# INTERNATIONAL STANDARD

# ISO 16484-3

First edition
2005-01-15

# Building automation and control systems (BACS) —

## Part 3:
## Functions

*Systèmes de gestion technique du bâtiment (SGTB) —*

*Partie 3: Fonctions*

Reference number
ISO 16484-3:2005(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16484-3 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 205, *Building environment design*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

ISO 16484 consists of the following parts, under the general title *Building automation and control systems (BACS)*:

— *Part 1: Overview and definitions*

— *Part 2: Hardware*

— *Part 3: Functions*

— *Part 4: Applications*

— *Part 5: Data communication — Protocol*

— *Part 6: Data communication — Conformance testing*

— *Part 7: Project implementation*

# Contents

# Foreword

This document (EN ISO 16484-3:2005) has been prepared by Technical Committee CEN /TC 247, "Building Automation, Controls and Building Management", the secretariat of which is held by SNV, in collaboration with Technical Committee ISO/TC 205 "Building environment design".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2005, and conflicting national standards shall be withdrawn at the latest by July 2005.

The EN ISO 16484-3 is part of the EN ISO 16484 series of European Standards under the general title *Building Automation and Control Systems (BACS)*, which will comprise the following parts:

Part 1: *Overview and vocabulary*

Part 2: *Hardware*

Part 3: *Functions*

Part 4: *Applications*

Part 5: *Data communication - Protocolcity*

Part 6: *Data communication - Conformance testing*

Part 7: *Project implementation*

Annex A , *BACS points list,* forms a normative part of this standard

In this standard annex B, *Examples for plant-/control schematic and BACS points list,* is informative.

This document includes a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

## Introduction

This series of standards is intended for design of new buildings and retrofit of existing buildings for an acceptable indoor environment, practical energy conservation and efficiency.

This part describes the software and the engineered functions used for building automation and control systems.

The application of this series of standards for BACS is envisaged as follows:

- the environmental design for all building types requires complex methods for automation and control. The functional integration of services other than HVAC e.g. lighting and electric power distribution control, security control, transportation, maintenance management or facilities management are general tasks for all parties employed to develop an integrated multi-application system. This integration allows the user to take advantage of synergies between the different applications. This standard will give guidance to architects, consultants and contractors as well as to users on how to share such resources;

- the innovation cycles between devices, systems and networks vary. To make it possible to add and to change existing devices, and extend the building network, several interfaces both proprietary and standardized are defined between the BACS network and the other systems. A manufacturer can design a product, both to meet his specific marketing objectives and to give the option to integrate that special device into a multi-application BACS. Interfaces are also defined in appropriate parts of this standard along with the necessary communications protocol and conformance test required to support the interworking of devices;

- a manufacturer, a systems house, or an electrical or mechanical contractor may assemble an implementation of a building automation and control system;

- the application of this standard is not to standardize the hardware and software design or the architecture of a System, but to define the process for the creation of project specifications, where functionality and the quality of the solution are clearly defined.

The purpose of this series of standards is intended for use by those involved in the design, manufacture, engineering, installation, commissioning, operational maintenance and training of BACS when contracted, i.e.:

— as a guide to the terminology of the building automation and control trade. Unambiguous terminology is required for a complete and accurate conveyance of the intent and details of this standard;

— in product development, to avoid unnecessary duplication of function or terminology, but should not place a restraint on the evolution of new products, systems or applications. A precise definition of system functionality is needed to prevent the overlap of functionality in different control system devices;

— as a basis for interfacing products and systems. In order to interoperate, the elements of a BACS require a common data communication protocol and information model;

— as a basis for drawing up a project specification for the procurement of building automation and control products for systems suppliers and customers. The successful design, procurement, installation, and operation of BACS require careful management and integration of the various aspects of the project;

— as a code of practice for proper commissioning prior to handover of a system;

— by educational establishments wishing to train people in the field of building automation and control systems.

This entire series of BACS standards consists of the following contents:

**Part 1: Overview and vocabulary (in preparation)**

Part 1 of this standard describes the objectives and interrelationships of all parts of this standard. It provides an overview and detailed information about the structure of the related series of standards for the BACS industry.

This part of the standard provides also the vocabulary with terms and definitions for the understanding of the entire series of this standard and it contains a translation of the main terms in English, French, Russian and German in an informative annex.

This ongoing work is coordinated at expert level with standards work from ISO/TC 205 WG 3 and CEN/TC 247/WG 2, WG 3, WG 4 and WG 5.

Each specific part of this standard contains its dedicated necessary terms and abbreviations/acronyms out of this part.

**Part 2: Hardware**

Part 2 of the standard specifies the requirements for the hardware to perform the tasks within a BACS. Part 2 provides the terms, definitions and abbreviations for the understanding of Part 2 and Part 3.

Part 2 relates only to physical items/devices, i.e.:

- devices for management functions, operator stations and other human system interface devices;
- controllers, automation stations and application specific controllers;
- field devices and their interfaces;
- cabling and interconnection of devices;
- engineering and commissioning tools.

Part 2 shows a generic system model to which all-different types of BACS and their interconnections (BACS network) can fit. A graphical concept of the BACS network in terms of LAN and internetwork topology will be provided in Part 5 of this standard.

**Regional amendment(s):**

Regional amendments can specify the local requirements of physical and electrical characteristics, the verifications for BACS devices and equipment, and the code of practice for the physical installation of systems. The amendments refer to the regional implementations of the relevant IEC standards.

**Part 3: Functions (refer to the scope of this part)**

**Part 4: Applications (in preparation)**

Part 4 of the standard specifies the requirements for specific communicating applications/devices, e.g. for general room automation and for sophisticated optimization of controls for heating, fan coil and induction units, CAV, VAV and radiant cooling.

This ongoing work will be coordinated at expert level with standards work from ISO/TC 205 WG 3 and CEN/TC 247.

**Part 5: Data Communication – Protocol**

Part 5 of the standard specifies data communication services and protocols for computer equipment and controllers used for monitoring and control of HVAC&R and other systems of building services.

This protocol provides a comprehensive set of messages for conveying encoded binary, analog, and alphanumeric data between devices including, but not limited to:

- input measuring: analog input object, analog input value, averaging object, trend log object;
- output positioning/setpoint: analog output object, analog output value;
- binary input counting: counter input value, totalised value, accumulated value;
- input state: binary input object, binary input value, multi-state input;
- output switching: binary output object, binary output, multi-state output;
- text string values;
- schedule information;
- alarm and event information;
- files; and
- control programs and parameters respectively.

This protocol models each building automation and control system as a collection of data structures called objects, the properties of which represent various aspects of the hardware, software, and operation of the device. These objects provide a means of identifying and accessing information without requiring knowledge of the details of the device's internal design or configuration.

An overview of possible integration with other systems in buildings, e.g. fire, security, access control, maintenance and facilities management, is shown in Figure 1 of Part 2 of this standard.

**Part 6: Data Communication – Conformance testing (in preparation)**

Part 6 of the standard specifies the technical requirements of the conformance test suite and the methods for testing the products for the conformance with the protocol. It provides a comprehensive set of procedures for verifying the correct implementation of each capability claimed on a BACS network protocol implementation conformance statement (PICS) including:

a) support of each claimed BACS network service, either as an initiator, executor, or both;

b) support of each claimed BACS network object-type, including both required properties and each claimed optional property;

c) support of the BACS network layer protocol;

d) support of each claimed data link option, and

e) support of all claimed special functionality.

**Part 7: Project implementation**

Part 7 of this standard specifies methods for project implementation and integration of BACS. This standard defines terms to be used for project specifications and gives guidelines of project specific system integration.
Project implementation can consist of two parts, the system implementation and, if required system integration:

- System implementation:

  This clause of the standard describes the procedures (codes of practice) required for the following;

  - System design,

    This also contains an example for a plant/system/customer premises wide unique structured addressing system for data point identification.

  - System engineering,
  - System installation,
  - System handover,
- System integration:

  This clause of the standard describes the special requirements and procedures for the integration and implementation of intersystem communication with other dedicated special system processes and the interconnection of other units/devices with integrated communications interfaces, (e.g. chillers, elevators).

# 1 Scope

This Part 3 of the standard specifies the requirements for the overall functionality and engineering services to achieve building automation and control systems. It defines terms, which shall be used for specifications and it gives guidelines for the functional documentation of project/application specific systems. It provides a sample template for documentation of plant/application specific functions, called BACS points list in annex A.

The informative function block examples explain a method to display the referenced functions in system documentation; they do not standardize the method for programming functions and applications.

This part of the standard covers the following:

Requirements and definitions regarding BACS and application software, generic functions for plant/project specific applications and engineering functions for building controls and operations. It provides communication functions for the integration of other dedicated special system processes. The functional requirements in this part of the standard are subdivided as follows:

— System management and application software:

  describes the requirements for plant independent systems and human system interface programs related to a project, including the operating system. This standard does not dedicate the following system functionality to any particular hardware, e.g.:

  — system diagnostics, watchdog, redundancy, time keeping, access control, log lists;

  — point identification, event message handling, print control;

  — database, statistics, data archiving, remote access;

  — system communications.

— Human system interface (HSI), point information presentation, graphics, alarms, time scheduling.

— Engineering process and tool software:

  describes the requirements for configuring of the hardware and control strategies, the system management and the commissioning process.

— BACS application processing programs and plant/application specific functions:

  describes the requirements for plant, application and/or project specific functions and a method for the documentation of a project. The functions are subdivided into the following types:

  — input and output functions, physical and shared;

  — processing functions (e.g. for monitoring, interlocks, control and optimization);

  — management functions (system programs), and required communications;

  — operator functions.

This Part 3 defines a method for specifying the procurement specifications containing all essential elements required for the operational functioning of a BACS. The successful installation and operation of a BACS requires that its procurement be based on a complete and accurate functional specification.

The standard provides a template called the ‘BACS points list’ that can be found in annex A (normative). Its purpose is to determine and document the options for plant/application specific functionality based on the plant/control schematic. Further explanations can be given in form of plant/control descriptions and control flow chart diagrams. Examples are given in annex B (informative). The exact specifications will be project-specific. Information about the standardized functions is given in the form of informative examples as function-blocks, textual, and graphical descriptions in 5.5.

It is recognized, that functions can be described and implemented in many different ways, depending on:

— climatic differences;

— cultural and regional differences;

— national regulations.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 60617-12, *Graphical symbols for diagrams - Part 12: Binary logic elements (IEC 60617-12:1997)*

EN 60617-13, *Graphical symbols for diagrams - Part 13: Analogue elements (IEC 60617-13:1993)*

EN ISO 16484-2:2004, *Building automation and control systems (BACS) - Part 2: Hardware (ISO 16484-2:2004)*

EN ISO 16484-5, *Building automation and control systems (BACS) - Part 5: Data communication protocolcity (ISO 16484-5:2003)*

## 3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN ISO 16484-2:2004 apply.

## 4 Symbols, abbreviations and acronyms

For the purposes of this European Standard, the symbols, abbreviations and acronyms given in EN ISO 16484-2:2004 apply.

NOTE The abbreviations used and explained within the Tables for the function block examples are for information only.

## 5 Requirements

### 5.1 Overview

#### 5.1.1 Structure of the requirements and functions

##### 5.1.1.1 General

The functional requirements in this part of the standard are subdivided as follows:

— System application and management software:

  describes the requirements for plant independent system, and human system interface programs related to a project. This standard does not dedicate this basic system functionality to any particular hardware;

— Engineering and commissioning tools:

  describes the requirements for the configuration of hardware, control strategies and management functions, and the commissioning process;

— Project/plant specific functions:

  describes the requirements for plant applications and/or project specific functions and methods for the functional documentation of project and/or application specific systems.

The (automatic) functions of a BACS in general are structured into three levels, for

— management,

— automation/control (processing functions), and

— input/output (interface to field devices).

Operator functions are not assigned to a specific level. A description of the hardware and communication means to perform the BACS software and functions is given in EN ISO 16484-2.

##### 5.1.1.2 Operator functions

Human system interface for supervision, alarms, state monitoring and human interaction for operation in general are not assigned to any functional level. Human system interface devices in a BACS are direct acting elements, as switches and signal lights, local override and/or indication devices, handheld units, monitoring and operator units or panels, operator stations including visual display units and Internet based browsers on different types of hardware. The VDU can provide a graphical user interface.

The range of functionality covers:

— system-, event- and state management, parameter adjustment and manual on/off control;

— local room operation;

— local override/indication device functions to provide restricted access for service operation;

— system engineering and servicing, engineered operator functions are, e.g. dynamic display, event instruction text, remote messaging.

#### 5.1.1.3 Management functions

Management functions are performed by the software of a BACS. The plant/application specific management functions are for the activity of a user taking decisions for supervision of plant and evaluating energy use and operational costs. The required functionality at this level is:

a) communications with devices of the control network and for shared data points;

b) communications for data exchange with dedicated special, or foreign systems to provide for operator and management functions at this level and/or within the BACS;

c) recording, archiving and statistical analysis;

d) decision support for e.g. energy management.

#### 5.1.1.4 Processing functions

The plant/project specific application software and parameters provide all automatic functionality for building services in real-time within self-contained controllers/automation stations. The required groups of processing functions are:

a) physical input and output functions;

b) shared input and output functions (communication);

c) monitoring;

d) interlocks;

e) closed loop and open loop control;

f) calculation/cross plant/system optimization;

g) room control functions, e.g. individual zone control, lighting control, shades/blinds control.

#### 5.1.1.5 Field devices

Field devices are generally sensors and actuators, coupling units and local override/indication, devices that are connected to input/output interfaces of controllers/automation stations. Field devices can be connected to controllers via field network or direct wiring. The field devices perform connection to the physical items of plant providing the necessary information about the conditions, states and values of the processes and effect the programmed operations. Functions supported by field devices are:

a) switching;

b) positioning;

c) state monitoring;

d) input for counting;

e) measuring.

### 5.1.2 Description of functions

The normative functional descriptions within this section are generic and are provided for use by the specifier to describe the project functionality. The descriptions in 5.5 contain no hardware related specifications, but the number of input and output functions help to determine the required physical or shared (communication) inputs and outputs of a BACS, the processor performance and memory size. For the required hardware components see EN ISO 16484-2.

The system programs and the plant and application specific functions to determine the engineering services are to be specified for each project.

The plant specific functions can be documented in plant/control schematics, control flow chart diagrams and the BACS PL (preferred as spreadsheet for further data processing), which is shown in annex A as a template.

Some complex projects and/or sophisticated control algorithms for optimal control performance require additional information and methods in order to describe the requirements in detail. These additional requirements include plant and control descriptions, control flow charts, psychrometric charts, reset schedules, field device mounting instructions/illustrations.

Annex B provides informative examples to indicate methods for creation accurate documentation for a project.

### 5.1.3 Description of function block examples

This standard has adopted (where appropriate) a function block (FB) method of describing BACS applications. The FB examples are designed according to the graphical symbols for diagrams in EN 60617-12, Binary logic elements and in EN 60617-13, Analog elements.

