requirements, competition, cost planning, acceptance, operating documentation, operating staff, maintenance) are not part of this recommendation.

For these general topics, see AMEV recommendation (only available in German) „Hinweise für Planung, Ausführung und Betrieb der Gebäudeautomation in öffentlichen Gebäuden (Gebäude-automation 2005)“ referred to simply as AMEV „BAC“ hereafter.

For completeness sake, "BACnet 2017" contains some information that is not exclusive to BACnet systems (e.g. implementation concepts). These aspects not considered in AMEV „BAC“ must be considered all the same in other BAC systems.

BAC planners are advised to note the following relations when considering the present recommendation:

- **Chapters 2 and 3** Introduction to BACnet (introduction, basics)
- **Chapter 4** Implementation of BACnet systems (planning, functionality)
- **Chapters 5 to 7** BACnet components (management and operating units, automation stations) and BACnet networks
- **Chapter 8** Implementation concepts (BACnet requirement specification, migration concepts)
- **Appendix 1** Overview of BACnet object types
- **Appendices 2 and 3** Allocation of BAC functions to BACnet object types (examples)
- **Appendices 4 and 5** Recommended BACnet functions (object types, properties, BIBBs)
- **Appendices 6 to 9** Additional supporting documents (PICS sample, AMEV attestations, glossary, and literature).

Experts for technical equipment in buildings who do not plan BAC systems on their own, thus requiring only basic knowledge of the BACnet protocol may focus on the following:

- **Chapters 2 to 4** Introduction to BACnet (introduction, basics, implementation)
- **Chapter 8** Implementation concepts (BACnet requirement specification, migration concepts)
- **Appendix 3** Allocation of BAC functions to BACnet object types (examples)
- **Appendix 6** Additional supporting documents (PICS samples, AMEV attestations).

The following terms are used throughout this document.

- BAC = Building automation and control
- MOU = Management and operating unit
- AS = Automation station
- LOU = Local override unit
- DP = Data point
- BIBBs = Interoperability blocks (see **Section 3.7**)
- PICS = Supplier conformance declaration (see **Section 3.9**)
- EPICS = Electronic conformance declaration (see **Section 3.10**)

BACnet standardization and experiences of AMEV with BACnet are subject to ongoing processes. Findings from new projects are discussed regularly in the AMEV circle for BAC.

AMEV publishes supplements to this recommendation on the AMEV website (see BAC at: (https://www.amev-online.de/AMEVInhalt/Planen/Gebaeudeautomation/BACnet%202017/).

The BACnet recommendation additionally contains links to third-party websites. AMEV cannot influence such sites and is not liable for the contents of such sites.

Text and figures contain specific trademarks and products to clearly describe products. This in no way can be interpreted as a recommendation by AMEV. At the same time, mentioning a product does not mean that that particular product is best suited for the related application.

AMEV does not make any claims to third-party names:

- BACnet® is a trademark of the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE).
- The BTL logo (BACnet Testing Laboratory) is a trademark of BACnet International (BI), earlier BACnet Manufacturers Association (BMA).
- KNX logo is a trademark of the KNX Association.
- Echelon, Lon, LonWorks, LonTalk, LonUsers and Neuron are trademarks of Echelon Corporation.

2 Introduction

The chapter provides an overview of standardization and the underlying idea of the BACnet protocol while explaining the principal build of BACnet systems.

2.1 Standardization

BACnet® (Building Automation and Control Network) is an international and european standard for data communication in building automation and control. As DIN EN, the standard is also a German standard, a new standard (draft = Entwurf) is published in Mai 2012:

> **DIN EN ISO 16484-5 Edition 2014-09 Building automation and control systems - Part 5: Data communication protocol (ISO 16484-5:2014) English version EN ISO 16484-5:2014**

The standard is based on ANSI/ASHRAE standard 135. The current version of standard 135 is available at http://www.techstreet.com/standards/ashrae-135-2016?product_id=1918140. ASHRAE provides supplementary information such as approved addenda free of charge for download (http://www.bacnet.org/Addenda/index.html).

The current ISO standard is more then 1000 pages strong when printed. In addition, about 550 pages contain the associated test standard (DIN EN ISO 16484-6). The standard has not been translated into national languages with the exception of the general part. Information on BACnet in German is available in the professional books mentioned in **Appendix 9**.

As ASHRAE, ISO, and DIN EN versions are published at different intervals, differences for BACnet products may result from different standard requirements. The process of BACnet standardization from ASHRAE and ANSI to ISO and DIN is shown in **Table 1**.

This and other information is available for download at the following Internet pages:

www.bacnet.org	**Official website for BACnet (with information on standardization status and free-of-charge download of addenda)**
www.bacnetinternational.org	**BACnet International website**
www.big-eu.org	**BIG-EU website with services and publications**
www.ashrae.org	**ASHRAE (information on ANSI/ASHRAE standard 135)**

A selection of additional publication on building automation and control (e.g. VDI 3814, VDI 3813, GAEB StLB-Bau 070, DIN ATV 18386) is specified in AMEV „BAC“.

This AMEV recommendation explains key terms and functions of the BACnet standard in **Chapter 3**. **Appendix 1** (Objects) and **Appendix 5** (BIBBs) provide a complete overview of current basics for BACnet standardization.

DIN EN ISO 16484-5 (2011-03) and **addenda up to Revision 1.12** by ANSI are included. BACnet functions defined by ASHRAE and released as addenda by ANSI but not yet included in the German standard are also mentioned.

"BACnet 2017" primarily aims at supporting practical application of the standard protocol. **Chapters 3 to 6** describe the recommended BACnet functions guaranteeing high applicability of BACnet systems and market presence of BACnet products.

Datum	ASHRAE	released addenda ANSI	version, revision	ISO 16484-5	DIN EN ISO 16484-5	AMEV BACnet
1	2	3	4	5	6	7
06/1995	135-1995					
10/1999		a				
04/2000		b	1.1			
09/2001		c, d, e	1.2			
	135-2001		1.2	→ 2003	→ 2004-08	→ 2007
04/2003		b	1.3			
10/2003		a, c, d	1.4			
	135-2004		1.4	→ 2007	→ 2008-05	(Erg. 2009)
02/2005		a, c, d	1.5			
03/2007		e, f	1.6			
10/2008		b, m	1.7			
	135-2008		1.7	→ 2010	→ 2011-03	
01/2009		g (s. Vers. 1.11 g)	1.8			
06/2009		j, l, o, r, s, v	1.9			
01/2010		h, k, n, t, u, w, x, y	1.10			
01/2010		g, p, z	1.11			
01/2011		ab, ac, ag, ah	1.12			
	135-2010		1.12	→ 2012	→ 2012-11	→ 2011
06/2011		ad, ae, af	1.13			
06/2012		i, aa, ao,ak	1.14			
	135-2012		1.14	→ 2014	→ 2014-09	
01/2013		ar	1.15			
07/2014		an,at,au,av,aw,ax,az	1.16			
12/2014		ai, al, as, ay	1.17			
02/2016		aj, ag, bf, bg, bh	1.18			
04/2016		am, ba, bc	1.19			
	135-2016		1.19	→ 2016 (FDIS)	→ 2016-12 (E)	

Table 1: Process of BACnet standardization (ASHRAE, ANSI, ISO, and DIN)

2.2 Basic intent of the BACnet protocol

BACnet is the first worldwide (ISO) standardized communications protocol for building automation and control (BAC). Much like other BAC protocols, it intends to provide supplier-independent communications between BAC components. To this end, BACnet contains all BAC elements (e.g. signal input, switching output, and controller) and describes their properties and states. This resulted in a common basis for all BAC elements and components.

BACnet applies an object-oriented approach proven many times over in IT to describe data elements and procedures. Each BAC elements is considered a complete object whose properties and states are described by a set of specifically assigned information.

The standard specifies the services used to read and write the above information from BAC elements, to generate, distribute, and process alarm and event notifications as well as to create and edit scheduler programs.

All elements required for supplier-independent communications are provided along with a definition of BACnet-approved transmission procedures.

The BACnet protocol with its supplier-independent communications and harmonized approach of all involved BAC elements offers a key prerequisite for transparent and cost-effective planning and engineering processes in building automation and control.

The final report of research project "Standardization of bus protocols for building automation and control in public facilities" by the German Federal Office for Building and Planning (BBR) from July 2007 (publication number 10.08.17.7-06.23) contains a practical evaluation of the BACnet protocol, its opportunities and risks. The results of the research project were included in this recommendation.

2.3 BACnet system structure

A BACnet system is a building automation and control system with communications between connected equipment based on the BACnet data protocol.

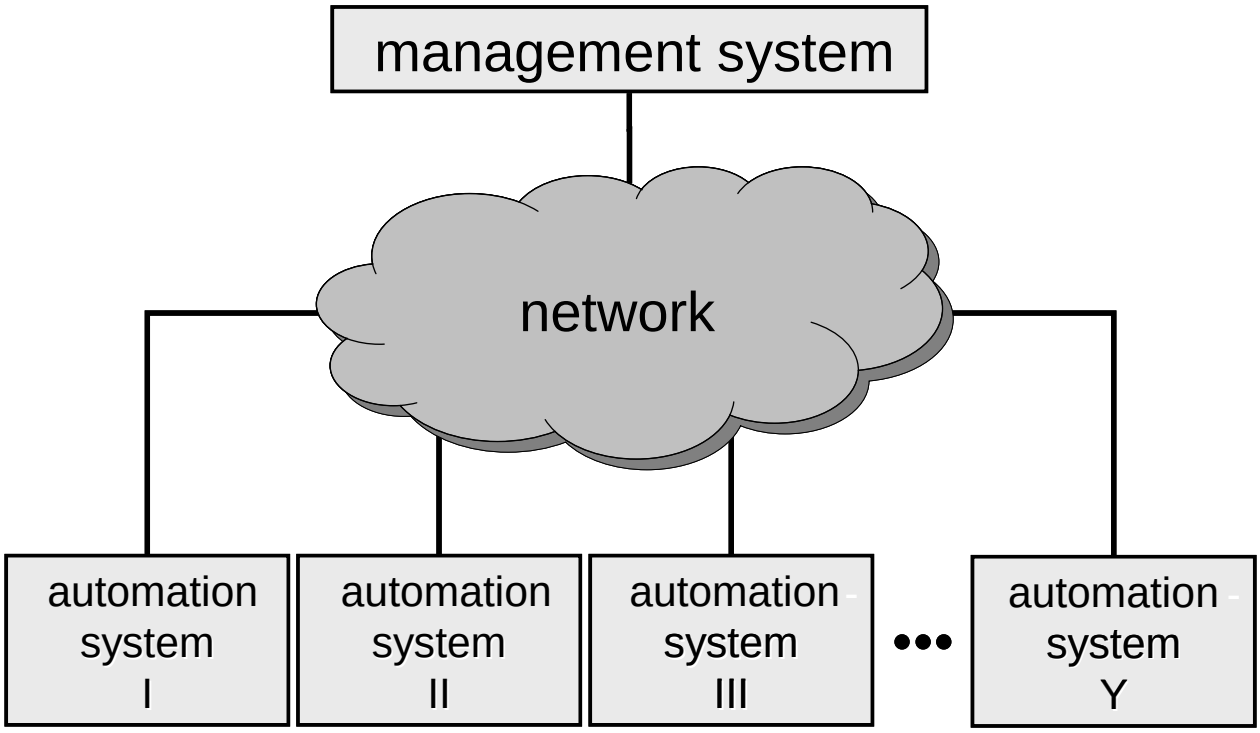


Figure 1: Basic principle of BACnet system

The basic structure of a BACnet system with its components (automation system(s), network and management system) is shown in **Figure 1**.

As a rule, the management system comprises one or multiple networked units (management and operating units - MOU) allowing for both management and operating functions.

The automation and control systems can include multiple, internetworked stations (automation stations AS) that can be grouped for various, technical installations. Subsystems can be placed in the automation and control systems (e.g. room automation, pump systems).

3 Basic principles

Below is an explanation of basic terms and structures of BACnet.

3.1 BACnet®

BACnet is an object-oriented data protocol for all building automation and control function levels (management, automation, and field level). Specifications for object types, services, and networks represent key elements of the protocol. BACnet allows for cross-system interoperability of equipment or systems from various suppliers, provided the BACnet functions implemented are aligned complementary one another.

3.2 Objects

Objects are created when the function properties of BAC are viewed as a whole. For example, the total information for an input function "room temperature" not only comprises the present numeric value of the room temperature but also further information such as physical unit, name and measuring point description, or limit values. As a whole, this information represents the BACnet object type "Analog Input" whose properties contain the aforementioned information.

Through March 2011, 50 standard object types were known, 30 of which were standardized as part of DIN EN ISO 16484-5:2011-03 and another 20 by the American National Standards Institute (ANSI).

Appendix 1 lists all 50 object types sorted alphabetically and provides the abbreviation as listed in the standard along with a short description.

The BACnet object types allow for mapping physical and communicating input and output functions as well as many processing functions such as scheduling, PI or PID control as per the specifications in the BAC list of functions under DIN EN ISO 16484-3 or VDI 3814 Sheet 1.

Allocation of BACnet object types to the BAC functions is described in **Section 4.3**. **Appendix 2** aids for a clear description of the allocation as well as a plant-oriented example for an air handling plant.

The allocation table in **Appendix 3** is sorted by plant parts and describes implementation of common BAC functions by means of BACnet object types.

Appendix 4 summarizes the object types recommended for public buildings. The existing BACnet object types clearly suffice to establish high-performance, interoperable building automation and control. The standard allows suppliers to develop proprietary object types. Replacing standardized object types by proprietary types is not allowed under the standard.

For engineering, each BACnet object is assigned a unique identification in each device by means of the Object_Identifier, established based on the related object type and instance number.

In higher-scope BACnet devices, individual object types shall be creatable and can be deleted dynamically (e.g. calendar, scheduler objects). These objects are listed in **Table 4** and explained in **Chapter 6**.

3.3 Properties

Properties (object properties) are an object-specific set of data whose fields contain all information required for the object's functionality. Properties either are read-only "R" (Readable) or read/write "W" (Writeable).

The standard specifies the mandatory properties for each standard object type of a BACnet server (normally an AS). It determines if these mandatory properties are either "R" (only Readable) or "W" (Readable and Writeable). A BACnet client (normally a MOU) can read and present the readable properties of the BACnet server (Present = „P“) and can read, present and modify the writeable properties (Modify = „M“).

Example:

> *An MOU can read but not change the setting of the readable property "Units" in an Analog Input object in the automation station. The readable value of the AS (**R**) is read and presented to the user by the MOU (**P**).*
>
> *To allow the user to enter a new Date_List in the Calendar object of an AS, the Date_List property of the Calendar object in the AS must be both readable and writeable (W). The MOU must allow the user to modify (M) the existing Date_List.*

In addition, the standard provides optional properties whose application and read/write properties depend on the function of the real plant and are needed in many cases. These must be set up both compliant with the standard and interoperable within the system.

Some properties do not contain a single information, but rather structured sets of information (e.g. Weekly_Schedule of the Schedule object in **Section 6.6**).

The standard allows suppliers to define their own properties. This may result in problems in multi-vendor-systems when connecting BACnet devices from multiple suppliers.

Appendix 4 comprises the object types, properties and read/write access recommended for public buildings in tables.

3.4 Services

Services describe the procedures available to BACnet system members for communication (e.g. to read and write properties of other BACnet objects).

Example:

> *BACnet knows multiple services to create notifications:*
>
> - *Notifications created upon a change of value (COV Reporting)*
> - *Object-internal notification (Intrinsic Reporting)*
> - *Rule-based notification (Algorithmic Change Reporting)*

COV Reporting also helps transfer a new value automatically to previously specified recipients in case of a change of value COV in an object. COV also comprises COS (change of state) Reporting. COV and COS are referred to as COV hereinafter.

In analog objects or controller objects, a threshold value for COV (e.g. room temperature change by 0.3 K) is set as property (COV_Increment). In binary objects, the change of state alternates from 0 to 1 or from 1 to 0.

Intrinsic reporting supports reporting based on multiple, variable selectable events (see event types in **Appendix 7.6**). This includes, for example, monitoring lower and upper limit values in analog objects (Low_Limit and High_Limit). Reporting is created within the object.

Algorithmic change reporting can be used to generate reporting by a predefined algorithm from one or several properties of one or several objects. Reporting is created in a separate event enrollment object.

Services can be applied only to set up object types and properties. For example, COV reporting in analog objects is carried out only if the objects have property COV_Increment, and if the service for COV reporting is set up in the AS and is subscribed to by the MOU.

In March 2011, the BACnet protocol provided more than **40** services allocated to five categories:

- Object access services
- Device and network management services
- Alarm and event services
- File access services
- Virtual terminal services

To promote technical development, the standard also allows for developing additional proprietary services based on PrivateTransfer services. Substitution of standardized services by proprietary services is not allowed.

3.5 Client-server principle

Data exchange on BACnet services follows the client-server principle. The BACnet client requests a service from the BACnet server, and the BACnet server carries out the service. Communication can also be triggered by an event in the server. For example, in case of a limit value violation the event notification service makes the server send out a notification to one or several clients.

An MOU is a typical BACnet client. An AS acts as a BACnet server if it provides the information requested by an MOU. BACnet members can be both client and server at the same time. For example, AS can contain both requesting and provisioning services.

Roles among BACnet communication members are specified during planning and execution of the BACnet system.

3.6 Interoperability areas

Interoperability areas describe function ranges of BACnet systems vital to operation. The BACnet standard has five interoperability areas (IOBs):

- Data Sharing - DS
- Alarm and Event Management - AE
- Schedule - SCHED
- Trending - T
- Device and Network Management - DM

BACnet services (BIBBs) required to carry out functions are assigned to each IOB.

3.7 BIBBs

BIBBs (BACnet Interoperability Building Blocks) describe the functional prerequisites BACnet devices must fulfill for interoperable communication. Associated BIBBs of clients and servers are prerequisite for interoperability of these devices.

The standard describes the functionality for each BIBB (e.g. the device processes notifications via alarms and other events) and lists the services the BIBB must have to carry out the related function.

In addition, the standard indicates if a BIBB must be able to initiate or execute a service. BIBB lettering (A or B) differentiates BIBBs for devices requesting data or services (client or A-Device) and BIBBs providing data or services (server or B-Device).

In addition, some BIBBs must support specific objects or properties. Furthermore, the value ranges of properties or service parameters can be limited.

BIBB designations comprise a short designation of the interoperability area, the function, and letters A or B as per the BIBBs' data exchange role.

Example:

> *According to the vendor, a device supports BIBB "DS-RP-B". DS stands for interoperability area "Data Sharing" (see **Section 3.6**). To this end, the device must be able to execute BACnet service "ReadProperty" (RP). The device must provide the service as B-Device to another device (A-Device).*

Annex K of the DIN EN ISO 16484-5 (2011-03) standard describes **67 BIBBs**. **Addendum L** defines 24 additional BIBBs and labels 6 BIBBs as deprecated, i.e., they will continue to be supported, but no longer are recommended for use.

Appendix 5 contains an overview of all currently standardized BIBBs along with a brief description of function and recommendations for using the BIBBs in public buildings.

3.8 Standard device profiles

Annex L of the standard describes standardized types (profiles) of BACnet devices (standardized BACnet devices). Each profile defines the BIBBs the devices must know to be able to be referred to as standardized BACnet devices.

The standard differentiates between eight standard device profiles:

- Management and operating unit with scope greater than B-OWS (B-AWS - Advanced Operator Workstation)
- Management and operating station (B-OWS - Operator Workstation)
- Local operator unit (B-OD - Operator Display)
- Programmable automation station (B-BC - Building Controller)
- Automation controller featuring lesser scope than BC[1)] (B-AAC - Advanced Application Controller)
- Automation controller featuring lesser scope than AAC[2)] (B-ASC - Application Specific Controller)
- Switching or actuating device (B-SA - Smart Actuator)
- Sensor (B-SS - Smart Sensor)

[1)] For example, a device with multiple, set programs for selection.
[2)] For example, a device with one set program, e.g. individual room controller.

Appendix 5 indicates (among others) which BIBBs are assigned to device profiles B-AWS, B-OWS, and B-BC.

In real life, predefining standard device profiles has not worked, as they do not contain minimum requirements for object types, properties and read/write access. A functional minimum scope so far has been defined only for BACnet services.

Similar to the device profiles, AMEV defined application-relevant BACnet functions for AS and MOU vendor-neutral as **AMEV profile** (see **Section 4.2**).

3.9 PICS

A PICS (Protocol Implementation Conformance Statement) is a manual declaration by the vendor according to Annex A that the device is conformant to the standard.

As per the standard, a PICS must contain information on the following:

- Product Description
- Standardized Device Profile
- BACnet Interoperability Building Blocks supported
- Segmentation Capability
- Standard Object Types Supported
- Data Link Layer Options
- Device Address Binding
- Networking Options
- Character Sets Supported)
- Further information (for gateways)

The following information must be indicated additionally for the supported object types:

- Information on dynamic creatability/deletablility of an object,
- List of all supported, optional properties,
- List of all writable properties,
- List of all proprietary properties with identifier, data type and meaning,
- List of all possibly existing, proprietary area limitations.

A PICS sample is provided in **Appendix 6.1**.

The PICS tells users which functions are supported by a BACnet device. The PICS only contains unchecked vendor information.

3.10 EPICS

EPICS (Electronic Protocol Implementation Conformance Statement) is defined in standard DIN EN ISO 16484-6. It is created by automatic reading of the BACnet functionality of an engineered BACnet device, and contains significantly more information than a PICS.

EPICS, among other information, contains a complete list of all services, objects, and properties, which are implemented (services) and set up in the BACnet device. Dynamic creation and deletion (DC/DD) of objects and writing (W) of properties are indicated also.

The EPICS, e.g., is used as electronically generated information on the engineered BACnet device when preparing conformance or interoperability tests. Following testing, the EPICS is added to the test report as an Appendix.

3.11 Conformance tests

BACnet product vendors use conformance testing to prove their devices' conformance to DIN EN ISO 16484-5. A BACnet Testing Laboratory (BTL) tests the devices based on the current test standard (including all addenda):

DIN EN ISO 16484-6 "Building automation and control systems (BACS) - Part 6: Data communication conformance testing"

The laboratory uses, among others, the BACnet test framework (BTF) software for testing and summarizes the test results in an extensive test report. The test report also contains the EPICS along with a detailed description of the objects, properties, and BIBBs set up by the vendor and tested by the lab. The test lab hands over the test report to the vendor.

After successful testing of a product by a test laboratory accredited according to EN ISO / IEC 17025 (General Requirements for the Competence of Calibration and Testing Laboratories) the BTL certificate may be awarded by a certification body designated by BACnet International. From 2017 onwards, BTL certificates replace the European BACnet certificates issued by WSPCert on behalf of BIG-EU. The BTL certificates are published in the BTL Product Listing.

3.12 AMEV attestations

In addition to conformance proof, the builder can require that offered BACnet devices must support a BACnet profile defined by AMEV. As a verification sheet for such a demand AMEV developed a so-called AMEV attestation in agreement with BIG-EU. The AMEV attestation reduces the expense for checking whether offered devices support the demanded BACnet functions. If the demand of the builder fits with an AMEV profile, an examination becomes dispensable by presentation of the corresponding AMEV attestation.

Appendix 6.2 briefly explains the procedure to establish an AMEV attestaton. **Appendix 6.3** contains the blank form for an attestation. The AMEV attestation names the certified BACnet device, the tested release status, some key performance features, the supported AMEV profile and the basis for the AMEV attestation (test report, AMEV recommendation and BACnet certificate).

Based on the testing methods set forth in DIN EN ISO 16484-6, the AMEV attestation confirms, that the device supports the BACnet functions as per the named AMEV profile. Other statements, e.g. on the device's interoperability with other BACnet devices or other functionality of the manufacturers own commissioning tool for setting up BACnet functions are not provided.

3.13 Interoperability tests

The BACnet protocol aims at interoperability of various BACnet devices. Conformance test results provide only limited information on interoperability, as they merely confirm that a device supports the tested BACnet functions.

For permanent, smooth communications, all BACnet devices involved must adhere to the exact same rules. The standard specifies two conditions that must be met to meet desired interoperability between devices of multiple vendors:

1. The BACnet devices involved must have exactly matched BACnet functions set up as per the desired type of interoperability, and
2. All set up BACnet functions must conform to the standard's requirements.

In vendor-neutral BACnet systems, planners and users must specify the required BAC and BACnet functions as well as implementation of BAC functions in BACnet objects and services to ensure suitable BACnet devices are employed and the required functions are enabled in the BACnet devices.

All companies involved in a BACnet project must set up BAC functions, BACnet objects, properties, read/write access, and services in their BACnet devices to comply with specifications.

When BACnet devices of multiple vendors are interconnected for the first time, interoperability testing is recommended to ensure effects of possible device-specific interoperability issues are identified prior to order.

The German Federal Office of Building and Regional Planning has commissioned a research project "Systematics of application-oriented interoperability testing to establish BACnet-based multi-vendor-systems in building automation and control" to clarify procedures for interoperability testing. The final report (German only) is published on the Internet (http://www.bbsr.bund.de/, use search item „BACnet“).The results of the research project were included in this recommendation.

The scientifically valid testing procedure allows independent, competent BAC experts to test guaranteed functionality upon interconnection of multi-vendor BACnet devices with regard to application and at reasonable effort. Future interoperability testing must be conducted on this basis. AMEV profile B is recommended as minimum scope to test BACnet devices.

In the case of completely successful testing, a publication is proposed so that further BACnet users can use the results. For this purpose, the test procedure is to be described in a differentiated and comprehensible manner using the form sheets of the following documents:

- Test specification (author, buyer)
- Documentation of test units (vendor)
- Testing lists for interoperability testing of BACnet communications, BAC functions, and performance (testing institute)

It is recommended to document the established interoperability of two BACnet devices in the so called BACnet interoperability attestation (BIOP attestation, German: BIOP-Testat). The BIOP attestation contains information about the tested devices, the test conditions (pre-defined BA functions, etc.) and the test institutes.

3.14 EDE lists

EDE lists (Engineering Data Exchange = EDE files) supplement the data contained in the EPICS with additional (meta) information which is necessary for a complete engineering. EDE lists containing selected, project-specific data may be useful as engineering aid if comprehensive information (e.g. EPICS) is not available.

Usualy - when the required BACnet services, objects and properties are available in the network - data are exchanged online between the BACnet communication partners during commissioning . If this type of network communication is unavailable (e.g. preengineeirng at factory), the MOU (and possibly AS in case of peer-to-peer operation) requires offline engineering of its data basis before commencing standard BACnet communications online. The required BACnet data is made available as a file for "offline" commissioning. Thus, the MOU is pre-set so that it can subsequently establish a network connection to the AS.
EDE lists facilitate “offline” engineering by providing a standardized form for preparation, exchange and documention of project-specific BACnet information.

The EDE list is not normatively defined, but version 2.3 (http://www.big-eu.org/fileadmin/downloads/big_ede_2_3.zip) is recommended by BIG-EU and AMEV. Due to the good suitability for tabular representations and wide dissemination, XLS or CSV were chosen for the representation format. The EDE list comprises a total of 4 sheets (EDE table, state texts, unit texts, object types).
If project- and property-specific additions are necessary in addition to the specified data fields of the EDE list, they must be defined by the project participants before realization.

EDE lists must fully document all BACnet objects along with the properties specified in the list. All information on names, addresses, units, value ranges, description texts, alarm limit values, notification classes, etc. must be coordinated with the user and shall follow unified systematics (see examples in **Appendices 7.2 to 7.6**). The available character set must be considered.

To ensure that the information provided in the EDE list correctly reflects the configuration of the AS, EDE lists must be generated in an automated manner by using a software tool and shall be exported to a file. Meta information which cannot be retrieved from the AS must be entered manually with care.

Blank page

4 Implementing BACnet systems

This chapter describes higher requirements of BACnet system members.

4.1 Planning and execution

BAC planning is tasked with establishing concepts from absolute requirements and derived demand, and proposing solutions (see AMEV „BAC“). Existing BAC specifications or operating concepts serve as fundamentals.

Observe the following **fundamentals** when planning BAC systems:

- The BAC functions required for the project are described in terms of quality and quantity.
- Determine which BAC functions are for AS and which for MOU.
- The BAC functions are implemented based on predefined objects, properties, and services.
- Proprietary services, object types, and properties are not allowed during online operation. Exceptions may be set up only if the operator/owner agrees.
- Extensions and updates must be compatible with a vendor-neutral BACnet concept.

BACnet systems, as a rule, are set up as modular IT systems based on client-server architecture, using standardized operating systems, networks, and protocols. The systems must allow for distributed functions in the entire network. Extensions must be possible to guarantee future requirements of flexibility and performance.

Use of the BACnet protocol does not impose special hardware (e.g. processors, memory chips) and software requirements (e.g. operating system) for a BAC system.

Rather, design and performance shall be oriented to the expected scope of data and functions, requirements for data security and memory as well as required interfaces.

The required performance of BACnet devices in terms of processing BACnet objects is derived from all BAC functions lists in the project and the resulting tasks for MOU, AS, and network components. All required objects for partial plants shall be specified by BAC functions lists (see **Sections 4.2 and 4.3**).

Hardware and software should be chosen in order to ensure required reaction times (see AMEV „BAC“).

When planning peer-to-peer communications (see **Appendix 8 Glossary**), clarify the scope required for peer-to-peer communications. Note especially clarification by system POCs and liability scopes.