The information in the FB examples provides common wording and descriptions of BACS functions. The terminology provided by these descriptions should be used in any discussions and documents that represent BACS applications. This involves describing inputs, outputs, parameters and functions in a common textual and graphic format. A complete application scheme can be engineered using a series of interconnected function blocks as shown in the informative examples. The function block principle can be used to introduce new BACS functions and can be referred to using the BACS PL.

### 5.1.4 Description of the BACS points list

#### 5.1.4.1 Scope

The BACS PL shown in annex A is based on the definitions in 5.5, and it provides the following benefits:

— it allows to determine engineered functions for specific projects by using a spread sheet program that provides for electronic data interchange;

— it provides a common structured method for the plant/system design and specifying process;

— it is based on the plant/control schematic, the plant/control description and the control flow chart diagram if necessary;

— it provides for the use of a unique structured point naming convention given in 5.3.1;

— the structured numbering scheme for the functions provides for addition of individually defined functions in the given categories, if required.

#### 5.1.4.2 Purpose

The BACS PL can be used for tendering, costing and accounting purposes, although this aspect of its use is outside the scope of this standard. It should be considered that the main expenditure when implementing a BACS is in the engineering. These efforts are in direct relation to the number and type of functions required for the application.

BACS specifications shall contain all relevant detailed documents required to fully interpret the overall functionality, this should enable comparable and thought through tendering.

For each plant to be controlled and supervised a plant control schematic shall be drawn. The data points, processing functions, and communication functions for complete control, human system interface, operation, energy and maintenance management can be listed in a separate BACS PL by the specifier. This allows a supplier-independent description of the controls requirements.

## 5.2 General system criteria

A BACS mainly consists of field and control devices, switchgear assembly, cabling, communication and computing devices (hardware), system software and functions achieved by engineering services.

Decisions regarding functionality are normally defined before determination of the structure and the hardware of a BACS.

The following descriptions define the options and performance criteria to be specified and stated in each project regarding the manufacturer specific and the project specific application software.

For Hardware criteria refer to EN ISO 16484-2.

## 5.3 Software

### 5.3.1 BACS programs general

For this standard the software of a BACS is subdivided into

— system management programs;

— communication programs;

— general application and optimization programs;

— human system interface programs;

— engineering programs.

### 5.3.2 System management programs

#### 5.3.2.1 General

System management involves the initialization, co-ordination, and maintenance of all configuration information relating to the operation of the system as a whole including network management. Each system function may be configured manually or automatically. Remote system management and human system interface for system maintenance capabilities shall be specified. The programs need not be mandatory due to system size and resources.

#### 5.3.2.2 System time keeping

The management methods for time, date and calendar within all management and control functions shall be stated.

Performance criteria for system time keeping are:

a) Internal/external clock, type of external clock;

b) System clock accuracy;

c) Overall system time synchronization, e.g. by radio clock;

d) Summer/winter time change handling for daylight savings;

e) Change of time and date for local data processing device or server station;

f) Change of time and date for networked and stand alone devices.

#### 5.3.2.3 Watchdog functions

Watchdog function requirements and system responses shall be specified for each project.

#### 5.3.2.4 System diagnostics

Devices and functions of a BACS are supported by diagnostic tools to ensure constant operation, quality and performance. The system's diagnostic features monitor a variety of functions and report on failure situations, or invoke corrective actions. Remote system diagnostics capabilities shall clearly be specified. The system diagnostic features shall indicate:

a) memory usage and system resources;

b) failure percentage of communication activity on all system networks;

c) causes of system failures.

Further system diagnostic features shall be stated for a specific project.

#### 5.3.2.5 Power down management and recovery

Any consequences due to loss of power shall be specified, i.e. for:

a) power down;

b) power return;

c) associated internal system functions;

Additionally, the following requirements shall be specified:

d) operator initiated power on/off operation;

e) system power failure return method;

f) uninterruptible power supply options.

#### 5.3.2.6 System activity logbook

A record of all system activity and events should be kept with date and time for subsequent displaying, printing and archiving. The full extent of system operations held within the system activity logbook is to be specified.

#### 5.3.2.7 Point identification

For information accessing and processing within a BACS it is necessary to establish a project specific, unambiguous naming convention for identification of all physical and virtual data points. Point addresses are used for accessing and displaying information provided by functions throughout the system(s).

NOTE Point addresses used by an operator at the HSI are referred to as mnemonics or user addresses.

Point addresses within a BACS have to be unique and shall exist within a unique structure for a plant, a system, or the entire customer premises. Associated descriptive text displayed with the information of data points should be provided. The means by which the user interface navigates to the data point information shall be specified.

For point information presentation requirements refer to 5.3.2.9.

Typical elements of user addresses in a BACS addressing system are: site, building, part, location (e.g. floor), plant type (e.g. HVAC), plant number, type of function, information number. There are also customer specific data point designation systems according to established standards possible.

#### 5.3.2.8 System access control

A number of access levels defined in profiles shall be provided to protect the system from misuse. The number and relevance of these access levels have to be specified e.g.:

**Table 1 — access control levels**

| Level | Activity |
|---|---|
| No password: | Read only, restricted access to specific information |
| Level 1: | Routine daily operations only allowed |
| Level 2: | Operator access to all non configurable functions |
| Level 3: | Engineering access, required to configure the entire system |

A BACS shall provide for all dialog oriented operator interfaces an operator authentication for corroboration that the operator logging on to a device is identified to be the entity claimed.

For user access control requirements refer to 5.3.5.5.

#### 5.3.2.9 Operator activity logbook

The extent of operations held within the operator activity logbook for subsequent displaying, printing and archiving is to be specified. This can include a record of all operators logging in and out, with name, date and time, command, event acknowledgment, parameter and password change.

#### 5.3.2.10 Data usage and storage

##### 5.3.2.10.1 General

Change of state or change of value data sent from I/O, processing or other management functions can be stored and shall be provided with a date and time stamp for subsequent analysis. This program refers to the management functions event storage/historical database, BACS PL, col. 7.3/7.4, as specified in 5.5.4.3.

The requirements are subdivided into system specific and project specific features and performance criteria.

#### 5.3.2.10.2 System specific features for data storage

The features required shall be specified:

a) type of inputs into log files;

EXAMPLE Log entries can be: events, alarms, state, measurements, totalized values, system failures, user message logs.

b) minimum required number of records of each log file or database;

c) post collection format of provided alarm/event/measure log/counter log and system information data;

d) the means of retrieving the data;

e) search facilities provided for querying each of the lists;

f) print facilities offered.

Performance criteria:

1) Maximum number of log lists (as files on the data storage);

2) Maximum number of entries per log list;

3) Maximum amount and types of records managed.

#### 5.3.2.10.3 Project specific features of the database

The required features required shall be specified:

a) log lists for states and values (e.g. alarms, maintenance criteria);

b) historical database (e.g. for statistical analysis, quality control);

c) system documentation.

The supplier shall state the type of DBMS and original license provider (with respect to regional copyright laws).

Performance criteria if database management software is used:

1) Maximum number of entries in database;

2) Data storage space used for application software and parameters;

3) Data storage space proposed for user data;

4) Method of filtering employed;

EXAMPLE By message type, by plant, by function etc.

5) Accuracy of time stamping;

6) Resolution of time stamp.

#### 5.3.2.11 Data archiving

Data gathered by the function historical data base, described in 5.5.4.3, and other system data can be permanently archived using a data archiving method, e.g. file server, data store, CD-ROM. For cross-reference see also backup in 5.3.2.13.

Performance criteria:

1) Maximum amount and types of records managed;

2) If applicable: type of database management system (DBMS) and original license provider shall be stated (with respect to regional copyright laws).

#### 5.3.2.12 Data import/export

Data that is intended to be used by a dedicated special system (often a third party system) shall be made available by the source database, if required. Any capability that the data processing device or server station has for import/export data is to be clearly specified.

The database format and, e.g., record type, text, delimiter for separating variables are to be specified.

Performance criteria:

1) Import format of data for the data processing device or server station;

2) Importing format of data for onward transmission to controllers/automation stations;

3) Export format of data collected from controllers/automation stations.

#### 5.3.2.13 Backup and restore

At least one complete backup of all software and site-specific data shall be given to the responsible user. The way in which a user can make a full back up and restore of all functions and their configuration at all levels shall be specified. Backup media to be used shall be specified.

Performance criteria:

— Time needed for complete system backup and restoring.

#### 5.3.2.14 Redundancy

Any capability for the use of multiple hardware to automatically overcome the failure of any piece(s) of equipment is to be stated. The requested capability for duplication of functions shall be stated with respect to:

a) power supply;

b) processing units;

c) input/output units;

d) network interface and access units;

e) hard disks e.g. RAID level;

f) main memory;

g) visual display;

h) keyboard, mouse/other pointing device;

i) printer failure/out of paper.

### 5.3.3 Communication programs

#### 5.3.3.1 Communication interfaces

In case there is not a unique network for all functional network levels as shown in Figure 1 of EN ISO 16484-2:2003, the typical data exchange communication interfaces can be manufacturer specific or standardized communication protocol(s).

For the MN, proven industry standards (LAN's) should be employed.

The failure of a part of a communication system shall not cause a disturbance or the failure of the whole communication system for the BACS.

The network/bus architecture shall allow for testing and analyzing for each communication partner.

Communication services and objects for system neutral data transmission in BACS applications are described in prEN ISO 16484-5.

If manufacturer specific protocols are used, driver and protocol software for foreign data interfaces and a description shall be supplied to allow project implementation, if required.

Performance criteria:

1) Number of communication interfaces (hardware and drivers) to be used simultaneously;

   EXAMPLE Interface to router, gateway, MN, CN, FN, PU, MOU, DSS.

2) Supported standardized protocols, degree of conformance or statement of interoperability;

3) Peer to peer communication ability;

4) Maximum baud rate of each communication network;

5) Supported MODEM functionality;

   EXAMPLE Capacity of phone numbers to be called automatically, automatic call-back.

6) Performance of MODEM interface by means of baud rate, data compression, data encryption;

7) Conformance to international data transmission standards/national regulations.

#### 5.3.3.2 Remote communications

The set up method for remote communications between management devices in distributed systems and MOU/PU, is to be specified.

The features offered by remote access shall be specified:

a) access to current live values;

b) dial-up to demand receipt of alarms;

c) remote graphic capability;

d) remote historical database access;

e) configuration up/download access.

Performance criteria:

1) Number of PSTN lines supported;

2) Number of ISDN lines supported;

3) Remote (private network) MODEMs/PADs supported;

4) Remote (public network) MODEMs/PADs supported;

5) Local MODEMs/PADs supported;

6) System use of MODEMs/PADs manual or automatic.

#### 5.3.3.3 Dynamic data links to other applications

Any data links, which are available for other applications to use, shall be specified giving:

a) Features offered;

b) Syntax of connection;

c) Protocol supported.

#### 5.3.3.4 Communication to dedicated special systems

In case of combinations of different systems, e.g. BACS and DSS, the capabilities for interoperability with other management systems shall be specified.

EXAMPLE Capabilities for:

— fire or intrusion alarm systems;

— maintenance systems;

— facility management systems.

The functional communication requirements shall be fully specified, including:

a) communication interface standards and methods (hardware and software);

b) protocol types;

c) the application objects or standard application profiles;

d) naming conventions;

e) type and specification of database access;

f) contents and rules of data file exchange;

g) maintenance message types;

h) methods of resetting functions, i.e. run time totalization, event counts.

Where interoperability between different systems is required, it is to state the other systems' brand name(s) and type(s) of product/software version of the third party system, for allowing the identification of the grade of possible interoperability.

The following project or application specific requirements shall be specified:

i) contractual and functional responsibilities for each third party system or foreign device;

j) if the chosen protocol is not standardized as given in prEN ISO 16484-5, then an adequate functional description is required to complete a project;

k) shared data points by using the BACS PL;

l) all application functionality;

m) the requested testing methods.

#### 5.3.3.5 Alarm/event message handling

Alarm/event messages sent from controllers/automation stations by change of state information shall be provided with a date and time stamp, an event type and collected and stored by management functions for immediate display and/or subsequent interrogation or protocol printout.

Features required at the moment of collection shall be specified, including:

a) warning mechanism type (event type);

b) current state of alarms on the system;

c) indication of disable condition of a point or device;

d) ability to drive the monitoring and operator unit to a pre defined screen display;

e) type and contents of messages to operator/user;

EXAMPLE 1 Date and time stamp, point name or user address, state, value, S.I. unit, limits, text.

f) time resolution for date and time stamp;

g) filtering of alarm/event details into different log files e.g. for event types;

h) ability to start predefined actions.

EXAMPLE 2 Programs, printout, physical input and output functions.

Post collection features shall also be specified, including:

i) format of actual alarm/event lists;

j) search facilities provided for querying the alarm/event lists;

k) print facilities offered;

l) event table offered for allocation of defined actions.

Performance criteria:

— Maximum number of entries in event list.

### 5.3.4 BACS application programs

#### 5.3.4.1 General

The BACS application program consist of all software required to perform the following general BACS specific tasks, the engineered functions described in 5.5, and, if required, the system engineering functions described in 5.4.

#### 5.3.4.2 Printer selection strategy

The method of automatic printer selection and message re-routing to different printers by predefined timetable and event class shall be specified.

Performance criteria:

— Recognition of printer failures (e.g. paper out) and indication of this as a system event.

#### 5.3.4.3 Information routing

Information routing allows specified information to be provided to the appropriate output device(s) at specified time periods or at the request of an authorized operator. The system can provide the possibility of creating information filters, according to 5.3.3.5 g).

### 5.3.5 Human system interface programs

#### 5.3.5.1 Supervisory programs general

Human system interface describes the interaction between an operator and a BACS for operating a plant. These program functions shall be selected and specified for each project.

#### 5.3.5.2 Basic human system interface functions

For the BACS-HSI the minimum basic requirements are to support the following functions:

a) system management;

b) event management;

c) state management;

d) parameter adjustment;

e) system engineering.

On certain interface device types some functions are not available due to performance and/or technology limitations.

Time and application critical (automatic) processing functions shall be performed independently of MOU’s.

Performance criteria:

1) Type of graphic supported;

2) Colour display supported;

3) Display resolution supported, specified in pixels;

4) Response time for alarm display.

#### 5.3.5.3 Operator interface types

The following Table shows the associations between different user groups, functions carried out, and typical equipment used.

**Table 2 — BACS operator class – HSI association**

| Class of operator | Functions | Type of Human system interface |
|---|---|---|
| Caretaker | Action according to explicit instructions | Text/icon based display,<br>audible device |
| Building operator | Event management<br>Operating parameter change<br>State management | Desktop computer with optional graphics, touch screen, pointing device, etc. |
| System operator | Control parameter change<br>system management/engineering | As building operator |
| Occupant | Local setpoint adjustment<br>local on/off control | Local adjustment knob/display, often wall mounted |
| Maintenance engineer | State management | As building operator,<br>Service operator unit,<br>paging device |
| Service engineer<br>commissioning eng. | Local configuration according to instruction | Portable engineering tools e.g.:<br>Portable computer,<br>handheld device,<br>local override/indication device |
| NOTE The type of HSI depends on the project specific requirements. | | |

#### 5.3.5.4 Login/logout

In order to prevent unauthorized commands and changes, a log in password will be required.