If plant components and monitoring functions via field bus systems (e.g. LON, KNX) are integrated in BACnet, the BACnet objects and properties for information exchange and subsystem monitoring (e.g. watchdog function) must be specified.

Character set UTF-8 is required to ensure interoperability. Certified BACnet devices up to BACnet revision 1.9 simply must support character set ANSI X3.4. Character set UTF-8 ist downward compatible to ANSI X3.4 (see **Appendix 8 Glossary**).

All BACnet objects contain user addresses as per the owner's addressing system. Clear texts, state texts, and physical units are predefined (**Appendices 7.4** and **7.5**). Alarm and event management is structured as notification class array (**Appendices 7.7 and 7.8**).

Integration of data networks must be discussed and agreed to with IT administration staff. Management of BACnet and IP addresses as well as BBMDs is possible via B-PAT table (see **Section 7.6**).

During planning, identify the tools required to prove BACnet functionality as well as fault identification during operation (e.g. BACnet tools or protocol analysis tools), and who will operate the tools. The tools must support all BACnet objects and services used in the project, and consider the conditions imposed by the BAC networks (e.g. switched IP networks). They must allow for real-time logging of all data packets and detailed network activity analyses to satisfy requirements of proof in the event of liability issues. Qualified tool operation shall ensure fast error analysis (e.g. in the event of errors).

BACnet tenders require technical descriptions, certificates, listings, AMEV attestations (complete testing reports as an alternative), and PICS for all offered BACnet products. Proof of conformance (certificates and BTL Product Listings) shall be provided by means of conformance testing based on DIN EN ISO 16484-6, carried out by an accredited testing facility.

For new BACnet AS, required BACnet functionality must be tested successfully as per DIN EN ISO 16484-6 (AMEV attestation).

Prior to initial interconnection of multi-vendor AS and MOU, interoperability of required functionality must be proven (e.g. by means of test installation as per AMEV „BAC“).

BACnet project contractors must provide proof of their expertise, performance, and reliability by means of references from similar BACnet projects.

BACnet MOUs must be able to monitor all devices and objects in a BACnet network (segment), i.e. the MOU must be able to read the current status of all properties. BACnet MOUs must be able to enable new AS with predefined functionality. If existing AS shall be integrated (e.g. with older BACnet revision), available functionality may be reduced.

As part of BACnet project implementation, all parties involved must set up the required objects, properties, services or BIBBs to ensure interoperability within the BACnet system.

Under the BACnet system philosophy, decentralized task processing requires that BAC functions be set up primarily in the AS and execute autonomously (active front-end processing).

With offline engineering of the MOU, contractors for the AS must generate the EDE lists (files) for their BACnet devices (see **Section 3.14**) and hand them over to the MOU contractor. All set up objects and properties shall be listed. Proprietary object types and properties must be released by the operator prior to implementation. All EDE files must be checked for completeness, unification, and plausibility – similar to the handling of assembly schedules and installation plans.

After AS and MOU are set up as required, they immediately start to communicate after interconnection. Both type and scope of data traffic shall be checked and documented during commissioning (e.g. via protocol analyzer).

As part of acceptance, the builder receives a complete and up-to-date set of documentation on the BAC plants in the required language both in electronic form and on paper, including all automation diagrams, BAC functions lists, function descriptions, lists of actually used objects and properties and supported BIBBs/services (EPICS), proof of training as well as operating, maintenance and service instructions.

In addition, the builder also receives all system passwords for unrestricted access to the MOU, AS, and other BACnet devices including system passwords up to administrator level. Furthermore, the builder receives all required software tools and project-specific programs (including source programs) with unrestricted user rights and access privileges.

Training sessions up to "Administrator" level empowers owners/operators to change or extend graphics, schedules, control parameters, objects, trends, alarms, application programs as needed, and hardware extensions, and make them transparent in BACnet.

In addition, note all recommendations listed in the sections below as well as the chapters on MOU, AS, and networks.

4.2 Recommended BACnet functions and AMEV profiles

Deciding in favor of the BACnet protocol and purchasing BACnet-capable components alone does not automatically translated into comprehensive and trouble free building automation and control and related data communications. The statement that components are compatible does not automatically mean that components are also interoperable.

Interoperability of components in BACnet systems must be ensured as part of the planning and execution process. During BAC planning, BACnet functionality requirements shall be defined project-specific.

The multitude of possible BACnet object types and properties allows for different ways to communicate, but may also result in a large number of variants with restricted interoperability requiring greater planning, coordinating, and administrative efforts.

The more special functions are added to actual operationally relevant standard functions, the more difficult BACnet operation and future extensions.

BACnet planning thus must be restricted to mandatory object types, properties, and BIBBs. Not required performance features must not be enabled to avoid possible sources of error and unnecessary effort. When updating BACnet devices, downward compatibility with regard to existing performance features is a must.

Minimum requirements for BACnet functionality and interoperability of the most important system components are described below as AMEV profiles A and B for certified BACnet MOU and AS.

Table 3 lists the standard object types with high application relevance and market availability, which are recommended as AMEV profiles for AS. In column 3 the object types are assigned to AMEV profiles AS-A and AS-B according to function and relevancy.

Object types as per **AMEV profile AS-A** are recommended as **basic set for AS**. This includes the Device object, all analog, binary, and multistate I/O and value object types, and four complex object types.

AMEV profile AS-B defines an **extended set for AS** comprising in addition to basic types three other complex object types. They may be important for plant management, or useful as supplementary equipment, or required for realization of special applications.

BACnet Object Type		**AMEV profile AS-**	**Notes**
(standard)	(abbr.)		
1	2	3	4
Device	DEV	A and B	Mandatory object
Analog Input	AI	A and B	
Analog Output	AO	A and B	
Analog Value	AV	A and B	
Binary Input	BI	A and B	
Binary Output	BO	A and B	see **Section 6.4**
Binary Value	BV	A and B	
Multi-state Input	MI	A and B	**optional**
Multi-state Output	MO	A and B	**optional**
Multi-state Value	MV	A and B	
Calendar	CAL	A and B	see **Section 6.6**
File	FIL	A and B	see **Section 4.2**
Notification Class	NC	A and B	see **Section 6.3**
Schedule	SCHED	A and B	see **Section 6.6**
Event Enrollment	EE	B	see **Section 6.2**
Loop	LP	B	see **Section 6.9**
Trend Log	TLOG	B	see **Section 6.8**

Table 3: Overview of recommended BACnet object types

Appendix 4 defines the BACnet object types for **AMEV profile A** (basic) and **AMEV profile B** (extended) including properties and read/write access for MOU and AS. Appendix 4.1 describes object type Device, **Appendix 4.2** all I/O object types, and **Appendix 4.3** recommended, complex object types. Support of Multi-state I/O-object types in AS is not required stringently, as their essential functions in AS may be realized by simple I/O-object types equivalently.

MOU according to **AMEV-Profil MOU-A and MOU-B** just support the Device object. They must be able to read and present the object types named in **table 3** and the readable properties as per **Appendix 4**. They can read, present and modify the writeable properties as per **Appendix 4**.
Note the recommendations for dynamic creation (DC) and dynamic deletion (DD) of BACnet object types as listed in the **Table 4** supplement **Appendix 4**. MOU-B enable the operator to create and delete the object types of AS as per **table 4**.

BACnet Object type (Dynamically Creatable - DC / Dynamically Deletable - DD)	AMEV profile	
	AS-A	AS-B
1	4	5
Calendar		DC/DD
Event Enrollment		DC/DD
Notification Class		DC/DD
Schedule		DC/DD
Trend Log		DC/DD

Table 4: Recommended, dynamically creatable and deletable BACnet object types

Appendix 5 contains a detailed overview of BIBBs standardized or released by ANSI. The table is sorted by BACnet standard and explains the BIBBs based on a short functional description.

In addition, **Appendix 5** defines BIBBs recommended for **AMEV profile A** (basic) and **AMEV profile B** (extended) for deployment in MOU and AS. AMEV profiles A and B support the BACnet / IP network protocol according to Annex J of the BACnet specification.

In Europe commonly used device versions support at least the object types, properties, read/write access, and BIBBs as specified in AMEV profile A. This basic set allows high-performance building automation and control and BACnet communications for standard applications.

AMEV profile A establishes communicative basics for the following key BAC functions:

- Automated binding of BACnet devices (dynamic device binding)
- Signaling event and alarm information to various recipients
- Notification of MOUs and other clients on current plant information
- Manual operation of total plants and plant components via MOU
- Creating and changing alarm limits, setpoints, and other parameters
- Creating and changing all schedule functions of the MOU
- Providing trend data via COV and logging historical data in MOU
- Monitoring functionality of all connected BACnet devices
- Automated time synchronization
- Saving and reloading application programs and parameters with object type File and BIBBs "DM-BR-A/B" (Backup and Restore)

Extended means deploying object types and BIBBs as per **AMEV profile B**, providing for the following, supplementary BAC functions:

- **Trendlog object:**
  Logging trend data locally in the AS, group them and pass them on to the MOU
- **Loop object**:
  Harmonized display as well as changing setpoints and parameters of the loop objects

Event Enrollment object:
Notification of complex event and alarm information by means of algorithmic change reporting.
To implement BACnet systems, the desired BACnet functionality shall be specified based on actual demand and current market conditions.

Builders, BAC planners, and operators are encouraged to avoid maximum demands, as they heighten efforts for procurement, engineering, operation, and administration, limit the number of possible competitors, and unnecessarily impair economic viability of the BACnet system.

It is important to ensure that no dependence on individual vendors, suppliers, or service providers is created (e.g. due to a requirement for special functions, purchase of insufficient licenses, or accepting incomplete documentation or passwords).

Third-party offerings for BAC systems required repeatedly during operation (e.g. adding to AS to MOU, updating MOUs and AS) must be specified in the tender (together with an escalator clause for human resource and material costs as needed).

The BACnet tender must fully describe the intended exchange of information.

Referencing the AMEV profiles in **Appendices 4 and 5** is recommended to simplify BACnet specifications for AS and MOU.

If an MOU or AS only requires basic BACnet functionality, it must support **AMEV profile MOU-A** or **AS-A** with object types, properties, read/write access, and BIBBs as per **Appendices 4 and 5**.

If an MOU or AS requires extended BACnet functionality, it must support **AMEV profile MOU-B** or **AS-B** with BACnet object types, properties, read/write access, and BIBBs as per **Appendices 4 and 5**.

If the required functionality exceeds AMEV profile B, the required, additional BACnet functions shall be defined impartial to vendors as per GAEB-Beiblatt 070-12 BACnet (GAEB = Common Committee for Electronic Tendering in Construction; Germany) – see http://www.gaeb.de/fileadmin/user_upload/Downloads/Beiblatt_070-12_BACnet.xls.

In case of doubt about commercial availability of the desired scope of functions (e.g. properties, read/write access, or BIBBs), the BAC planner shall establish a market overview of possible certified BACnet devices). Generally, avoid selecting stand-alone BACnet functions.

A separate GAEB-Beiblatt 070-12 must be established for each device type with special BACnet profile. Beiblatt 070-12 is also recommended for user-specific definitions of the desired BACnet functionality in vendor-neutral specifications and migration concepts for BACnet systems.

The technical specifications must require handover of PICS and required certificate along with each offered BACnet product.

The tender also shall contain the required AMEV attestation for certified BACnet devices as proof of actual testing of the BACnet functions as per the required AMEV profile (e.g. AS-A) during certification of the tendered BACnet device (see **Appendix 6.3**).

Based on the documentation, planners ensure that the required object types, properties, read/write access, and BIBBs are supported.

4.3 Allocation of BAC functions to BACnet object types

The BAC functions list (BAC-FL) as per DIN EN ISO 16484-3 or VDI 3814 Sheet 1 documents the scope and type of information exchange between plant and BAC system for each data point. It is required to describe the automation and management tasks, and, at the same time, serves as calculation and billing aid for automation and management functions. The BAC functions as per DIN EN ISO 16484-3 or VDI 3814 Sheet 1 comprise all required services to provide a fully functioning BAC system.

The BAC functions list is structured as a matrix comprising one uniquely number row for each data point. The first column contains the clear-text name of the data point and user address indication. All other columns define one BAC function each, allocated to one of eight topical areas (e.g. I/O functions, processing functions, management function, operating function).

The required BAC functions for each data point must be documented clearly by entering the required number in the fields marked by row number (data point), section number, and column number (BAC function).

Comments (Section 9) contains a functional relationship description of the respective data point's BAC function with networked, other BAC functions, and must be supplemented on a separate sheet as needed. In addition, the BAC function used to exchange information between AS, MOU, and other BACnet devices (e.g. present value) must be allocated to a BACnet object type as needed.

Comments in Section 9 vary by BAC planner and often are hard to understand. For this reason, AMEV developed a key for clear and definite short descriptions in the BAC functions list. The symbols for short descriptions are listed as an excerpt in **Table 5** and explained based on examples. **Appendix 2.1** contains a comprehensive AMVE key for the BAC functions lists.

No.	**Symbol** (**blue**)	**Meaning**	**Example** (with explanation)
1	2	3	4
1	R.S.C	The 3-digit code specifies a BAC function : **R**=Row no., **S**=Section no., **C**=Column no of BAC-FL	1.1.3 (DP 1; BAC function: Binary input notification)
2	**BI**	Abbreviation for BACnet object type (e. g. BI)	Binary Input
3	R.S.C=BI	Allocation of BAC function to R.S.C to BACnet object BI	1.1.3=BI

Table 5 Symbols for a short description of BACnet object type allocation

The AMEV key names each BAC function based on the BAC functions list by indicating the row number of the data point along with section and column in the BAC function (see row 1 in **Table 5**). In case of self-reference of a BAC function within one row, the BAC function symbol may have 2 places only (without Row). For the BACnet object type, the standardized abbreviation is used as per **Appendix 1** (row 2). Symbol "=" allocates a BAC function (e. g. 1.1.3: Binary input notification) to a BACnet object type (e. g. Binary Input).

The following minimum requirements are placed on BAC functions lists as per DIN EN ISO 16484-3 or VDI 3814 Sheet 1 for a unique specification of all BAC functions as well as traceable allocation of required BACnet objects and related properties:

- All planned data points must be displayed by row and contain user addresses as well as clear text if possible.
- For each automation station, all rows in the related BAC functions list must be numbered continuously across all plants to allow for unique referencing.
- All required BAC functions (physical I/O functions, shared I/O functions, processing functions (monitoring, interlock, control, and optimization function), management and operator functions) must be defined in Sections 1 to 8 and the associated columns along with number and allocation per data point.
- All I/O functions used previously in a BAC system and all virtual data points with own user address for common use must be entered for the related automation and control equipment in Section 2 of the BAC functions list, not Section 1.
- Control functions must be allocated to the reference actual value (sensor) of the control loop.
- When generating alarms and event notifications, additional dynamicism must be entered in Section 8 only if the graphic diagram must show additional dynamicism for the event (e.g. additional display/detailed information window). This does not apply to event and alarm entries in the event and alarm logs.
- Comments in Section 9 contains clear allocation of BAC functions via row no., section no, and column no. as per AMEV key.
- The type of notification processing [summary, delay, suppression] must be specified in Section 9 Comments (state processing ≠ alarming!).
- All complex object types (Column 7.2) must be entered in Section 9 Comments along with the abbreviations of the BACnet object types to be used.
- All virtual data points with own user address must be displayed in a separate row, and the related BACnet object types must be indicated in Section 9 Comments.
- The planned logic functions must be entered by indicating associated inputs as per AMEV key in Section 9 Comments.
- For each predefined function, "external influence" must be indicated along with the related BAC functions (reference points) in Section 9 Comments.
- In case of sequencing, sequence points must be indicated by the referenced data points or BACnet objects in Section 9 Comments.
- If a row in Section 9 Comments does not suffice, other rows can be used or extra sheets (along with clear indication of unique references).
- Complex functions (e.g. "plant control" or "motor control") must be displayed additionally as flow charts or function graphs (cp. VDI 3814 Sheet 6). Control functions (e. g. interlocks) must be indicated in Section 9 Comments or on a separate sheet.
- The BAC functions list must contain all data points and functions required for plant functionality as per the plant diagram, but not reserve functions.

Appendix 2 contains the BAC functions and their allocation to BACnet object types based on an example for an air handling plant. The example was selected because it contains comprehensive BAC functions.

Caution:
*In an **air handling project**, the BAC functions list of the AMEV example **may not** be taken over as is, but rather must be defined specific to builder requirements (e.g. clarify required local overrides and feedback of damper positions).*

Appendix 2.1 contains a comprehensive key of symbols to designate functional relationships in the BAC functions list. The AMEV key is structured similar to **Table 5**, but includes common examples for functional relationships of BAC functions.

Appendix 2.2 lists recommended, dynamic displays of properties on the MOU.

Appendix 2.3 provides an example of an automation diagram for an air handling plant. Each BAC function has a unique identifier in the form of a user address. The abbreviations (german) refer to the BAC functions (e.g. BE: Binary input). Rather than project-specific user addresses as shown in the example, addressing as per **Section 4.4** is recommended.

Appendix 2.4 lists the BAC functions of the air handling plant as per the diagram in **Appendix 2.3**. The information contains all information from the BAC-FL as per VDI 3814 sheet 1. One AMEV row, however, describes only one BAC function of the data point and thus allows for individual comments. Different BAC functions of a data point are displayed below one another on different rows.

Appendix 2.4 contains a continuous row number in column 1; column 2 contains the BAC function to be implemented. AMEV columns 1 to 8 comprise all BAC functions as per BAC-FL as per VDI 3814 Sheet 1 in coded form. Functional relationships are described with a code as per the key. The assigned BACnet objects are listed in Column 9 and can be added up.

The comments in Column 8 (corresponds to Section 9 of the BAC functions list) are key to understanding the relationship of BAC functions). Information exchange with other BAC functions must be indicated completely for each BAC function (first as client, then as server).

Appendix 3 contains a higher, plant-crossing, structured assignment table. The overview lists all common BAC functions for technical plants sorted by plant parts. This table shows how to implement data communication for the most common BAC functions with the help of BACnet object types and document clearly, and in provable form.

For BAC planning, the AMEV system for traceable descriptions and allocation of BAC functions to BACnet functions in the BAC functions lists must be used. For BAC implementation, BACnet objects, properties, and services must be set up so that the data exchange scope described in the BAC functions lists is achieved.

Preference shall be given to higher-performing object types with associated properties and BIBBs in **Appendices 4 and 5**. For example, changes to schedules in the AS must be carried out via MOU with the aid of object type Schedule or Calendar, not by combining simple object types.

Required BAC functions not named in **Appendices 2 or 3** shall be set up accordingly with the highest-possible performing, required object types in the AS (e.g. runtime totals via property "Elapsed_Active_Time" in the binary object).

Participants may only set up the required services, objects, and properties. All properties used shall feature plant-specific and unique values within the project (see **Sections 5 to 7**).

Proprietary services, objects, or properties as well as specific restrictions or extensions must not be used. When existing, older BACnet systems are deployed, changed or special solutions featuring auxiliary objects may be required. These and all other exceptions must be agreed to by the buyer in agreement with the plant owner.

4.4 Addressing system

System member addresses are set up as per a self-explanatory addressing system and must be displayed easy to understand and trace for the operator.

Property Object_Name is used as user address for the BACnet object. It must offer at least 32 characters and is set up as per the addressing system specified by the buyer. Vendor-specified syntax is not allowed; exceptions are made for objects which are dynamically generated within the system (e.g. file to back up and restore data).

Addresses contained in the object name must be provided to the operator completely and consistently for all levels of the BACnet system.

Property Description contains important additional information. It must offer at least 64 characters and must be set up with an explicit clear text. The users provide contents, display type, and maximum number of characters.

The addressing system serves to quickly, clearly identify data points. All system members must be displayed with explicit abbreviations in an intuitive, traceable relationship. Extensive, unclear addressing or shortened, unclear abbreviations must be avoided. Clarity shall be supported visually (e.g. change of letters and numbers, formation of blocks, separators from the selected character set).

Table 6 displays 28-character data point addressing. Designations for plants, components, and data point types under AMEV „BAC“ is limited to typical management applications. Use the addressing system as per **Table 6** unless specified differently by the owner/operator.

Example:

Position:	1 2 3 4 5 6 7	9 10 11	13 14 15 16 17	19 20 21 22 23	25 26 27 28
Designation:	Site.Bldg.Part	Trade	Plant	Component	Data point
Short text:	2199203	AHU	SEV01	EXF02	MM01

DP address (example): 2199203_RLT_RWA01_VRA02_WM01			
Positíon	**Designation**	**Short text**	**Long text**
1 bis 5	Site / Bldg / Part no.	21992	Site 219; Building 92
6 und 7	Floor number	03	3rd floor
8	Separator	_	_
9 bis 11	Trade - Designation	AHU	Air Handling Unit
12	Separator	_	_
13 bis 15	Plant - Designation	SEV	Smoke & heat exhaust ventilation system
16 und 17	Plant - cont. number	01	SEV plant No. 01
18	Separator	_	_
19 bis 21	Component - Designation	EXF	Exhaust air fan
22 und 23	Component - cont. number	02	Exhaust air fan No. 02
24	Separator	_	_
25 und 26	Data point - Designation	MM	Maintenance message
27 und 28	Data point - cont. number	01	Maintenance message No. 01

Table 6: DP address (example)

5 Management and operating unit (MOU)

The following section describes BACnet-specific requirements of MOUs.

5.1 General

Management and operating units (MOU) functionality has significant importance to the benefits of a BAC system. It greatly influences acceptance by the owner/operator and is fundamentally for rational operation of buildings and sites.

In vendor-neutral BAC systems, the higher management level is a key strategy tool. When setting up the MOU, all technical, organizational and personnel prerequisites for qualified BAC planning, fair competition, and ongoing independence of individual vendors, suppliers, and service providers must be established. Concrete presettings must be drafted for planning, execution, and maintenance (see BACnet requirement specification in **Section 8.3**).

For new BACnet system design, procuring a neutral BACnet MOU featuring at least AMEV profile MOU-A as technological basis for the BACnet functionality required in the planned BAC system is recommended. It must be able to communicate with AS of different vendors via the BACnet protocol and allow for interoperable coupling of new AS to be procured (see BACnet migration concept in **Section 8.4**).

BAC owners are encouraged to ask own experts to administer the MOU, qualify them accordingly, and grant them full access to all management level functions. In addition, these experts must receive complete and current documentation and all system passwords (see **Section 4.1**).

The number of I/O and processing functions generally is determined by the technical equipment in the building. The information to be provided for management and operating functions must be determined during planning by considering all operational tasks.

BACnet functionality of the MOU must be specified during planning as per **Section 4**.

MOU as per AMEV profile **MOU-A** can perform, e.g., the following tasks:

- Discover and display BACnet devices and all objects and properties of these devices
- Graphically visualize plant information
- Display event and alarm information (with acknowledgement and logging)
- Display plant information in reports
- Manual operation of plants and their components
- Create and change schedules
- Change setpoints, limit values, and parameters (properties)
- Display trend data
- Archive historical data
- Synchronize date and time of all BACnet server
- Monitor functions of all connected BACnet devices (e.g. start, stop, and disable devices in case of data transmission errors)
- Back up and restore programs and data of the AS

MOU as per AMEV profile **MOU-B** can additionally perform, e.g., the following tasks:

- Dynamically create and delete objects in AS-B according to **Table 4**
- Synchronize date and time of other BACnet clients

The MOU must support character sets used by the connected BACnet devices. The MOU must support text lengths of 32 characters per state text (see **Addendum L** for profiles B-AWS, B-OWS, and B-OD).

The password concept contains at least four password levels. Operator interventions may be possible only following user authentication (e.g. by entering user name and password) and must be logged in a revision-proof log file.

In case of a complex BAC system with multiple distributed MOU a concept for the management of all passwords and log files must be established. Supervising administration and clarification of all read/write access are required as well as a master function for time synchronization.

A new MOU must be downward compatible, i. e. it must be able to recognize and support earlier BACnet revisions of the participating BACnet servers.

For existing MOUs, a check must be run to verify if updates or upgrades are required prior to adding BACnet servers of later revisions.

The recommendations for BACnet AS in **Section 6** shall be considered as needed provided no other information is given.

5.2 Hardware

The management system generally is structured as a modular computer network featuring standardized IT components such as servers, workplace PCs, and memory drives.

DIN EN ISO 16484-2, AMEV „BAC“, and GAEB StLB-Bau LB 070 contain notes on hardware requirements. BACnet in this context does not expect special requirements.

Accessories such as modems, routers, etc. are selected from commercially available product ranges. The requirements shall be given as part of planning.

5.3 Operating system

The BACnet communications protocol itself does not impose special requirements on the computer operating system. Requirements may result e.g. from special IT administration requirements and data exchange with other systems.

5.4 Monitor and operate

Monitoring and operating technical plants is a basic function of the MOU. Operators must be able to retrieve and display information from the MOU any time:

- Status of each BACnet device (MOU, AS etc.),
- Status of each BACnet object,
- Status of each property.

All objects whose addresses correspond to the search on individual or combined criteria by the user must be listed. The addressing system (e.g. site, building, floor, technical installation, plant number, zone number, function designation, object type, etc.) must allow for deriving the criteria. The resulting list can be sorted at least by BACnet object type and address.

A list of all objects whose addresses correspond to the search criteria specified individually or in combination by users must be established. The addressing system (e.g. site, building, floor, technical installation, plant number, zone number, function designation, object type, etc.) must allow for deriving the criteria. The event list can be sorted at least by BACnet object type and address.

In addition, it must be possible to visualize all object properties with just a few operating actions.

Users can override automatic operation manually to ensure secure and safe plant operation.

Manual intervention in the AS from the MOU serve e.g. the following purposes:

- Override I/O objects
- Override calculated setpoints
- Change limit values

Manually set operating states shall not maintain for extended periods of time. Therefore manual intervention via MOU must be clearly designated and assigned to an event notification. This also applies to manual intervention via local override equipment and operating elements on I/O modules of automaton equipment.

5.5 Fault management

Fault management is designed to notify, manage and document all faults in a connected total system.

To keep network load to a minimum, alarms and events may not be generated in the MOU, but rather in the AS. In addition, for each project must be clarified, whether automatic entry of the MOU in notification class objects of AS is allowed or not.

An MOU supports alarm and event handling as recipient via the services COV Reporting, Intrinsic Reporting, and Algorithmic Change Reporting.

Notification class objects allow for scheduled routing of event/alarm information in dependence of the notification class to different recipients such as E-Mail, printer, fax, SMS, or remote operating station.

The notification class matrix in **Appendix 7.7** offers examples for notification class objects with different event categories, priorities, scheduled recipient lists, short descriptions, and application examples. Examples for event and acknowledgement options are available in **Appendix 7.8**.

5.6 Scheduling

Operating functions for scheduling is one of the key functions of the BACnet MOU from an energy and economic viewpoint.

To do this, the MOU accesses Schedule and Calendar objects in the AS.

5.7 Trend and historical data

Trend diagrams and historical data of a BAC system (e.g. temperature or operating state trends) are a must for troubleshooting, operational analysis, and plant optimization.

The MOU supports the following functions:

- Display trends from AS
- Read trends in AS and archive to database (historical data)
- Display trendlog objects graphically and in tabular format
- Dynamically create and delete trendlog objects in AS
- Provide stored data for export (e.g.: as CSV or XML file)
- Support queries via standardized query (SQL) as needed.

An application program converts the trend data logged in the AS as per **Section 6.8** into a purely time-based data structure. To export the data to other systems, storage as CSV or XML file featuring underscores as separator is recommended. The file name must contain the start date of logging (YYYYMMDD) and the object designation of the AS.

Operators must also be able to display logged trend data in tabular form as per their requirements. To assign logged values to equidistant time series, a set logging interval must be given (see example featuring minute intervals in **Table 7**).

DP address (in MOU)		2199203_HZG_ WVN01_TAL01_MW01	2199203_HZG_ WVN01_TPV01_MW01	2199203_HZG_ WVN01_TRL01_MW01
Designation (in MOU)	**Time stamp**	Outside temperature actual value	Flow temperature actual value	Room temperature actual value
Unit (MOU)	Date Time	°C	°C	°C
Value 1	01.11.2011 13:23	5,5	43	20,6
Value 2	01.11.2011 13:24	5,6	43	20,6
Value 3	01.11.2011 13:25	5,7	43	20,7
Value n	…	…	…	…

Table 7: Trend data table (example)

6 Automation stations (AS)

This section discusses BACnet-specific requirements of the AS. The recommendations supplement the general notes on BACnet systems in **Section 4** as well as the system-independent recommendations in AMEV „BAC“.

6.1 General

Automation stations (AS) are networked, yet autonomous devices to automate processes in technical plants in buildings featuring properties and functions as per DIN EN ISO 16484. The devices must be designed and programmed to carry out autonomously all required control and optimization tasks without higher network.

As a rule, an AS with AMEV profile AS-A or AS-B is installed in a mechanical equipment room as automation equipment.

BACnet functionality of the AS must be specified during planning as per **Section 4**.

BACnet-AS can be used to extend the functional scope (trends, schedules, alarms, etc.) of other low-scope/-performance BACnet devices (e.g. room automation equipment, factory-integrated controls for chillers, pumps, or frequency inverters).