After a period of inactivity (adjustable) the user shall be automatically logged out.

#### 5.3.5.5 User access control

User access to a system requires a password. Other means of security may be used in addition or instead of, e.g. key cards. Individual identification of an operator is achieved by password according to 5.3.2.8 or by hardware devices as described in EN ISO 16484-2:2004, 5.2.3.2. j).

The system should have various profiles or levels of user access to distinguish between users of varying competence, e.g. a high level user such as a building operator may have access to statistics and parameter changes, whereas a caretaker can have read only states shown in Table 2.

#### 5.3.5.6 General information presentation

A user interface shall use a common methodology throughout the system to provide an intuitive human system interface.

#### 5.3.5.7 Types of dialogue

##### 5.3.5.7.1 Character based user interface

Character based user interfaces are subdivided into following types:

**Command language**: The system offers the ability to input a command line at the MOU. The operator can input a command sequence containing a character string with a specific syntax.

**Command with interactive dialogue**: The system offers the ability to guide the operator with system texts and the user can input his command strings after a prompt from the system.

**Command with interactive menu**: The system offers the ability to offer the user a list of dialogues. The user can make a selection from a menu.

Performance criteria:

1) Amount of text simultaneously displayed, e.g. 80 characters 25 lines;

2) Command verification for syntax check.

##### 5.3.5.7.2 Graphical user interface

In a system with a GUI the system provides the information to the user in a graphical form. The user may interact using a pointing device, e.g. mouse, to select, and/or the keyboard to type in information. It is recommended that a system with a GUI provide a graphical editor. The time to open a new schematic of given size and to update a given number of dynamic display items is to be stated.

Performance criteria:

1) Number of schematics supported by an application;

2) Symbols used;

3) Scroll, zoom capability;

4) Command verification for syntax check.

#### 5.3.5.8 Accessing information

Data within a BACS is normally accessed by using user addresses as mnemonics to uniquely identify items of information. Where a point name structure is used, it shall be established on the basis of the user's requirements, independently of the technical system structure.

#### 5.3.5.9 Point information presentation

Plant related information is represented by any or all of the following; date and time, user address, state, value and unit, limits, event type and optional text of functions, as stated in the BACS PL

A date/time stamp indicates the last change of state or value. The text describes the state of the function and the meaning of the state, e.g. incoming high limit alarm, state of operation. Additional text, digital voice, or pictures may be assigned and presented upon request by the operator.

The format of the date and time stamp is to be specified, e.g. yy.mm.dd – hh.mm.ss.

Displays should indicate if point states and values are not updated, or are not being refreshed.

Performance criteria:

1) Amount of characters for each Item of displayed text;

2) Refresh rate for displayed values.

#### 5.3.5.10 State management

The operator will receive information from the system about the actual or historical state of the plant in reports with specific dates and times. A state is indicated, where a point or device is inhibited from normal operation by a disable condition.

#### 5.3.5.11 Parameter adjustment

This means switching or changing a value within a plant or system. This task can be supported by a check as to whether the command has been executed or not.

Performance criteria:

— Command verification for syntax check.

#### 5.3.5.12 Annunciation of alarms

The BACS shall have the ability to provide annunciation of an alarm and bring the information to the immediate attention of an operator.

The type of annunciation shall be specified, e.g.:

a) alarm detail automatically coming to foreground on screens;

b) flashing, change of brightness of visual devices;

c) overriding text messages on MOU's.

#### 5.3.5.13 Event management

Information about various events occurring in the system can be automatically presented at defined output devices without any operator intervention. Some of these events have to be acknowledged by an operator. In these cases the system shall keep the initial information until the operator has acknowledged the given message.

#### 5.3.5.14 Display of trend logs

The display shows one or more selected logged values in x/y plot format against a time base.

Presentation in a sector of the recorded time with:

a) fixed scan time rates;

b) change of value.

Performance criteria:

1) Maximum number of different values simultaneously displayed;

2) Range of x values;

3) Range of y values and state if auto ranging;

4) Method used to select y scale values;

5) Method used for identification of values;

6) Ability to extract more detailed information by e.g. zooming, cursor selection.

#### 5.3.5.15 Time scheduling

Individual time schedule switching is normally a function of the controllers. The possibility of global changes to these schedules can be included within the data processing device, server station or MOU. The method of changing time profiles shall be specified, e.g. by using keyboard/mouse etc.

Performance criteria:

1) The number of time profiles which can be controlled as a group;

2) The number of different groups.

#### 5.3.5.16 Analytical and statistical functions

Analytical and statistical functions provide for evaluation of actual and historical values. The type of functions available shall be specified, e.g.:

a) calculation of mean, minimum and maximum;

b) correlation calculation;

c) regression calculation.

#### 5.3.5.17 Alarm/event statistics

This function involves the processing of alarm inputs and event messages into some form of statistical report, which can be used to summarize the alarms and events received at an operator display. The analysis includes all of the alarms and events received, or can be a filtered analysis of the results.

#### 5.3.5.18 Consumption statistics

The Consumption statistics function is an energy monitor that can accumulate energy data for set time periods to determine and report the energy used during a specific period.

Run time totalization, calculated values and the related I/O functions measuring and/or counting are required to fulfill this requirement.

#### 5.3.5.19 Statistical display

The ability to display the results in graphical formats shall be stated, e.g.:

a) trend plot;

b) pie chart;

c) histogram;

d) bar chart, stacked bar charts.

Performance criteria:

1) Method used to select information and time periods, e.g. drag and drop of data points;

2) Method used to select information by project specific groups;

3) Any additional features for analysis of actual and/or historical data, e.g. filters;

4) Ability to customize reports.

#### 5.3.5.20 Printing

The print content shall be specified as e.g.:

— messages;

— alarms;

— schematics;

— lists;

— trend logs, on line or historic;

— reports.

The type and quality of printing shall be specified, e.g.:

a) list protocols and/or formatted reports;

b) continuous line printing;

c) screen copy;

d) black and white/color;

e) quality, e.g. draft, letter, graphics.

And the methods of printing shall be specified, e.g.:

f) event triggered;

g) time and date triggered;

h) user initiated.

Performance criteria:

1) Printer protocols supported;

2) Graphic standard supported;

3) Print spool ability available.

#### 5.3.5.21 Online help

The system should have a help system included. It shall be stated if a help system is required.

Performance criteria:

1) Context based;

2) Always available.

#### 5.3.5.22 Electronic handbook

The BACS can contain an electronic handbook. It shall be stated if project specific documentation is to be included.

Performance criteria:

— Navigation method through the electronic handbook, e.g. by hypertext functions.

#### 5.3.5.23 Multilingual operation

The degree of translation offered in the product shall be specified as follows:

a) operator entered data in local language;

b) project specific data and parameters in local language;

c) application software prompts and commands in local language;

d) operating system and software environment prompts and commands in local language;

e) possibility of using different languages simultaneously in different MOU's;

f) possibility of switching between languages on line;

g) whether and how new translations can be produced.

#### 5.3.5.24 Remote management/operation functions

The following functions are the minimum requirements for remote management/operation:

a) system management;

b) event management;

c) state management;

d) parameter adjustment;

e) system engineering.

The remote management/operation functions are similar to the described human system interface functions.

Performance criteria:

1) Dial up on demand receipt of alarms;

2) Remote graphic capability;

3) Remote historical database access;

4) Configuration up/download access.

#### 5.3.5.25 Local operation functions

The occupants of buildings often require the possibility to adapt space conditions (thermal comfort) to their individual needs by means of a local operating device. Since these users are not trained and are not expected to understand the operation of the mechanical building services equipment, in particular the HVAC controls, they are normally granted limited operating capability, such as:

a) manual temperature setpoint adjustment, relative (+/-) or absolute in units;

b) manual operation time extension to extend the operation of the relevant plant beyond the normal time program;

c) manually overriding the programmed occupancy state, for operating mode occupied/unoccupied;

d) being informed of plant failure by a common alarm indication.

For local override and indication refer to EN ISO 16484-2.

#### 5.3.6 Service and commissioning functions

The service and commissioning engineer shall be able to perform the following tasks by using the operator stations, portable computers and hand held devices:

a) verify and maintain application software;

b) adjust control parameters;

c) test the communication functions.

It is to specify if manual local override is required. In the case of plant failure, during commissioning or while performing a maintenance task, the components of a HVAC plant can be switched on/off or positioned by means of the manual operation using local override/indication devices, details for LO/ID as given in EN ISO 16484-2.

#### 5.3.7 Operating system

The data processing devices, e.g., computer, for monitoring and operation units, operator and server stations use operating system software. The operating system of data processing devices should have multitasking capability, e.g. alarm and history functions are permanently active in the background, a critical alarm shall be able to be brought to the attention of an operator and be displayed within a specified and acceptable time. Several MOU's can be run in parallel either by using a multi-user operating system and/or a network operating system with independent computers.

Other software programs, e.g. spreadsheets, external data bases, can interchange data concurrently with the BACS data processing device's software. Proprietary software may be implemented within MOU's based on PC hardware if specified.

The supplier shall state the operating system type and version and the original license provider (with respect to the regional copyright laws).

The functions supported by the data processing device's operating system shall be stated:

a) management functions;

b) number of concurrent users supported by the system;

c) type of HSI, i.e. alpha-numeric/graphics;

d) system response time permitted for human system interface;

e) number of I/O, processing and management functions within the capacity of the data processing device;

f) type and number of communication interfaces;

g) type and number of peripherals and annunciation devices;

h) any third party application software.

Performance criteria:

1) Software environment type and version level;
2) Memory and media requirements of the application programs;
3) Any capabilities of recognizing and/or auto-correction of functional software faults;
4) Database management system(s) supported;
5) Any necessary third party application packages required;
6) Compatible proprietary networking software;
7) Maximum number of concurrent users supported;
8) Graphic standard(s) supported;
9) Maximum number of communication interfaces supported;
10) Maximum number of controllers supported;
11) Maximum number of addresses for physical, virtual, communication and processing functions;
12) Language(s) for system related messages;
13) Editor supplied for configuration changes.

## 5.4 System engineering programs

### 5.4.1 General description of functions for the engineering process

This section describes functions carried out in the process of configuring the various parts of a BACS. The tasks to perform are project/system specific. Further requirements and guidelines for project management and system implementation are given in Part 7 of this standard.

System engineering includes the following items:

a) hardware configuration;
b) control strategy configuration;
c) management function configuration;
d) commissioning;
e) documentation.

Performance criteria:

1) Coexistence of engineering tool/operator functions;
2) Engineering tool included in system license;
3) Remote engineering via MODEM, LAN, WAN etc.;
4) Automatic documentation.

### 5.4.2 Hardware configuration

This stage takes input from the final specification process and generates the documentation for describing the equipment/devices required including the wiring diagrams physical parameters.

Hardware configuration includes the following items:

a) control schematic or plant and instrumentation diagrams;

b) BACS PL, the data points list with section for I/O-functions to configure physical I/Os and processing functions to estimate processor performance and memory size;

c) system and network descriptions;

d) equipment lists;

e) instrumentation diagrams;

f) wiring schedules (field connection diagram);

g) labels for equipment.

Performance criteria:

1) Number of times the same data needs to be entered in different parts of the system;

2) Automatic verification of:

3) Address duplication;

4) Point name duplication;

5) Correct usage of equipment;

6) Accuracy of information entered, e.g., by syntax checking.

### 5.4.3 Control strategy configuration

This stage takes the requirements defined by the consultant, plant supplier(s) and end user specifications as input to generate one or more control strategies to be downloaded into controllers.

Control strategy configuration includes the following items:

a) download files of control strategy;

b) paper listing/drawing of the control strategy;

c) default parameter sets;

d) BACS PL completed with processing and operator functions.

Performance criteria:

1) Program methodology;

i) text based (programming languages),

ii) graphic based (function block method),

iii) object oriented.

2) Number and type of application library functions available;

3) Type of download supported;

i) all controller/automation station software downloaded as one command,

ii) partial download into one controller/automation station,

iii) ability to partially download program segments without interrupting other functions running within the controller/automation station or on the network,

iv) time required for download.

4) Configuration upload capability;

i) ability to upload configuration to a programming tool,

ii) ability to regenerate program source,

iii) ability to regenerate original source layout and comments,

iv) ability to compare the upload with the original source.

### 5.4.4 Management function configuration

This stage takes the requirements defined by the consultant, plant supplier(s) and end user specifications as input to generate management functions.

Management function configuration includes the following items:

a) schematic pictures with dynamic items linked to point information;

b) alarms including identification of groups, classes and filtering;

c) user access rights;

d) report formats and associated links to data points;

e) system time schedules;

f) BACS PL completed with I/O, processing, management and operator functions.

Performance criteria:

1) Ability to input drawings generated on third party applications;

2) Libraries supported;

i) basic HVAC symbols,

ii) HVAC plant items,

iii) model building templates,

iv) report templates.

3) Ability to use data entered in previous engineering processes, e.g. user addresses/mnemonics;

4) Time schedule entry;

    i) text based,

    ii) graphic based,

    iii) diary oriented,

    iv) copy facilities.

#### 5.4.5 Commissioning tool functions

Commissioning tools should support the following tasks:

a) field equipment and hardware connection checks;

b) communication system test and protocol analysis;

c) control strategy simulation/verification;

d) control strategy download and parameter initialization;

e) functional verification by plant operation and interlock simulation;

f) optimization/tuning of the system.

Performance criteria:

1) The ability to temporarily override values in the strategy;

2) The ability to observe the behaviour of the system through single program cycles.

### 5.5 Engineered functions

#### 5.5.1 General

The normative functional descriptions within this section are generic and provided for use by the specifier to describe the engineered functionality of BACS. The informative examples are provided to demonstrate methods for creating accurate design documentation for a project. For each project, the number and the types of required functions are to be determined to ascertain the required application software and engineering work. The BACS PL (annex A) is a tool for determination and adding up the project specific functions. For data point identification in BACS there is a need for a unique structured addressing system. This has to apply throughout a plant, a complete BACS, or the entire customer premises. The derived functions shall be assigned to a dedicated name (mnemonic) in a row of the BACS PL. Its remarks column may indicate the derived functions to each related data point, if necessary.

Events that cause safety functions to be performed shall be specified. It is necessary to determine whether or not actuator safety positions have to be ensured without auxiliary energy. For further performance criteria for actuators and electrical switchgear refer to 5.4.5.1 in EN ISO 16484-2:2004.

For each input and output function (physical and shared/communication) the following interlocking conditions and decisions for priorities shall be stated where applicable:

a) automatic mode driven from a controller/automation station;

b) override mode from MOU in the management function level;

c) manual override mode from MOU in the control function level;

d) manual external override issued at a field device as a signal source, e.g. day extension switch;

e) local manual override mode issued from an LOID;

f) override mode by function of safety equipment, e.g. frost thermostat.

Performance criteria:

— Fault detection, e.g.: cable open/short circuit.

### 5.5.2 I/O functions

#### 5.5.2.1 Physical input and output functions

##### 5.5.2.1.1 General

Physical input and output functions include all necessary software programs and engineering/commissioning services for recognizing the state and value of inputs and command of outputs. This includes e.g. data point address, sensor characteristic and range, S.I. unit, state and associated status definitions, text assignments and parameters. All other BACS functions, particularly processing types, rely on the information provided by these physical input and output signals.

##### 5.5.2.1.2 Binary output switching/positioning

###### 5.5.2.1.2.1 Switching

The physical output switching function (BO) comprises single stage (on/off) or multi stage commands. They are output as continuous (steady state) or pulsed signals via physical binary outputs. Each switching function shall be specified by entering the quantity of stages in the BACS PL.

**Table 3 — Switching functions for maintained and momentary contact control**

| Type of switching function | Stages of switched equipment | Number of functions/corresponding hardware outputs |
|---|---|---|
| Steady state output for maintained contact control | 1 | 1 BO |
| Pulsed signal output for momentary contact control | 1 | 2 BO |
| Steady state output for maintained contact control | 2 | 2 BO |
| Pulsed signal output for momentary contact control | 2 | 3 BO |

Feedback signals which logically belong to the switching commands as well as the local/remote switch or LO/ID information are to be specified in the column binary input state (Col. 1.1).

If required, the command execution check (Col. 3.5) has to be specified as a corresponding processing function.

###### 5.5.2.1.2.2 Positioning

The physical output positioning function (BO) comprises either two on/off outputs in case of 3-point control or a single output in case of pulse width modulation.

**Table 4 — Binary output functions for positioning**

| | Type of positioning function | Number of functions/corresponding hardware outputs |
|---|---|---|
| 1. | Opening - stopped - closing | 2 BO |
| 2. | Pulse width modulation | 1 BO |

Measurement of the position that logically belongs to the positioning command shall be specified in the analog input measuring function (Col. 1.5) on the same row of the BACS PL.

Indication of the fully open or fully closed positions shall be specified via a binary input state function.

#### 5.5.2.1.3 Analog output positioning

The physical output analog positioning function (AO) comprises analog positioning commands derived from processing, management, and operator functions.

Measurement of the position that logically belongs to the positioning command shall be specified with the function analog input measuring (Col. 1.5) on the same row of the BACS PL.

#### 5.5.2.1.4 Binary input state

The physical binary input state function (BI) comprises digital information that is acquired via a physical BI. It provides information depending upon the defined state. Physical binary input state functions do not provide internal diagnostics.

Any binary pulse input that requires a fast response from the system shall be specified to ensure that the system will perform without missing events. Alarm signals should be configured to ensure a high degree of integrity i.e. a ‘normally closed’ loop is preferred so that accidental open circuits can be detected.

For dual state points a pair of binary inputs connected to separate ON and OFF contacts from electrical switchgear is used to detect intermediate positions.

Where change of state processing (Col. 3.6) is required, e.g. for event delay/suppression, Boolean logic in any plant condition, the function shall be specified.

The BACS PL should indicate other corresponding functions in the same row.

#### 5.5.2.1.5 Binary input counting

The physical binary input counting function (CI) comprises counting, processing and totalizing of pulses via physical counter inputs or binary state inputs. A facility for resetting shall be provided.

The BACS PL should indicate other corresponding functions in the same row.

Performance criteria:

— The function has to operate as a forward counter with a minimum totalizing range of $2^{16}$ (16 bit/5 digits) or $2^{32}$ (32 bit/10 digits) depending on the application, the value range is to be specified within each project.

#### 5.5.2.1.6 Analog input

The physical analog input function (AI) comprises analog value information, derived from measured signal information from analog sensors. This includes the processing of physical position values, which logically belong to positioning commands.

The BACS PL should indicate other corresponding functions in the same row.

#### 5.5.2.2 Shared input and output functions

##### 5.5.2.2.1 General

I/O functions for shared data points are concerning user accessible virtual data points with a unique point address as identifier or mnemonic, within multiple connected devices in system integration projects, e.g. for serial interface to pump control.

Shared I/O functions include software and engineering/commissioning services for (e.g.) data point address, value, state and status, S.I. unit, state and status definitions, text assignments and parameters, but not the communication protocol. The shared I/O function's information is available for further processing by all other BACS functions such as physical I/O functions, processing functions, management or operator functions.

Shared I/O functions can be derived from a calculation and/or a logical result that needs to be communicated between systems, e.g. state/temperature/consumption from a boiler or chiller. Any data may be communicated that is part of the control process, but system internal communications are not to be stated for project design. It shall be explicitly specified where peer-to-peer functionality between distinct devices is required. The shared I/O functions do not comprise of processing functions, internal diagnostics or messages of the operating system.

These shared I/O functions make it possible to define the exchange and processing of data to and from distinct dedicated special systems e.g. via a DIU from another network. For communication with devices or stations for management functions refer to 5.5.4.

The BACS PL should indicate other corresponding functions in the same row.

##### 5.5.2.2.2 Binary value (output), switching

The shared binary value output function for switching comprises a single or multi stage command, which is transferred to processing or physical I/O functions according to the project specific requirements.

##### 5.5.2.2.3 Analog value (output), positioning/setpoint

The shared analog value output function for positioning/setpoint comprises a positioning command or a setpoint value which is transferred to processing or physical I/O functions according to the project specific requirements.

##### 5.5.2.2.4 Binary value (input), state

The shared binary value input function for state monitoring provides the information about the change of a binary or a multi state input which is transferred from another system.

##### 5.5.2.2.5 Accumulated/totalized value (input)

The shared input accumulated/totalized value function provides the information about an accumulated or totalized value, which is transferred from another system, e.g. from a pulse converter.

##### 5.5.2.2.6 Analog value (input), measuring

The shared analog input function for measuring provides the information about an analog value which is transferred from another system.

### 5.5.3 Processing functions

#### 5.5.3.1 General

Processing functions provide logical or digital output values. Other function types can use these values as an input.

### 5.5.3.2 Monitoring

#### 5.5.3.2.1 General

These processing functions are used to monitor input and output functions or the results of processing functions. Any other type of function can use the results of monitoring functions.

#### 5.5.3.2.2 Fixed limit

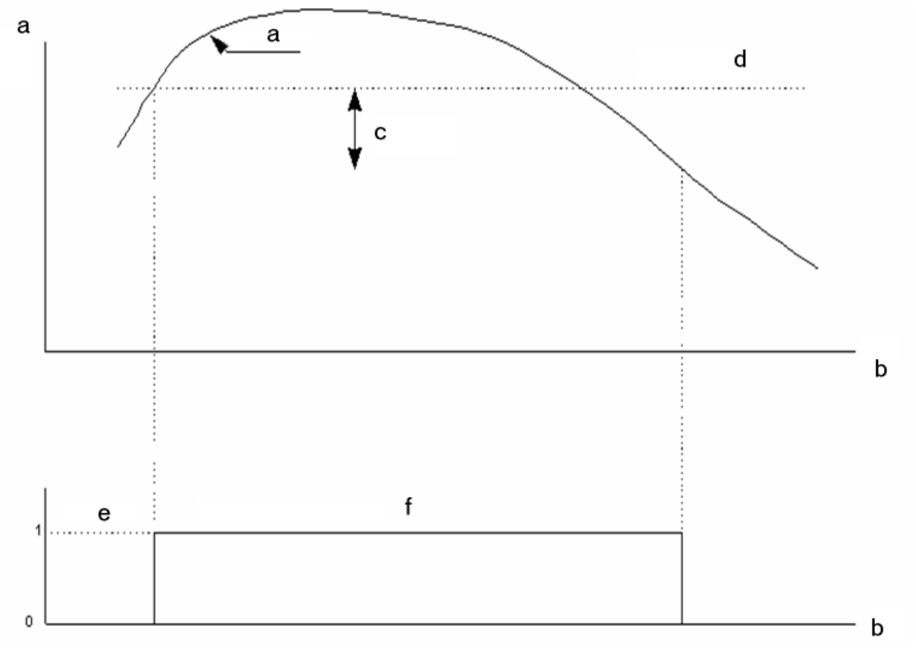
##### 5.5.3.2.2.1 General

The function fixed limit compares the measured or totalized input value with a high and/or low limit value under consideration of a hysteresis. Totalized values only are compared with high limit values. If limit is exceeded, the function causes an appropriate output signal. The limiting value and the hysteresis value have to be parameterized with the same units as the input values.

Each limit monitoring function shall be specified by entering the quantity of limits in the BACS PL.

Performance criteria: None

Graphical function description:




**Key**

a Input value
b Time
c Hysteresis
d High limit value
e Event
f High limit value reached

**Figure 1 — Fixed limit function**

**Table 5 — Informative FB example (for hi/lo limits):**

**Graphical FB representation**

**Inputs** | **Fixed limit** | **Outputs**

Input value --------- Real IV | HLVR ------- Bool High limit value reached

LLVR ------- Bool Low limit value reached

**Parameters**

High limit value --------- Real HLV

Low limit value --------- Real LLV

Hysteresis -------- Real HYS

**FB example abbreviations**

| **Name** | **Type** | **Description** | **Unit/symbol** |
|---|---|---|---|
| Inputs | | | |
| IV | Real | Input value | Phys. value |
| Outputs | | | |
| HLVR | Bool | High limit value reached | |
| LLVR | Bool | Low limit value reached | |
| Parameters | | | |
| HLV | Real | High limiting value | Phys. value |
| LLV | Real | Low limiting value | Phys. value |
| HYS | Real | Hysteresis | Phys. value |

NOTE Explanation of the example:
This function checks the input value, and provides an indication of when it exceeds the high or low limit value. Hysteresis is used to avoid the oscillation of the output signals when the input value fluctuates around a limiting value. If two, or more high/low limits are demanded for a common input value this function can be used two or more times. A more complex function with additional limits inputs and corresponding outputs can be used.

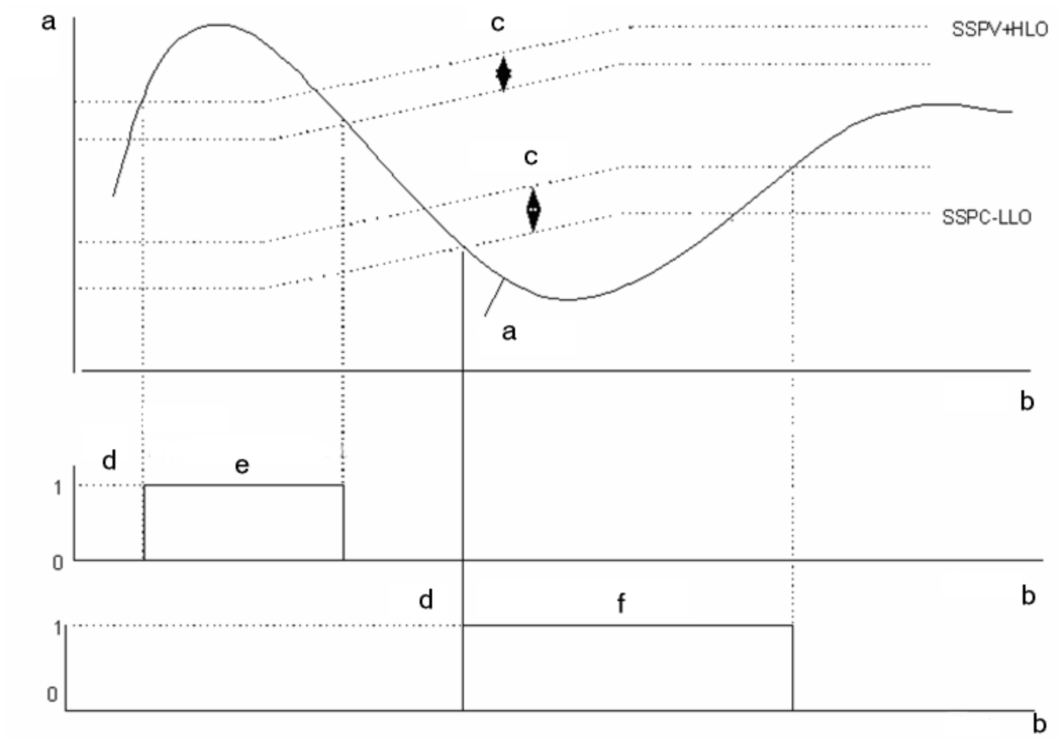
#### 5.5.3.2.2.2 Sliding limit

The sliding limit function compares the measured input value with a sliding high and/or low limit value depending on a variable value (e.g. a setpoint) and under consideration of a hysteresis. If limit is exceeded, the function causes an appropriate output signal. The sliding limiting value and the hysteresis value have to be parameterized with the same units as the input values.

Each limit monitoring function shall be specified by entering the quantity of limits in the BACS PL.

Performance criteria: None

Graphical function description:



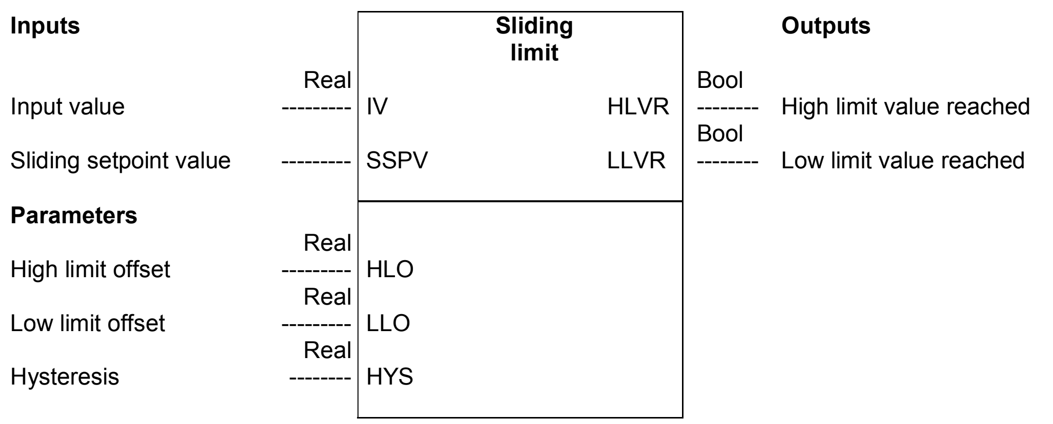

**Key**

a Input value
b Time
c Hysteresis
d Event
e High limit value reached
f Low limit value reached

**Figure 2 — Sliding limit function**

**Table 6 — Informative FB example (Sliding limit)**

**Graphical FB representation**




**FB example abbreviations**

| Name | Type | Description | Unit/symbol |
|---|---|---|---|
| Inputs | | | |
| IV | Real | Input value | Phys. Value |
| SSPV | Real | Sliding setpoint value | Phys. Value |
| Outputs | | | |
| HLVR | Bool | High limit value reached | |
| LLVR | Bool | Low limit value reached | |
| Parameters | | | |
| HLO | Real | High limit offset | Phys. Value |
| LLO | Real | Low limit offset | Phys. Value |
| HYS | Real | Hysteresis | Phys. Value |

NOTE Explanation of the example:
This function checks the input value and indicates when a sliding limit value has been reached. Sliding limit values are defined as a sliding setpoint value plus high limit offset, minus low limiting offset. Hysteresis is used to avoid the oscillation of the output signals when the input value fluctuates around a limiting value. Hysteresis operates in the opposite direction to the setpoint and offset combined. E.g. for the high limit offset, the output stays set until the input has returned to a value less than high limit hysteresis.