In AMEV profile AS-B, additional, complex objects help reduce (among other functions) the number of otherwise required, simple BACnet objects. The Loop object allows for changing setting parameters of Loop objects and ensures harmonized display. The Trend Log object allows for saving trend data in the AS and for bundled transfer of trend data to the MOU. The Event Enrollment object implements extended alarm and event handling (algorithmic change reporting).

The engineering tool helps fully set up the required BAC functions, BACnet objects, properties, read/write access, and services in the AS. All programs and configuration data have to be saved as remanent data to the AS.

During planning the tasks of plant operator must be verified: if and to which extent e. g. changes to programs, creation of new programs, testing and loading of new programs in the AS must be possible (recommended: Operator concept) The engineering tool may need to be handed over to the plant operator along with a time and functionally limited license and all system passwords.

The minimum requirements listed below must be able to be implemented at the same time.

6.2 Alarm and event management

Structured alarm and event management must be set up in the BACnet system to transmit information state changes and events as needed.

Prioritization and categorization of triggering events and events requiring acknowledgement must be determined during planning.

Section A describes the possibilities to generate notifications in a BACnet system.

In addition, events are allocated to categories dependent on meaning and evaluation as well as acknowledgement. Allocation to event categories is explained in **Section B**.

Section 6.3 explains how the Notification Class object in a BACnet system is used to prioritize, categorize, and require acknowledgement for messages.

A. NOTIFICATION GENERATION

Notifications are only generated in the AS, not in the MOU.

The relationship between event occurrence and notification transmission to recipients can be established in different ways:

A.1 Simple change of values (COV) can be transmitted to subscribers via COV service.

A.2 For Intrinsic Reporting, multiple predefined events can be transmitted to the recipients specified in the Notification Class object.

A.3 For Algorithmic Change Reporting, Event Enrollment objects may generate notifications based on algorithms and transmit them to the recipients specified in the Notification Class object.

Criteria identified following an event are specified by the objects' properties generating events as well as by the parameters of the services related to COV reporting and alarm and event management.

Each AS must support COV Reporting and Intrinsic Reporting.

MOUs and other authorized clients can change the properties determining notification behavior of objects via the BACnet network. Event reporting can be enabled or disabled for each object.

A.1 COV Reporting

As part of COV Reporting, information on events is reported by indicating state and value changes (e.g. new outside temperature value).

MOUs and other clients must subscribe to the value or state of I/O objects (subscription request) to receive COVs from the AS. They must be entered with service SubscribeCOV in the notification list to receive notifications, and removed from the notification list following successful notification.

Sie müssen sich mit der Funktion „SubscribeCOV“ für den Benachrichtigungsdienst eintragen und bei ordnungsgemäßem Ende wieder aus der Benachrichtigungsliste austragen.

COV Reporting requires property Active_COV_Subscriptions in the Device object. It automatically notifies subscribed clients of changes to the present value or status flags in I/O objects.

Property COV_Increment in analog objects must be set up meaningful values to receive sufficiently exact values as per the application and avoid unnecessary value notifications. The MOU can change the COV increment in the AS via the network.

Unrequested COV (COVU) is a special case of SubscribeCOV and must not be used to avoid unnecessary network load.

All properties required to support COV reporting are designated "Required for COV" in **Appendix 4**.

A.2 Intrinsic Reporting

Intrinsic Reporting allows for specifying different conditions for a BACnet device required to generate alarms and event notifications and to send them to the specified recipients (e.g. operator units).

Intrinsic Reporting triggers a change of value of properties or an event notification. Intrinsic Reporting e.g. is used to monitor binary I/O objects for state changes or analog I/O objects with properties High_Limit, Low_Limit, and Deadband for limit value breaches.

BACnet objects use different, standardized criteria to determine event triggers. Event-triggering objects and the supported event types for Intrinsic Reporting are described in **Appendix 7.6**.

Intrinsic Reporting is described in the **Binary Input object.**

Example for Binary Input object:

In the Binary Input object, property Event_State can assume the following three states:

- *Normal*
- *Fault*
- *Offnormal*

State "Fault" occurs when property Reliability has a state different from "NO FAULT DETECTED". "Offnormal" occurs when the properties Present_Value and Alarm_Value have the same value longer than defined in property Time_Delay. Return to "Normal" occurs when the properties Present_Value and Alarm_Value differ longer than defined in property Time_Delay.

A change from "Offnormal" to "Fault" or back to "Normal" can trigger notification. Notifications are generated dependent on the settings of the three bits (flags for: To-Offnormal, To-Fault, To-Normal) of property Event_Enable in the Binary Input object.

Further processing of notifications is as per the property Notification_Class of the Binary Input objects.

Intrinsic Reporting is additionally described in the **Analog Input object.**

Example for Analog Input object:

In the Analog Input object, property Event_State can assume the following three states (similar to Binary Input object):

State "Fault" occurs when property Reliability in the Analog Input object has a state different from "NO FAULT DETECTED". “Offnormal” occurs when the value of property Present_Value breaches the value of property High_Limit or Low_Limit longer than specified in property Time_Delay. A return to “Normal” occurs when the value of property breaches the value of property High_Limit or Low_Limit by considering the value of property Deadband longer than specified in property Time_Delay.

A change from “Offnormal” to “Fault” or back to “Normal” can trigger notification. Notifications are generated dependent on the settings of the three bits (flags for: To-Offnormal, To-Fault, To-Normal) in property Event_Enable, and the two bits (lowLimitEnable, highLImitEnable) in the Analog Input object.

A.3. Algorithmic Change Reporting

Algorithmic Change Reporting can be used in a BACnet device to define in multiple ways the conditions to generate events and alarms, generate alarm and event notifications, and send them to clients.

For example, algorithmic change reporting in an AS can be used to implement complex alarm notifications, or to generate notifications for individual room controllers, or for other application-specific units that do not support reporting.

Algorithmic change reporting is enabled by the Event Enrollment object (see Appendix 4.3). The object generates an alarm or event notification, if an event is detected by aid of the predefined algorithm. The recipients of the notification are set in the Notification Class object.

The Event Enrollment object is able to support 16 different algorithms.

Property Event_Parameters provides the parameters needed by the chosen algorithm. Property Event_Type indicates the algorithm that is used to determine the state of an event. Property Event_State indicates the state as the result of the current analysis (e. g. NORMAL, HIGH_LIMIT).

There is a specific relationship between the particular algorithm, the needed event parameters, and the event states which are corresponding to the event type. The valid combinations of Event_Type, Event_State, and Event_Parameters values are determined by the standard.

B. EVENT CATEGORIES

BACnet distinguishes between three event categories and event acknowledgements as per their trigger events and different evaluation and acknowledgement:

- **Maintenance notification**
  Maintenance notifications are simple notifications not critical with regard to time (addressing: ...MN...). Acknowledgement following troubleshooting is not mandatory, and can be carried out automatically as part of event resolution.

- **Fault notification**
  Fault notifications (addressing: ...FN...) transmit information on events not representing an immediate risk (e.g. temperature limit value breach). Acknowledgement following troubleshooting is not mandatory, and can be carried out automatically as part of alarm resolution.

- **Alarm notification**
  Alarm notifications (addressing: ...AN...) transmit information on events representing an immediate risk to persons, property, or plant, and requiring plant shutdown (e.g. frost protection). Following fault resolution the acknowlegement by an authorized operator is a must to allow the plant to resume normal operation.

At least three basic event categories must be set up in a BACnet project. Each category requires harmonized definitions for the related notification classes (see **Section 6.3**), their priorities, and acknowledgement options.

Alarms represent the highest notification priority. A fault or alarm notification (AN, FN) shall be set up for each plant fault as per the predefined classification.

In addition, alarms can be set up as needed for:

- Feedback errors (unallowed ON/OFF)
- Manual intervention on I/O modules from AS or local override unit on control panel
- Setpoint violations, also for floating setpoints; setpoint violations due to plant downtime must be suppressed.
- System faults of the AS (e.g. AS or AS component failure)
- Other system faults (e.g. communications interruptions)

Appendix 7.7 contains recommended examples for event categories and message priorities.
Examples for event and acknowledgement options are available in **Appendix 7.8**.

6.3 Notification classes

A Notification Class object, containing information on event notification distribution, must be assigned to each BACnet object intended to generate notifications via Intrinsic Reporting or Algorithmic Change Reporting.

The notification class object specifies which priorities are assigned to the event notifications, whether the events require acknowledgement, and which recipients receive the notifications.

Appendix 7.7 contains an example for a notification class matrix with recommended specifications for notification classes, priorities, and event categories as well as scheduled recipient lists, brief descriptions, and application examples. Priorities have values between 0 and 255; the lower the number, the higher the priority. The number of notification classes, event categories, and priorities can be decreased or - as per the specific cases – increased.

Examples for setting up related event and acknowledgement options are available in **Appendix 7.8**.

A separate Notification Class object shall be set up containing only a specific recipient if the notification must be acknowledged by a specific recipient. Acknowledgement receipt is saved in property Acked_Transitions in the event-triggering BACnet object.

At least three different Notification Class objects must be set up for each AS. The Notification Class object can be configured statically (AMEV profile A) or dynamically (AMEV profile B). Multiple alarm or event generating objects may reference the same Notification Class object in a BACnet device.

Recipient list

All Notification Class objects have property Recipient_List. This is where the BACnet clients serving as notification recipients are entered in BACnet servers. Information can be transmitted by type, weekday, or time of day to different targets.

The recipient list is entered in the AS during engineering and saved as remanent data. The AS must support recipient list processing via services AddListElement, RemoveListElement, and WriteProperty.

If a new or additional MOU is integrated in the network, automatic entry of existing recipient lists in the AS may make sense, but must be carried out carefully.

AS-A do not support dynamic generation of Notification Class objects. All required Notification Class objects must be set up in AS-A during commissioning.

For more information on Notification Class object properties, see **Appendix 4.3**.

6.4 I/O objects

I/O objects are Analog, Binary, und Multistate Input, Output, and Value objects.

Physical inputs and outputs are assigned to analog or binary input and output objects depending on data type (see **Appendix 3**). The values of physical I/Os are displayed together with their engineering units as per Column 3 in **Appendix 7.5**.

The required properties of the I/O objects (e.g. state texts and engineering units) shall be set up for all I/O objects.

Multistate I/O objects must be able to display at least 12 states. All states of a Multistate objects are mutually interlocked.

Multistate object types, contrary to binary object types, do not have their own properties for runtime totals (see **Section 6.5**).

In the event of competing access to output and value objects (e.g. 2 accesses to a recirculating pump via schedule and manual switch), execution sequence is set via priorities. One of 16 possible priorities is assigned to each access in property Priority_Array. The value with the highest priority (lowest number) generates the output value.

Status flags
I/O objects must be able to distinguish between the following states via property Status_Flags:

- Alarm state (In Alarm)
- System fault (e.g. source fault) (Fault)
- Overridden value/state (manual intervention) (Overridden)
- Out of service (system operation) (Out Of Service)

The states Alarm and Fault must be transmitted as fault notification. Each fault notification is assigned a priority as per its importance.

Status texts
The states of binary or multistate objects (e.g. On/Off, Normal/Fault, Manual/Auto) are described specific to each project by means of properties Active_Text, Inactive_Text or State_Text.

The properties must allow for at least 32 characters for the state texts as per **Addendum L**. Short, clear status texts shall be used (e.g. max. 20 characters).

The status texts must be fully configured during engineering. For new installations, the planner and operator together specify the status texts. In the event of extensions, new texts follow existing texts.

The status texts as listed in **Appendix 7.4** shall be used if no other information is available. The first two digits of the reference number name the number of different states (e.g. 02 for binary states). They and three other digits indicate the operating states (e. g. 03322 = Setback mode). The table in **Appendix 7.4** can be supplemented as needed.

Command execution control
In binary and multistate output objects, property Feedback_Value must allow for determining the desired state via Intrinsic Reporting. If desired and actual state deviation, a fault must be generated after a specific, adjustable time. The actual state must be acquired via a physical input.

Enabling consumption meters
Direct integration of consumption meters for heating energy, power, water, and other media to BAC is used increasingly and allows to centrally provide consumption values.

Recording values via bus-capable consumption meters (M-bus, Lon bus) works best. Bus-capable consumption meters are integrated in the BACnet system via a user-friendly interface (gateway) as Analog Value object. The objects Accumulator and Pulse Converter are not needed for this solution.

For more information on I/O object properties, see **Appendix 4.2**.

6.5 Runtime totalization

Runtime is logged in binary objects via property Elapsed_Active_Time. Runtime hours are logged in seconds as per the standard. Logged seconds can be converted and displayed as runtime hours via an additional Analog Value object. The time value is available in property Present_ Value. Property Units contains the hour as unit. An additional calculation function is required for conversion.

Reset of runtime hours is executed by overwriting the value in property Elapsed_Active_Time with value 0 and logged in property Time_Of_Active_Time_Reset in the binary object, The client must be able to reset runtime hours to value 0 and allow for setting an upper limit to trigger maintenance notification.

The following two solutions are possible to automatically transmit maintenance notification in case of upper limit breaches by the runtime totalizer.

a) Transmission of maintenance notification is monitored with Intrinsic Reporting when an additional Analog Value object is used. The upper limit is set in property High_Limit.

b) If binary objects alone are used, Algorithmic Change Reporting is set up in an Event Enrollment object. This object monitors property Elapsed_active_time in the related binary object. Limit value supervision is set up in the Event Enrollment object in property Event_Parameter by setting several parameters such as Time_Delay, Low_Limit, and Deadband, and is enabled via property Event_Enable.

Examples for runtime totalization of plants and plant components contain **Appendices 2 and 3**. For multi-stage actuators, the runtime for individual stages can be logged and evaluated via Trendlog (**Section 6.8**).

6.6 Scheduling

As a rule, schedule functions are implemented in the AS.

The **Calender object** saves the required date information (e.g. individual days, time periods, or recurring days) in property Date_List. Property Present_Value indicates if a calendar entry is fulfilled at any given time.

The **Schedule object** can change states or values in dependence of time and date. Property **Weekly_Schedule** saves recurring switching times and associated values. Writable properties in I/O objects (e.g. physical outputs, parameters) or virtual objects (e.g. " Operating mode total plant") are modified dependent on time.

Exceptions to weekly schedules (e.g. extended runtime hours for special events or setback mode during vacation) are saved to property **Exception_Schedule** in the Schedule object. The validity range of the exception (explicitly or by referencing a Calendar object) and the exception schedule with associated values valid for this time must be indicated.

Schedule object (SCHED): Schedules						
Property Schedule_Default = Night						
Property Weekly_Schedule						
Mon	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**	**Sun**
07:00 On	07:00 On	07:00 On	07:00 On	07:00 On	00:00 Off	00:00 Off
16:30 Night	16:30 Night	16:30 Night	16:30 Night	16:30 Off		

Property Exception_Schedule						
Date				**Time**	**Value**	**Priority**
Day	**Interval**	**Recurring**	**CAL. object (CAL x)**	**(Time)**	**(Value)**	**(Event Priority)**
		2nd Saturday per month		05:00	On	11 (School board) (IT user)
				12:00	Off	
	04-Apr-2011 – 06-Apr-2011			05:00	On	12 (IT user)
				13:00	Off	
01-Apr-2011				17:00	On	13 (caretaker)
				21:00	Off	
			CAL 1: Variable holidays	00:00	Off	14
			CAL 2: Set holidays	00:00	Off	15
			CAL 3: School vacation	00:00	Off	16

Calendar object CAL 1: Variable holidays			
Day	**Interval**	**Recurring**	**Note**
22-Apr-2011			Easter Monday
02-Jun-2011			Ascencion day
13-Jun-2011			Whit Monday
Calendar object CAL 2: Set holidays			
		Jan 01.	New Year's
		Jan 06.	Epiphany
		May 01	Labor day
		Oct 03	German unification day
		Dec 24	Christmas Eve
		Dec 25	Christmas day
		Dec 26	Feast of Saint Stevens
		Dec 31	New Year's Eve
Calendar object CAL 3: Vacation			
	01-Apr-2011 – 10-Apr-2011		
	25-May-2011 – 05-Jun-2011		
	29-Jul-2011 – 11-Sep-2011		
	02-Nov-2011 – 06-Nov-2011		
	23-Dec-2011 – 08-Jan-2012		

Table 8: Scheduling based on Schedule and Calendar objects (example)

The example **in Table 8** clearly illustrates the functions and interactions of Schedule object (with Weekly and Exception Schedule) and multiple Calendar objects. The switching times are assigned short designations (e.g. 07:00 On):

Cont. no.	Short designation	Meaning	Code (s. Appendix 7.4)
1	Off	Sustained mode	03321
2	Night	Setback mode	03322
3	On	Heating mode	03323

According to the standard the value of the property Schedule_Default will be set at 00:00 hours (e. g. night), unless another value is programmed for the day at 00:00 hours.

The Exception Schedule generally takes priority over the Weekly Schedule. In addition, each entry in the Exception Schedule must be prioritized by an Event_Priority from 1 to 16. If several entries are present, the entry featuring the lowest Event_Priority is executed.

Caution:

Event_Priority is not identical with property Priority_For_Writing.

Graded definitions for Event_Priority allow for centrally setting energy-saving operating modes while granting user groups priority to override preset programs as needed.

Example:

*In **Table 8**, a heating circuit in a school is operated as per a Weekly Schedule from Monday to Friday from 07:00 through 16:30 hours in heating mode (On), and from Monday to Friday from 16:30 to 07:00 hours in the morning in setback mode (Night). On weekends, the heating circuit runs in sustained mode (Off).*

The Exception Schedule, which accesses the calendar featuring dates for school vacation and set and variable holidays, takes priority over the Weekly Schedule. Thus, on holidays and during vacation, the heating circuit is switched to Off. On 01-Apr-2011, the caretaker entered heating from 17:00 to 21:00 hours. Due to a lower priority value (13), this entry takes priority over holiday and vacation days. *In addition, other authorized users (school board and IT users) are entitled to enable heating at the assigned priorities (11 or 12).*

Property Effective_Period specifies the validity of Schedule objects. As a result, multiple Schedule objects can be assigned to a time function of the BAC list and weekly schedules featuring different times can be set by means of property Effective_Period (e.g. to differentiate between summer/winter operation). For times without defined Schedule object, the value from property Schedule_Default is valid.

To each Schedule object, a List_Of_Object_Property_References must be assigned in addition to write priority. If the current time reaches a switching point, the currently valid value is entered in the properties of the objects which are listed in the reference list. The properties to be influenced must have the same type.

Example:

*The example for the Schedule object in **Table 8** (with possible values On, Night, Off) is linked to an object of type Multistate Value acting as selector switch for possible operating modes. As a result, different operating modes of the heating circuit are controlled by schedule.*

Each AS must support **Schedule objects** featuring the following **minimum options**:

- at least **12 switching times** per weekday (e.g. On on Monday at 07.00 hours) in the Weekly_Schedule and
- at least **6 date entries** or references to Calendar objects (combination is possible), each with at least **6 switching times**, in the exception_Schedule.

In addition, each AS must provide at least **3 Calendar objects** as a **minimum set** with one date list each at minimum **10 date entries**.

Exception days shall be entered in the schedule via MOU and the Calendar object. The standard as an alternative allows for direct exception day entry in the Schedule object.

For tendering, the required minimum number of Calendar and Schedule objects to be supported (including minimum number of switching times and references to Calendar objects) must be indicated. The minimum number of Schedule objects results from the BAC functions list.

The Schedule and Calendar objects can be read and changed via MOU and locally via AS operator units. Unless specified otherwise, both operating options are equal and the last entry is valid.

For more information on Calendar and Schedule object properties, see **Appendix 4.3**.

6.7 Time synchronization

Each AS must have a system clock with battery buffer for 72 hours (see **Section 6.12**). A BACnet device (normally an MOU) acts as system-wide time master. Devices assigned to the time master take over the time and synchronize their clocks accordingly.

Time synchronization shall use the following BACnet services as per standard:

- DM-TS-B (AS contains time synchronization by local time)
- DM-UTC-B (AS contains time synchronization by global time)
- DM-MTS-A (MOU triggers automatic, cyclical time synchronization)

AS to be synchronized must support at least one synchronization service (or DM-UTC-B). The time master must support DM-MTS-A.

Local time shall be used for operation.

6.8 Trend logging

Trend logging helps document a time-related sequence of operating states and process variables. Trend logs can also be used for the management functions Long-term storage and historical Database as per DIN EN ISO 16484-3.

In AMEV profile AS-A, trends are logged in the MOU and other clients without using Trendlog objects. This type of online trend transmits data to be logged via Read Property (RP) or COV Reporting to the client where it is saved in a database.

When Trendlog objects are used, data can be logged locally in BACnet devices (e.g. AS). The data then is available for requests from a client (e.g. MOU) as well as for evaluation and long-term storage in the client. This can be helpful if no permanent network connection is available between AS and MOU, e.g. in small sites with stand-alone BAC solutions and modem connection for remote readings. Intermediate storage in AS avoids unnecessary network loads and possibly operating costs due to frequent establishment of connections.

Trendlog object designations must match logged object designations to allow for interpretation without additional references. An MOU must be able to modify Trendlog object parameters.

In AMEV profile AS-B, Trendlog objects must allow for dynamic creation and deletion to make sure an MOU can generate and enable trends during operation. Builders may only do without dynamic creatability of Trendlog objects if a replacement solution is guaranteed. A sufficient number of Trend objects at sufficient memory must be provided permanently for each AS, and property Log_DeviceObjectProperty must be writable.

Start and stop times for Trend logging can be specified as needed in the Trendlog object. For multi-day logs, finalized data records for each day must be transmitted to the MOU. Data is transferred at the same time as new data is logged in the AS.

For Trend evaluation for energy management, the data must be saved at minute intervals in the AS. The following units and resolutions can be selected:

Variable	Resolution	Unit
1	2	3
Room/outside temperature	0,1	°C
Flow/return temperature	0,1	°C
Pressure	0,01	bar
Volume flow	0,01	m³/h
Energy – Heat	1	kWh
Energy – Electricity	0,1	Wh
Gas	0,1	m³
Water	0,01	m³
CO_2	10	ppm
Air humidity	1	%
Valve position	1	%
Rotation	1	%

For more information on Trendlog object properties, see **Appendix 4.3**.

6.9 Loop

In AMEV profile AS-A, setpoints and other control parameters are transmitted with the aid of Value objects from AS-A to MOU.

In AMEV profile AS-B, Loop objects are used to operate complex control loops via the BACnet network (e.g. P-portion, I-portion, D-portion).

Project-specific requirements of controllers must be specified in the BAC functions list.

Standard controller models from technical equipment in buildings such as heating circuit controllers or P-PI cascades do not have their own BACnet object types. These controller models can be transmitted as a combination of different Loop objects via BACnet communication.

For more information on Loop object properties, see **Appendix 4.3**.

6.10 Manual intervention

In special cases, I/O values must be changed manually.

As for an Input object, the property Out_Of_Service is set in the associated object. Following the activation, property Present_Value can be changed as needed by the MOU. The changed value is used by all applications until reset.

As for an Output object, manual intervention occurs by writing property Present_Value at priority 8 (manual intervention). If no other higher-priority commands (<8) are available, the physical output is set to the manually entered value.

Setting property Out_Of_Service results in removing property Present_Value from the physical output value. In this case, the output value (vendor-specific) remains at a set value (normally the last value). When resetting property Out_Of_Service, the present value must be taken over automatically and immediately.

Overriding of I/O values of the AS must be shown in property Status_Flags of the I/O objects. Additionally the AS shall sent a notification of the overriding of I/O values to MOU. In big-scale plants the monitoring and notification of Status_Flags is managed by an Event_Enrollment object. Intrinsic reporting doesn't support this monitoring.

Manual interventions via a local override unit (LOU), which is not linked via BACnet, must be monitored and notified to the MOU accordingly. Binary input object states (physical connection) or binary value objects (communicating connection) may be used as indicators.

In the MOU, all overridings must be labeled differently (e.g. by specific background colors of the plant pictures for output objects: Manual intervention by MOU or operator unit: yellow; or by LOU: orange; or by Out_Of_Service: red).

Manual intervention actions are assigned notification class 7 in the example in **Appendix 7.7**.

6.11 System faults

Each AS must monitor itself (e.g. watchdog, actuation, sensors, buffer battery charge) and indicate fault functions as system faults. Faulty modules must be indicated in modular AS.

System fault notifications in the AS are listed in Column 7.1 I/O object type of the BAC functions list as per VDI 3814 Sheet 1, and labeled as Faults in Column 9 Comments. They must be set up as Value objects and be assigned to an event category each (see **Section 6.3**).

If the AS does not contain system-specific monitoring functions, project-specific, meaningful solutions must be found.

For example, a client can be monitored for communications errors via cyclical query of all servers using service Who-Is. Functioning servers will reply with service I-Am. No reply is interpreted as server communications error.

If an AS or sensor signals an error, the operator must be able to disable communications with the BACnet device until repaired, or physically disconnect the sensor.

At least one operator unit on the BACnet network must be capable of disabling and enabling all BACnet devices on the network in terms of communications.

Disabling communications must be documented with a time stamp and displayed in the associated lists.

6.12 Power failure and return

Dynamical variable properties of the AS must be buffered for at least 72 hours in case of power failure. This applies e.g. to Trendlog, Schedule, and Calendar objects as well as to the properties Recipient_List in the Notification Class objects.

If special UPS (uninterrupted power supply) buffered AS are required, all faults resulting from power failure must be suppressed and only the power failure notification transmitted to the management level to prevent notification floods.

Upon power return, restart must be controlled by means of permanently saved programs and parameters in the AS. Power return as per the BAC functions list is a program function in the AS.

Restart must be signaled to the MOU. After power return and restart, only still pending notifications must be passed on.

7 BACnet networks

This section deals with BACnet-specific networks.

7.1 Network protocols

Since the BACnet standard is based on the ISO layer model for communications systems, BACnet notifications can be exchanged via different media with different access procedures.

Common types of BACnet networks in Europe:

BACnet/IP networks
BACnet MS/TP networks
BACnet/LonTalk networks
BACnet PTP networks

The following structural overviews show the network and protocol layers used based on application ranges and examples.

7.2 BACnet/IP

The BACnet/IP (BACnet over IP) network protocol under Annex J of the standard is the most common network protocol in public buildings. The IP solution offers high performance and sustainability, but requires sufficient network capacity, suitable active network components as well as an alignment of responsibilities and capacity of IT departments, which normally are responsible for network component management.

Layer	Protocol	Application, example	Standard
1	2	3	4
Application Layer	BACnet Application Protocol	BACnet-Object, BACnet-Service	BACnet Standard
Network Layer	BACnet Network Protocol	Network number (max. 65.535 subnets) + device address	
Data Link Layer	BACnet Virtual Link Protocol	Distributes BACnet broadcasts via IP router	
	User Datagram Protocol (UDP)	Access via ports 0xBAC0…0xBACF*	TCP/IP Protocol Suite
	Internet Protocol (IP)	IP address (e.g. 192.168.000.001)	
	Logical Link Control ISO8802-2 / IEEE802.2	Medium Access Control (MAC) (z. B. 00-11-22-33-00-00)	IEEE 802.3 Protocol Suite
Physical Layer	ISO 8802-3 (IEEE 802.3)	100Base-Tx, 1000Base-Tx	

Table 9: Structural overview of BACnet/IP

* For BACnet, only port 47808 is reserved, but BACnet can be run via any UDP port as a rule. It is recommended to use ports between 47808 (0xBAC0) through 47823 (0xBACF).

In routed BACnet/IP networks, one BBMD (BACnet Broadcast Management Device) device each is required per subnet to ensure transmission of broadcasts if transmission of broadcasts via IT routers is blocked (**Appendix 8** - Glossary).

7.3 BACnet MS/TP

BACnet MS/TP (BACnet Master-Slave/Token-Passing protocol) provides a field bus as network medium. Contrary to proprietary or other field busses with open protocol, the BACnet field bus does not require gateways, but only routers to BACnet/IP.

BACnet-MS/TP can be used to connect external automation equipment (e.g. refrigeration machines or frequency inverters) and bus-capable field devices to BACnet-AS. Deviations from system-wide BACnet definitions are allowed for MS/TP (e.g. with BACnet objects, properties, user addresses, clear texts, etc.), but must be clarified in advance.

MS/TP networks use MAC addresses from 0 to 254 (255 for broadcasts). Address 0 must be used for the MS/TP router. Range 1 to 127 can be used for master and slave devices. Addresses 128 to 254 re reserved for slave devices.

Layer	Protocol	Application, example	Standard
1	2	3	4
Application Layer	BACnet Application Protocol	BACnet object, BACnet service	BACnet Standard
Network Layer	BACnet Network Protocol	Network number (max. 65.535 subnets) + device address	
Data Link Layer	BACnet MS/TP	Medium Access Control (MAC), Bereich 0 - 254	BACnet MS/TP
Physical Layer	EIA-RS485	Two-wire line, twisted, screened	ANSI/TIA/EIA -485-A-98

Table 10: Structural overview of BACnet MS/TP

7.4 BACnet LonTalk

Field bus BACnet LonTalk (BACnet over LonTalk) allows for connecting multiple BACnet devices via a LON network. Connecting a LonWorks network to a BACnet device requires a gateway.

The Neuron chip has a set and unique MAC address, the Neuron_ID. For BACnet addressing, the subnet/node structure of the LON domain may be used as an alternative, but users are responsible for unique node identification.