#### 5.5.3.2.2.3 Run time totalization

The run time totalization of an item of equipment, i.e. Boiler, chiller, pump, etc., is calculated by monitoring its start/stop states and the on duration is accumulated to the past totalized value as information for a virtual function counted value. For limit information, if required, use the fixed limit function (col. 3.1).

It shall be possible to pre-set the starting value.

Performance criteria:

1) Maximum totalized value possible;

2) The accuracy of the totalized value.

**Table 7 — Informative FB example (run time totalization)**

**Graphical FB representation**

| **Inputs** | | **Run time totalization** | | **Outputs** |
|---|---|---|---|---|
| Start/stop state | Bool --------- | SSS | RTV | Real --------- Run-time value |
| Reset | Bool --------- | RS | | |
| **Parameters** | | | | |
| Starting value | Real --------- | SY | | |

**FB example abbreviations**

| Name | Type | Description | Unit/symbol |
|---|---|---|---|
| Inputs | | | |
| SSS<br>RS | Bool<br>Bool | Start/stop state<br>Reset (set the actual count to starting value) | |
| Outputs | | | |
| RTV | Real | Run time value | h |
| Parameters | | | |
| SV | Real | Starting value | h |

NOTE Explanation of the example:
This function calculates the run time of an item of equipment. The totalized run time is available as an output value. A value on the pre-set input sets the run time to an initial value.

#### 5.5.3.2.2.4 Event counting

For event counting the number of events (changes of state of the corresponding input information) is detected and accumulated to the past totalized value as information for a virtual function counted value. For limit information, if required, use the fixed limit function (Col. 3.1).

It shall be possible to pre-set the starting value.

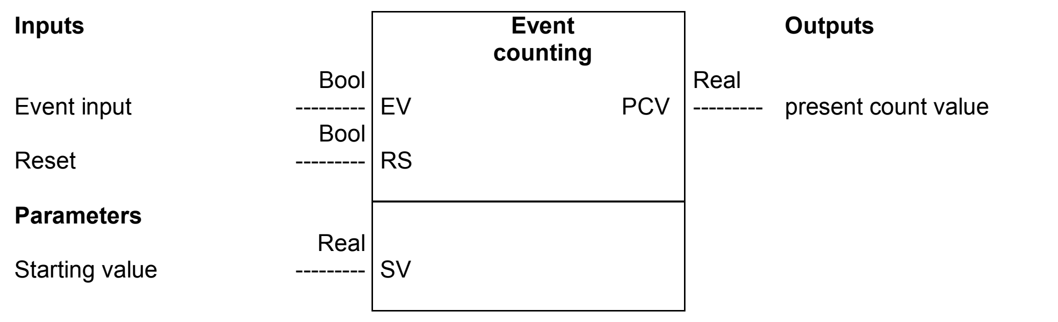
All relevant, detected events, such as change of state, limit value reached, marked at the BACS PL have to be counted.

Performance criteria:

— Maximum count value possible.

**Table 8 — Informative FB example (Event counting)**

**Graphical FB representation**




**FB example abbreviations**

| Name | Type | Description | Unit/symbol |
|---|---|---|---|
| Inputs | | | |
| EV<br>RS | Bool<br>Bool | Event<br>Reset. | |
| Outputs | | | |
| PCV | Real | present count value | h |
| Parameters | | | |
| SV | Real | Starting value | h |
| NOTE Explanation of the example:<br>This monitoring function detects and counts events. An event is a change of state from either high to low or low to high on the event input. A value on the pre-set input sets the count to an initial value. | | | |

#### 5.5.3.2.2.5 Command execution check

For command execution check the execution of switching commands and positioning commands within a set time is monitored. An error message/alarm/signal is given after expiry of the set time if a feedback, check back or inhibit signal has not been effected.

Inputs and outputs to this function block can be positive or negative logic. Whichever logic is chosen shall be stated.

These functions shall be listed in the BACS PL per corresponding/controlled device or stage.

Performance criteria:

1) Minimum/maximum set time;

2) Resolution of set time;

3) Logic polarity combinations.

**Table 9 — Informative FB example (Command execution check)**

**Graphical FB representation**

| **Inputs** | | **Command execution check** | | | **Outputs** |
|---|---|---|---|---|---|
| Command state | Bool --------- | CS | CNE | Bool --------- | Command not executed |
| Command execution check back | Bool --------- | CER | | | |
| **Parameters** | | | | | |
| Command execution check time | Real --------- | CECT | | | |

**FB example abbreviations**

| **Name** | **Type** | **Description** | **Unit/symbol** |
|---|---|---|---|
| Inputs | | | |
| CS (PSV)<br>CER | Bool (Real)<br>Bool (Real) | Command state (position/setpoint value)<br>Command execution check back | |
| Outputs | | | |
| CNE | Bool | Command not executed | |
| Parameters | | | |
| CECT | Real | Command execution check time | s |

NOTE Explanation of the example:
This function is used when a plant or part of a plant is to be switched on/off, or when a setpoint value is to be changed as a function of an event or time program. The new command state/setpoint initiates a check of command execution function. If there is no check back signal within the command execution check time (CECT), a command not executed output (CNE) is provided for further processing (e.g. for alarm message).

### 5.5.3.2.2.6 State processing

State processing includes any form of processing involving the conditional production of a logic output state as a consequence of a pre-determined process i.e. delay, suppression, logic interlock.

a) common alarm generation
from a number of items of plant by means of logical function;

b) change of state delay
can be used to disregard any action from the input, unless the input signal is sustained for a pre-set time;

c) change of state suppression
inhibits the propagation of an input change of state according to defined criteria. The new state will be suppressed under consideration of parameters such as real time, elapsed time or state(s) of other input functions e.g. mains recovery, or off- state of a plant.

This function shall be listed in the BACS PL per corresponding input point address.

Performance criteria: None

**Table 10 — Informative FB example (State processing)**

**Graphical FB representation**

| **Inputs** | **State processing** | **Outputs** |
|---|---|---|
| Point state 1 --------- (Bool) | PS1     OS | (Bool) --------- Output state |
| Point state n --------- (Bool) | PSn | |
| Program enable --------- (Bool) | PEN | |
| **Parameters** | | |
| Processing parameter --------- | PP | |

**FB example abbreviations**

| Name | Type | Description | Unit/symbol |
|---|---|---|---|
| Inputs | | | |
| PS1 - PSn<br>PEN | Bool<br>Bool | Point state (of a physical or virtual point)<br>Program enable (may disable the output change of state generation) | |
| Outputs | | | |
| OS | Bool | Output state (generated by the processing function) | |
| Parameters | | | |
| PP | | Processing parameters (customizing the behavior of the function) | |

NOTE Explanation of the example:
This function is used wherever processing is involved in the conditional generation of an output message.

### 5.5.3.3 Interlocks

#### 5.5.3.3.1 General

In general, interlock functions require logic to derive output signals, which are some combination of a number of input signals.

The functions required to achieve this are in general made up from AND, OR, XOR, NOT. It is expected that these functions and timer delay functions are available for general program design, and are used by the more complex interlock functions described in the remainder of this subclause.

Performance criteria:

1) Number of input signals to be combined;

2) Type of logical functions supported;

3) Number of logical links possible.

#### 5.5.3.3.2 Plant control

The processing function plant control is a control sequence for switching on or off the separate items of plant in a predefined sequence depending on the application, e.g. start up control. This action is necessary to protect damage to equipment. Other I/O, processing functions and parameters, such as pre set times; setpoints and events, e.g. a safety control function, which are for a specific plant, shall be considered when designing the overall plant control function. Each complex plant control sequence is to be specified in a verbal form, and if required, in a control flow chart form, and shall be listed in the BACS PL per corresponding/controlled plant.

The processing functions calculation/optimization can activate or enable a plant control function, but optimization functions are not intended to be used for plant internal interlocks and controls, as e.g. the event switching function is intended for cross plant/system events only.

Example for plant control:

On start up the activation of switching on the plant can come from a time program or from manual activation. Normally a sequence of commands such as open dampers, start pumps and fans, and enabling controllers, is performed. Variations of a sequence can be automatically initiated depending on variables such as outside temperature, i.e. if the outdoor temperature is below a low limit, the pre heater pump starts first and the heating controller is activated.

NOTE See examples in annex B.

#### 5.5.3.3.3 Motor control

Motor control is a processing function for switching electric drives. It includes the processing function monitoring for the necessary interlock conditions as with emergency off switches, plant control sequence, start/stop feedback, fan belt check, drive/device related timing and LO/ID's. This motor control function can have multiple physical output functions to provide speed control. This function is not used for positioning actuators.

The number of stages is to be stated in the BACS PL under physical output function switching.

If motor control is dedicated to a water pump, an internal blocking protection feature is a part of this function.

The star/delta starter is not a part of this function.

Performance criteria: None

**Table 11 — Informative FB example (Motor control)**

**Graphical FB representation**

| Inputs | Type | Motor control | | Type | Outputs |
|---|---|---|---|---|---|
| Motor release Interlock | Bool --------- | MRI | MSS | Bool --------- | Motor start/stop |
| Motor electrical alarm | Bool --------- | MEA | MS | Bool --------- | Motor state |
| Start/Stop check back | Bool --------- | SSF | MA | Bool --------- | Motor alarm |
| Manual override | Bool --------- | MOR | | | |
| Parameters | | | | | |
| Delay time | Real --------- | DT | | | |

**FB example abbreviations**

| Name | Type | Description | Unit/symbol |
|---|---|---|---|
| Inputs | | | |
| MRI<br>SSF<br>MEA<br>MOR | Bool<br>Bool<br>Bool<br>Bool | Motor release interlock<br>Start/stop check back<br>Motor elec. alarm (e.g. bimetal)<br>Manual override | 0/I |
| Outputs | | | |
| MSS<br>MS<br>MA | Bool<br>Bool<br>Bool | Motor start/stop<br>Motor state<br>Motor alarm | |
| Parameters | | | |
| DT | Real | Delay time | s |

NOTE Explanation of the example:
The motor is switched on as a result of an event, i.e. start up control. The start/stop check back signal indicates that the motor is running. If there is a signal to indicate that the motor has failed, the motor start/stop output will be switched to off.

#### 5.5.3.3.4 Switch over

Identical devices such as twin or double pumps or compressors are switched over depending on a pre-set run time/schedule and/or event, e.g. a failure. The purpose of the function switchover is to achieve specific/similar run times for the associated devices.

This function is to be combined with e.g. time dependent switching, runtime totalization, interlocks and motor control.

When more than one device has to be switched on, e.g. boiler, chiller sequencing, this function can be used to define the priorities.

This function shall be listed in the BACS PL per corresponding/controlled device.

Performance criteria: None

**Table 12 — Informative FB example (Switch over)**

**Graphical FB representation**

| Inputs | | Switch over | | | Outputs |
|---|---|---|---|---|---|
| Runtime device1 | Real --------- | RD1 | D1R | Bool --------- | Device 1 release |
| Runtime device2 | Real --------- | RD2 | D2R | Bool --------- | Device 2 release |
| Failure device 1 | Real --------- | FD1 | R1R | Bool --------- | Runtime 1 reset |
| Failure device 2 | Real --------- | FD2 | R2R | Bool --------- | Runtime 2 reset |
| **Parameters** | | | | | |
| Runtime limit | Real --------- | RL | | | |

**FB example abbreviations**

| Name | Type | Description | Unit/symbol |
|---|---|---|---|
| Inputs | | | |
| RD1 | Real | Runtime total of device 1 | h |
| RD2 | Real | Runtime total of device 2 | h |
| FD1 | Bool | Failure of device 1 | |
| FD2 | Bool | Failure of device 2 | |
| Outputs | | | |
| D1R | Bool | Release of device 1 | |
| D2R | Bool | Release of device 2 | |
| R1R | Bool | Reset of runtime device 1 | |
| R2R | Bool | Reset of runtime device 2 | |
| Parameters | | | |
| RL | Real | Runtime limit | h |

NOTE Explanation of the example:
After a predefined runtime the function switches over from device 1 to device 2. If a failure occurs (FD1/FD2), the function switches over to the other device.

#### 5.5.3.3.5 Step control

When two or more devices can operate together to meet demand, they can be step controlled. The step control sequence can be influenced by other parameters, e.g. the individual device rating, hysteresis, on/off thresholds and time. This control type also is referred to as multistage.

The step control input(s) can also be from the following functions: time (Col. 6.4), event (Col. 1.3/2.3/6.3), limiting (Col. 3.1/3.2), run time (Col. 3.3) and state processing (Col. 3.6).

The step control output can be an input to a processing function or an output function, e.g. motor control (Col 4.2).

This function shall be listed in the BACS PL per corresponding/controlled device.

Performance criteria: None

**Table 13 — Informative FB example (Step control)**

**Graphical FB representation**

| **Inputs** | | **Step control** | | | **Outputs** |
|---|---|---|---|---|---|
| Load value | Real --------- | LV | D1R | Bool --------- | Device 1 release |
| On/off period | Bool --------- | OOP | D2R | Bool --------- | Device 2 release |
| **Parameters** | | | | | |
| Rating device 1 | Real --------- | RD1 | | | |
| Rating device 2 | Real --------- | RD2 | | | |
| Hysteresis | Real --------- | HYS | | | |

**FB example abbreviations**

| **Name** | **Type** | **Description** | **Unit/symbol** |
|---|---|---|---|
| Inputs | | | |
| LV | Real | Load value | kW |
| OOP | Bool | On off period | |
| Outputs | | | |
| D1R | Bool | Device 1 release | |
| D2R | Bool | Device 2 release | |
| Parameters | | | |
| RD1 | Real | Rating device 1 | kW |
| RD2 | Real | Rating device 2 | kW |
| HYS | Real | Hysteresis | kW |

NOTE Explanation of the example:
In this function block example the devices are switched on as a function of the load value and hysteresis when the plant is in an on period. Devices are: boilers, chillers, pumps and AHUs etc.

#### 5.5.3.3.6 Safety/frost protection control

**Safety control** is a function with a latching and locking facility for switching a plant or part of a plant into a pre-defined and safe or protected state in order to avoid damage to the building, plant, etc., and in specially specified cases to prevent harm to people.
An acknowledge facility shall be provided. If required, an operator shall manually instigate the reset.
For example, a pressure, temperature, or humidity limiter triggers this function.

**Frost protection control** is a safety control function for switching all relevant parts of a plant into a pre-defined state to avoid frost damage. It is triggered if the temperature drops below a limit detected by a specific sensor, e.g. frost thermostat. Software latching and locking requirements shall be specified for each project. If required, an operator shall manually instigate the reset.
Frost protection control should remain active if the plant is switched off by a processing function. If the plant is switched off by manual override or power failure, then it shall be specified whether frost protection control will remain active.

These functions shall be listed in the BACS PL in the same row as the corresponding inputs to indicate their dedication to the corresponding controlled plant. In case several different “safety control” functions are involved for one plant; they shall be indexed and referenced in the remarks column.

Performance criteria: None

#### 5.5.3.4 Closed loop control

##### 5.5.3.4.1 General

Processing functions for closed loop control mainly process I/O and virtual functions. Other function types can use the results of these functions.

Closed loop control results from an algorithm, e.g. P, PI, PID, that requires feedback from the controlled medium, e.g. if temperature is being controlled to a setpoint, the actual temperature value is fed back to the algorithm which will then decide to increase or decrease the heating/cooling supply.

Each closed control loop includes one setpoint.
To define a complete control loop in the BACS PL, the combination of a P control loop or PI/PID control loop function and at least one control loop output function is necessary. Other functions may be combined as required.

For cascade control a process value is controlled by means of a master control loop function and a slave control loop function. The output signal of the master control loop is used as setpoint input to the slave control loop.

In the BACS PL an on/off controller requires one processing function P/PI-control loop and additionally one proportional to on/off conversion function.

A 3-point control requires two proportional to on/off conversion functions, e.g. open/close.

It shall be possible for a setpoint parameter to be changed via a MOU whilst on-line.

##### 5.5.3.4.2 P control loop

Proportional control provides an output that is proportional to the deviation between the setpoint and the input signal. The level of output depends on the value of ‘P’.

The P control loop function includes a fixed setpoint and the associated parameters; it will combine with at least one output function.

##### 5.5.3.4.3 PI/PID control loop

The proportional and integral control algorithm is the same as the P algorithm but with the influence of a time dependent function which alters the output signal at a rate proportional to the deviation between the input signal and setpoint.

The proportional, integral and derivative control algorithm has the same operation as the PI algorithm with the addition of an influence on the output determined by the rate of change of the input signal.

The PI/PID-algorithm control loop functions include the associated parameters and will combine with at least one output function.

##### 5.5.3.4.4 Sliding/curve setpoint

The sliding/curve setpoint function is used in closed loop control. The actual setpoint value is defined by the magnitude of an input signal and/or a calculated function.

EXAMPLE 1 Sliding setpoint, summer compensation. This function provides a means to avoid thermal shock to the building occupants and save energy. The room temperature setpoint is linearly increased, starting from a predefined outdoor temperature value (starting point).

EXAMPLE 2 Curve setpoint, outside winter compensation. This function provides a means to vary the inside temperature depending upon the outside temperature. The present setpoint of the water flow temperature is calculated or defined by a reset schedule.

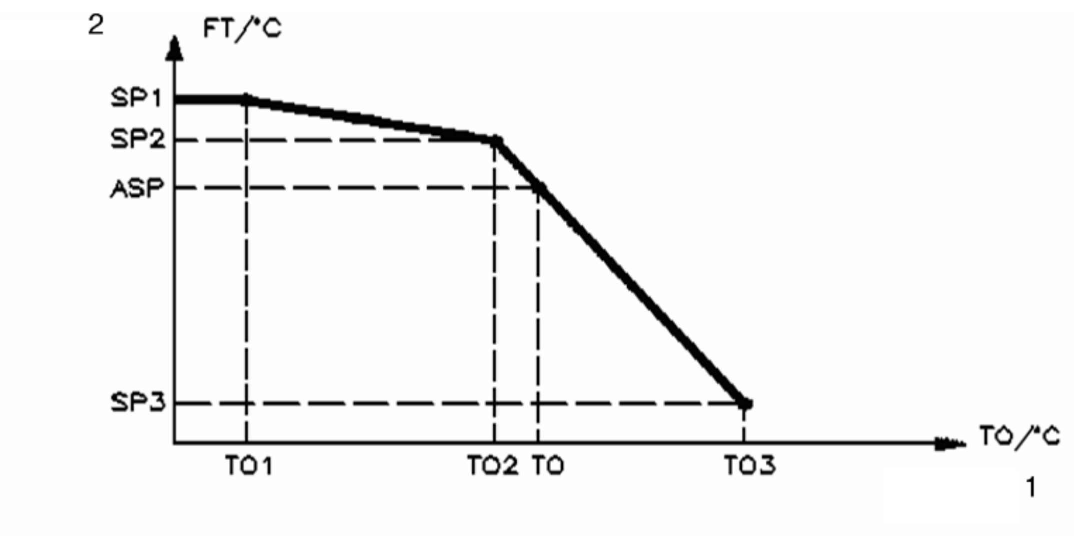
It shall be possible for a setpoint parameter and/or for the shape of the curve of the reset schedule to be changed via a MOU whilst online. Setpoint limitation has to be defined by a separate setpoint/output limitation function.

Performance criteria:

1) Number of steps for the reset schedule;

2) Calculated setpoint.

Graphical function example:




**Key**

1 Outdoor temperature
2 Flow temperature

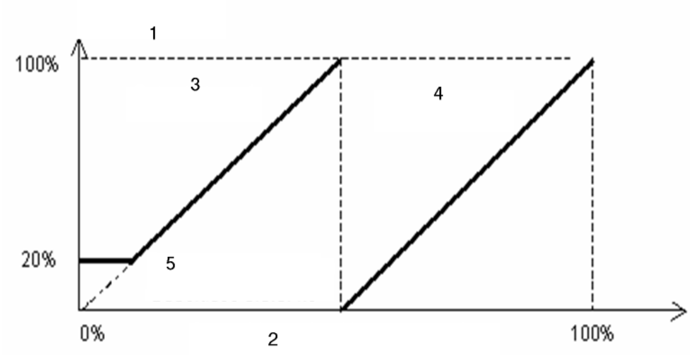
**Figure 3 — Setpoint curve function**

#### 5.5.3.4.5 Proportional output stage

The proportional output stage function converts the controller output into n virtual values when load sequencing is required. One output function may be split into two or more outputs with the magnitude and co-efficient defined. The output values have to be combined with I/O functions. Each output stage shall be stated in the BACS PL.

Performance criteria: None

Graphical function example 1:

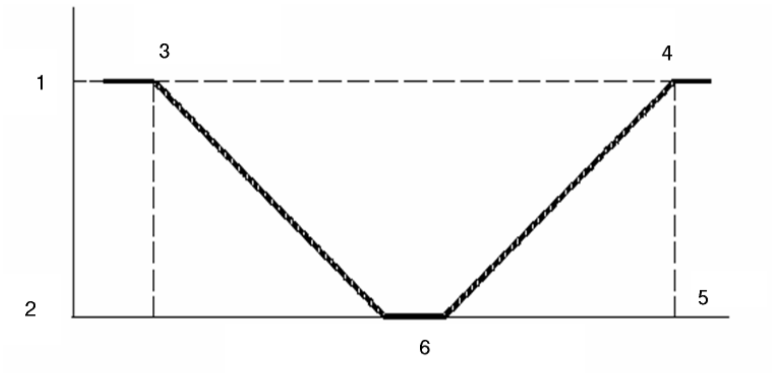



**Key**

1 Actuator position
2 Control loop algorithm output value
3 Output stage 1
4 Output stage 2
5 See Output Limitation subclause 5.5.3.4.8

**Figure 4 — 2 proportional output stage functions for damper/valve sequence**

Graphical function example 2:




**Key**

1 Open
2 Closed
3 Cooling valve position
4 Heating valve position
5 Output %
6 Control loop algorithm output value

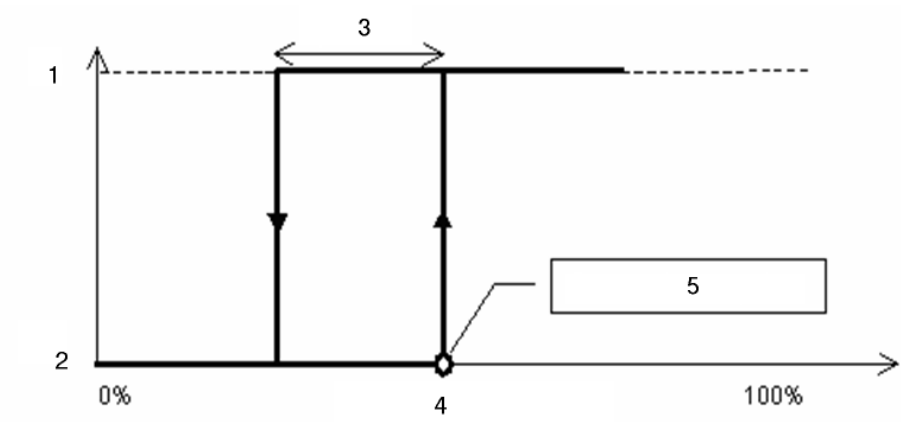
**Figure 5 — 2 proportional output stage functions for cooling/heating sequence**

#### 5.5.3.4.6 Proportional to on/off conversion

The proportional to on/off conversion function converts the proportional output value of a controller into an on/off output. The conversion is done depending upon the setpoint and hysteresis values and is used for logic, physical and communication output functions.

Performance criteria: None

Graphical function example 1:

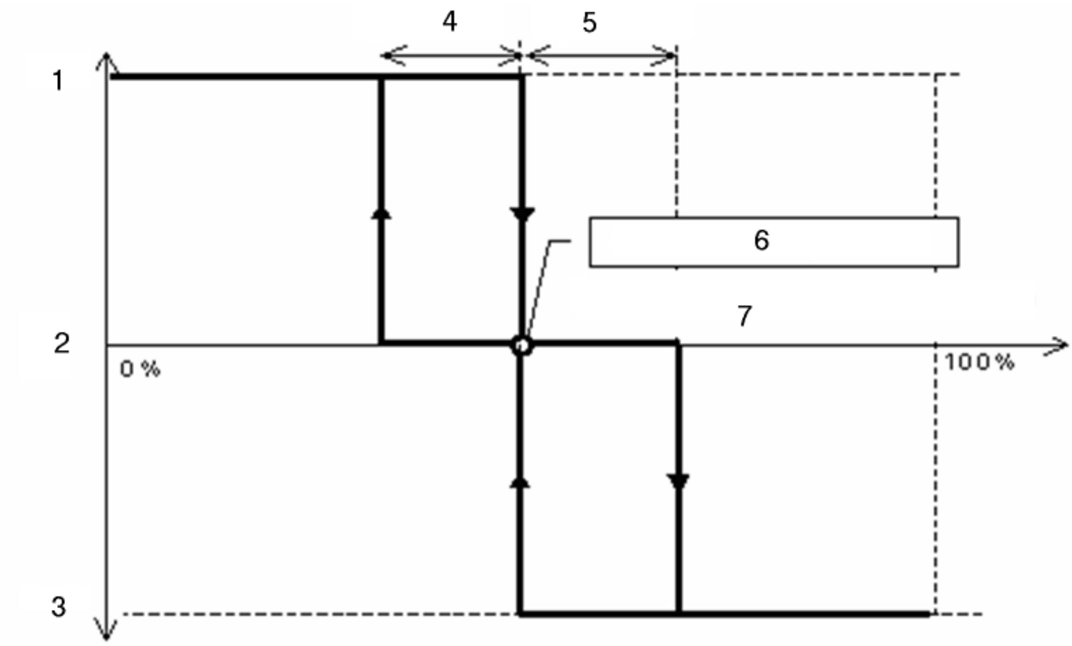



**Key**

1 On
2 Off
3 Hysteresis
4 Controller output value
5 Conversion setpoint

**Figure 6 — On/off conversion**

Graphical function example 2:




**Key**

1 On 1
2 Off
3 On 2
4 Hysteresis 1
5 Hysteresis 2
6 Conversion setpoint ½
7 Control loop algorithm output value

**Figure 7 — On/off conversion for 3-point control**

Textual function description:

**Table 14 — Informative FB example (On/off conversion)**

| **Graphical FB representation** | | | | |
|---|---|---|---|---|
| **Inputs** | | **On/off conversion** | | **Outputs** |
| Input value | Real --------- | IV | OOS | Bool --------- On/off state |
| **Parameters** | | | | |
| Setpoint | Real --------- | SP | | |
| Hysteresis | Real --------- | HY | | |

**FB example abbreviations**

| **Name** | **Type** | **Description** | **Unit/symbol** |
|---|---|---|---|
| Inputs | | | |
| IV | Real | Input value | Phys. value |
| Outputs | | | |
| OOS | Bool | On/Off state | 0/1 |
| Parameters | | | |
| SP | Real | Setpoint value | Phys. value |
| HY | Real | Hysteresis | % |

NOTE Explanation of the example:
In this function block example the output value of a control loop function is converted into on/off states as a function of the internal triggering value (the setpoint for this conversion) and a hysteresis. The output of this function can control a physical or shared output function.

#### 5.5.3.4.7 Proportional to pulse width modulation

The proportional to pulse width modulation function converts the proportional output value of a P, PI or PID control loop function into pulses with a variable mark/space ratio that depends on the magnitude of the input value.

EXAMPLE The control of electro thermal actuators.

Performance criteria: None

#### 5.5.3.4.8 Setpoint/output limitation

The setpoint and/or output limitation function is used to limit a signal to a value between two limits e.g. to ensure a minimum fresh airflow rate. This function may be overridden by safety functions.

Each setpoint/output limitation shall be specified by entering the quantity of limits in the BACS PL.

Performance criteria: None

**Table 15 — Informative FB example (Setpoint/output limitation)**

**Graphical FB representation**

| Inputs | | Setpoint/output limitation | | | Outputs |
|---|---|---|---|---|---|
| Variable setpoint value | Real --------- | VSPV | ALSP | Real --------- | Actual limited setpoint |
| **Parameters** | | | | | |
| Low limit setpoint | Real --------- | LLSP | | | |
| High limit setpoint | Real --------- | HLSP | | | |

**FB example abbreviations**

| Name | Type | Description | Unit/symbol |
|---|---|---|---|
| Inputs | | | |
| VSPV | Real | Variable setpoint value | Phys. value |
| Outputs | | | |
| ALSP | Real | Actual limited setpoint | Phys. value |
| Parameters | | | |
| LLSP | Real | Low limit setpoint | Phys. value |
| HLSP | Real | High limit setpoint | Phys. value |

NOTE Explanation of the example:
This function block example implements a high and a low limit to the setpoint value.

#### 5.5.3.4.9 Switchover of parameters

The switchover of parameters function is used to modify the control loop parameters to optimize the control action depending on an event, e.g. deviation, setpoint, valve position, etc.

Performance criteria: None

### 5.5.3.5 Calculation/optimization functions

#### 5.5.3.5.1 General

The calculation function is used to calculate derived values and providing complex data to a user, or to another type of function to enable a consequential decision function.

Cross plant/system optimization functions are used for energy management to reduce energy consumption and costs. They are implemented as pre-configured standard functions not requiring project specific programming. For adaptation to varying application needs, they have to be provided with adjustable parameters that give the flexibility to cope with varying types of building construction. Standard monitoring, interlock and control functions, e.g. plant and motor control, are not to be considered as optimization functions.

#### 5.5.3.5.2 h,x- directed control

In the case of an h,x- directed control function, a strategy determines an energy optimized method of conditioning outdoor air to achieve the required supply air values for the specified room temperature and relative humidity. The specified temperature and humidity is defined within a comfort field on an h,x- diagram or psychrometric chart.