Layer	Protocol	Application, example	Standard
1	2	3	4
Application Layer	BACnet Application Protocol	BACnet object, BACnet service	BACnet Standard
Network Layer	BACnet Network Protocol	Network number (max. 65.535 subnets) + device address	
Data Link Layer	Lon-Link Layer	Domain: Subnet/Node	LonTalk
	Media Access Control Sublayer	Neuron ID: e.g. 00-11-22-33-44-55	
Physical Layer	Transceiver Interface	e.g. TP/FTT10	

Table 11: Structural overview of BACnet LonTalk

7.5 BACnet/PTP

The BACnet point-to-point protocol BACnet PTP can be used together with EIA/RS-232C (e.g. serial interface on PC) for dial-up modem connections. The BACnet standard does not cover use of multiple modems and thus requires use of special software to manage phone numbers. PTP connections did not prove successful.

Layer	Protocol	Application, example	Standard
1	2	3	4
Application Layer	BACnet Application Protocol	BACnet object, BACnet service	BACnet Standard
Network Layer	BACnet Network Protocol	Network number (max. 65.535 subnets) + device address	
Data Link Layer	Point-to-Point (PTP)	Phone numbers, passwords, automatic call back	Point-to-point protocol
Physical Layer	EIA-RS232c	Serial connection E.g. to dial-up modem	

Table 12: Structural overview of BACnet PTP

7.6 BACnet addressing

BACnet can manage up to 65.535 subnets. Different network media can be used in different subnets (e.g. BACnet/IP and MS/TP).

Addresses, subnet numbers, and BBMDs in BACnet system must be planned and documented centrally. Structuring by building, floors, and equipment is possible. Duplicate designations and assignments result in faults and must be avoided.

A B-PAT table should be used to manage cross-vendor BACnet and IP addresses. B-PAT (BACnet Project Address Table) contains address tables (B-PAT template table), describes the basics of BACnet addressing (B-PAT description), and is provided for free-of-charge download by BIG-EU at the following address: (http://www.big-eu.org/en/service/downloads/).

7.7 Connection to universal data networks

BAC systems shall co-use existing data networks where possible to avoid greater effort to establish and maintain concurrent data networks.

Performance and liability limits and system responsibilities of buyers, contractors, and network providers must be identified consensually and defined clearly in an agreement for shared networks.

Existing IT specifications and any required cooperation with IT administration shall be clarified at the outset. Agreed to decision-making processes on transmission paths and communications protocols are important. In particular, the following aspects must be clarified and agreed to in writing:

- Responsibilities and limits
- Required connections
- Interfaces to be provided
- Data transmission protocols
- Network addresses
- Network security and data protection
- Guaranteed bandwidth and allowed delays
- Availability
- Procedures for IT maintenance
- Procedure during errors/faults
- Service and fault resolution times
- Costs

In special cases (e.g. lack of reserve capacity or availability, or highly sophisticated security standard of data networks), agreements with administrative bodies may be sought for using available capacity on remote lines (e.g. DSL modem lines) or leased data lines. Wireless connections (e.g. UMTS or microwave) may be used as an alternative.

Under special conditions (e.g. highly sophisticated security standard), physically separate networks may be advantageous.

7.8 Security concept against unauthorized manipulation

The open BACnet concept allows access to the BAC network from anywhere.

Since July 2010, the BACnet standard defines in **Addendum g** telegram encryption and deployment of latest security technologies.

A security concept is required for the BAC network employing demand-dependent common security mechanisms for IT data networks (e.g. VPN tunneling in IT networks, authorization only of devices with known MAC address).

Additional protection against unauthorized applications is considered a part of BAC programs.

8 Implementation concepts

This section explains important aspects and provides overviews needed to implement BACnet systems.

8.1 Issues and application notes

Merely requiring the possibility of certain BAC functions in tenders does not mean that these functions will then be executed in the current project. A tender must require that BAC functions be set up and functional and ready for testing upon acceptance.

The following selection of practical examples intends to heighten awareness of certain application issues and their consequences:

- Priority control of a physical output is carried out via one or multiple BACnet objects rather than property Priority_Array. This solution is unacceptable as it does not represent a standard solution, thereby increasing the number of BACnet objects resulting in higher costs.
- Property Units exists, but is not set up or cannot be set up. This is unacceptable, as the BAC function is limited, resulting in greater effort for later activation.
- The properties for status texts are not or not fully set up, resulting in no value display when displaying property Present_Value. This is unacceptable, as the BAC function is limited, resulting in greater effort for later activation.
- Only one instance of a Notification Class object is possible in the AS, or only one instance is set up despite differentiated user specifications. This is unacceptable, as the BAC function is limited, resulting in greater effort for later revision.
- Physical outputs are displayed as BACnet input objects and cannot be overridden. This is unacceptable, as allocation is not as standardized and required override is not possible.
- In BACnet objects whose properties (different from the AMEV profile) are not writable, additional objects must be set up to enable writing of properties. This solution is unacceptable as it does not represent a standard solution, thereby increasing the number of BACnet objects resulting in higher costs. The standard object types (e.g. controller) are intended to lower not increase the number of objects.

8.2 System-oriented solutions concept

Builders and operators of large sites featuring a great number of buildings are responsible - among others - for administration and extension of BAC systems. Recurrently they will face a number of typical BAC problems due to different planning concepts, multiple vendor philosophies, and varying execution quality. This situation will persist, until they decide to realize an adequate system-oriented BAC solution.

Significant improvements can only be achieved if a system-oriented BAC concept is established which observes and clarifies the important Builder-specific basic conditions. Necessary is a requirement specification document containing all relevant specifications for the extension of the BAC system. Previously a comprehensive migration concept may be useful to find out the best way to establish a multi-vendor BACnet system.

In case of stepwise extensions of a BACnet system standardized technical and administrative definitions in a **BACnet requirement specification** are urgently recommended (see VDI/VDE 3694). Definite vendor-neutral specifications in tenders with BACnet integration simplify the connection of devices from multiple vendors. Cooperation efforts and possible communication problems by planners, builders, and operators are minimized. Basic requirements must be defined for designation systems, BAC and BACnet functions as well as for documentation.

Section 8.3 contains recommendations for BACnet requirement specification information.

Management of a large number of proprietary BAC systems is urged to establish a **migration concept** prior to investing more money in BAC. The concept outlines methods to migrate existing BAC systems to establish an economically viable and sustainable BAC system under given conditions. Existing buildings, technical plants, BAC systems and communications networks, foreseeable extensions and modifications as well as primary aspects of BAC operation along with human resources conditions are recorded and evaluated. This serves as the basis for drafting a concept entailing demand-based design of BAC systems, required renovations, and suitable extensions. The results of the analyzed inventory and recommended BAC measures along with a concept for future extensions (BACnet requirement specification) are presented as part of a comprehensive migration concept.

Section 8.4 names relevant aspects for a BACnet-based migration concept.

It is important that a qualified BAC planner with technical knowledge and experience in implementing multi-vendor BACnet systems manages the migration concept and requirement specification.

This also applies to planning, tendering, and acceptance of BACnet in new buildings, renovations, or extensions.

A competent BACnet expert must check comprehensively and document adherence to BACnet specifications for each BAC project.

8.3 BACnet requirement specification (overview)

Target

- Definition of comprehensive, system-wide specifications for all BAC projects and BAC operation.

General rules

- Adhere to recommendations AMEV „BAC“ and BACnet 2017 en.
- No project- or vendor-specific definitions, restrictions, or extensions.
- Specific function descriptions, automation diagrams, and BAC functions lists.
- Declarations of conformity for BACnet components by certificates and AMEV attestations (see **Appendix 6.3**) of BACnet certification body.
- Required downward compatibility of BACnet equipment updates.
- Concept to manage passwords and log files (e.g. for several MOUs).
- Organizational specifications for engineering MOU and AS for retrofitting or changes to building automation and control.

Comprehensive designations and basic information

- System-wide, harmonized addressing system (**Section 4.4**).
- Character sets to be supported (**Section 4.1**).
- Harmonized definitions for clear texts, status texts, and units for all I/O functions as per **Section 6.4** and **Appendices 7.4** and **7.5**.
- Alarm and event management with definite notification parameters, event and acknowledgement options as per **Sections 6.2 and 6.3** as well as **Appendices 7.6 to 7.8**.
- Definitions for calendar and date entries, command priority, and trend logging.
- Labeling of sensors, actuators, terminals, etc. as per the addressing system, function description, and automation diagram.

BAC specifications

- Planning and documentation of BAC functions and allocation of BACnet objects in BAC functions lists as per **Section 4** and **Appendices 2 and 3**.
- Listing information required system-wide for overall functionality.
- Specification of information contents in BACnet objects for each component type (pumps, fans, actuators, etc.).
- Function descriptions for all operating modes of the automated plants.
- Definition of key BAC functions in the entire system (e.g. read/write access, fault indication and routing, trend logging, consumption metering, overviews, logging, archiving, and data security).
- Reaction on faults (e.g. data networks, BAC components, technical plants).

BACnet specifications

- Support of required object types, properties, read/write access, and BIBBs by MOU and AS as per AMEV profile MOU-A and AMEV profile AS-A as per **Appendices 4 and 5**.
- If needed support of further object types, properties, read/write access, and BIBBs by MOU and AS as per AMEV profile MOU-B and AMEV profile AS-B as per **Appendices 4 and 5**.
- Proprietary services, objects, properties are not allowed. Exceptions require agreement of the operator.
- When initially connecting new BACnet devices, proof of interoperability as per **Section 3.13** must be established prior to ordering (by means of a test installation as per AMEV „BAC“ as needed).
- BACnet implementation of AS as per Section 6 of the AMEV BACnet recommendation.
- BACnet implementation of MOU as per **Section 5** and of AS as per **Appendix 7.7** of the AMEV BACnet recommendation.

BACnet network

- Early coordination with IT administration (see **Section 7.7**).
- Use of BACnet/IP as per Annex J of the BACnet specification.
- Networks with own, secured network segments and a specified network quality for BAC (see **Section 7.7**) also when integrating in universal data networks:
- Segmentation rules for different network segments.
- Planning of BACnet and IP addresses as well as BBMDs via B-PAT table (see **Section 7.6**).
- Integration and operation of a BACnet protocol analyzer.

Documentation and licenses

- Specifications for system-wide structure and contents of BAC system documentation 8e.g. as per AMEV „BAC“.
- Handover of a complete and up-to-date set of documentation on the BAC plants in required language both in electronic form and on paper (including all automation diagrams, BAC functions lists, function descriptions, EDE files, lists of used objects, properties, and BIBBs (see GAEB Sheet BACnet), proof of training as well as operating, maintenance and service instructions etc.).
- Handover of all system passwords for unrestricted access to the MOU, AS, and other BACnet devices including system administrator level passwords.
- Handover of project-specific programs (including source programs and libraries with complete documentation) and all software tools required for complete system generation along with unrestricted rights of use and admission privileges.
- Updated documentation in case of extensions and modifications, inclusive realized systems during operation (e.g. changed use, operational optimization, software updates).

8.4 BACnet migration concept (overview)

Inventory of buildings

- Building stock
- Planned and started building projects
- Influence of planned buildings on technical equipment and BAC (e.g. 3 stages: high, medium, low)
- Overview with designations, uses, areas
- Site plan

Inventory of technical equipment in buildings

- Documentation (e.g. plant diagrams, output/performance data)
- Remaining life of equipment
- Economic viability

Inventory of BAC

- Documentation (e.g. BAC requirement specification, system topology, mechanical equipment rooms)
- Plant schematics (examples and samples)
- Addressing and labeling system
- Usable AS and MOUs (vendors, models, interfaces)
- Available communications connections

Inventory of communications infrastructure

- Inventory as per **Sections 7.7 and 7.8**

BAC concept

- Basic requirements, basic structure, open communications
- Performance and capacity (e.g. number of data points, BAC functions in final stage)
- Concept for control functions (automation diagram samples, BAC functions lists)
- Field device functions features
- System integration requirements as per VDI 3814 Sheet 5
- IT system interfaces (e.g. CAFM, utility cost billing)
- Specification of communications and transmission protocols

Human resources, third-party services

- Operating concept
- BAC operators (number, qualifications)
- Training
- Maintenance (own, third-party)
- Software maintenance and update for MOU and AS

BACnet requirement specification (see **Section 8.3**)

- General rules and basic information
- Comprehensive designations
- BAC specifications
- BACnet specifications
- BACnet network
- Documentation and licenses

BACnet MOU

- Minimum requirements of hardware (visualization)
- Application software
- Software for supervising and operating, visualization, databases
- Remote access options
- Fault management, maintenance management
- Energy management, load management, environmental management
- Engineering
- Documentation

BACnet AS

- Requirements of BACnet AS
- Integration/provisioning of existing BAC functions
- Engineering
- Documentation

Data networks

- Lines, tracks, active network components
- Network topology, segmentation, addressing
- Network protocols
- Agreements with IT administration
- Special features for using BACnet

Time and finance planning

- Immediate measures (e.g. vendor-neutral MOU for new building or renovation)
- Mid-term BAC upgrade (e.g. new AS, integration of technical equipment in buildings)
- Long-term BAC upgrade (e.g. for technical equipment upgrades)
- Costs (immediate measures, mid-term financial planning)

Appendix

Appendix 1 Object types: Overview

Object type (standard)	**Obj.typ Abbr.**	**Object type** (informative)	**Explanation** (informative)	**Source**
1	2	3	4	5
Access Credential	(AC)	Proof of access right	Object for access control systems: Describes authentification data (e.g. pin, card, biometric features).	Add. j
Access Door	(AD)	Access door	Object for access control systems: Describes a door or a gate.	DIN
Access Point	(AP)	Access control point	Object for access control systems: Describes the entry or gate where authentication and authorization are carried out.	Add. j
Access Rights	(AR)	Access rights	Object for access control systems: Describes access rights (e.g. time span, conditions).	Add. j
Access User	(AU)	Authorized access users	Object for access control systems: Describes access rights of persons or groups.	Add. j
Access Zone	(AZ)	Access area	Object for access control systems: Describes a secured zone (e.g. a building) with entry and exit points.	Add. j
Accumulator	ACC	Counter value input	Adding up of measuring pulses over time; suitable for balance, billing and energy load management; for simple interval quantity counts, see pulse converter.	DIN
Analog Input	AI	Analog input	Measuring (e.g. measured value from temperature measurement).	DIN
Analog Output	AO	Analog output	Positioning (e.g. positioning command for control valve).	DIN
Analog Value	AV	Analog value	Analog value (e.g. as a result of calculation):	DIN
Averaging	AVG	Average value	Object for smoothing techniques with statistical functions (Minimum, Maximum, Average, Variance).	DIN
Binary Input	BI	Binary input	Signaling of binary states (e.g. operating, fault, alarm notification).	DIN
Binary Output	BO	Binary output	Switching, positioning (e.g. switching command On/Off, switching command open/close).	DIN
Binary Value	BV	Binary value	Binary value (e.g. calculated from logical binding).	DIN
BitString Value	(BSV)	String of single bit values	Data object to map a string of bit values.	Add. w
Calendar	CAL	Calendar	Operating calendar (e.g. holidays, vacation).	DIN
CharacterStringValue	(CSV)	String	Data object to map character strings.	Add. w
Command	CMD	Group command	Command to execute predefined activities by other objects.	DIN
Credential Data	(CD)	Access rights entries	Object for access control systems: Entered data for authentification (e.g. card reader, pin entry devices, biometric systems).	Add. j
Date Pattern Value	(DPV)	Date pattern	Data object to map a pattern of recurring dates.	Add. w
Date Value	(DV)	Date	Data object to map a date.	Add. w
DateTime Pattern Value	(DTPV)	Date/time pattern	Data object to map a pattern of recurring date/time combinations.	Add. w

DateTime Value	(DTV)	Date/Time	Data object to map a date/time combination.	Add. w
Device	DEV	Device	Basic system parameter to describe the BACnet device (e.g. AS or MOU).	DIN
Event Enrollment	EE	Event enrollment	Object to map criteria for algorithmic event detection.	DIN
Event Log	ELOG	Event logging	Object to store a list of events and alarms and their time stamps.	DIN
File	FIL	File	Object to transfer files (e.g. program, data security, archiving).	DIN
Global Group	GGRP	Global group entry	Object to group readable properties and current values of any object in any device in a BACnet-network.	Add. b
Group	GRP	Group entry	Object to group readable properties and their values of any object within a single device.	DIN
Integer Value	(IV)	Integer value	Data object to map an integer value (positive or negative).	Add. w
Large Analog Value	(LAV)	Analog value with double precision	Data object to map floating point numbers at double precision.	Add. w
Life Safety Point	LSP	Risk detection	Object contains information on properties for risk/danger management applications in a BACnet network.	DIN
Life Safety Zone	LSZ	Safety area	Object to summarize risk detection objects (e.g. for fire detection lines, fire sectors, alarming sections).	DIN
Load Control	(LC)	Load control	Object to limit peak loads (e.g. load management using load shedding)	DIN
Loop	LP	Controllers	Object to represent loop controller functions (e.g. PID controller).	DIN
Multi-state Input	MI	Multistate input	Multi-state representation as coded number (e.g. notification: Off, Stage 1, Stage 2, …).	DIN
Multi-state Output	MO	Multistate output	Switching, positioning; states as coded number (e.g. switching command: Off, Stage 1, Stage 2, …).	DIN
Multi-state Value	MV	Multistate value	Multi-state value (e.g. as calculated value).	DIN
Network Security	(NS)	Network security	Object to represent the externally visible network security settings and status of a device (e.g. public keys, encryption method).	Add. g
Notification Class	NC	Notification class	Object to represent classes for alarm and event notifications containing current notification recipients.	DIN
OctetString Value	(OSV)	8-bit string	Data object to map a string of hexadecimal octets with 8 bits each.	Add. w
Positive Integer Value	(PIV)	Positive integer value	Data object to map an integer value (positive only).	Add. w
Program	PR	Program	Object to control programs in a BACnet device (e.g. load and start).	DIN
Pulse Converter	PC	Pulse converter	Object to convert pulses to count quantities for set intervals. Not suitable for billing purposes; see Accumulator object).	DIN
Schedule	SCHED	Schedule	Object to define recurring switching times and exceptions.	DIN
Structured View	(SV)	Object structure	Object to support display of inter-object relationships.	DIN
Time Pattern Value	(TPV)	Time pattern	Data object to map patterns of recurring times of a day.	Add. w
Time Value	(TV)	Time	Data object to map time.	Add. w
Trend Log	TLOG	Trend logging	Object to log trends from an object in the local device or from a foreign device in a BACnet-network.	DIN
Trend Log Multiple	TLOGM	Multiple trend logging	Object to log trends for multiple values in the local device or from a foreign device in a BACnet-network.	DIN

Appendix 2 Planning aids for BAC functions lists

Appendix 2.1 Key for BAC functions list

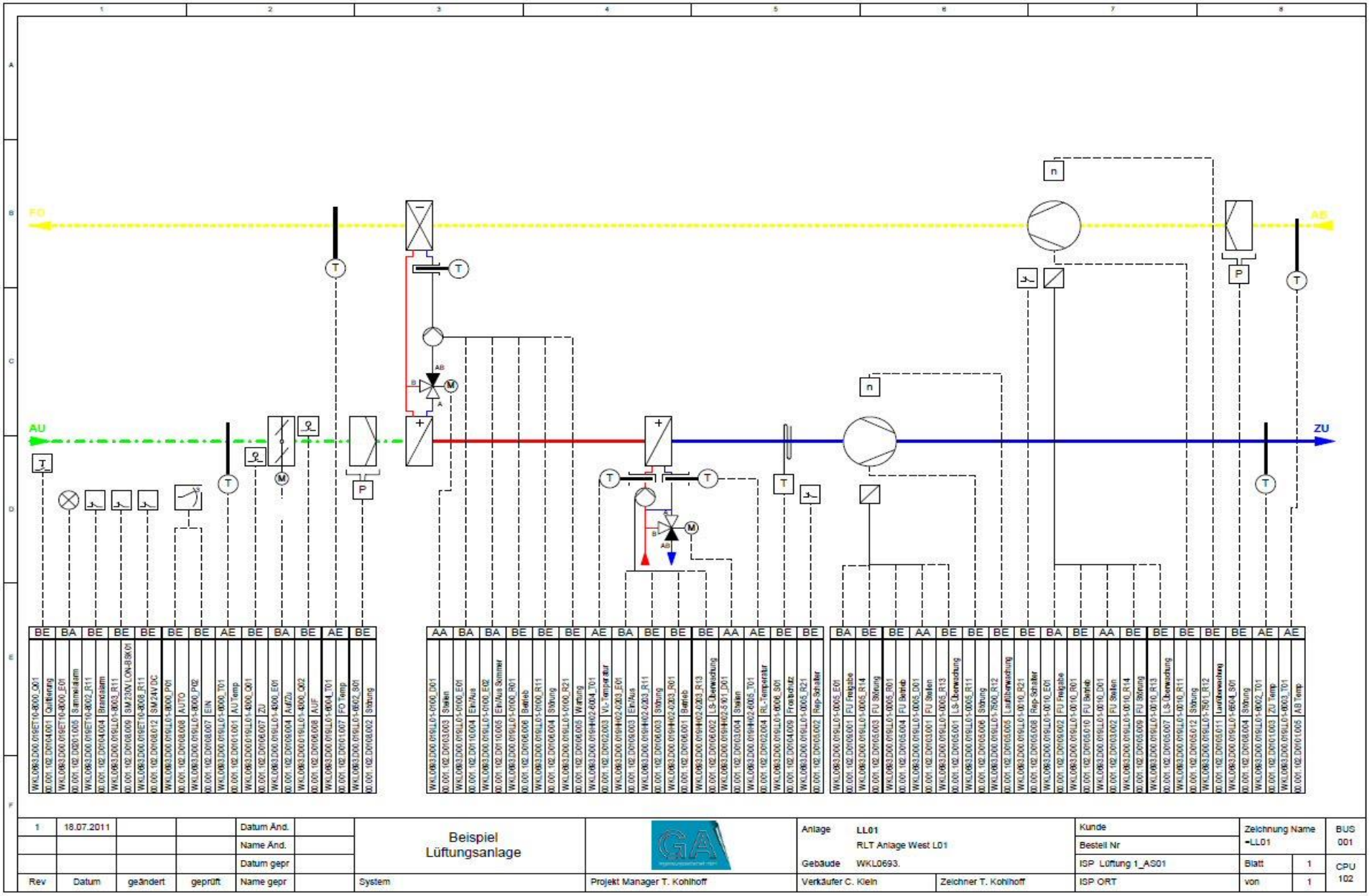
No.	Symbol (**blue, bold**)	Meaning	Example (and explanation)
1	2	3	4
1	**O**	Abbreviation for BACnet object type (see 17 **Appendix 1 Column 2**).	BI (Binary Input)
2	***AGG***	Italics designate an abbreviation of an aggregate.	*HRC* (heat recovery)
3	**"**Value**"**	Value of a BAC function (e.g. plant switch positions).	"Off"; "Auto"; "On"
4	R.S.C	The three-part code (row, section, column) represents a BAC function: R=BAC-FL Row, S=BAC-FL Section, C=BAC-FL Column; *Self-references within a BAC-FL row may contain only two places (only: **S.C**).*	1.1.3 (BAC-FL row 1 with BAC function: Binary input notification)
5	R.S.C=BI	Allocation of BAC function R.S.C to a BACnet object (e. g. Binary Input)	1.1.3=BI
6	**Prop.** BI	Use of property of a BACnet object (e. g. BI).	Prop. BI (part of Binary Input object)
7	X**:=**Y	X always has value Y.	"Auto":=1
8	X◄Y	Input of X (client) is influenced by output of Y (server).	5.3.6◄6.1.3
9	X►Y	Output of X (server) acts on input of Y (client).	5.3.6►5.1.1
10	X**;** Y	Separator.	5.3.6◄6.1.3; 5.3.6►5.1.1
11	**(**X; Y; Z**)**	List of multiple elements.	2.1.3►(1.1.3; 2.7.1; 2.3.6)
12	**NOT** X	Binary value X inversion.	NOT 1.1.3
13	(X **AND** Y)	Logical AND operator for binary values X and Y.	(1.1.3 AND 2.1.4)
14	(X **OR** Y)	Logical OR operator for binary values X and Y.	(1.1.3 OR 2.1.4)
15	(X **NAND** Y)	Logical NOT-AND operator for binary values X and Y.	(1.1.3 NAND 2.1.4)
16	(X **NOR** Y)	Logical NOT-OR operator for binary values X and Y.	(1.1.3 NOR 2.1.4)
17	(X **XOR** Y)	Exclusive OR operator for binary values X and Y.	(1.1.3 XOR 2.1.4)
18	**TP** X	X acts on Y via pulse.	TP 1.1.3
19	**TON** X	X acts on Y via switch-on delay.	TON 1.1.3
20	**TOF** X	X acts on Y via switch-off delay.	TOF 1.1.3
21	**PRIM**	Permanent (primary) display of a property in the MOU.	Present value (see **Appendix 2.2**)
22	**SEK**	Temporary (secondary) display of a property in the MOU.	Object name (see **Appendix 2.2**)

Appendix 2.2 Dynamic displays in the MOU

Cont. no.	Object type	BAC-FL	Prim./ Sec. *	**Dynamic displays in an MOU** (recommended properties - information)	Volume
1	AI	8.2	PRIM	Present value, unit, status flag, acked transitions	6
1	AI	8.2	SEC	Object name, object description	
2	AO	8.2	PRIM	Present value, unit, status flag	6
2	AO	8.2	SEC	Object name, object description, priority array	
3	AV	8.2	PRIM	Present value or default value, unit	5
3	AV	8.2	SEC	Object name, object description, priority array	
4	BI	8.2	PRIM	Present value, status flag, acked transitions	5
4	BI	8.2	SEC	Object name, object description	
5	BO	8.2	PRIM	Present value, status flag	5
5	BO	8.2	SEC	Object name, object description, priority array	
6	BV	8.2	PRIM	Present value, status flag, acked transitions	6
6	BV	8.2	SEC	Object name, object description, priority array	
7	CAL	8.2	PRIM	Present value	3
7	CAL	8.2	SEC	Object name, object description	
8	DEV	8.2	PRIM	System status	3
8	DEV	8.2	SEC	Object name, object description	
9	EE	8.2	SEC	Object name	1
10	LP	8.2	PRIM	None (only loop symbol and explanatory text)	5
10	LP	8.2	SEC	Object name, proportional value, integral value, differential value, controlled variable value	
11	MI	8.2	PRIM	Present value, status flag, acked transitions	5
11	MI	8.2	SEC	Object name, object description	
12	MO	8.2	PRIM	Present value, status flag	5
12	MO	8.2	SEC	Object name, object description, priority array	
13	MV	8.2	PRIM	Present value, status flag, acked transitions	5
13	MV	8.2	SEC	Object name, object description, priority array	
14	NC	8.2	PRIM	Notification class	3
14	NC	8.2	SEC	Object name, object description	
15	SCHED	8.2	PRIM	Present value, status flag	4
15	SCHED	8.2	SEC	Object name, object description	
16	TLOG	7.2	SEC	Trend logging	1

* primary = permanent display; secondary = temporary display

Appendix 2.3 Plant diagram (example: AHU)


FO
AB
AU
ZU
n
T
P
M
Beispiel
Lüftungsanlage
Anlage LL01
RLT Anlage West L01
Gebäude WKL0693.
Datum Änd.
Name Änd.
Datum gepr
Rev
Datum
geändert
geprüft
Name gepr
System
Projekt Manager T. Kohlhoff
Verkäufer C. Klein
Zeichner T. Kohlhoff
Kunde
Bestell Nr
ISP Lüftung 1_AS01
ISP ORT
Zeichnung Name
-LL01
Blatt 1
von 1
BUS 001
CPU 102

Blank page

Appendix 2.4 Explanation of BAC functions and BACnet objects (example: AHU)

AMEV notes		Excerpt of BAC functions list (VDI 3814 Sheet 1)						BACnet
No.	BAC function	Data point: User address	Row	Sec. Col.	Data point: Function (Sections 1 to 8)	Quant.	Comments (Section 9)	Object type
1	2	3	4	5	6	7	8	9
1	**Plant switch**							
2	Phys. input plant switch (Auto/Man)	WKL0693.D00.019LL01-8000_P01	1	1.3	Binary input state	1	1.1.3=BI►(1.7.1; 3.2.3)	BI
3			1	7.1	Input/output/value object	1	1.7.1◄1.1.3	
4	Phys. input plant switch (On/Off)	WKL0693.D00.019LL01-8000_P02	2	1.3	Binary input state	1	2.1.3=BI►(2.7.1; 2.3.6)	BI
5			2	3.6	State processing	5	2.3.6"On"◄NOT 1.1.3 AND 2.1.3; 2.3.6"Offs"◄NOT 1.1.3 AND NOT 2.1.3; 2.3.6 ►3.2.3	
6			2	7.1	Input/output/value object	1	2.7.1◄2.1.3	
7	Plant switch (Off/Auto/On)	WKL0693.D00.019LL01-8000_P03	3	2.3	Binary Input value, state	3	3.2.3=MV◄(1.1.3 "Auto"; 2.3.6 "On"; 2.3.6 "Off")	MV
8			3	3.6	State processing	1	3.3.6◄(6.1.3 OR 7.1.3); 3.3.6►3.4.1	user progr.
9	Control of multiple aggregates (outside air damper, ERC, supply/extract air fan)		3	4.1	Plant control	1	3.4.1"Off"◄3.3.6; 3.4.1►(11.1.1; 14.1.2; 15.1.1; 33.1.1; 49.1.1)	user progr.
10	Scheduler programs		3	6.4	Time schedule	10	3.6.4◄56.7.2	
11	Display output stages in MOU		3	7.1	Input/output/value object	1	3.7.1◄3.2.3	
12	Dynamic display in MOU		3	8.2	Dynamic display	1	3.8.2◄see Appendix 2.2	
13	**Acknowledgement on panel**	WKL0693.D00.019ET10-8000_Q01	4	1.3	Binary input state	1	4.1.3=BI►4.7.1	BI
14	Time-delayed control of multiple aggreg. (air damper, ERC, supply/extr. air fan)		4	3.6	State processing	1	4.3.6 ◄4.1.3; 4.3.6 TON►(11.4.5; 15.4.5; 18.4.5; 22.4.5; 24.4.5)	user progr.
15			4	7.1	Input/output/value object	1	4.7.1◄4.1.3	
16	**Common alarm notification**	WKL0693.D00.019ET10-8000_E01	5	1.1	Bin.output switching/pos.	1	5.1.1=BO◄5.3.6; 5.1.1►5.7.1	BO
17			5	3.6	State processing	1	5.3.6◄(6.1.3 OR 7.1.3); 5.3.6►5.1.1	user progr.
18			5	7.1	Input/output/value object	1	5.7.1◄5.1.3	
19	Dynamic display in MOU		5	8.2	Dynamic display	5	5.8.2◄see Appendix 2.2	
20	**Fire alarm**	WKL0693.D00.019ET10-8000_R11	6	1.3	Binary input state	1	6.1.3=BI►(6.7.1; 3.4.1"Off"; 37.7.2; 56.7.2)	BI
21			6	7.1	Input/output/value object	1	6.7.1◄6.1.3	
22	Dynamic display in MOU		6	8.2	Dynamic display	4	6.8.2◄see Appendix 2.2	
23	**Fault notification 230 V**	WKL0693.D00.019ET10-8003_R11	7	1.3	Binary input state	1	7.1.3=BI►(7.7.1; 3.4.1 "Off"; 57.7.2)	BI

24			7	7.1	Input/output/value object	1	7.7.1◄7.1.3	
25	Dynamic display in MOU		7	8.2	Dynamic display	5	7.8.2◄see Appendix 2.2	
26	**Outside temperature**							
27	Measured value	WKL0693.D00.019LL01-6000_T01	8	1.5	Analog input	1	8.1.5=AI►8.7.1	AI
28	Alarm upon limit value breach		8	3.1	Fixed limit	1	8.3.1►56.7.2	Prop.AI
29			8	7.1	Input/output/value object	1	8.7.1◄8.1.5	
30	Dynamic display in MOU		8	8.2	Dynamic display	6	8.8.2◄see Appendix 2.2	
31	**Trend log** *(example)*	WKL0693.D00.019LL01-6000_X01	9	7.2	Complex object type		9.7.2=TLOG◄8.1.5	TLOG
32	**Outside air damper (OAD)**							
33	End pos.notif. closed (1=end pos.)	WKL0693.D00.019LL01-4300_Q01	10	1.3	Binary input state	1	10.1.3=BI►10.7.1	BI
34			10	7.1	Input/output/value object	1	10.7.1◄10.1.3	
35	Dynamic display in MOU		10	8.2	Dynamic display	5	10.8.2◄see Appendix 2.2	
36	Actuator command open/close (0=closed; 1=open)	WKL0693.D00.019LL01-4300_E01	11	1.1	Bin.output switching/pos.	1	11.1.1=BO►5.7.1	BO
37			11	3.5	Command exec. check	1	11.3.5►57.7.2	Prop.BO
38			11	4.5	Safety/frost prot.control	1	11.4.5◄27.4.5; 11.4.5►11.1.1"Off"	
39			11	7.1	Input/output/value object	1	11.7.1◄11.1.1	
40	Dynamic display in MOU		11	8.2	Dynamic display	5	11.8.2◄see Appendix 2.2	
41	End pos.notification (1=end pos.)	WKL0693.D00.019LL01-4300_Q02	12	1.3	Binary input state	1	12.1.3=BI►12.7.1	BI
42			12	7.1	Input/output/value object	1	12.7.1◄12.1.3	
43	Dynamic display in MOU		12	8.2	Dynamic display	5	12.8.2◄see Appendix 2.2	
44	Supply air filter diff. press. monitor	WKL0693.D00.019LL01-6502_S01	13	1.3	Binary input state	1	13.1.3=BI►13.7.1	BI
45			13	3.6	State processing	1	13.3.6◄13.1.3; 13.3.6 TON►59.7.2	Prop. BI
46			13	7.1	Input/output/value object	1	14.7.1◄14.1.3	
47	Dynamic display in MOU		13	8.2	Dynamic display	5	14.8.2◄see Appendix 2.2	
48	**ERC control valve**	WKL0693.D00.019LL01-0100_D01	14	1.2	Analog output positioning	1	14.1.2=AO►14.7.1	AO
49			14	7.1	Input/output/value object	1	14.7.1◄14.1.2	
50	Dynamic display in MOU		14	8.2	Dynamic display	6	14.8.2◄see Appendix 2.2	
51	**ERC pump**							
52	Switching command	WKL0693.D00.019LL01-0100_E01	15	1.1	Bin.output switching/pos.	1	15.1.1=BO►(5.7.1; 57.7.2)	BO
53			15	3.5	Command exec. check	1	15.3.5►15.4.2	Prop.BO
54			15	4.2	Motor control	1	15.4.2◄15.3.5	user progr.
55			15	4.5	Safety/frost prot.control	1	15.4.5◄27.4.5; 15.4.5►15.1.1"On"	
56			15	7.1	Input/output/value object	1	15.7.1◄15.1.1	
57	Dynamic display in MOU		15	8.2	Dynamic display	5	15.8.2◄see Appendix 2.2	
58	Refrig. request (pump=ON)	WKL0693.D00.019LL01-0100_E02	16	1.1	Bin.output switching/pos.	1	16.1.1=BO►16.7.1	BO
59			16	7.1	Input/output/value object	1	16.7.1◄16.1.1	
60	Dynamic display in MOU		16	8.2	Dynamic display	5	16.8.2◄see Appendix 2.2	

AMEV notes	**Excerpt of BAC functions list** (VDI 3814 Sheet 1)	**BACnet**

No.	BAC function	Data point: User address	Row	Sec. Col.	Data point: Function (Sections 1 to 8)	Quant.	Comments (Section 9)	Object type
1	2	3	4	5	6	7	8	9
61	Operating notification	WKL0693.D00.019LL01-0100_R01	17	1.3	Binary input state	1	17.1.3=BI►17.7.1	BI
62			17	7.1	Input/output/value object	1	17.7.1◄17.1.3	
63	Dynamic display in MOU		17	8.2	Dynamic display	5	17.8.2◄see Appendix 2.2	
64	Fault notification	WKL0693.D00.019LL01-0100_R11	18	1.3	Binary input state	1	18.1.3=BI►(18.4.5; 18.7.1; 57.7.2)	BI
65			18	7.1	Input/output/value object	1	18.7.1◄18.1.3	
66	Dynamic display in MOU		18	8.2	Dynamic display	5	18.8.2◄see Appendix 2.2	
67	LSS monitoring	WKL0693.D00.019LL01-0100_R13	19	1.3	Binary input state	1	19.1.3=BI►(15.1.1; 19.7.1; 57.7.2)	BI
68			19	7.1	Input/output/value object	1	19.7.1◄19.1.3	
69	Dynamic display in MOU		19	8.2	Dynamic display	5	19.8.2◄see Appendix 2.2	
70	Maintenance notification	WKL0693.D00.019LL01-0100_R21	20	1.3	Binary input state	1	20.1.3=BI►(20.7.1; 59.7.2)	BI
71			20	7.1	Input/output/value object	1	20.7.1◄20.1.3	
72	Dynamic display in MOU		20	8.2	Dynamic display	5	20.8.2◄see Appendix 2.2	
73	**ERC supply air temperature**	WKL0693.D00.019HH02-6004_T01	21	1.5	Analog input	1	21.1.5=AI►21.7.1	AI
74			21	7.1	Input/output/value object	1	21.7.1◄21.1.5	
75	Dynamic display in MOU		21	8.2	Dynamic display		21.8.2◄see Appendix 2.2	
76	**Preheater pump**							
77	Switching command	WKL0693.D00.019HH02-0203_E01	22	1.1	Bin.output switching/pos.	1	22.1.1=BO►22.7.1	BO
78			22	3.5	Command exec. check	1	22.3.5►(22.4.5; 57.7.2)	Prop.BO
79			22	4.2	Motor control	1	22.4.2◄25.1.3	user progr.
80	Anti-blocking protection		22	4.4	Step control	1	22.4.4◄61.7.2	
81			22	4.5	Safety/frost prot.control	1	22.4.5◄27.4.5; 22.4.5►22.1.1"On"	
82			22	7.1	Input/output/value object	1	22.7.1◄21.1.1	
83	Dynamic display in MOU		22	8.2	Dynamic display	5	22.8.2◄see Appendix 2.2	
84	Operating notification	WKL0693.D00.019HH02-0203_R01	23	1.3	Binary input state	1	23.1.3=BI►23.7.1	BI
85			23	7.1	Input/output/value object	1	23.7.1◄23.1.3	
86	Dynamic display in MOU		23	8.2	Dynamic display	5	23.8.2◄see Appendix 2.2	
87	Fault notification	WKL0693.D00.019HH02-0203_R11	24	1.3	Binary input state	1	24.1.3=BI►(24.7.1; 57.7.2)	BI
88			24	7.1	Input/output/value object	1	24.7.1◄24.1.3	
89	Dynamic display in MOU		24	8.2	Dynamic display	5	24.8.2◄see Appendix 2.2	
90	LSS monitoring	WKL0693.D00.019HH02-0203_R13	25	1.3	Binary input state	1	25.1.3=BI►(22.1.1 Off; 25.7.1; 57.7.2)	BI
91			25	7.1	Input/output/value object	1	25.7.1◄25.1.3	
92	Dynamic display in MOU		25	8.2	Dynamic display	5	25.8.2◄see Appendix 2.2	
93	**Preheater flow temperature**	WKL0693.D00.019HH02-6004_T01	26	1.5	Analog input	1	26.1.5=AI►26.7.1	AI
94			26	7.1	Input/output/value object	1	26.7.1◄26.1.5	
95	Dynamic display in MOU		26	8.2	Dynamic display	5	26.8.2◄see Appendix 2.2	
96	**Preheater return temperature**	WKL0693.D00.019HH02-6005_T01	27	1.5	Analog input	1	27.1.5=AI►(27.7.1; 27.3.1; 28.7.2)	AI

97	Low limit value 5 °C		27	3.1	Fixed limit	1	27.3.1◄27.1.5; 27.3.1►27.3.6	
98			27	3.6	State processing	2	27.3.6◄27.3.1 OR 30.4.5; 27.3.6►27.4.5	
99			27	4.5	Safety/frost prot.control	1	27.4.5◄27.3.6; 27.4.5►(3.4.1"Off"; 11.4.5; 15.4.5; 22.4.5; 30.4.5; 31.4.5; 51.4.5)	
100			27	5.2	PI/PID control loop	1	27.5.2◄28.7.2	
101			27	5.4	Proportional output stage	1	27.5.4◄27.5.2; 27.5.4►27.6.2	
102	Max. value calculation		27	6.2	Arithmetic calculation	1	27.6.2◄"Max"(27.5.4; 39.5.4); 27.6.2►29.1.2	
103			27	7.1	Input/output/value object	1	27.7.1◄27.1.5	
104	Dynamic display in MOU		27	8.2	Dynamic display	5	27.8.2◄see Appendix 2.2	
105	**Controller setpoint fixed 20°C**	WKL0693.D00.019HH02-6005_X11	28	7.2	Complex object type	1	28.7.2=LP◄27.1.5; 28.7.2►(27.5.2, 28.8.2)	LP
106	Dynamic display in MOU		28	8.2	Dynamic display	2	28.8.2◄see Appendix 2.2	
107	**Preheater control valve**							
108	Positioning command	WKL0693.D00.019HH02-5101_D01	29	1.2	Analog output positioning	1	29.1.2=AO◄27.6.2; 29.1.2►29.7.1	AO
109	Anti-blocking protection		29	4.4	Step control	1	29.4.4◄61.7.2; 29.4.4►29.1.2	
110			29	7.1	Input/output/value object	1	29.7.1◄29.1.2	
111	Dynamic display in MOU		29	8.2	Dynamic display	5	29.8.2◄see Appendix 2.2	
112	**Preheater flow temperature**	WKL0693.D00.019LL01-6006_S01	30	1.3	Binary input state	1	30.1.3=BI►30.4.5	BI
113			30	4.5	Safety/frost prot.control	1	30.4.5 Reset◄4.3.6; 30.4.5►(27.3.6; 56.7.2)	
114			30	7.1	Input/output/value object	1	30.7.1◄30.1.3	
115	Dynamic display in MOU		30	8.2	Dynamic display	5	30.8.2◄see Appendix 2.2	
116	**Supply air fan (SAF)**							
117	Fault indication motor	WKL0693.D00.019LL01-0005_R11	31	1.3	Binary input state	1	31.1.3=BI►(31.7.1; 57.7.2)	BI
118			31	4.5	Safety/frost prot.control	1	31.4.5◄27.4.5; 31.4.5►33.1.1 Off	
119			31	7.1	Input/output/value object	1	31.7.1◄31.1.3	
120	Dynamic display in MOU		31	8.2	Dynamic display	5	31.8.2◄see Appendix 2.2	
121	Repair switch	WKL0693.D00.019LL01-0005_R21	32	1.3	Binary input state	1	32.1.3=BI►(32.7.1; 59.7.2)	BI
122			32	7.1	Input/output/value object	1	32.7.1◄32.1.3	
123	Dynamic display in MOU		32	8.2	Dynamic display	5	32.8.2◄see Appendix 2.2	
124	Pos. command frequency inverter FI	WKL0693.D00.019LL01-0005_E01	33	1.1	Bin.output switching/pos.	1	33.1.1=BO►33.7.1	BO
125			33	7.1	Input/output/value object	1	33.7.1◄33.1.1	
126	Dynamic display in MOU		33	8.2	Dynamic display	5	33.8.2◄see Appendix 2.2	
127	Fault notification FI	WKL0693.D00.019LL01-0005_R14	34	1.3	Binary input state	1	34.1.3=BI►(34.7.1; 57.7.2)	BI
128			34	7.1	Input/output/value object	1	34.7.1◄34.1.3	
129	Dynamic display in MOU		34	8.2	Dynamic display	5	34.8.2◄see Appendix 2.2	

AMEV notes		Excerpt of BAC functions list (VDI 3814 Sheet 1)						BACnet
No.	BAC function	Data point: User address	Row	Sec. Col.	Data point: Function (Sections 1 to 8)	Quant.	Comments (Section 9)	Object type
1	2	3	4	5	6	7	8	9
130	Operating notification FI	WKL0693.D00.019LL01-0005_R01	35	1.3	Binary input state	1	35.1.3=BI►35.7.1	BI
131			35	7.1	Input/output/value object	1	35.7.1◄35.1.3	
132	Dynamic display in MOU		35	8.2	Dynamic display	5	35.8.2◄see Appendix 2.2	
133	Pos.command FI	WKL0693.D00.019LL01-0005_D01	36	1.2	Analog output positioning	1	36.1.2=AO►36.7.1	AO
134			36	7.1	Input/output/value object		36.7.1◄36.1.2	
135	Dynamic display in MOU		36	8.2	Dynamic display	6	36.8.2◄see Appendix 2.2	
136	LSS monitoring FI	WKL0693.D00.019LL01-0005_R13	37	1.3	Binary input state	1	37.1.3=BI►(37.4.5; 37.7.1; 57.7.2)	BI
137			37	7.1	Input/output/value object	1	37.7.1◄37.1.3	
138	Dynamic display in MOU		37	8.2	Dynamic display	6	37.8.2◄see Appendix 2.2	
139	Monitoring SAF	WKL0693.D00.019LL01-7500_R12	38	1.3	Binary input state	1	38.1.3=BI►38.3.6	BI
140			38	3.6	State processing	4	38.3.6◄(27.4.5 OR 38.1.3 OR 32.1.3); 38.3.6►33.1.1"Off"	
141			38	7.1	Input/output/value object	1	38.7.1◄38.1.3	
142	Dynamic display in MOU		38	8.2	Dynamic display	5	38.8.2◄see Appendix 2.2	
143	**Supply air temperature**	WKL0693.D00.019LL01-6002_T01	39	1.5	Analog input	1	39.1.5=AI►(39.5.2; 39.7.1)	AI
144			39	5.2	PI/PID control loop	1	39.5.2◄40.7.2	
145			39	5.4	Proportional output stage	2	39.5.4◄39.5.2; 39.5.4►29.1.2	
146			39	7.1	Input/output/value object	1	39.7.1◄39.1.5	
147	Dynamic display in MOU		39	8.2	Dynamic display	4	39.8.2◄see Appendix 2.2	
148	**Controller**	WKL0693.D00.019LL01-6002_X11	40	7.2	Complex object type	1	40.7.2=LP◄(39.1.5; 41.2.2); 40.7.2►(39.5.2; 40.8.2)	LP
149	Dynamic display in MOU		40	8.2	Dynamic display	2	40.8.2◄see Appendix 2.2	
150	Setpoint	WKL0693.D00.019LL01-6002_B01	41	2.2	Analog.Outp. Pos./Setpoint	1	41.2.2=AV►(40.7.2; 41.7.1)	AV
151			41	7.1	Input/output/value object	1	41.7.1◄41.2.2	
152	Dynamic display in MOU		41	8.2	Dynamic display	2	41.8.2◄see Appendix 2.2	
153	**Supply air pressure**	WKL0693.D00.019LL01-6500_T01	42	1.5	Analog input	1	42.1.5=AI►(42.5.2; 42.7.1)	AI
154			42	5.2	PI/PID control loop	1	42.5.2◄43.7.2	
155			42	5.4	Proportional output stage	1	42.5.4◄42.5.2; 42.5.4►(36.1.2; 51.1.2)	
156			42	7.1	Input/output/value object	1	42.7.1◄42.1.5	
157	Dynamic display in MOU		42	8.2	Dynamic display	4	42.8.2◄see Appendix 2.2	

158	**Controller**	WKL0693.D00.019LL01-6500_X11	43	7.2	Complex object type	1	43.7.2=LP◄(42.1.5; 44.2.2); 43.7.2►(42.5.2; 43.8.2)	LP
159	Dynamic display in MOU		43	8.2	Dynamic display	2	43.8.2◄see Appendix 2.2	
160	Setpoint	WKL0693.D00.019LL01-6500_B01	44	2.2	Analog Outp..Pos./Setpoint	1	44.2.2=AV►(42.5.2; 44.7.1)	AV
161			44	7.1	Input/output/value object	1	44.7.1◄44.2.2	
162	Dynamic display in MOU		44	8.2	Dynamic display	2	44.8.2◄see Appendix 2.2	
163	**Extract air temperature**	WKL0693.D00.019LL01-6003_T01	45					
164	**Extract air filter**	WKL0693.D00.019LL01-6604_S01	46					
165	**EAF fault indication motor**	WKL0693.D00.019LL01-6500_R11	47					
166	**EAF repair switch**	WKL0693.D00.019LL01-6500_R21	48					
167	**EAF FI release**	WKL0693.D00.019LL01-0010_E01	49	**Extract air components are handled similar to supply air components.**				
168	**EAF FI operating notification**	WKL0693.D00.019LL01-0010_R01	50	**Supply air components, see AMEV row 116.**				
169	**EAF FI positioning**	WKL0693.D00.019LL01-0010_D01	51	**No repeat of display needed**				
170	**EAF FI fault notification**	WKL0693.D00.019LL01-0010_R14	52					
171	**EAF FI LSS monitoring**	WKL0693.D00.019LL01-0010_R13	53					
172	**EAF monitoring**	WKL0693.D00.019LL01-7501_R12	54					
173	**Exhaust air temperature**	WKL0693.D00.019LL01-6004_T01	55					
174	**Events (notification classes)**							
175	Alarm notification	WKL0693.D00.019MX01-0102_J10	56	7.2	Complex object type	1	56.7.2=NC◄(3.6.4; 6.1.3; 8.3.1; 30.4.5)	NC 30
176	Fault notification	WKL0693.D00.019MX01-0102_J11	57	7.2	Complex object type	1	57.7.2=NC◄(7.1.3; 11.3.5; 15.1.1; 18.1.3; 19.1.3; 22.3.5: 24.1.3; 25.1.3; 31.1.3; 34.1.3; 37.1.3)	NC 40
177	Notification **LOU**	WKL0693.D00.019MX01-0102_J12	58	7.2	Complex object type	1	58.7.2=NC◄(…)	NC 49
178	Maintenance notification	WKL0693.D00.019MX01-0102_J13	59	7.2	Complex object type	1	59.7.2=NC◄(13.36; 20.1.3; 32.1.5)	NC 50
179	**Scheduler programs**							
180	Scheduler program plant	WKL0693.D00.019MX01-0102_J01	60	7.2	Complex object type	1	60.7.2=SCHED◄(62.7.2; 63.7.2; 64.7.2); 0.7.2►3.6.4	SCHED
181	Scheduler prog. anti-blocking prot.	WKL0693.D00.019MX01-0102_J02	61	7.2	Complex object type	1	61.7.2=SCHED►(22.4.4; 29.4.4)	SCHED
182	**Calendar**							
183	Weekly calendar	WKL0693.D00.019MX01-0102_J03	62	7.2	Complex object type	1	62.7.2=CAL►60.7.2	CAL
184	Holiday calendar	WKL0693.D00.019MX01-0102_J04	63	7.2	Complex object type	1	63.7.2=CAL►60.7.2	CAL
185	Vacation calendar	WKL0693.D00.019MX01-0102_J05	64	7.2	Complex object type	1	64.7.2=CAL►60.7.2	CAL

Appendix 3 Allocation of BAC functions to BACnet object types

BAC task (DIN EN ISO 16484-3 or VDI 3814-1)					**BACnet object**		**Note**
No.	**Plant part**	**No.**	**BAC function**	**Designation** (VDI 3814-1)	**Quant.**	**Type**	
1	2	3	4	5	6	7	8
1	Total plant	1	Switch-on/switch-off	Binary output switching	1	BV	Virtual
		2	Operating state notif.	Binary input state	1	BV	Virtual
		3	Record runtime	Runtime totalization	Prop. BV		
2	Switching command, 1-stage	1	Switch-on/switch-off	Binary output switching	1	BO	
		2	Feedback On/Off	Binary input state	1	BI	E.g. On/Off
		3	Record runtime	Runtime totalization	Prop. BI		
3	Switching command, n-stage	1	Switch on/off (n-stages)	Binary output value, switching	1	MV	
				Binary output switching	n	BO	
		2	Operating notify., n-stage	Binary input state	n	BI	E.g. Off/St.1/St.2
				Binary input value, state	1	MV	
		3	Runtime (total)	Runtime totalization	1	BV	
4	Contact source	1	Record state	Binary input state	1	BI	E.g. level switch
		2	Count COS	Number of state changes	Prop. BI		Change_of_State_Count
5	Measured value source With limit value	1	Record actual value	Analog input	1	AI	
		2	High limit value	Fixed limit	Prop. AI		
		3	Low limit value	Fixed limit	Prop. AI		
6	Damper actuator open/close	1	Open/close	Binary output switching	1	BO	No feedback
7	Damper actuator open/close (e.g. motorized smoke extr. damper)	1	Open/close	Binary output switching	1	BO	Open/close
		2	Feedback open/close	Binary input state	2	BI	Feedback open/close
8	Control valve/damper actuator cont.	1	Positioning command	Analog output positioning	1	AO	0 - 100%, no feedback
9	Control valve/damper actuator Continuous	1	Positioning command	Analog output positioning	1	AO	0 - 100%
		2	Feedback open/close	Binary input state	2	BI	Feedback open/close
10	Control valve/damper actuator Continuous	1	Positioning command	Analog output positioning	1	AO	0 - 100%
		2	Feedback position	Analog input	1	AI	Feedback 0-100%
11	Pump/fan 1-stage (e.g. HTG, CLG, AHU, SAN)	1	Switch-on/switch-off	Binary output switching	1	BO	
		2	Record runtime	Runtime totalization	Prop. BO		
		3	Operating notification	Binary input state	1	BI	
		4	Motor fault notification	Binary input state	1	BI	
12	Pump/fan 2-stage (e.g. HTG, CLG, AHU, SAN)	1	Switch on/off (n-stages)	Binary value output, switching	1	MV	
				Binary output switching	2	BO	
		2	Op. notification (by stage)	Binary input state	2	BI	
				Binary value input ,state	1	MV	
		3	Runtime (total)	Runtime totalization	1	BV	
		4	Motor fault notification	Binary input state	1	BI	

13	Frequency inverter	1	Switch-on/switch-off	Binary output switching	1	BO	
		2	Record runtime	Runtime totalization	Prop. BO		
		3	Operational readiness notif.	Binary value input, state	1	BI	
		4	Default setpoint	Analog output positioning	1	AO	
		5	Display actual value	Analog input	1	AI	
		6	Fault notification	Binary value input, state	1	BI	
14	Chiller, 1-stage (Small plants, simple vers.)	1	Switch-on/switch-off	Binary output switching	1	BO	
		2	Record runtime	Runtime totalization	Prop. BO		
		3	Operational readiness notif.	Binary value input, state	1	BI	
		4	Operating notification	Binary value input, state	1	BI	
		5	Common fault notification	Binary value input, state	1	BI	
15	Chiller, n-stage	1	Switch on/off (n-stages)	Binary output value, switching	1	MV	
				Binary output switching	n	BO	
		2	Operating states notification	Binary value input, state	n	BI	
				Binary value input, state	1	MV	
		3	Runtime (total)	Runtime totalization	1	BV	
		4	Fault notification	Binary value input, state	1	BI	
16	Pump lifting unit	1	Operational readiness notif.	Binary value input, state	1	BI	
		2	Motor fault notification	Binary value input, state	1	BI	
		3	Level exceeded	Binary value input, state	1	BI	Max alarm
17	Local override	1	Changeover Auto/Man.	Binary value input, state	1	BI	Indicate changeover
18	General	1	Positioning command	Analog output positioning	1	AO	
19	General	1	Feedback, binary	BBinary value input, state	1	BI	
20	General	1	Feedback, analog	Analog input, measuring	1	AI	
21	General	1	Common fault notification	Binary value input, state	1	BI	
22	General	1	Record runtime	Runtime totalization	Prop. BI/BO/BV		
23	Counter (with bus connection)	1	Record count value	Accumulated value input	1	AV	Communicating I/O function
24	Counter (with pulse count and link via user prog.)	1	Count pulse input	Binary Input counting	1	BI	
		2	Record count value	Accumulated value input	1	AV	
25	Weekly schedule	1	Switching/pos.comm.per day	Time schedule	1	SCHED	e.g. 3x On/Off per day
26	Annual schedule - variable holidays	1	List of holidays	Time schedule	1	CAL	Combined with SCHED
27	Annual schedule - set holidays	1	List of holidays	Time schedule	1	CAL	Combined with SCHED
28	Annual schedule - vacation days	1	List of vacation days	Time schedule	1	CAL	Combined with SCHED
29	Controller with setpoint adjustment	1	PI/PID control	PI/PID control loop	1	LP	
		2	Setpoint adjustment		Prop. LP		
		3	Parameter setting		Prop. LP		
		4	Floating limit value	Floating limit value	Prop. LP		Control deviation