This function shall be listed in the BACS PL in the same row as the corresponding input data points to indicate their dedication to the corresponding/controlled plant.

Performance criteria: None

#### 5.5.3.5.3 Arithmetic calculation

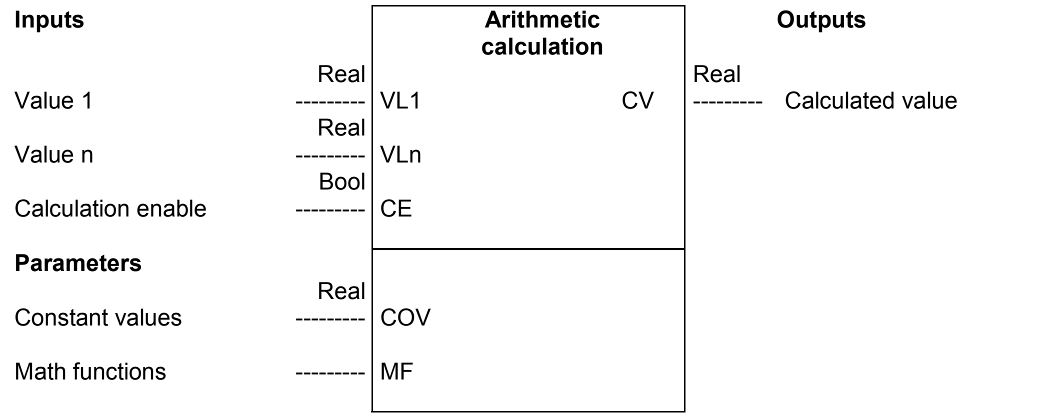
The arithmetic calculation function provides an output that is the arithmetic combination of any number of input variables. The output is then available for use in other functions.

This function shall be listed in the BACS PL in the same row as the corresponding input data points to indicate their dedication to the corresponding/controlled plant items. The calculation result is presented in a virtual data point which has its own data point address, the corresponding remarks column may be used to indicate the associated input functions.

Performance criteria: None

**Table 16 — Informative FB example (Arithmetic calculation)**

**Graphical FB representation**




**FB example abbreviations**

| **Name** | **Type** | **Description** | **Unit/symbol** |
|---|---|---|---|
| Inputs | | | |
| VL1<br>VLn<br>CE | Real<br>Real<br>Bool | Value 1<br>Value n<br>Calculation enable | |
| Outputs | | | |
| CV | Real | Calculated value | |
| Parameters | | | |
| COV<br>MF | Real | Constant values<br>Mathematical functions | |
| NOTE Explanation of the example:<br>Calculated values are produced by processing inputs through freely defined functions created by a set of algorithms and mathematical functions, e.g., -, x, /. | | | |

#### 5.5.3.5.4 Event switching

The event switching function provides a logic output when a predefined event occurs. The event can be initiated by a logic, physical or communication input.

This function shall be listed in the BACS PL in the same row as the processing function plant control of the corresponding/controlled plant or as the output function switching of the corresponding/controlled plant equipment/component.

The BACS PL shall indicate this function per output address.

Performance criteria: None

#### 5.5.3.5.5 Time schedule

The time schedule function provides a logic output when a set time matches the real time value. The output can be inhibited if the real time matches with exception day data. The result is assigned to an output function.

This function shall be listed in the BACS PL in the same row as the processing function plant control of the corresponding/controlled plant. The stated amount represents the dedicated on/off cycles per period of the assigned schedule.

Performance criteria:

1) Type of time schedule; daily, weekly, yearly programmable;

2) Number of exception days.

**Table 17 — Informative FB example (Time schedule)**

**Graphical FB representation**

| | | | | | |
|---|---|---|---|---|---|
| **Inputs** | | **Time schedule** | | | **Outputs** |
| | Real | | | Bool | |
| Actual Time | --------- | AT | PSS | --------- | Plant start stop |
| | Real | | | Real | |
| Override | --------- | OR | PPC | --------- | Present program condition |
| **Parameters** | | | | | |
| Time Table | --------- | TT | | | |

**FB example abbreviations**

| Name | Type | Description | Unit/symbol |
|---|---|---|---|
| Inputs | | | |
| AT | Real | Actual time | MM.DD; HH:MM |
| OR | Real | Override input e.g. on/off/auto | |
| Outputs | | | |
| PSS<br>PPC | Bool<br>Bool | Plant start/stop (time program output state)<br>Present condition of the active time program, e.g. currently an exception day or override | |
| Parameters | | | |
| TT | | Time table, including plant start stop requirements on typically daily, weekly, and exceptional profiles. | |
| NOTE Explanation of the example:<br>The actual time is provided by an internal or external reference source. | | | |

#### 5.5.3.5.6 Optimum start/stop

##### 5.5.3.5.6.1 General

The optimum start/stop function provides a logic output when an algorithm calculates an optimum time to switch on or off an item of plant in order to optimize energy usage, based on the input from the time schedule function.

This function shall be listed in the BACS PL in the same row as the processing function plant control of the corresponding/controlled plant.

Performance criteria: None

**Table 18 — Informative FB example (Optimum start stop)**

**Graphical FB representation**

| Inputs | Type | Optimum start stop | | Type | Outputs |
|---|---|---|---|---|---|
| Outdoor temperature | Real --------- | TO | PSS | Bool --------- | Plant start/stop |
| Room temperature | Real --------- | TR | PPC | Bool --------- | Present program condition |
| Actual time | Real --------- | AT | | | |
| Program enable | Bool --------- | PEN | | | |
| **Parameters** | | | | | |
| Time schedule reference list | Real | TSRL | | | |
| Occupancy time schedule | Real --------- | OTS | | | |
| Basic parameters | Real --------- | BPAR | | | |

**FB example abbreviations**

| Name | Type | Description | Unit/symbol |
|---|---|---|---|
| Inputs | | | |
| TO | Real | Outdoor temperature | °C |
| TR | Real | Room temperature | °C |
| AT | Real | Actual time | HH:MM |
| PEN | Bool | Program enable | |
| Outputs | | | |
| PSS | Bool | Optimum start/stop | |
| PPC | Bool | Output State (plant start/stop)<br>Present program condition, | |
| Parameters | | | |
| TSRL | Real | Time schedule reference list | |
| OTS | Real | Occupancy time schedule | |
| BPAR | Real | Basic parameters | |

NOTE Explanation of the example:
The optimum start function calculates the best possible starting time for the change between unoccupied and occupied mode depending upon the controlled temperature (e.g. room temperature). To achieve the desired conditions at the start of occupancy it can also be necessary to consider outside conditions, supply capacity of the energy source and the thermal behavior of the building.
The optimum stop function calculates the earliest stop time for the change between occupied and unoccupied mode, normally depending upon outside temperature conditions. It is also strongly recommended to consider the thermal behavior of the building in order to maintain the desired conditions until the end of occupancy mode.
This function can have fixed parameters or be a self adaptive function. Self adaptive means that the function itself calculates and stores the required parameters.

### 5.5.3.5.6.2 Duty cycling

The duty cycling function provides a logic output when an algorithm calculates that an item of plant shall be cycled off in order to save energy. This reduced run time of plant will be a result of temperature and/or state of inputs.

This function shall be listed in the BACS PL in the same row as the processing function plant control of the corresponding/controlled plant, or if required corresponding to the output function switching of the corresponding/controlled device.

Performance criteria: None

**Table 19 — Informative FB example (Duty cycling)**

**Graphical FB representation**

| **Inputs** | | **Duty cycling** | | | **Outputs** |
|---|---|---|---|---|---|
| | Bool | | | Bool | |
| Plant state | --------- | PS | PSS | --------- | Plant start/stop |
| | Real | | | | |
| Room temperature (reference) | --------- | TR | | | |
| | Bool | | | | |
| Program Enable | --------- | PEN | | | |
| **Parameters** | | | | | |
| | Real | | | | |
| Duty cycling reference list | | DCRL | | | |
| | Real | | | | |
| Cycle time | --------- | CT | | | |
| | Real | | | | |
| Off – time | --------- | OT | | | |

**FB example abbreviations**

| Name | Type | Description | Unit/symbol |
|---|---|---|---|
| Inputs | | | |
| PS | Bool | Plant state (occupied, unoccupied) | 0/I |
| TR | Real | (Reference-) room temperature | °C |
| PEN | Bool | Program enable | |
| Outputs | | | |
| PSS | Bool | Duty cycling output state (plant start/stop) | |
| Parameters | | | |
| DCRL | Real | Duty cycling reference list | |
| CT | Real | Cycle time | min |
| CT | Real | Off time | min |

NOTE Explanation of the example:
This function is active while the plant is in the on state, e.g. an air-handling unit should be cycled on and off if its capacity exceeds the required load.

#### 5.5.3.5.7 Night cooling

The night cooling function provides a logic output when an algorithm calculates that the inside temperature is above the temperature that will be required within the forthcoming occupancy period. Other considerations will be the outside temperature during the night.

This function shall be listed in the BACS PL in the same row as the processing function plant control of the corresponding/controlled plant, or if required corresponding to the output function switching of the corresponding/controlled device.

Performance criteria: None

**Table 20 — Informative FB example (Night cooling)**

**Graphical FB representation**

| Inputs | Type | Night cooling | | Type | Outputs |
|---|---|---|---|---|---|
| Outdoor temperature | Bool --------- | TO | PSS | Bool --------- | Plant start/stop |
| Room temperature | Real --------- | TR | ADP | Real --------- | Air damper position |
| Room controller setpoint | Real --------- | RCSP | | | |
| Program enable | Bool --------- | PEN | | | |
| **Parameters** | | | | | |
| Difference temperature limit (TR-TO) | Real --------- | DTL | | | |
| Occupancy time/state list | Real --------- | OTSL | | | |

**FB example abbreviations**

| Name | Type | Description | Unit/symbol |
|---|---|---|---|
| Inputs | | | |
| TO | Real | Outdoor temperature | °C |
| TR | Real | Room temperature | °C |
| RCSP | Real | Room controller setpoint | °C |
| PEN | Bool | Program enable | |
| Outputs | | | |
| PSS | Bool | Night cooling output state (plant start/stop) | 0/1 |
| ADP | Real | Air damper position | % |
| Parameters | | | |
| DTL | Real | Difference temperature limit (TR-TO) | K |
| OTSL | Real | Occupancy time/state list | |

NOTE Explanation of the example:
This function provides free cooling. It uses the cooler outside air in the early morning to cool down the buildings internal fabric and inside air. Night cooling is started with outside air dampers fully open if, and as long as, outside air temperature is significantly cooler than inside air and inside air temperature is significantly higher than the occupancy setpoint.

#### 5.5.3.5.8 Room temperature limitation

The room temperature limitation function prevents room temperature during the occupied period from falling below or rising above acceptable limits to protect against frost or dew damage. When the referencing room temperature reaches these limits the HVAC plant cycles on and off, effectively maintaining the room temperature limitation setpoints.

This function shall be listed in the BACS PL in the same row as the processing function plant control of the corresponding/controlled plant, or if required corresponding to the output function switching of the corresponding/controlled device.

Performance criteria: None

**Table 21 — Informative FB example (Room temperature limitation)**

**Graphical FB representation**

| **Inputs** | | **Room temperature limitation** | | | **Outputs** |
|---|---|---|---|---|---|
| Plant state | Bool --------- | PS | PSS | Bool --------- | Plant start/stop |
| Room temperature | Real --------- | TR | | | |
| Program enable | Bool --------- | PEN | | | |
| **Parameters** | | | | | |
| Upper setpoint | Real --------- | USP | | | |
| Lower setpoint | Real --------- | LSP | | | |
| Hysteresis | Real --------- | HYS | | | |

**FB example abbreviations**

| **Name** | **Type** | **Description** | **Unit/symbol** |
|---|---|---|---|
| Inputs | | | |
| TR | Real | Room temperature | °C |
| PS | Bool | Plant state | |
| PEN | Bool | Program enable | |
| Outputs | | | |
| PSS | Bool | BTL output state (Plant Start/Stop) | |
| Parameters | | | |
| USP | Real | Upper setpoint of RTL | °C |
| LSP | Real | Lower setpoint of RTL | °C |
| HYS | Real | Hysteresis | °C |

NOTE Explanation of the example:
This function is active while the plant is in the off state, e.g. a heating plant or an air-handling/air-conditioning unit should be switched on if a reference temperature exceeds the lower/higher setpoint until it reaches again the required temperature at the upper/lower setpoint.

#### 5.5.3.5.9 Energy recovery

The energy recovery function is a process strategy applied for recovering heating/cooling/humidity depending on the energy demand of a controlled space and the energy available from the extracted air from this space. This function depends on an enthalpy calculation and includes the comparison between outside air and return air enthalpies (or temperatures). Thus the desired space comfort condition can be achieved with a minimum of energy.

A function to select if the output is switched or modulated depending on the differential between the enthalpy values may be provided.

If required, a minimum fresh air supply shall be assured.

The result of an energy recovery calculation is the triggering of a logic output function switching and/or positioning.

This function shall be listed in the BACS PL in the same row as the processing function plant control of the corresponding/controlled plant, or if required corresponding to the output function switching of the corresponding/controlled device.

Performance criteria: None

#### 5.5.3.5.10 Backup power operation

The backup power operation function provides a logic output that can be used to switch items of plant relative to the available power supply capacity for as long as the backup supply is in operation. The items of plant shall be prioritized.

Backup power operation is typically a system wide function.

This function shall be listed in the BACS PL in the same row as the processing function plant control of the corresponding/controlled plant, or if required corresponding to the output function switching of the corresponding/controlled device.

NOTE Upon the return of the main power supply the restoration of normal operation can be performed by the main power recovery program function (Col. 6.11) if required.

Performance criteria: None

#### 5.5.3.5.11 Mains power recovery program

The mains power recovery program triggers a sequence of events that bring on items of plant. Delay times and priorities can be applied.

Mains power recovery program is typically a system wide function.

This function shall be listed in the BACS PL in the same row as the processing function plant control of the corresponding/controlled plant, or if required corresponding to the output function switching of the corresponding/controlled device.

Performance criteria: None

#### 5.5.3.5.12 Peak load limitation

The peak load limitation function provides an output that is a result of a trend calculation for the maximum level of energy being reached within a specified time period. Items of plant can be switched off in a predefined order of priority so that the maximum energy level is not exceeded. The amount of energy being used at any instant is often provided by a physical counter input. The time period for which the energy level is calculated is determined in a variety of ways depending on the energy supply contract.

Peak load limitation is typically a system wide function.

This function shall be listed in the BACS PL in the same row as the processing function plant control of the corresponding/controlled plant, or if required corresponding to the output function switching of the corresponding/controlled device.