Appendix 4 Object types: Recommendations

Appendix 4.1 Object type device

Object Type, Property (standard)	AMEV profile *				Notes (information) * Key see page 81
	MOU-A	MOU-B	AS-A	AS-B	
1	2	3	4	5	6
Device					
Object_Identifier	**P**	**P**	**R**	**R**	
Object_Name	**P**	**P**	**R**	**R**	Min. 32 characters with any syntax
Object_Type	**P**	**P**	**R**	**R**	See Appendix 7.3.
System_Status	**P**	**P**	**R**	**R**	
Vendor_Name	**P**	**P**	**R**	**R**	
Vendor_Identifier	**P**	**P**	**R**	**R**	
Model_Name	**P**	**P**	**R**	**R**	
Firmware_Revision	**P**	**P**	**R**	**R**	
Application_Software_Version	**P**	**P**	**R**	**R**	
Location	**P**	**P**	**R**	**R**	Mounting location must be configurable and readable
Description	**P**	**M**	**R**	**W**	Min. 64 characters available, must be set up
Protocol_Version	**P**	**P**	**R**	**R**	
Protocol_Revision	**P**	**P**	**R**	**R**	
Protocol_Services_Supported	**P**	**P**	**R**	**R**	
Protocol_Object_Types_Supported	**P**	**P**	**R**	**R**	
Object_List	**P**	**P**	**R**	**R**	
Structured_Object_List					
Max_APDU_Length_Accepted	**P**	**P**	**R**	**R**	
Segmentation_Supported	**P**	**P**	**R**	**R**	
Max_Segments_Accepted	**P**	**P**	**R**	**R**	Required for segmentation
VT_Classes_Supported					Do not use Virtual Terminal (VT) services
Active_VT_Sessions					Do not use Virtual Terminal (VT) services
Local_Time	**P**	**P**	**R**	**R**	Time must exist and allow for synchronization
Local_Date	**P**	**P**	**R**	**R**	Date must exist and allow for synchronization
UTC_Offset	**P**	**P**	**R**	**R**	Required to use UTC
Daylight_Savings_Status	**P**	**P**	**R**	**R**	Status must exist and allow for synchronization
APDU_Segment_Timeout	**P**	**P**	**R**	**R**	Required for segmentation
APDU_Timeout	**P**	**P**	**R**	**R**	
Number_Of_APDU_Retries	**P**	**P**	**R**	**R**	
Time_Synchronization_Recipients		**M**			Required only for Time master function
Max_Master					Poss. required if using MS/TP
Max_Info_Frames					Poss. required if using MS/TP
Device_Address_Binding	**P**	**P**	**R**	**R**	
Database_Revision	**P**	**P**	**R**	**R**	
Configuration_Files	**P**	**P**	**R**	**R**	Required for backup and restore
Last_Restore_Time	**P**	**P**	**R**	**R**	Required for backup and restore
Backup_Failure_Timeout	**P**	**P**	**R**	**R**	Required for backup and restore
Backup_Preparation_Time					
Restore_Preparation_Time					
Restore_Completion_Time					
Backup_And_Restore_State					
Active_COV_Subscriptions	**P**	**P**	**R**	**R**	Required for COV capability
Slave_Proxy_Enable					Poss. required if using MS/TP
Manual_Slave_Address_Binding					Poss. required if using MS/TP
Auto_Slave_Discovery					Poss. required if using MS/TP
Slave_Address_Binding					Poss. required if using MS/TP
Last_Restart_Reason					
Time_Of_Device_Restart					
Restart_Notification_Recipients					
UTC_Time_Synchronization_Recipients		**M**			
Time_Synchronization_Interval		**P**			
Align_Intervals		**P**			
Interval_Offset		**P**			
Profile_Name					Do not use

Appendix 4.2 I/O object types

Object Type, Property (standard)	AMEV profile *				Notes (information) ** Key see page 81*
	MOU-A	MOU-B	AS-A	AS-B	
1	2	3	4	5	6
Analog Input					
Object_Identifier	P	P	R	R	
Object_Name	P	P	R	R	Min. 32 characters with any syntax
Object_Type	P	P	R	R	See Appendix 7.3.
Present_Value	P	P	R	R	Writable if Out_Of_Service
Description	P	M	R	W	Min. 64 characters available, must be set up
Device_Type	P	P		R	Designation of connected field device
Status_Flags	P	P	R	R	
Event_State	P	P	R	R	Required for Intrinsic Reporting
Reliability	P	P		R	Not needed with AS, avoids high HW costs
Out_Of_Service	M	M	W	W	Must allow for setting Out of Service and override
Update_Interval	P	P		R	Information on operational issues may be helpful
Units	P	P	R	R	See Appendix 7.5.
Min_Pres_Value	P	P		R	
Max_Pres_Value	P	P		R	
Resolution	P	P	R	R	Resolution field device/analog input must be readable
COV_Increment	M	M	W	W	Required for COV capability
Time_Delay	M	M	W	W	Required for Intrinsic Reporting
Notification_Class	M	M	R	W	Required for Intrinsic Reporting
High_Limit	M	M	W	W	Required for Intrinsic Reporting
Low_Limit	M	M	W	W	Required for Intrinsic Reporting
Deadband	M	M	W	W	Dead zone must be changeable (same as limit values)
Limit_Enable	M	M	W	W	Required for Intrinsic Reporting
Event_Enable	M	M	W	W	Required for Intrinsic Reporting
Acked_Transitions	P	P	R	R	Required for Intrinsic Reporting
Notify_Type	P	P	R	R	Required for Intrinsic Reporting
Event_Time_Stamps	P	P	R	R	Required for Intrinsic Reporting
Event_Message_Texts					
Profile_Name					Do not use
Analog Output					
Object_Identifier	P	P	R	R	
Object_Name	P	P	R	R	Min. 32 characters with any syntax
Object_Type	P	P	R	R	See Appendix 7.3.
Present_Value	M	M	W	W	
Description	P	M	R	W	Min. 64 characters available, must be set up
Device_Type	P	P		R	Designation of connected field device
Status_Flags	P	P	R	R	
Event_State	P	P	R	R	Required for Intrinsic Reporting
Reliability	P	P		R	Not needed with AS, avoids high HW costs
Out_Of_Service	P	P	R	R	Must allow for setting Out of Service and override
Units	P	P	R	R	See Appendix 7.5.
Min_Pres_Value	P	P		R	
Max_Pres_Value	P	P		R	
Resolution	P	P	R	R	Resolution field device/analog input must be readable
Priority_Array	P	P	R	R	Required for command priority array
Relinquish_Default	P	P	R	R	
COV_Increment	M	M	W	W	Required for COV capability
Time_Delay	M	M	W	W	Required for Intrinsic Reporting
Notification_Class	M	M	R	W	Required for Intrinsic Reporting
High_Limit	M	M	W	W	Required for Intrinsic Reporting
Low_Limit	M	M	W	W	Required for Intrinsic Reporting
Deadband	M	M	W	W	Dead zone must be changeable (same as limit values)
Limit_Enable	M	M	W	W	Required for Intrinsic Reporting
Event_Enable	M	M	W	W	Required for Intrinsic Reporting
Acked_Transitions	P	P	R	R	Required for Intrinsic Reporting
Notify_Type	P	P	R	R	Required for Intrinsic Reporting
Event_Time_Stamps	P	P	R	R	Required for Intrinsic Reporting
Event_Message_Texts					
Profile_Name					Do not use

Object Type, Property (standard)	AMEV profile *				Notes (information) * *Key see page 81*
	MOU-A	MOU-B	AS-A	AS-B	
1	2	3	4	5	6
Analog Value					
Object_Identifier	P	P	R	R	
Object_Name	P	P	R	R	Min. 32 characters with any syntax
Object_Type	P	P	R	R	See Appendix 7.3.
Present_Value	M	M	W	W	
Description	P	M	R	W	Min. 64 characters available, must be set up
Status_Flags	P	P	R	R	
Event_State	P	P	R	R	Required for Intrinsic Reporting
Reliability	P	P	R	R	
Out_Of_Service	P	P	R	R	Must allow for setting Out of Service and override
Units	P	P	R	R	See Appendix 7.5.
Priority_Array	P	P	R	R	Required for command priority array
Relinquish_Default	P	P	R	R	
COV_Increment	M	M	W	W	Required for COV capability
Time_Delay	M	M	W	W	Required for Intrinsic Reporting
Notification_Class	M	M	R	W	Required for Intrinsic Reporting
High_Limit	M	M	W	W	Required for Intrinsic Reporting
Low_Limit	M	M	W	W	Required for Intrinsic Reporting
Deadband	M	M	W	W	Dead zone must be changeable (same as limit values)
Limit_Enable	M	M	W	W	Required for Intrinsic Reporting
Event_Enable	M	M	W	W	Required for Intrinsic Reporting
Acked_Transitions	P	P	R	R	Required for Intrinsic Reporting
Notify_Type	P	P	R	R	Required for Intrinsic Reporting
Event_Time_Stamps	P	P	R	R	Required for Intrinsic Reporting
Event_Message_Texts					
Profile_Name					Do not use
Binary Input					
Object_Identifier	P	P	R	R	
Object_Name	P	P	R	R	Min. 32 characters with any syntax
Object_Type	P	P	R	R	See Appendix 7.3.
Present_Value	P	P	R	R	Writable if Out_Of_Service
Description	P	M	R	W	Min. 64 characters available, must be set up
Device_Type	P	P		R	Designation of connected field device
Status_Flags	P	P	R	R	
Event_State	P	P	R	R	Required for Intrinsic Reporting
Reliability	P	P		R	Not needed with AS, avoids high HW costs
Out_Of_Service	M	M	W	W	Must allow for setting Out of Service and override
Polarity	P	P	R	R	
Inactive_Text	P	P	R	R	Inactive state must be defined (see **Appendix 7.4**)
Active_Text	P	P	R	R	Active state must be defined (see **Appendix 7.4**)
Change_Of_State_Time		P		R	Only required for change of state counts
Change_Of_State_Count		P^0		R^0	Only required for change of state counts
Time_Of_State_Count_Reset		P		R	Only required for change of state counts
Elapsed_Active_Time	P^0	P^0	R^0	R^0	Required to count total runtime hours
Time_Of_Active_Time_Reset	P	P	R	R	Required to count total runtime hours
Time_Delay	M	M	W	W	Required for Intrinsic Reporting
Notification_Class	M	M	R	W	Required for Intrinsic Reporting
Alarm_Value	P	P	R	R	Required for Intrinsic Reporting
Event_Enable	M	M	W	W	Required for Intrinsic Reporting
Acked_Transitions	P	P	R	R	Required for Intrinsic Reporting
Notify_Type	P	P	R	R	Required for Intrinsic Reporting
Event_Time_Stamps	P	P	R	R	Required for Intrinsic Reporting
Event_Message_Texts					
Profile_Name					Do not use

Object Type, Property (standard)	AMEV profile *				Notes (information) * *Key see page 81*
	MOU-A	MOU-B	AS-A	AS-B	
1	2	3	4	5	6
Binary Output					
Object_Identifier	P	P	R	R	
Object_Name	P	P	R	R	Min. 32 characters with any syntax
Object_Type	P	P	R	R	See Appendix 7.3.
Present_Value	M	M	W	W	
Description	P	M	R	W	Min. 64 characters available, must be set up
Device_Type	P	P		R	Designation of connected field device
Status_Flags	P	P	R	R	
Event_State	P	P	R	R	Required for Intrinsic Reporting
Reliability	P	P		R	Not needed with AS, avoids high HW costs
Out_Of_Service	P	P	R	R	Must allow for setting Out of Service and override
Polarity	P	P	R	R	
Inactive_Text	P	P	R	R	Inactive state must be defined (see **Appendix 7.4**)
Active_Text	P	P	R	R	Active state must be defined (see **Appendix 7.4**)
Change_Of_State_Time		P		R	Only required for change of state counts
Change_Of_State_Count		P^0		R^0	Only required for change of state counts
Time_Of_State_Count_Reset		P		R	Only required for change of state counts
Elapsed_Active_Time	P^0	P^0	R^0	R^0	Required to count total runtime hours
Time_Of_Active_Time_Reset	P	P	R	R	Required to count total runtime hours
Minimum_Off_Time		P		R	Recommendation of future application in MOU
Minimum_On_Time		P		R	Recommendation of future application in MOU
Priority_Array	P	P	R	R	Required for command priority array
Relinquish_Default	P	P	R	R	
Time_Delay	M	M	W	W	Required for Intrinsic Reporting
Notification_Class	M	M	R	W	Required for Intrinsic Reporting
Feedback_Value	P	P	R	R	Required for Intrinsic Reporting
Event_Enable	M	M	W	W	Required for Intrinsic Reporting
Acked_Transitions	P	P	R	R	Required for Intrinsic Reporting
Notify_Type	P	P	R	R	Required for Intrinsic Reporting
Event_Time_Stamps	P	P	R	R	Required for Intrinsic Reporting
Event_Message_Texts					
Profile_Name					Do not use
Binary Value					
Object_Identifier	P	P	R	R	
Object_Name	P	P	R	R	Min. 32 characters with any syntax
Object_Type	P	P	R	R	See Appendix 7.3.
Present_Value	M	M	W	W	
Description	P	M	R	W	Min. 64 characters available, must be set up
Status_Flags	P	P	R	R	
Event_State	P	P	R	R	Required for Intrinsic Reporting
Reliability	P	P	R	R	
Out_Of_Service	P	P	R	R	Must allow for setting Out of Service and override
Inactive_Text	P	P	R	R	Inactive state must be defined (see **Appendix 7.4**)
Active_Text	P	P	R	R	Active state must be defined (see **Appendix 7.4**)
Change_Of_State_Time		P		R	Only required for change of state counts
Change_Of_State_Count		P^0		R^0	Only required for change of state counts
Time_Of_State_Count_Reset		P		R	Only required for change of state counts
Elapsed_Active_Time	P^0	P^0	R^0	R^0	Required to count total runtime hours
Time_Of_Active_Time_Reset	P	P	R	R	Required to count total runtime hours
Minimum_Off_Time		P		R	Recommendation of future application in MOU
Minimum_On_Time		P		R	Recommendation of future application in MOU
Priority_Array	P	P	R	R	Required for command priority array
Relinquish_Default	P	P	R	R	
Time_Delay	M	M	W	W	Required for Intrinsic Reporting
Notification_Class	M	M	R	W	Required for Intrinsic Reporting
Alarm_Value	P	P	R	R	Required for Intrinsic Reporting
Event_Enable	M	M	W	W	Required for Intrinsic Reporting
Acked_Transitions	P	P	R	R	Required for Intrinsic Reporting
Notify_Type	P	P	R	R	Required for Intrinsic Reporting
Event_Time_Stamps	P	P	R	R	Required for Intrinsic Reporting
Event_Message_Texts					
Profile_Name					Do not use

Object Type, Property (standard)	AMEV profile *				Notes (information) * *Key see page 81*
	MOU-A	MOU-B	AS-A	AS-B	
1	2	3	4	5	6
Multi-state Input			*	*	* optional in AS
Object_Identifier	P	P	R	R	
Object_Name	P	P	R	R	Min. 32 characters with any syntax
Object_Type	P	P	R	R	See Appendix 7.3.
Present_Value	P	P	R	R	Writable if Out_Of_Service
Description	P	M	R	W	Min. 64 characters available, must be set up
Device_Type	P	P		R	Designation of connected field device
Status_Flags	P	P	R	R	
Event_State	P	P	R	R	Required for Intrinsic Reporting
Reliability	P	P		R	Not needed with AS, avoids high HW costs
Out_Of_Service	M	M	W	W	Must allow for setting Out of Service and override
Number_Of_States	P	P	R	R	
State_Text	P	P	R	R	MOU: Min. 32 characters and all states defined
Time_Delay	M	M	W	W	Required for Intrinsic Reporting
Notification_Class	M	M	R	W	Required for Intrinsic Reporting
Alarm_Values	P	P	R	R	Required for Intrinsic Reporting
Fault_Values	P	P	R	R	Required for Intrinsic Reporting
Event_Enable	M	M	W	W	Required for Intrinsic Reporting
Acked_Transitions	P	P	R	R	Required for Intrinsic Reporting
Notify_Type	P	P	R	R	Required for Intrinsic Reporting
Event_Time_Stamps	P	P	R	R	Required for Intrinsic Reporting
Event_Message_Texts					
Profile_Name					Do not use
Multi-state Output			*	*	* optional in AS
Object_Identifier	P	P	R	R	
Object_Name	P	P	R	R	Min. 32 characters with any syntax
Object_Type	P	P	R	R	See Appendix 7.3.
Present_Value	M	M	W	W	
Description	P	M	R	W	Min. 64 characters available, must be set up
Device_Type	P	P		R	Designation of connected field device
Status_Flags	P	P	R	R	
Event_State	P	P	R	R	Required for Intrinsic Reporting
Reliability	P	P		R	Not needed with AS, avoids high HW costs
Out_Of_Service	P	P	R	R	Must allow for setting Out of Service and override
Number_Of_States	P	P	R	R	
State_Text	P	P	R	R	MOU: Min. 32 characters and all states defined
Priority_Array	P	P	R	R	Required for command priority array
Relinquish_Default	P	P	R	R	
Time_Delay	M	M	W	W	Required for Intrinsic Reporting
Notification_Class	M	M	R	W	Required for Intrinsic Reporting
Feedback_Value	P	P	R	R	Required for Intrinsic Reporting
Event_Enable	M	M	W	W	Required for Intrinsic Reporting
Acked_Transitions	P	P	R	R	Required for Intrinsic Reporting
Notify_Type	P	P	R	R	Required for Intrinsic Reporting
Event_Time_Stamps	P	P	R	R	Required for Intrinsic Reporting
Event_Message_Texts					
Profile_Name					Do not use

Object Type, Property (standard)	AMEV profile *				Notes (information) * *Key see page 81*
	MOU-A	MOU-B	AS-A	AS-B	
1	2	3	4	5	6
Multi-state Value					
Object_Identifier	**P**	**P**	**R**	**R**	
Object_Name	**P**	**P**	**R**	**R**	Min. 32 characters with any syntax
Object_Type	**P**	**P**	**R**	**R**	See Appendix 7.3.
Present_Value	**M**	**M**	**W**	**W**	
Description	**P**	**M**	**R**	**W**	Min. 64 characters available, must be set up
Status_Flags	**P**	**P**	**R**	**R**	
Event_State	**P**	**P**	**R**	**R**	Required for Intrinsic Reporting
Reliability	**P**	**P**	**R**	**R**	
Out_Of_Service	**P**	**P**	**R**	**R**	Must allow for setting Out of Service and override
Number_Of_States	**P**	**P**	**R**	**R**	
State_Text	**P**	**P**	**R**	**R**	MOU: Min. 32 characters and all states defined
Priority_Array	**P**	**P**	**R**	**R**	Required for command priority array
Relinquish_Default	**P**	**P**	**R**	**R**	
Time_Delay	**M**	**M**	**W**	**W**	Required for Intrinsic Reporting
Notification_Class	**M**	**M**	**R**	**W**	Required for Intrinsic Reporting
Alarm_Values	**P**	**P**	**R**	**R**	Required for Intrinsic Reporting
Fault_Values	**P**	**P**	**R**	**R**	Required for Intrinsic Reporting
Event_Enable	**M**	**M**	**W**	**W**	Required for Intrinsic Reporting
Acked_Transitions	**P**	**P**	**R**	**R**	Required for Intrinsic Reporting
Notify_Type	**P**	**P**	**R**	**R**	Required for Intrinsic Reporting
Event_Time_Stamps	**P**	**P**	**R**	**R**	Required for Intrinsic Reporting
Event_Message_Texts					
Profile_Name					Do not use

Key for Appendices 4.1 to 4.3

The objects and properties (Column 1) are allocated to AMEV profile MOU-A and MOU-B (Columns 2 and 3) and AMEV profile AS-A und AS-B (Columns 4 and 5).

Columns 2 to 5 indicate additionally the read/write access to properties as per AMEV profile A and B. The abbreviations are explained below:

P MOU is able to read and present the readable property of an AS (P = Present).

M MOU is able to read, present and modify the writeable property of a BACnet server (M = Modify).

R Property of AS is only readable.

W Property of AS is readable and writeable.

P^0 MOU is able to reset the runtime totalizer or change of state counter in a BACnet server by writing the property with value 0.

P^C MOU is able to write the property of a BACnet server during generation of a new object instance with the CreateObject service or generally with the WriteProperty service (M).

R^0 Property of AS is writeable with value 0 to reset the runtime totalizer or change of state counter.

R^C Property of AS is writeable during generation of a new object instance with the CreateObject service or generally with the WriteProperty service (W).

***** Support of Multi-state I/O-object types MI and MO in AS is optional (see **section 4.2**).

The associated dynamic creation (DC) and deletion (DD) of objects is explained in **Section 4**.

Appendix 4.3 Complex object types

Object Type, Property (standard)	AMEV profile *				Notes (information) * *Key see page 81*
	MOU-A	MOU-B	AS-A	AS-B	
1	2	3	4	5	6
Calendar					
Object_Identifier	P	P	R	R	
Object_Name	P	P[C]	R	R[C]	Min. 32 characters with any syntax
Object_Type	P	P	R	R	See Appendix 7.3.
Description	P	P[C]	R	R[C]	Min. 64 characters available, must be set up
Present_Value	P	P	R	R	
Date_List	M	M	W	W	Date list must be editable
Profile_Name					Do not use
Event Enrollment					**For Algorithmic Reporting only**
Object_Identifier	P	P		R	
Object_Name	P	P[C]		R[C]	Min. 32 characters with any syntax
Object_Type	P	P		R	See Appendix 7.3.
Description	P	P[C]		R[C]	Min. 64 characters available, must be set up
Event_Type	P	P		R	
Notify_Type	P	P[C]		R[C]	
Event_Parameters	P	P[C]		R[C]	
Object_Property_Reference	P	P[C]		R[C]	
Event_State	P	P		R	
Event_Enable	P	P[C]		R[C]	
Acked_Transitions	P	P		R	
Notification_Class	P	P[C]		R[C]	
Event_Time_Stamps	P	P		R	
Event_Message_Texts					
Profile_Name					Do not use
File					
Object_Identifier	P	P	R	R	
Object_Name	P	P	R	R	Min. 32 characters with any syntax
Object_Type	P	P	R	R	See Appendix 7.3.
Description	P	M	R	W	Min. 64 characters available, must be set up
File_Type	P	P	R	R	
File_Size	P	P	R	R	
Modification_Date	P	P	R	R	
Archive	M	M	W	W	
Read_Only	P	P	R	R	
File_Access_Method	P	P	R	R	
Record_Count					
Profile_Name					Do not use

Object Type, Property (standard)	AMEV profile *				Notes (information) * Key see page 81
	MOU-A	MOU-B	AS-A	AS-B	
1	2	3	4	5	6
Loop					
Object_Identifier	P	P		R	
Object_Name	P	P		R	Min. 32 characters with any syntax
Object_Type	P	P		R	See Appendix 7.3.
Present_Value	P	P		R	Writable if Out_Of_Service
Description	P	M		W	Min. 64 characters available, must be set up
Status_Flags	P	P		R	
Event_State	P	P		R	Required for Intrinsic Reporting
Reliability	P	P		R	Implausible values must be identifiable
Out_Of_Service	M	M		W	Must allow for setting Out of Service and override
Update_Interval		P		R	
Output_Units	P	P		R	
Manipulated_Variable_Reference	P	P		R	
Controlled_Variable_Reference	P	P		R	
Controlled_Variable_Value	P	P		R	
Controlled_Variable_Units	P	P		R	
Setpoint_Reference	P	P		R	
Setpoint	P	P		R	
Action	P	P		R	
Proportional_Constant	M	M		W	Controller P-portion must be adjustable
Proportional_Constant_Units	P	P		R	Unit of P-portion must be available
Integral_Constant	M	M		W	Controller I-portion must be adjustable
Integral_Constant_Units	P	P		R	Unit of I-portion must be available
Derivative_Constant	M	M		W	Controller D-portion must be adjustable
Derivative_Constant_Units	P	P		R	Unit of D-portion must be available
Bias	M	M		W	
Maximum_Output	M	M		W	Limitation must be adjustable
Minimum_Output	M	M		W	Limitation must be adjustable
Priority_For_Writing	P	P		R	
COV_Increment	M	M		W	Required for COV capability
Time_Delay	M	M		W	Required for Intrinsic Reporting
Notification_Class	M	M		W	Required for Intrinsic Reporting
Error_Limit	M	M		W	Allowed control deviation must be adjustable
Deadband	M	M		W	Required for Intrinsic Reporting
Event_Enable	M	M		W	Required for Intrinsic Reporting
Acked_Transitions	P	P		R	Required for Intrinsic Reporting
Notify_Type	P	P		R	Required for Intrinsic Reporting
Event_Time_Stamps	P	P		R	Required for Intrinsic Reporting
Event_Message_Texts					
Profile_Name					Do not use
Notification Class					
Object_Identifier	P	P	R	R	
Object_Name	P	P^C	R	R^C	Min. 32 characters with any syntax
Object_Type	P	P	R	R	See Appendix 7.3.
Description	P	P^C	R	R^C	Min. 64 characters available, must be set up
Notification_Class	P	P	R	R	
Priority	P	P^C	R	R^C	
Ack_Required	P	P^C	R	R^C	
Recipient_List	P	P^C	R	R^C	
Profile_Name					Do not use

Object Type, Property (standard)	AMEV profile *				Notes (information) * *Key see page 81*
	MOU-A	MOU-B	AS-A	AS-B	
1	2	3	4	5	6
Schedule					
Object_Identifier	P	P	R	R	
Object_Name	P	P[C]	R	R[C]	Min. 32 characters with any syntax
Object_Type	P	P	R	R	See Appendix 7.3.
Present_Value	P	P	R	R	Writable if Out_Of_Service
Description	P	P[C]	R	R[C]	Min. 64 characters available, must be set up
Effective_Period	M	M	W	W	Range of validity must be writeable
Weekly_Schedule	M	M	W	W	Schedule must be writeable
Exception_Schedule	M	M	W	W	Schedule must be writeable
Schedule_Default	P	P[C]	R	R[C]	Must be set up
List_Of_Object_Property_References	P	P[C]	R	R[C]	
Priority_For_Writing	P	P[C]	R	R[C]	
Status_Flags	P	P	R	R	
Reliability	P	P	R	R	Implausible values must be identifiable
Out_Of_Service	M	M	W	W	Must allow for setting Out of Service and override
Profile_Name					Do not use
Trend Log					
Object_Identifier	P	P		R	
Object_Name	P	P[C]		R[C]	Min. 32 characters with any syntax
Object_Type	P	P		R	See Appendix 7.3.
Description	P	P[C]		R[C]	Min. 64 characters available, must be set up
Enable	M	M		W	
Start_Time	M	M		W	Required for trend logging of a property
Stop_Time	M	M		W	Required for trend logging of a property
Log_DeviceObjectProperty	P	P[C]		R[C]	Required for trend logging of a property
Log_Interval	M	M		W	Required for trend logging of a property
COV_Resubscription_Interval	M	M		W	Required for COV capability
Client_COV_Increment	M	M		W	Required for COV capability
Stop_When_Full	M	M		W	
Buffer_Size	P	P		R	
Log_Buffer	P	P		R	
Record_Count	M	M		W	
Total_Record_Count	P	P		R	
Notification_Threshold	M	M		W	Can be used with Intrinsic Reporting
Records_Since_Notification	P	P		R	Can be used with Intrinsic Reporting
Last_Notify_Record	P	P		R	Required for Intrinsic Reporting
Event_State	P	P		R	Required for Intrinsic Reporting
Notification_Class	P	P[C]		R[C]	Required for Intrinsic Reporting
Event_Enable	M	M		W	Required for Intrinsic Reporting
Acked_Transitions	P	P		R	Required for Intrinsic Reporting
Notify_Type	P	P[C]		R[C]	Required for Intrinsic Reporting
Event_Time_Stamps	P	P		R	Required for Intrinsic Reporting
Profile_Name					Do not use
Logging_Type					
Align_Intervals					
Interval_Offset					
Trigger					
Status_Flags					
Reliability					

Appendix 5 BIBBs: Overview and recommendations

Cont. no.	BIBBs		Stand.profile			AMEV profile *				Related objects (information)	Function description (information) ** Key see page 89*
	Short form (standard *)	**Designation** (standard *)	**B-OWS**	**B-AWS**	**B-BC**	**MOU-A**	**MOU-B**	**AS-A**	**AS-B**		
1	2	3	4	5	6	7	8	9	10	11	12
Data Sharing (DS)											
1	DS-RP-A	DS-ReadProperty-A	**X**	**X**	**X**	**X**	**X**	**X**	**X**	all objects	A (BACnet client) reads a property of B (BACnet server)
2	DS-RP-B	DS-ReadProperty-B	**X**	**X**	**X**	**X**	**X**	**X**	**X**		B (BACnet server) allows A (BACnet client) to read a property
3	DS-RPM-A	DS-ReadProperty Multiple-A	**X**	**X**	**X**	**X**	**X**	**X**	**X**	all objects	A reads multiple properties of B at the same time
4	DS-RPM-B	DS-ReadProperty Multiple-B			**X**			**X**	**X**		B allows A to read multiple properties
5	DS-WP-A	DS-WriteProperty-A	**X**	**X**	**X**	**X**	**X**	**X**	**X**	all objects	A writes a property of B
6	DS-WP-B	DS-WriteProperty-B			**X**			**X**	**X**		B allows A to write a property
7	DS-WPM-A	DS-WriteProperty Multiple-A	**X**	**X**		**X**	**X**			all objects	A writes multiple properties of B at the same time
8	DS-WPM-B	DS-WriteProperty Multiple-B			**X**			**X**	**X**		B allows A to write multiple properties
9	DS-COV-A	DS-COV-Support-A				**X**	**X**	**X**	**X**	all objects	A subscribes to information on specific value changes of B
10	DS-COV-B	DS-COV-Support-B						**X**	**X**		B provides subscribed information for A
11	DS-COVP-A	DS-COV-Property-A					**X**			all objects	A subscribes to information on a value change of B
12	DS-COVP-B	DS-COV-Property-B							**X**		B provides subscribed information of its property for A
13	DS-COVU-A	DS-COV-Unsolicited-A								all objects	From 135-2010 cancelled for profile B-BC without replacement; A processes value changes from B without being prompted
14	DS-COVU-B	DS-COV-Unsolicited-B									From 135-2010 cancelled for profile B-BC without replacement; B transmits to A value changes without being prompted
15	DS-V-A	DS-View-A	**X**			**X**				all objects	A receives properties from a basic selection of objects from B and displays them
16	DS-AV-A	DS-Advanced View-A		**X**			**X**			all objects	A receives properties of all objects from B (excepting Life Safety and Access Control objects) and displays them
17	DS-M-A	DS-Modify-A	**X**			**X**				all objects	A can describe properties of B that can be changed during normal operation
18	DS-AM-A	DS-Advanced Modify-A		**X**			**X**			all objects	A can change writable properties of objects from B (except Life Safety and Access Control objects) with service WriteProperty

Cont. no.	BIBBs		Stand.profile			AMEV profile *				Related objects (information)	Function description (information) * *Key see page 89*
	Short form (standard *)	**Designation** (standard *)	**B-OWS**	**B-AWS**	**B-BC**	**MOU-A**	**MOU-B**	**AS-A**	**AS-B**		
1	2	3	4	5	6	7	8	9	10	11	12
Alarm and Event Management (AE)											
19	AE-N-A	AE-Notification-A	X	X		X	X			E/A, NC, EE, TLOG, LP	A processes notifications and events transmitted by B
20	AE-N-I-B	AE-Notification Internal B			X			X	X		B generates Intrinsic Reporting and supports Intrinsic Reporting and Algorithmic Reporting
21	AE-N-E-B	AE-Notification External B							X		B generates notifications from information of other BACnet devices via algorithmic reporting
22	AE-ACK-A	AE-ACK-A	X	X		X	X			E/A, NC, EE, TLOG, LP	A acknowledges alarms and events transmitted by B
23	AE-ACK-B	AE-ACK-B			X			X	X		B processes notification acknowledgements for notifications by A
24	AE-ASUM-A	AE-Alarm-Summary-A	X[A1]							E/A, NC, EE, TLOG, LP	Deprecated from 135-2010 (replaced by AE-AS-A); A requests alarm overviews from B
25	AE-ASUM-B	AE-Alarm-Summary-B							X		B provides alarm overviews for A
26	AE-ESUM-A	AE-Enroll-Summary-A	X[A1]							E/A, NC, EE, TLOG, LP	Deprecated from 135-2010 (replaced by AE-AS-A); A requests list of event-triggering objects
27	AE-ESUM-B	AE-Enroll-Summary-B			X			X	X		B provides a list of event-triggering objects for A
28	AE-INFO-A	AE-Information-A	X[A1]							E/A, NC, EE, TLOG, LP	Deprecated from 135-2010 (replaced by AE-AS-A); A requests lists of pending alarms and events
29	AE-INFO-B	AE-Information-B			X			X	X		B provides lists of pending alarms and events with time stamp and outstanding acknowledgements for A
30	AE-LS-A	AE-Lifesafety-A								LSP, LSZ	A requests alarm state from B, confirmes alarm and distributes change
31	AE-LS-B	AE-Lifesafety-B									B provides information on alarm states to A
32	AE-VN-A	AE-View Notifications-A	X			X				E/A, NC, EE, TLOG, LP	A requests alarms and events from B for display; A supports AE-N-A
33	AE-AVN-A	AE-Advanced View Notifications-A		X			X				A displays all alarm and event notifications of B
34	AE-VM-A	AE-View and Modify-A	X			X					A presents and changes alarm limits and other alarm parameters of alarm-triggering objects of B
35	AE-AVM-A	AE-Advanced View and Modify-A		X			X				A provides alarm-triggering objects and notification class objects for configuration in B
36	AE-AS-A	AE-Alarm Summary View-A	X[N1]	X		X	X				A displays alarm overview of B (replaces AE-ASUM, AE-ESUM, AE-INFO)
37	AE-ELV-A	AE-Event Log View-A								E/A, NC, EE, TLOG, LP	A displays event logs of a device (Event Log object)
38	AE-ELVM-A	AE-Event Log View and Modify-A		X[R]							A displays event logs of B and changes log parameters of B
39	AE-EL-I-B	AE-Event Log - Internal-B								E/A, NC, EE, TLOG, LP	B collects event notifications in an internal buffer
40	AE-EL-E-B	AE-Event Log - External-B									B collects event notifications of other BACnet devices and saves them to an internal buffer.

Scheduling (SCHED)											
41	SCHED-A	Scheduling-A	X[A2]							CAL, SCHED	Deprecated from 135-2010 (replaced by Sched-VM-A); A can display and change schedules and calendar entries of B
42	SCHED-I-B	Scheduling-Internal-B						X	X	CAL, SCHED	B executes scheduling on own data points
43	SCHED-E-B	Scheduling-External-B			X				X		B executes scheduling on data points of other BACnet devices
44	SCHED-R-B	Scheduling-Readonly-B									B provides read-only Schedule object(s).
45	SCHED-AVM-A	Scheduling-Advanced View and Modify-A		X[N2]			X			CAL, SCHED	A can generate, change, and delete SCHED and CAL objects in B (replaces SCHED-A).
46	SCHED-VM-A	Scheduling-View and Modify-A	X[N2]			X					A can change schedules and calendars in B (replaces SCHED-A).
47	SCHED-WS-A	Scheduling-Weekly Schedule-A									A can change schedules in a SCHED object of B
48	SCHED-WS-I-B	Scheduling-Weekly Schedule Internal-B								CAL, SCHED	B provides a weekly schedule via SCHED objects without exception schedule for properties of specific objects.
Trending (T)											
49	T-VMT-A	Trending-Viewing and Modifying Trends-A	X[A3]							TLOG	Deprecated from 135-2010 (replaced by T-V-A); A can display Trend data and change parameters of B
50	T-VMT-I-B	Trending-Viewing and Modifying Trends-Internal-B			X				X	TLOG	B sends trend data for device-internal data points saved to the internal buffer to A
51	T-VMT-E-B	Trending-Viewing and Modifying Trends-External-B							X		B sends trend data saved in the internal buffer for data points in the BAC network to A
52	T-ATR-A	Trending-Automated Trend Retrieval-A				X	X			TLOG	From 135-2010 cancelled for profile B-OWS (replaced by T-A-A); A reacts to notification of B that Trend data is available
53	T-ATR-B	Trending-Automated Trend Retrieval-B			X				X		B informs A that a number of defined entries is available in the trendlog buffer
54	T-VMMV-A	Trending-Viewing and Modifying Multiple Values-A								TLOG	Deprecated from 135-2010; A displays trend data from multiple trend logs of B
55	T-VMMV-I-B	Trending-Viewing and Modifying Multiple Values Internal-B								TLOG	B sends trend data saved to the internal buffer from multiple loggings of device-internal data points saved to A
56	T-VMMV-E-B	Trending-Viewing and Modifying Multiple Values External-B									B sends trend data saved in the internal buffer for multiple loggings of data points in the BAC network to A
57	T-AMVR-A	Trending-Automated Multiple Value Retrieval-A								TLOG	A reacts to the notification that trend values from multiple loggings are provided and triggers their transmission
58	T-AMVR-B	Trending-Automated Multiple Value Retrieval-B									B notifies A via Intrinsic or Algorithmic Reporting that a set number of entries is in the trend buffer
59	T-V-A	Trending-View-A	X[N3]			X				TLOG	A displays trend logs of B (replaces T-VMT-A)
60	T-AVM-A	Trending-Advanced View and Modify-A		X			X				A displays trend logs of B and changes trend log parameters in B
61	T-A-A	Trending-Archival-A									A archives trend logs from TLOG and TLOGM objects

Cont. no.	BIBBs		Stand.profile			AMEV profile *				Related objects (information)	Function description (information) ** Key see page 89*
	Short form (standard *)	**Designation** (standard *)	**B-OWS**	**B-AWS**	**B-BC**	**MOU-A**	**MOU-B**	**AS-A**	**AS-B**		
1	2	3	4	5	6	7	8	9	10	11	12
Device and Network Management (DM / NM)											
62	DM-DDB-A	DM-Dynamic-Device-Binding-A	X	X	X	X	X	X	X	DEV	A searches for Device properties of other BACnet devices (Who-Is, I-Am)
63	DM-DDB-B	DM-Dynamic-Device-Binding-B	X	X	X	X	X	X	X		B provides information to A on its own Device properties and reacts to an identification request
64	DM-DOB-A	DM-Dynamic-Object-Binding-A				X	X			all objects	From 135-2010 cancelled for profile B-OWS; A searches the network for address information of BACnet objects (Who-Has, I-Have)
65	DM-DOB-B	DM-Dynamic-Object-Binding-B	X	X	X	X	X	X	X		B sends address information to A on objects of B
66	DM-DCC-A	DM-DeviceCommunicationControl-A		X		X	X			DEV	A switches on or off BACnet communications of B
67	DM-DCC-B	DM-DeviceCommunicationControl-B			X			X	X		B switches on or off BACnet communications of A
68	DM-TM-A	DM-Text Message-A								DEV	A transmits free text to B (proprietary interpretation and processing)
69	DM-TM-B	DM-Text Message-B									B processes free text from A
70	DM-TS-A	DM-TimeSynchronization-A								DEV	From 135-2010 cancelled for profile B-OWS (replaced by DM-MTS-A); A requests time synchronization by regional time
71	DM-TS-B	DM-TimeSynchronization-B			X^T			X^T	X^T		B takes over time synchronization from A by regional time
72	DM-UTC-A	DM-UTCTimeSynchronization-A								DEV	From 135-2010 cancelled for profile B-OWS (replaced by DM-MTS-A); A prompts time synchronization by Greenwich time
73	DM-UTC-B	DM-UTCTimeSynchronization-B			X^T			X^T	X^T		B takes over time synchronization from A by Greenwich time
74	DM-RD-A	DM-Reinitialize Device-A		X		X	X			DEV	From 135-2010 cancelled for B-OWS; A prompts program restart of B
75	DM-RD-B	DM-Reinitialize Device-B			X			X	X		B executes program start command from A
76	DM-BR-A	DM-Backup and Restore-A		X		X	X			FIL, DEV	From 135-2010 cancelled for profile B-OWS; A saves configuration data of B (backup) or reloads the data in B (restore)
77	DM-BR-B	DM-Backup and Restore-B			X			X	X		B sends configuration data to B for backup or reloads the configuration data following failure of B (restore)
78	DM-R-A	DM-Restart-A								DEV	A processes restart messages from B and interprets the reasons
79	DM-R-B	DM-Restart-B									B informs A on a restart
80	DM-LM-A	DM-List Manipulation-A					X			DEV, NC, CAL, SCHED et. al.	A prompts B to create or delete list elements in properties
81	DM-LM-B	DM-List Manipulation-B							X		B creates or deletes list elements in properties
82	DM-OCD-A	DM-Object Creation and Deletion-A		X			X			all objects (except DEV)	A prompts B to create or delete objects
83	DM-OCD-B	DM-Object Creation and Deletion-B							X		B creates or deletes supported objects upon request from A

84	DM-VT-A	DM-Virtual Terminal-A								Special cases	A accesses terminal interface on device B
85	DM-VT-B	DM-Virtual Terminal-B									B executes commands from A via terminal interface
86	NM-CE-A	NM-Connection Establishment-A								project-specific	From 135-2010 cancelled for profile allocations; A prompts B to connect/ disconnect remote connections via half-router (caution: not local modem)
87	NM-CE-B	NM-Connection Establishment-B									B connects or disconnects remote connections via half-router
88	NM-RC-A	NM-Router Configuration-A								project-specific	A prompts B to query or change config. data of routers and half-routers
89	NM-RC-B	NM-Router Configuration-B									B queries or changes configuration data of routers or half-routers
90	DM-ANM-A	DM-Automatic Network Mapping-A		X			X			DEV	A finds and presents BACnet devices in the network supporting DM-DDB-B
91	DM-ADM-A	DM-Automatic Device Mapping-A		X			X			DEV	A requests a list of all objects in a BACnet device from B
92	DM-ATS-A	DM-Automatic Time Synchronization-A								DEV	A provides automatic, cyclical time synchronization for B
93	DM-MTS-A	DM-Manual Time Synchronization-A	X	X		X	X			DEV	A provides manual, cyclical time synchronization for B; (replaces DM-TS-A and DM-UTC-A)
94	NS-SD	Network Security-Secure Device									Describes basic functionality that all secure BACnet devices shall support.
95	NS-ED	Network Security-Encrypted Device									Is claimed by devices that are capable of using encryption for all BACnet communications.
96	NS-MAD	Network Security-Multi-Application Device									Is claimed by devices that are capable of using more than 1 Application-Specific security key.
97	NS-DMK-A	Network Security-Device Master Key-A									A is capable of providing Device-Master to secure devices.
98	NS-DMK-B	Network Security-Device Master Key-B									B is capable of accepting Device-Master keys via the Requeste-Master-Key and Set-Master-Key services.
99	NS-KS	Network Security-Key Server									Describes the functionality that all BACnet Key Servers shall support.
100	NS-TKS	Network Security-Temporary Key Server									Describes the functionality required to configure keys in installations that do not have a permanent Key Server installed.
101	NS-SR	Network Security-Secure Router									Describes basic functionality that all secure BACnet routers shall support.
102	NS-SP	Network Security-Security Proxy									Describes the basic functionality that all secure BACnet Secure Proxy devices shall support.

Key for Appendix 5:

Standard DIN EN ISO 16484-5 (March 2011) and addenda including **Revision 1.12**

X^{An} BIBB is deprecated and replaced by BIBB X^{Nn} (see explanation in Column 12)

X^{Nn} BIBB replaces BIBB X^{An} (see explanation in Column 12)

X^{R} Requested for devices of BACnet Revision 1.7 or higher under the standard

X^{T} Standard profile must support either DM-TS-B (row 71) or DM-UTC-B (row 73)

Appendix 6 Documents for BACnet devices

Appendix 6.1 PICS (form)

Annex A Protocol Implementation Conformance Statement (PICS)

Date: ……..……..
Vendor Name:……..……..
Product Name:……..……..
Product Model Number: ……..……..
Applications Software Version: ……..……..
Firmware Revision: ……..……..
BACnet Protocol Revision: ……..……..

1. Product Description: ……..……

2. BACnet Standardized Device Profile (Annex L):

☐ BACnet Advanced Operator Workstation (B-AWS)
☐ BACnet Operator Workstation (B-OWS)
☐ BACnet Operator Display (B-OD)
☐ BACnet Building Controller (B-BC)
☐ BACnet Advanced Application Controller (B-AAC)
☐ BACnet Application Specific Controller (B-ASC)
☐ BACnet Smart Sensor (B-SS)
☐ BACnet Smart Actuator (B-SA)

3. List of all BACnet Interoperability Building Blocks Supported (Annex K):

4. Segmentation Capability:

☐ Segmented requests supported Windows Size ……..
☐ Segmented responses supported Windows Size ……

5. Standard Object Types Supported:

An object type is supported if it may be present in the device. For each standard Object Type supported provide the following data:
1) Whether objects of this type are dynamically creatable using the CreateObject service
2) Whether objects of this type are dynamically deletable using the DeleteObject service
3) List of the optional properties supported
4) List of all properties that are writable where not otherwise required by this standard
5) List of all properties that are conditionally writable where not otherwise required by this standard
6) List of proprietary properties and for each its property identifier, datatype, and meaning
7) List of any property range restrictions

6. Data Link Layer Options:

☐ BACnet IP, (Annex J)
☐ BACnet IP, (Annex J), Foreign Device
☐ ISO 8802-3, Ethernet (Clause 7)
☐ ATA 878.1,2.5 Mb. ARCNET (Clause 8)
☐ ATA 878.1, EIA-485 ARCNET (Clause 8), baud rate(s): ……..…
☐ MS/TP master (Clause 9), baud rate(s): ……..…
☐ MS/TP slave (Clause 9), baud rate(s): ……..…
☐ Point-To-Point, EIA 232 (Clause 10), baud rate(s): ……..…
☐ Point-To-Point, modem, (Clause 10), baud rate(s): ……..…
☐ LonTalk, (Clause 11), medium: ……..…
☐ BACnet/Zigbee (Annex O): ……..…
☐ Other: ……..

7. Device Address Binding:

Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.)

☐ Yes ☐ No

8. Networking Options:

☐ Router, Clause 6 - List all routing configurations,
e.g. ARCNET-Ethernet, Ethernet-MS/TP
☐ Annex H, BACnet Tunneling Router over IP
☐ BACnet/IP Broadcast Management Device (BBMD)
Does the BBMD support registrations by Foreign Devices? ☐ Yes ☐ No
Does the BBMD support network address translation? ☐ Yes ☐ No

9. Character Sets Supported:

Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

☐ ISO 10646 (UTF-8) ☐ IBM™/Microsoft™ DBCS ☐ ISO 8859-1
☐ ISO 10646 (UCS-2) ☐ ISO 10646 (UCS-4) ☐ JIS X 0208

If this product is a communication gateway, describe the types of non-BACnet equipment/-networks(s) that the gateway supports: ……

10. Network Security Options:

☐ Non-secure Device - is capable of operating without BACnet Network Security

☐ Secure Device - is capable of using BACnet Network Security (NS-SD BIBB)
☐ Multiple Application-Specific Keys
☐ Supports encryption (NS-ED BIBB)
☐ Key Server (NS-KS BIBB)

Appendix 6.2 AMEV attestation (brief description)

By order of the supplier the BACnet certification body can confirm via AMEV attestation, that a certified BACnet device supports the range of BACnet functions according to the named AMEV profile. The course of the procedure is described below.

The supplier (vendor) submits his request on AMEV attestation to the BACnet certification body. For logical reasons this happens at the same time with his demand on conformance test in a BACnet test laboratory. Additionally he implements his device according to the desired AMEV profile.

Moreover he can hand the EPICS file (see **Section 3.10**) needed for conformance test to the BACnet certification body. This allows a pre-check of the certification body, whether the requirements of the desired AMEV profile can be fulfilled.

Precondition of an AMEV attestation is that the BACnet device has passed the conformance test as per DIN EN ISO 16484-6 carried out by an accredited BACnet test laboratory (BTL). Furthermore the conformance test must be documented in a certificate issued by the BACnet certification body named by BACnet International (see Section 3.11).

In addition, AMEV publishes blank forms of checklists for AMEV attestations for MOU and AS (http://amev-online.de/AMEVInhalt/Planen/Gebaeudeautomation/BACnet%202017/).
In a checklist the results of the review are documented, if a certain device fulfills the requirements of an AMEV profile for MOU or AS.

After successful completion of the conformance test by a BTL the BACnet certification body prepares the AMEV attestation. Basis for the review are - among others - the test report as per DIN EN ISO 16484-6 and the checklist for AMEV attestations. The certification body reviews, whether the BACnet functions under the desired AMEV profile belonged to the testing scope for the comformance test and were successfully tested.

The BACnet certification body certifies the successful testings in the checklist for AMEV attestations. The body sends the AMEV chairman BACnet one copy each of the test report, the BACnet certificate and the completed checklist for AMEV attestations plus the draft of the AMEV attestation.

The AMEV chairman BACnet uses the received documentations exclusively for the release of BACnet attestations. He reviews the documents for completeness. AMEV thereby doesn´t take over responsibility for the correctness of statements of a third party.

The certification body receives the released and dated AMEV attestation by the AMEV chairman BACnet. The certification body issues the AMEV attestation, sends the original to the supplier (vendor) and informs the AMEV about the released AMEV attestations.

AMEV publishes an overview of the available AMEV attestations on the AMEV Homepage (see (http://amev-online.de/AMEVInhalt/Planen/Gebaeudeautomation/BACnet%202017/).

Further publications of the particular AMEV attestation are reserved to the supplier. He can use the AMEV attestation in technical descriptions and publications, but he must include the issue date and the corresponding BACnet certificate. The AMEV attestation terminates if the validity of the BACnet certificate expires.

Appendix 6.3 AMEV attestation (form)

AMEV

Mechanical and Electrical Engineering Working Party
of National, Regional and Local Authorities

.....

BACnet certification body

AMEV attestation for certified BACnet devices

1. The following BACnet device is certified as per DIN EN ISO 16484-5:

Supplier		
Product name		
Product model number		
Standard device profile		**BACnet Protocol Vers. / Rev.**
Firmware revision		

Data link layer options	☐ **BACnet IP (Annex J)**	☐ **BACnet over LonTalk**
	☐ **BACnet MS/TP master**	☐ **BACnet MS/TP slave**
	☐ **MS/TP baud rates: ……**	
	☐ **……**	
Stat. device binding	☐ **Yes (for MS/TP only)**	
Networking options	☐ **BBMD**	☐ **Reg. by Foreign Devices**
	☐ **Router, medium: ……**	
Character set	☐ **UTF-8**	
Reporting options	☐ **Intrinsic reporting**	☐ **Algorithmic reporting**

2. The device supports BACnet functions as per AMEV profile:

☐ **AMEV profile AS-A (Automation station, base version)**	**As of:** .....
☐ **AMEV profile AS-B (Automation station, extended version)**	**As of:** .....
☐ **AMEV profile ……**	**As of:** .....

3. Basis for AMEV attestation:

☐ **Test report** of test lab ……..…….... dated ……..... number ……
☐ **AMEV recommendation BACnet** …… As of: ..... (see www.amev-online.de)

4. The AMEV attestation is only valid in combination with the certificate:

☐ **Certificate number** …… ……..(see http://bacnetinternational.net/btl/)

(location, date) ……

…….
(AMEV chairman BACnet)

…….
(BACnet certification body)

Appendix 7 Engineering aids for BACnet projects

Appendix 7.1 includes the table **BACnet object types** with clear text designations of all standardized object types and assignment of a standardized code number (Object Type Code).

Appendix 7.2 includes a table with examples for **status texts** and reference numbers (state text reference) of binary and multistate input and output objects.

Appendix 7.3 includes a table of **physical units** with the standard units and unit codes, but excludes U.S. units (e.g. feet, gallons).

Appendix 7.4 includes examples for **event types for intrinsic reporting**

Appendix 7.5 includes a **notification class matrix** with suggestions for common coding event categories, their meaning, priorities, and notification classes as well as Notification Class object (NC) and typical examples.

Appendix 7.6 includes examples for event and acknowledgement options.

Appendix 7.7 includes **sample specifications for the BACnet-MOU**

Appendix 7.1 Object type code (overview)

Object type code	Object type (sorted by code)
1	2
0	Analog Input
1	Analog Output
2	Analog Value
3	Binary Input
4	Binary Output
5	Binary Value
6	Calendar
7	Command
8	Device
9	Event Enrollment
10	File
11	Group
12	Loop
13	Multi-state Input
14	Multi-state Output
15	Notification Class
16	Program
17	Schedule
18	Averaging
19	Multi-state Value
20	Trend Log
21	Life Safety Point
22	Life Safety Zone
23	Accumulator
24	Pulse Converter
25	Event Log
26	Global Group
27	Trend Log Multiple
28	Load Control
29	Structured View
30	Access Door
32	Access Credential
33	Access Point
34	Access Rights
35	Access User
36	Access Zone
37	Credential Data
38	Network Security
39	Bitstring Value
40	Characterstring Value
41	Date Pattern Value
42	Date Value
43	Datetime Pattern Value
44	Datetime Value
45	Integer Value
46	Large Analog Value
47	Octetstring Value
48	Positive Integer Value
49	Time Pattern Value
50	Time Value

Object type (sorted by name)	Object type code
1	2
Access Credential	32
Access Door	30
Access Point	33
Access Rights	34
Access User	35
Access Zone	36
Accumulator	23
Analog Input	0
Analog Output	1
Analog Value	2
Averaging	18
Binary Input	3
Binary Output	4
Binary Value	5
Bitstring Value	39
Calendar	6
Characterstring Value	40
Command	7
Credential Data	37
Date Pattern Value	41
Date Value	42
Datetime Pattern Value	43
Datetime Value	44
Device	8
Event Enrollment	9
Event Log	25
File	10
Global Group	26
Group	11
Integer Value	45
Large Analog Value	46
Life Safety Point	21
Life Safety Zone	22
Load Control	28
Loop	12
Multi-state Input	13
Multi-state Output	14
Multi-state Value	19
Network Security	38
Notification Class	15
Octetstring Value	47
Positive Integer Value	48
Program	16
Pulse Converter	24
Schedule	17
Structured View	29
Time Pattern Value	49
Time Value	50
Trend Log	20
Trend Log Multiple	27

Appendix 7.2 Status texts (overview)

State_Text reference	**Inactive_text** (Binary object)	**Activ_Text** (Binary object)								
NO.	**1**	**2**								
0201	No	Yes								
0202	Off	On								
0203	Closed	Open								
0204	Close	Open								
0205	Stop	Start								
0206	Starting position	End pos.								
0211	Passive	Active								
0212	Manual	Auto								
0221	Reset	Set								
0222	Back	Forward								
0231	Down	Up								
0232	Bottom	Top								
0233	Left	Right								
0234	Direct	Reverse								
0235	Slow	Fast								
0241	Night operation	Day operation								
0242	Heating	Cooling								
0243	Winter	Sumer								
0244	Gas	Oil								
0251	Normal	Danger								
0252	Normal	Alarm								
0253	Normal	Fault								
0254	Normal	Maintenance								
0255	Normal	Abnormal								
0261	Normal	Initialization								
0262	Normal	Optimization								

State_Text Reference	State text (multiple object)									
Nr.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0301	Off	Manual	Auto							
0302	Closed	Center position	Open							
0303	Starting position	Center position	End pos.							
0304	Back	Center position	Forward							
0311	Bottom	Center position	Top							
0321	Left	Center position	Right							
0322	Left	Start position	Right							
0323	Left	Neutral position	Right							
0324	Left	Off	Right							
0331	Heating	Zero energy	Cooling							
0332	Sustained mode	Setback mode	Heating mode							
0341	Normal	Maintenance	Alarm							
0351	Slow	Medium	Fast							
0361	Off	Stage 1	Stage 2							
0401	Off	Stage 1	Stage 2	Stage 3						
0411	Emergency Off	Off	On	Frost protection						
0501	Off	Stage 1	Stage 2	Stage 3	Stage 4					
0511	Off	On	Controller	Min. limit.	Max. limit.					
0601	Off	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5				
0701	Off	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6			
0801	Off	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7		
0901	Off	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8	
1001	Off	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8	Stage 9

Appendix 7.3 Engineering units (overview)

Unit Code (Standard)	Unit (Standard - ISO units)	Symbol (informat.)	Variable (information)
1	2	3	4
0	square-meters	m²	Area
2	milliamperes	mA	Current
3	amperes	A	Current
4	ohms	Ω	Electrical resistance
5	volts	V	Electrical voltage
6	kilovolts	kV	Electrical voltage
7	megavolts	MV	Electrical voltage
8	volt-amperes	VA	Electrical apparent power
9	kilovolt-amperes	kVA	Electrical apparent power
10	megavolt-amperes	MVA	Electrical apparent power
11	volt-amperes-reactive	var	Electrical reactive power
12	kilovolt-amperes-reactive	kvar	Electrical reactive power
13	megavolt-amperes-reactive	Mvar	Electrical reactive power
15	power-factor	---	Power factor
16	joules	J	Energy
17	kilojoules	kJ	Energy
18	watt-hours	Wh	Energy
19	kilowatt-hours	kWh	Energy
23	joules-per-kilogram-dry-air	J/kg	Energy content
25	cycles-per-hour	1/h	Operating cycles
26	cycles-per-minute	1/min	Operating cycles
27	hertz	Hz	Frequency
28	grams-of-water-per-kilogram-dry-air	g/kg	Absolute humidity
29	percent-relative-humidity	% r.h.	Relative humidity
30	millimeters	mm	Length
31	meters	m	Length
35	watts-per-square-meter	W/m²	Area-specific power
36	lumens	lm	Light flux
37	luxes	lx	Illumination
39	kilograms	kg	Weight
41	tons	t	Weight
42	kilograms-per-second	kg/s	Mass flow
43	kilograms-per-minute	kg/min	Mass flow
44	kilograms-per-hour	kg/h	Mass flow
47	watts	W	Power
48	kilowatts	kW	Power
49	megawatts	MW	Power
51	horsepower	PS	Power
53	pascals	Pa	Pressure
54	kilopascals	kPa	Pressure
55	bars	bar	Pressure
62	degrees-Celsius	°C	Temperature
63	degrees-Kelvin	K	Temperature
67	years	a	Time
68	months	Mon	Time
69	weeks	We	Time
70	days	d	Time
71	hours	h	Time
72	minutes	min	Time
73	seconds	s	Time
74	meters-per-second	m/s	Velocity
75	kilometers-per-hour	km/h	Velocity
80	cubic-meters	m³	Volume
82	liters	l	Volume
87	liters-per-second	l/s	Volume flow
88	liters-per-minute	l/min	Volume flow
90	degrees-angular	°	Solid angle

Unit Code (Standard)	Unit (Standard - ISO units)	Symbol (informat.)	Variable (information)
1	2	3	4
91	degrees-Celsius-per-hour	°C/h	Temperature gradient
92	degrees-Celsius-per-minute	°C/min	Temperature gradient
95	no-units	0	(no unit)
96	parts-per-million	ppm	Concentration
97	parts-per-billion	ppb	Concentration
98	Percent	%	Percentage
99	percent-per-second	%/s	Speed of change
100	per-minute	1/min	Frequency
101	per-second	1/s	Frequency
103	Radians	rad	Angle
104	revolutions-per-minute	rpm	Rotational speed
105	currency1	€	Currency
106	currency2	DM	Currency
116	square-centimeters	cm²	Area
118	Centimeters	cm	Length
121	delta-degrees-Kelvin	K	Temperature difference
122	Kilohms	kΩ	Electrical resistance
123	Megohms	MΩ	Electrical resistance
124	Millivolts	mV	Electrical voltage
125	kilojoules-per-kilogram	kJ/kg	Specific energy content
126	Megajoules	MJ	Energy
127	joules-per-degree-Kelvin	J/K	Heat capacity, entropy
128	joules-per-kilogram-degree-Kelvin	J/(kg*K)	Specific heat capacity
129	Kilohertz	kHz	Frequency
130	Megahertz	MHz	Frequency
131	per-hour	1/h	Frequency
132	Milliwatt	mW	Power
133	hectopascals	hPa	Pressure
134	millibars	mbar	Pressure
135	cubic-meters-per-hour	m³/h	Throughput
136	liters-per-hour	l/h	Throughput
137	kilowatt-hours-per-square-meter	kWh/m²	Energy demand value
139	megajoules-per-square-meter	MJ/m²	Energy demand value
141	watts-per-square-meter-degree-kelvin	W/(m²*K)	Heat coefficient
144	percent-obscuration-per-meter	%/m	% obscuration
145	milliohms	mΩ	Electrical resistance
146	megawatt-hours	MWh	Electrical energy
149	kilojoules-per-kilogram-dry-air	kJ/kg dry.air	Enthalpy
150	megajoules-per-kilogram-dry-air	MJ/kg dry.air	Enthalpy
151	kilojoules-per-degree-Kelvin	kJ/K	Entropy
152	megajoules-per-degree-Kelvin	MJ/K	Entropy
153	newton	N	Force
154	grams-per-second	g/s	Mass flow
155	grams-per-minute	g/min	Mass flow
158	hundredths-seconds	10^{-2} s	Time
159	milliseconds	ms	Time
160	newton-meters	Nm	Torque
161	millimeters-per-second	mm/s	Velocity
162	millimeters-per-minute	mm/min	Velocity
163	meters-per-minute	m/min	Velocity
164	meters-per-hour	m/h	Velocity
165	cubic-meters-per-minute	m³/min	Volume flow
166	meters-per-second-per-second	m/s²	Acceleration
170	farads	F	Electrical capacity
171	henrys	H	Inductivity
172	ohm-meters	Ωm	Specif. electr. resistance
173	siemens	S	Electrical conductance
174	siemens-per-meter	S/m	Electrical conductance
175	teslas	T	Magnetic flux density
176	volts-per-degree-Kelvin	V/K	Volts per degree Kelvin
177	volts-per-meter	V/m	Electric field strength

Unit Code (Standard)	Unit (Standard - ISO units)	Symbol (informat.)	Variable (information)
1	2	3	4
178	webers	Wb	Magnetic flux
179	candelas	cd	Luminance
180	candelas-per-square-meter	cd/m²	Light density
181	degrees-Kelvin-per-hour	K/h	Temperature gradient
182	degrees-Kelvin-per-minute	K/min	Temperature gradient
183	joule-seconds	Js	Angular momentum
184	radians-per-second	rad/s	Angular speed
185	square-meters-per-Newton	m²/N	Force distribution
186	kilograms-per-cubic-meter	kg/m³	Density
187	newton-seconds	Ns	Pulse
188	newtons-per-meter	N/m	Surface tension
189	watts-per-meter-per-degree-Kelvin	W/m K	Thermal conductivity
190	microsiemen	µS	Electric conductance
193	kilometers	km	Length
194	micrometers	µm	Length
195	grams	g	Weight
196	milligrams	mg	Weight
197	milliliters	ml	Volumes
198	milliliters-per-second	ml/s	Volume flow
199	decibels	dB	Level
200	decibels-millivolt	dBV	Voltage level (rel. to 1V)
201	decibels-volt	dBmV	Voltage level (rel. to 1mV)
202	millisiemens	mS	Electrical conductance
203	watt-hours-reactive	Whr	Electrical reactive
204	kilowatt-hours-reactive	kWhr	Electrical reactive
205	megawatt-hours-reactive	MWhr	Electrical reactive
206	millimeters-of-water	mmWS	Mechanical pressure
207	per-mille	‰	Share
208	grams-per-gram	g/g	Weight
209	kilograms-per-kilogram	kg/kg	Weight
210	grams-per-kilogram	g/kg	Weight
211	milligrams-per-gram	mg/g	Weight
212	milligrams-per-kilogram	mg/kg	Weight
213	grams-per-milliliter	g/ml	Concentration, spec. weight
214	grams-per-liter	g/l	Mass per unit volume
215	milligrams-per-liter	Mg/l	Mass per unit volume
216	micrograms-per-liter	µg/l	Mass per unit volume
217	grams-per-cubic-meter	g/m3	Mass per unit volume
218	milligrams-per-cubic-meter	mg/m3	Mass per unit volume
219	micrograms-per-cubic-meter	µg/m3	Mass per unit volume
220	nanograms-per-cubic-meter	ng/m3	Mass per unit volume
221	grams-per-cubic-centimeter	g/cm3	Mass per unit volume
222	becquerels	Bq	Activity (radioactive material)
223	kilobecquerels	kBq	Activity (radioactive material)
224	megabecquerels	MBq	Activity (radioactive material)
225	gray	Gy	Energy dose (ion. radiation)
226	milligray	mGy	Energy dose (ion. radiation)
227	microgray	µGy	Energy dose (ion. radiation)
228	sieverts	Sv	Weighted radiation dose
229	millisieverts	mSv	Weighted radiation dose
230	microsieverts	µSv	Weighted radiation dose
231	microsieverts-per-hour	µSv/h	Radiation dose output
232	decibels-a	dB(a)	Evaluated sound level
233	nephelometric-turbidity-unit	NTU	Turbidity (water quality)
234	pH	---	Hydrogen ion concentation
235	grams-per-square-meter	g/m2	Mass distribution
236	minutes-per-degree-kelvin	min/K	Temperature gradient

Appendix 7.4 Event types for Intrinsic Reporting (examples)

Object type	Event_Type	Conditions
1	2	3
Binary input, Binary value, Multistate input, Multistate value	Change_Of_State	If the present value assumes a new state longer than the setting in property Time_Delay **and** this change of state is enabled in property Event_Enable.
Analog input, Analog output, Analog value	Out_Of_Range	If the present value exceeds the range set between High_Limit and Low_Limit that is longer than in the property Time_Delay **and** this change of state is enabled in the property Event_Enable and Limit_Enable **or** if the present value in the property Time_Delay returns to the defined time in the range between High_Limit - Deadband and Low_Limit + Deadband **and** this change of state is enabled in the property Event_Enable and Limit_Enable.
Binary output, Multistate output	Command_-Failure	If the present value assumes is longer than the setting in property Time_Delay **and** this change of state is enabled in property Event_Enable.
Load Control	Command_Failure	If the present value is assumes a value Shed_Non_-Compliant that is longer than set in the property Time_Delay **and** this change of state is enabled in the property Event_Enable and Limit_Enable.
Controller	Floating_Limit	If the absolute difference between the Setpoint value and the Controlled_Variable_Value, the Error_Limit, longer than is set in the property Time_Delay, is exceeded **and** this change of state is enabled in property Event_Enable.
Trend Log, Event Log, Trend Log Multiple	Buffer_Ready	If the Event_State assumes the state NORMAL and the Records_Since_Notification are greater than or equal to the Notification_Threshold.
Accumulator	Unsigned_Range	If the value for the property Pulse_Rate exceeds the range set between High_Limit and Low_Limit that is longer than in the property Time_Delay **and** this change of state is enabled in the property Event_Enable and Limit_Enable **or** if the present value in the property Time_Delay returns to the defined time in the range between High_Limit - Deadband and Low_Limit + Deadband **and** this change of state is enabled in the property Event_Enable and Limit_Enable.

Appendix 7.5 Notification class matrix (example)

Event category	Meaning	Priority	Not. class	NC Object	MOU BAC	MOU plumb.	MOU security	SMS Heating	E-Mail MSR/GA	Application example
		Priority		Object_Name	Recipient					
1	2	3	4	5	6	7	8	9	10	11
Life Safety	Hazard to life	00 - 29	1	NC10	Target 1		Target 2		Target 3	Fire alarm, robbery
Property Safety	Safety message	30 - 59	2	NC20	Target 1		Target 2			Intrusion, unauthorized access
Alarm message	Message signaling plant failure or requires immediate intervention	60 - 89	3	NC30	Target 1	Target 2	Target 3 18:00-06:00	Target 4 Mo…Fr 00:00-07:00 17:00-23:59 Sa…So 00:00-23:59	Target 5 Mo…Fr 00:00-07:00 16:00-23:59 Sa...So 00:00-23:59	Safety temperature limiter (STB), Safety pressure limiter (SDB), DHW overtemperature, safety valves, primary pumps, V-belt detector, frequency inverters, refrigeration plants, power outage, etc.
Fault message	Message refers to an abnormal plant state	90 -119	4	NC40	Target 1	Target 2		Target 3 Mo...Fr 00:00-07:00 17:30-23:59 Sa…So 00:00-23:59	Target 4 Mo…Fr 00:00-07:00 17:30-23:59 Sa…So 00:00-23:59	Temperature detector (TD), pressure detector (PD), Temperature monitoring heat exchanger and hot water motor protection, elevator common fault messages, etc.
Maintenance message	Refers to maintenance activity (among others)	120 -149	5	NC50	Target 1					Operating hours, container level, repair switch, etc.
			(51)	NC51		Target 1				Filter end reached, dirty filter,
System message	Fault message from BACS	150 - 219	6	NC60	Target 1				Target 2	Device fault, battery message, failed communications, etc.
Man. intervention	Man. intervention	220	7	NC70	Target 1	Target 2				Manual intervention
Reserved	Other messages	221 - 255	8	NC80	Target 1	Target 2				Change of operating state, operating modes, trend buffer full, etc.

Appendix 7.6 Event and acknowledgement options (example)

Event category (see **Appendix 7.7**)	**Priority** *	**Event_Enable** **	**Ack_Required** ***
1	2	3	4
Alarm message	060, Not required, 255	1 (Alarm message), 0 (Not required), 1 (Report return to normal)	1 (Acknowledge alarm), 0 (Fault not acknowledged), 1 (Return to normal acknowledged)
Fault message	100, Not required, 255	1,0,1 (see above)	1 (Acknowledge alarm), 0 (Fault not acknowledged), 0 (Return to normal not ack)
Maintenance message	130, Not required, 255	1,0,1 (see above)	1 (Acknowledge alarm), 0 (Fault not acknowledged), 0 (Return to normal not ack)
System message	180, Not required, 255	1,0,1 (see above)	0 (Not acknowledged), 0 (Fault not acknowledged), 0 (Return to normal not ack)

* **Priority**
The priorities in the property Priority of the Notification Class Object control the processing and display sequence of time-critical alarms and event messages. Any change of event (TO-OFFNORMAL, TO-FAULT and TO-NORMAL) can be link to its own priority.

** **Enable event messages (Event_Enable**)
The property Event_Enable is available on a number of event-generating BACnet objects. With three bits (three flags = 0 or 1) locking or enabling event messages for the three events (TO-OFFNORMAL, TO-FAULT and TO-NORMAL) can be set individually. The conditions of these events are defined in the standard for the given object.

*** **Ack_Required**
Acknowledgement requirements are set in the property "Ack_Required" of the notification class object. With three bits (three flags = 0 or 1) acknowledgements which are required for the three events (TO-OFFNORMAL, TO-FAULT and TO-NORMAL) can be set individually

Appendix 7.7 Sample Specification for MOU

The requirements for a BACnet MOU are summarized in the following as a sample specification. This sample specification has to be supplemented by the project-specific requirements of the building owner and the operator.
Project-specific definitions recommended by AMEV are printed in *italics*.

Certification

The MOU satisfies the AMEV profile MOU-B and is certified as B-AWS (BACnet Advanced Workstation).

Access Control and Verification

The MOU must offer access control featuring at least four password levels. Operator interventions may only be carried out after authentication of the operator (e.g. by entering user identification and password).

Visualization

Dynamic visualization in control diagrams must be implemented as per AMEV BACnet 2017 Appendix 2.2. Primary information is displayed permanently, secondary information only at the operator's request*, e.g. as a tooltip when pointing on the associated primary information on the display*.

The MOU must be able to list all BACnet objects in the system and display all object properties. Constructed and nested BACnet data structures must be able to be broken down in their elements and displayed at the operator's request. *All modifiable / writable values must be identified accordingly and modifiable / writable.*

The MOU must support the filtering and sorting of all generated lists by either user addresses or parts of user addresses. The criteria must be able to be specified by the operator - individually or in combinations. The criteria must be able to be derived from the addressing system *(e.g. property, building, component, floor, discipline, plant number, zone number, function designation, object type, etc.)*. The results list must allow for sorting by BACnet object type and user address.

The MOU provides a graphics editor for the creation of control diagrams. For basic plant components, preconfigured editable sample graphic elements are to be provided in plant libraries. Graphic elements created from graphical basic elements or from samples can be saved to plant libraries. The graphic elements must allow for live updates, i.e. they change (for instance by blinking or changing color or text) depending on BACnet objects or application program variables. The graphics editor supports assignment of properties of dynamic objects to all BACnet objects and program variables.

Manual Operation

Manual interventions via the MOU are recorded in a revision-proof log file which contains user identification, time stamps and all the necessary information for the complete description of the interventions. Other manual operations must also be recorded by the MOU and stored in the log file.

Manual set operating states are marked conspicuously in the control diagrams. *The control diagram visualization differs depending on the type of manual operation*

- *by the MOU (management level)*
- *by an operator unit at the automation level*
- *by a local override/indication device(LO/ID)*
- *by a system message "Out_Of_Service".*

The MOU provides an up-to-date list of all effective manual interventions.

Reports

All plant information must be presented in the form of clear, printable reports. *The reports can be freely compiled by the operator.* All BACnet objects with all associated properties as well as the application program variables can be selected and presented in reports.

Alarm, message processing / forwarding

All alarm notifications are displayed chronologically in an alarm table. *The alarms remain in the table until they are acknowledged.*

All event notifications are displayed chronologically in the event table.

Alarms and events are forwarded by the MOU, either directly or time-controlled, depending on the Notification_Class of the Notification Class objects to the following possible receivers

- *E-mail address,*
- *Printer,*
- *Fax,*
- *Mobile phone (SMS),*
- *Other operator stations*
- ...

Note:
It is to be defined in a project-specific manner whether and how the MOU automatically registers in Notification Class objects of automation stations.

Incoming alarm notifications are displayed dynamically in the plant graphics *by means of flashing of the related objects. The operator can also set up supplementary acoustic signaling for alarm notifications.*

Time Switch

Schedule and calendar objects can be read and edited by the operator via the MOU. For this purpose, graphics / pop-ups with scheduled times and changeable parameters / properties are provided.

Trend Data Acquisition and Processing

The MOU maintains a list of all trend log objects contained in the AS.

The MOU archives the data from trend log objects of automations stations in a database, allowing for graphical and tabular representation of the data. *The archived data are exported to … a storage medium … at regular intervals of ….*

Note:
The plant operator is responsible for organizing the safekeeping of the storage media containing the archived data.

Trend data featuring different logging types or intervals can be converted and displayed in equidistant time series.

Data provision and export

The database of the MOU allows the authorized operator - also via network access – to perform SQL queries on the stored data. *The MOU provides predefined SQL queries with functional descriptions in the form of a selection list to the operator. Queries created or modified by the operator can be stored in the list.*

Stored data is provided by the MOU for export in the form of a

- CSV file
  with underscore as a separator
- XML file
- ...

as described below.

The name of the export file shall contain the date of the start of recording (YYYYMMDD) and the object name of the automation station.

Loop object

The loop object is represented in the control diagram by a symbol with a dynamic visualization of the current loop output value (Present_Value). Clicking the symbol opens a pop-up window with detailed information.
For operation, at least the following properties must be presented:

- *Object name*
- *Description*
- *Proportional constant*
- *Integral constant*
- *Derivative constant*
- *Controlled variable value*

Time Synchronisation

The MOU serves as a system-wide time master for the automatic time synchronization of all BACnet devices. The assigned devices accept the time settings and synchronize accordingly.

System Functions

The MOU must monitor the proper operating condition (life-check) of all BACnet devices. *For this purpose, a cyclic polling of the system status of the device objects is to be applied. The polling cycle can be set individually for each device*.

Note:
To prevent significant impairment of network performance, a life-check cycle is to be selected commensurate with the criticality of the device to be monitored.

The MOU must store changes to the communication of BACnet devices (switching off and on) in log files along with a time stamp, a user ID and the type of intervention and be able to present such information to the user.

Appendix 8 Glossary

BBMD
A BBMD (BACnet Broadcast Management Device) device transmits broadcast messages on routed IP networks by tunneling the broadcast messages to the BBMD of other IP sub networks. BBMD may only be used on network environments where broadcast messages are blocked. The use of multiple BBMDs per sub network or in environments with broadcast forwarding result in network faults through the inflationary increase in broadcast messages.

Broadcast
Broadcast messages are "broadcasts without special addressees"". IP router do not permit broadcast messages to pass through on IP networks.

Ethernet
Ethernet is a common access procedure to local networks (Local area network - LAN) and allow for fast network connections. It specifies from the viewpoint of the OSI model both the physical layer (OSI Layer 1) as well as the data link layer (OSI Layer 2). Ethernet is largely standardized as part of IEEE standard 802.3.

Firewall
A firewall is installed at the connection between networks. It only allowed approved communications to pass and reject unauthorized actions and logs attempted abuses. At the transport level, packet filters filter the IP packets in accordance with predefined rules for forwarding or blocking. Application-Gateways filter by application level.

When establishing BACnet networks, the access computer checks, on the application level, the packets and permits or prohibits connections as per preset rules. For file transfer or remote operation, conditions and rules of access are introduced on the services. This provides the opportunity for user-related authentication and logging of services.

Gateway
Gateways (protocol converter) connect networks with different, non-compatible protocols. In BACnet systems, Gateways are used for example to implement data from LON applications or for OPC systems.

IP (Internet-Protocol)
The internet protocol transport data packets over multiple networks from one sender to a recipient. Transmission is packet oriented, not requiring a connection and not in real time. IP guarantees neither delivery at the recipient nor that the packets arrive in the proper sequence. High protocol layers or application programs assume these tasks. IPv4 is specified in the current BACnet standard. Modification to IPv6 is in the works. IPv6 permits a significantly higher address space than does IPv4.

IP address
The IP address has two elements: the network and host element. 4 decimal numbers in a range of 0 to 255, separated by a period are used for display purposes (e.g. 194.62.15.2).

MAC address (Media Access Control address)
The MAC address is required for the unique identification of each piece of equipment (device, router) on the network. The MAC address is either fixed coded in the communications chip (e.g. Ethernet) or must be assigned and documented in a coordinate manner (MS/TP).

MOU
Monitoring and operating units (MOU) refer to BAC equipment that has operating and management functions.

Native BACnet
The term is not standardized and should not be used due to a lack of validity and traceability. The ability of BACnet device to communication as per DIN EN ISO 16484-5 can be exclusively documents by testing per DIN EN ISO 16484-6.

Peer-to-peer
All network participants on peer-to-peer networks are equal. Each computer (peer) can simultaneously be a client and server and claim or provide services.

Ports
Ports are address components used in network protocols to assign data packets to the correct services (protocols). This concept is used, for example, in TCP and UDP. Values range from 0 to 65535. Certain applications (e.g. http, smtp) use port numbers that are fixed and generally known. They generally reside between 0 and 1023 and are referred to as well known ports. The registered ports reside between 1024 and 49151. Application manufacturers can register ports for their own protocols, much like domain names. The registration allows the application to be identified based on the port number, of course only when the application actually uses the port.

For BACnet post the following numbers are registered at TCP and UDP: 47808 (0xBAC0), whereby BACnet/IP currently uses UDP only. The remaining ports, port numbers 49152 to 65535, are the dynamic or private ports. They can be used variably, since they are not registered and therefore do not belong to any application.

Proprietary
Specific to the manufacturer, not standardized.

Repeater
Repeaters are used to overcome length restrictions on cables due to attenuation. Repeater are used in BAC systems, e.g. for RS485 and LON networks.

Router
A router connects networks to layer 3 of the ISO-OSI model (e.g. IP level). Routers optimize packet transmitted communications between networks. They maintain tables with information on networks, network participants and other routers and their IP addresses. Data packets are only forwarded to impacted network participants or networks.

Switch
A switch separates a network into network segments (partial networks) to improve load separation. Data for a network segment does not spill into other segments and does not impair the overall network.

A switch has physical connection to connect up the network segments. Incoming data is only forwarded to connection with the indicated target address. The switch connects the recipient and output out free of collision with the full channel bandwidth and is capable of learning with regard to connected stations.

Transmission Control Protocol (TCP)
TCP provides connection-oriented services on the transport layer and secure in this manner data transmission. In contrast to UDP, TCP monitors data exchange and eliminates loss of data by re-transmitting the data. TCP/IP is a combination of TCP with the Internet Protocol (IP) and is the most commonly used protocol worldwide. BACnet uses UDP instead of TCP.

Tunneling
Tunneling refers to the encapsulating of a communication protocol within another protocol, e.g. BACnet broadcasts over routed IP networks.

User Datagram Protocol (UDP)
UDP is an IP-based data transmission protocol and largely corresponds to TCP. UDP is faster than TCP since is has no flow control and error correction. Which is why BACnet uses UDP instead of TCP. Flow control (receipt confirmation of telegrams) occurs in BACnet on the application level (ISO/OSI layer 7).

VLAN
VLAN (Virtual Local Area Network) describes a procedure for forming logical networks (virtual LAN) in a network structure. The VLAN is formed on OSI-Layer 2. As an option, VLAN networks can be connected to one another through additional VLAN routing on OSI-Layer 3 via IP protocol (routing). VLAN is commonly used to logical separate various network areas on an intranet.

VPN
VPN (Virtual Private Network) describes a process for forming connected logical networks within public networks (Internet) or private IP networks (Intranet). Among participants, a VPT tunnel is setup; the external IP network is used for transport of enciphered information only. For VPN participants, the external network cannot be reached, since the VPN structure responds logically like a directly connected IP network. VPN routers have security mechanisms including enciphered data transmission and should be used when using DSL connections for connection via public internet.

Character set
ANSI X3.4 (ASCII) is a characterized by the American National Standards Institute (ANSI). It uses 7 binary digits with a decimal space from 0 to 127 and permits Latin characters and numbers, but no Umlauts for example.

UTF-8 is an international character set as per ISO 10646. With UTF-8, up to 8 bytes can be used for character coding. UTF-8 permits the use of a number of special characters, e.g. german umlauts. For ASCII characters are a subset obtained in the UTF-8 character set, UTF-8 is downward compatible to ANSI X3.4.

Appendix 9 Literature (german)

- AMEV recommendation „BAC" in actual valid version ("*Gebäudeautomation*")

- DIN EN ISO 16484 Systeme der Gebäudeautomation (GA),
  Teil 1: Projektplanung und –ausführung (Entwurf)
  Teil 2: Hardware
  Teil 3: Funktionen;
  Teil 5: Datenkommunikationsprotokoll
  Teil 6: Datenkommunikationsprotokoll - Konformitätsprüfung

- VDI 3814 Gebäudeautomation (GA)
  Blatt 1 Systemgrundlagen
  Blatt 2 Gesetze, Verordnungen, Technische Regeln
  Blatt 3 Hinweise für das TGM - Planung, Betrieb und Instandhaltung
  Blatt 5 Hinweise zur Systemintegration
  Blatt 6 Grafische Darstellung von Steuerungsaufgaben

- GAEB StLB Bau 070 Gebäudeautomation in actual valid version
  (see http://www.gaeb.de/home2.en.php)

- Hans Kranz: "BACnet Gebäudeautomation 1.12", 3., vollständig überarbeitete Ausgabe 2012
  Promotor Verlag, Karlsruhe, ISBN 978-3-922420-25-5

- Herrmann Merz / Thomas Hansemann / Christof Hübner: "Gebäudeautomation. Kommunikationssysteme mit EIB/KNX, LON und BACnet", 2009,
  Hanser Fachbuchverlag, Leipzig, ISBN: 3-446-42152-1

- Friedbert Tiersch / Christian Kuhles: "BACnet and BACnet/IP Wie funktioniert das ?", 2007, Promotor Verlag, Karlsruhe, ISBN 3-922420-13-2

Additional literature available at:

- Official BACnet website: www.bacnet.org
- BACnet International website: www.bacnetinternational.org
- BACnet Interest Group Europe (BIG-EU): www.big-eu.org

Contributors

BACnet 2017

Dr.-Ing. Hall	Vermögen und Bau Baden-Württemberg, Stuttgart (chairman)
Mrs. Benneckenstein	Deutsche Bundesbank, Hannover
Dr.-Ing. Bitter	WSPCert, Stuttgart
Hardkop	former: Ministerium für Wirtschaft, Energie, Bauen, Wohnen und Verkehr (MWEBWV) des Landes Nordrhein-Westfalen, Düsseldorf
Hartel	GA Ingenieurgesellschaft mbH, Salzkotten
Hasselbach	Technische Universität Dresden
Hinck	Gebäudewirtschaft der Stadt Köln
Kohlhoff	GA Ingenieurgesellschaft mbH, Dülmen
Kurowski	Siemens Schweiz AG
Person	HIS-Institut für Hochschulentwicklung e. V., Hannover
Schubert	Beckhoff Automation GmbH & Co. KG, Verl
Zwischenberger	Ingenieurbüro Inplan, Odelzhausen

BACnet 2007 und BACnet 2011

Hardkop	Ministerium für Wirtschaft, Energie, Bauen, Wohnen und Verkehr (MWEBWV) des Landes Nordrhein-Westfalen, Düsseldorf (chairman)
Frau Assaouci	Universität zu Köln
Dr.-Ing. Bitter	WSPLab, Stuttgart
Birlo	Fachhochschule Gelsenkirchen
Brinkmann	Wehrbereichsverwaltung (WBV) West Arbeitskreis GA, Wiesbaden
Prof. Dr. Büchel	Fachhochschule Gelsenkirchen
Crecelius	Energie- und Umweltbüro e. V., Berlin
Didjurgeit	Landeshauptstadt München
Prof. Dr. Fischer	Fachhochschule Dortmund
Fries	Büro für technische Datenverarbeitung, Dachau
Gerhard	Handwerkskammer des Saarlandes, Saarbrücken
Hadré	Hadré + Partner Beratende Ingenieure, Rösrath
Dr.-Ing. Haeseler (†)	Cofely Deutschland GmbH, Berlin

Dr.-Ing. Hall	Vermögen und Bau Baden-Württemberg, Stuttgart
Harrach	Universitätsklinikum Essen
Hartel	GA Ingenieurgesellschaft mbH, Salzkotten
Hasselbach	Technische Universität Dresden
Herrmann	ARUP Ingenieurgesellschaft, Berlin
Hinck	Gebäudewirtschaft der Stadt Köln
Janetschek	Bayer Immobilien Service (BIS), Leverkusen
Kaps	Landeshauptstadt München
Keilholz	Stadt Nürnberg
König	CAESAR Ingenieure GmbH, Berlin
Klose (†)	Ingenieurbüro Theurich + Klose, Hannover
Köster	Bundesverteidigungsministerium (BMVg), Bonn
Kohlhoff	GA Ingenieurgesellschaft mbH, Dülmen
Koser	Wehrbereichsverwaltung (WBV) Nord Arbeitskreis GA, Hannover
Koster	Oberfinanzdirektion (OFD) Hannover
Kranz	Ingenieurbüro HAK, Forst
Kroll	Ministerium für Wirtschaft, Energie, Bauen, Wohnen und Verkehr (MWEBWV) des Landes Nordrhein-Westfalen, Düsseldorf
Kurowski	WSPLab, Stuttgart
Kwas	GA Ingenieurgesellschaft mbH, Salzkotten
Lambert	Ingenieurbüro Scholz, Regensburg
Lützke	Bundesbaugesellschaft Berlin mbH
Maurer	Energie- und Umweltbüro e. V., Berlin
Frau Müller	Leibniz-Universität Hannover
Naturski	Oberste Baubehörde im Bayerischen Staatsministerium des Innern, München
Person	Hochschul-Informations-System (HIS) GmbH, Hannover
Pütz	Rheinische Friedrich-Wilhelms-Universität Bonn
Seibt	Deutsche Bahn, DB Station & Service AG, Berlin
Schröder	FRAPORT AG, Frankfurt am Main
Schubert	MBS GmbH, Krefeld
Speelmanns	Bundesamt für Bauwesen und Raumordnung (BBR), Bonn
Zeller	Sauter AG, Sauter HeadOffice, Basel (CH)
Zwischenberger	Ingenieurbüro Inplan, Eichenau

Translation

Wächter	Siemens Switzerland Ltd., Infrastructure & Cities Sector, Building Technologies Division, International Headquarters, Zug (CH)
Kurowski	Siemens Switzerland Ltd., Infrastructure & Cities Sector, Building Technologies Division, International Headquarters, Zug (CH)
Rohrbacher	Siemens Switzerland Ltd., Infrastructure & Cities Sector, Building Technologies Division, International Headquarters, Zug (CH)

Revision history

Revision history		
Version	**Date**	**Explanations**
1	2	3
2017	26.07.2017	Modifications of BACnet 2011 V1.2 en on pages 12, 13, 20 to 22, 25, 54, 59, 85, 92 to 94, 104 to 106 (see margins).

AMEV office at
Federal Ministry for the Environment, Nature Conservation,
Building and Nuclear Safety (BMUB); Ref. B I 32
Krausenstrasse 17-20, 10117 Berlin
Telefon: +49 30 18 305 7136
Computerfax: +49 30 18 10 305 7136
E-Mail:amev@bmub.bund.de

Information on new publications is available at
http://www.amev-online.de
or at the AMEV office