Performance criteria: None

**Table 22 — Informative FB example (Peak load limitation)**

**Graphical FB representation**

| Inputs | Type | Peak load limitation | | Type | Outputs |
|---|---|---|---|---|---|
| Actual consumption value | Real | ACV | PSS | Bool | Plant start/stop |
| Charging period start | Bool | CPS | PPC | | Present program condition |
| Tariff state | Real | TARS | | | |
| Program enable | Bool | PEN | | | |
| **Parameters** | | | | | |
| Program parameters | | PP | | | |
| Energy target | | ET | | | |

**FB example abbreviations**

| Name | Type | Description | Unit/symbol |
|---|---|---|---|
| Inputs | | | |
| ACV | Real | Actual consumption value | KWh |
| CPS | Bool | Signal to indicate the start of the charging period. | |
| TARS | Real | Tariff states (limit for consumption within a cycle) | |
| PEN | Bool | Program enable, releases or blocks the function as a whole | |
| Outputs | | | |
| PSS | Bool | Plant start/stop | |
| CPC | | Current program condition, e.g. current tariff | |
| Parameters | | | |
| PP | | List of parameters that configure the precise nature of the algorithm. | |
| ET | | Energy limit target to be used in the algorithm. | |

NOTE Explanation of the example:
The purpose of this function is to reduce load costs caused by peaks in consumption. The calculation considers the remaining time within the sample period and determines the current available load that can be reduced. The function determines whether the current demand and consumption would be within the defined target. Different algorithm/strategies can be used to achieve the target (e.g. predictive methods, sliding window, hierarchical, or rotating load shed). Additionally, in some cases, energy savings can be achieved as a by-product but are not the primary goal of this function.

#### 5.5.3.5.13 Energy tariff dependent switching

Energy tariff dependent switching is a processing function used according to energy tariff costs which may vary hourly, daily, and/or weekly, or seasonally. Low priority plant equipment is disabled, or reduced during higher cost energy periods. In the case of energy tariff dependent switching output functions switching is triggered depending on tariff state and tariff costs as well as set priorities.

This function is mainly used in the case of multi tariff electrical energy distribution.

Energy tariff dependent switching is typically a system wide function.

This function shall be listed in the BACS PL in the same row as the processing function plant control of the corresponding/controlled plant, or if required corresponding to the output function switching of the corresponding/controlled device.

Performance criteria: None

### 5.5.4 Management functions

#### 5.5.4.1 General

Management functions are used to provide information for storage, evaluation and display by application programs/management functions. This selected information can be processed and stored in data files and databases.

Management communication functions can be used for definition and selection of data point information from I/O functions, processing functions and of shared data point functions to be engineered for management functions.

#### 5.5.4.2 Management communications functions

##### 5.5.4.2.1 General

These functions apply twice for interoperable heterogeneous systems (for the server system and for the client system). The different communication object types are grouped separately within two columns of section seven in the BACS PL, which differ in complexity of the data being transferred to and from the management functions.

##### 5.5.4.2.2 Input/output object type

This communication function covers data passed to or from the management functions which is considered to be simple, e.g. I/O data point information, including states, values and other information as described in 5.5.2. The analog and binary data objects are described in prEN ISO 16484-5. The indication of these functions and objects in the BACS data points list is required in case of data sharing with foreign systems for management and operator functionality.

NOTE Device objects should not be indicated as functions, but can be stated if required.

The following list provides a mapping from I/O and associated functions to communication objects:

a) Binary value (output), points list function 1.1 and 2.1, switching:

   1) binary output object;

   2) binary value object;

   3) multi-state output object;

   4) multi-state value object.

b) Analog value (output), points list function 1.2 and 2.2, positioning/setpoint:

   1) analog output object;

   2) analog value object.

c) Binary value (input), points list function 1.3 and 2.3, state:

   1) binary input object;

   2) binary value object;

   3) multi-state input object;

4) multi-state value object.

d) Accumulated/totalized value (input), points list function 1.4 and 2.4, counting:

1) counter input object;

2) accumulated value object.

e) Analog value (input), points list function 1.5 and 2.5, measuring:

1) analog input object;

2) analog value object;

3) averaging object.

#### 5.5.4.2.3 Complex object type

This communication function covers complex data passed to or from the management functions. It shall be specified in detail when using the following communication objects. These are described in prEN ISO 16484-5.

One data point can refer to multiple complex BACS object types, e.g.:

a) command object;

b) group object;

c) life safety point object;

d) life safety zone object;

e) loop object;

f) notification class object, i.e. alarm and event notification for message routing;

g) schedule object.

The following objects are not to be indicated as functions, but can be stated in the BACS points list, if required:

h) calendar object;

i) device object;

j) event enrollment object;

k) file object;

l) life safety device object;

m) program object;

n) trend log object.

#### 5.5.4.3 Historical data

##### 5.5.4.3.1 General

Historical data functions are system functions performing the non-volatile storage of any type of events and measured values, including managing the retrieval of information as described in 5.3.2.10.

##### 5.5.4.3.2 Event storage, event logging

The event storage function of the data logging program provides for the storage of the point address, state and information text, resulting from I/O and processing functions. Time and date stamps shall be stored with each item of information.

The number of event storage functions shall be indicated in the BACS PL. For selection criteria refer to the example in 5.5.5.3, Table 23.

##### 5.5.4.3.3 Historical database

The historical database function provides for the storage of the point address, value, state and information text, resulting from I/O and processing functions. Time and date shall be stored with each item of information. Measured values may be sampled over interval times and/or in the event of reaching a predefined threshold value.

The number of historical data storage functions shall be indicated in the BACS PL. For selection criteria refer to the example in 5.5.5.3, Table 23.

### 5.5.5 Operator functions

#### 5.5.5.1 General

Operator functions are provided by the human system interface and define the complexity of requirements, i.e.:

a) Dynamically updating data within a static background graphic, where the system reports current state, and/or the user is able to alter the appropriate parameters;

b) Any instructions and/or context sensitive graphics that are presented to the system user as a result of an event within the plant.

Output is sent to visual displays, printers, audible and optical indicating devices or is provided to other functions within the BACS, or is transferred to dedicated special systems (DSS) for further processing.

#### 5.5.5.2 Graphic/plant schematic

Graphic/plant schematics are pictorial descriptions of the site/building/application, being monitored/controlled, displayed on a graphical user interface.

The schematic can take the form of several pages of graphical drawings; the number of pages to be included in a particular application is to be indicated in the BACS PL. The number of terminals to display the same graphic is not relevant for the BACS PL.

#### 5.5.5.3 Dynamic display

The dynamic display presents the actual states or values of I/O or processing functions within a plant schematic. The BACS PL shall indicate the number of information as result of functions for dynamic display (see Col. 8.2).

**Table 23 — Example dedication of dynamic display functions**

| | Type of data point and functions | Number of I/O and processing functions | Selected for dynamic display (example) | Number of dynamic display functions |
|---|---|---|---|---|
| 1. | Plant, 2 step control:<br>mode command (0)-I-II and state (0)-I-II<br>monitoring run time<br>runtime limit<br>interlocks, plant control<br>optimization, e.g.:<br>time schedule<br>optimum start/stop<br>night cooling<br>mains power recovery program<br>peak load limitation | <br>4<br>1<br>1<br>1<br><br>2<br>1<br>1<br>1<br>1 | <br>4<br>1<br>1<br>0<br><br>0<br>1<br>0<br>0<br>1 | 8 |
| 2. | Temperature value with<br>2 limits | 1<br>2 | 1<br>2 | 3 |
| 3. | Steady state output (0)-I-II<br>with check back per step<br>run time<br>runtime limit<br>command execution check<br>sequence control and<br>backup power operation | 2<br>2<br>1<br>1<br>1<br>1<br>1 | 2<br>2<br>1<br>1<br>1<br>1<br>1 | 9 |
| 4. | Cascade control:<br>input value (room temp.)<br>P master loop (requires block commun.)<br>input value (supply temp.)<br>sliding limit (lo);<br>PI slave loop<br>sliding slave setpoint<br>setpoint limitation<br>output limitation<br>2 proportional output stages | <br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>2 | <br>1<br>1<br>1<br>1<br>0<br>0<br>0<br>0<br>0 | 4 |

#### 5.5.5.4 Event instruction text

Event instruction text is added to an event message to instruct or guide an operator for different dedicated activities. The required number of lines per instruction text is to be specified.

Performance criteria:

— Number of lines, number of characters per line.

#### 5.5.5.5 Remote messaging

When triggered the remote messaging function sends event text to a data interface unit which forwards the data to a specified destination e.g. short message service, fax, and e-mail. This function is the interface between the BACS and another system and provides the functions necessary to manage re-transmission of events (i.e. acknowledgement). The remote messaging function can trigger a physical output function switching. If required, this is to be indicated as output function in the BACS PL.

Performance criteria: None

# Annex A
(normative)

# BACS points list (BACS PL)

## A.1 Use of the BACS PL

### A.1.1 Functions in the BACS PL

The BACS PL is used as a spread sheet calculation form to add up functions. These functions include all software and project engineering/commissioning/documentation services for complete plant item functionality. The processing functions are used to monitor, control and optimize electrical and mechanical plants. Complete processing functions are parts of complex programs that are based on assigned physical or communication functions. They include necessary parameters, S.I. units and text.

The described functions for the BACS points list are ready to use and contain all engineering services as:

a) Technical clarification;

b) Revising project specification;

c) Programming;

d) Input of addresses, mnemonics (user related point addresses), sensor curves, measuring ranges, units, program segments, programs and parameters;

e) Function of internal memory and interlocks;

f) Testing, tuning and commissioning;

g) Documentation.

### A.1.2 Structure of the BACS PL

The BACS PL is subdivided into four main sections for specifying plant specific functions, referring to the descriptions in 5.5 of this standard :

a) Input and output functions, sub-divided into; physical I/O, and shared I/O;

b) Processing functions, sub-divided into monitoring, interlocks, closed loop control, calculation and cross plant/system optimization;

c) Management functions, sub-divided into communication (shared data) and historical data (other management functionality is described in 5.3;

d) 4. Operator functions, sub-divided into visual display and other messaging functions.

The basis for working with the BACS PL is the plant control schematic and, if required, a control flow chart diagram, referenced in the footer part under “Control diagram No.”. A control flow chart diagram also can be referenced there. A recommended method of use is to follow the flow of the main medium (air, water) in the schematic and fill in the rows with control related plant items for inputs and outputs. To continue in that order, the plant objects appear in the schematic from left to right. General data points, such as plant start/stop and global functions should be at the start of the list.

The first column of the BACS PL shows the point descriptions assigned to all required functions (in text format or in the structure of the intended point identifiers, e.g. point address) referenced in that row. A related comment in the remarks column should be used for further statements - if necessary on separate sheets. It is recommended that rows be completed in an object oriented way regarding the “originator principle”, so that the corresponding functions are indicated in the same row.

### A.1.3 Describing applications by functions of the BACS PL

To describe plant control, processing functions have to be combined by filling in the number of functions required in the appropriate column and row of the BACS PL. The data point’s functionality is given by the amount of the required functions. It may be necessary to use several columns in order to convey a particular application function required from a set of functions. It is to state, that optimization functions are not to be understood as interlock or loop functions. Detailed plant control functions are covered by section 4 and 5 i.e. Col. 4.1 Plant control and Col 4.2 Motor control include all internal interlocks. The event switching function, e.g. is for optimization of cross plant/system operation from plant external events.

Internal and vendor specific BACS functions are not project/plant or application related and they are not to be included in the BACS PL, i.e. watchdog and other device status related information.

When the BACS points list cannot fully describe the required control methods, especially in case of sophisticated optimal controls and additional non standard functions, it is necessary to prepare additional documents as described in 5.1.4.1. These shall be stated in the rows of the BACS PL together with related functions. The specifying document shall then be referenced in the remarks column. To identify the data point to be processed by this additional or enhanced function, this reference shall be entered in the row of the data point.

In case of the enhancement of a function description the section and column number of the standard function is to be stated, e.g. 6.1X for h,x directed control strategy. In case of a non standard functions the extended col. number of the appropriate section may be used, e.g. 5.9 for a new closed loop control function. Further explanations/references can be given in the BACS PL.

EXAMPLE

Defining a cascade control in the BACS PL:

A cascade control requirement may be expressed by having for each of the process input values a row. The (P or PI/PID) master and one or more slave control loop functions can be entered in the row of the assigned input data points or the controllers can be entered each in an own row, in this case a clear point name for this (virtual) data point being a control function is to be assigned, and the use remark column for further explanation is recommended. The output value of the master control function is connected as sliding setpoint function to the slave controller(s). The master controller has (normally) no further output function, but can have setpoint/output limitation, switchover of parameters, management communications and operator functions.

### A.1.4 Describing system integration by functions of the BACS PL

In case of system integration with shared data points, it can be necessary to define the client and the server of data. prEN ISO 16484-5 describes a method using the BACnet Interoperability Building Blocks (BIBBs). This prescribes the services in terms of "A" and "B" devices. In most cases, the "A" device will act as the user of data (client), and the "B" device will be the provider of this data (server). The BACS PL can indicate this dedication of data point objects if required.

## A.2 BACS points list template

1) Steady state output, e.g.: 0,I,II = 2 BO
Pulsed output, e.g.: 0,I,II = 3 BO
Positioning outp. close-0-open = 2 BO
Puls width modulation output = 1 BO

2) Active or passive

3) Only shared (networked) I/O data points from third party systems for interoperable functions

4) Per input point address for collected, delayed or suppressed informations

5) Per output point address

6) For cooling / heating use 2x on / off conversions

7) Per input point address

8) e.g. Schedule, Life safety, Loop, File (see ISO 16484-5)

9) if required, indicate for dedication of client devices "A" and for server devices "B"; (see BIBBs in EN ISO 16484-5)

| Type of service / Plant | | | |
|---|---|---|---|
| **Point description and Pt.Nbr. or name** | **Section No.** | **Column No.** | **Function** |
| I/O functions – Physical | 1 | 1 | Binary outp. switching/positioning 1) |
| | 1 | 2 | Analog output positioning |
| | 1 | 3 | Binary input state |
| | 1 | 4 | Binary input counting |
| | 1 | 5 | Analog input 2) |
| I/O functions – Shared 3), x) | 2 | 1 | Output switching |
| | 2 | 2 | Output positioning / setpoint |
| | 2 | 3 | Input state |
| | 2 | 4 | Input accumulated/totalized value |
| | 2 | 5 | Input measuring |
| Processing functions – Monitoring | 3 | 1 | Fixed limit |
| | 3 | 2 | Sliding limit |
| | 3 | 3 | Run time totalization |
| | 3 | 4 | Event counting |
| | 3 | 5 | Command execution check |
| | 3 | 6 | State processing 4) |
| Processing functions – Interlocks | 4 | 1 | Plant control |
| | 4 | 2 | Motor control |
| | 4 | 3 | Switchover 5) |
| | 4 | 4 | Step control 5) |
| | 4 | 5 | Safety / Frost protection control |
| Processing functions – Closed loop control | 5 | 1 | P control loop |
| | 5 | 2 | PI / PID control loop |
| | 5 | 3 | Sliding- / Curve setpoint |
| | 5 | 4 | Proportional output stage |
| | 5 | 5 | Proportional to on/off conversion 6) |
| | 5 | 6 | Proportional to pulse width modulation |
| | 5 | 7 | Setpoint / Output limitation |
| | 5 | 8 | Switchover of parameters |
| Processing functions – Calculation / Optimisation | 6 | 1 | h,x directed control 7) |
| | 6 | 2 | Arithmetic calculation 7) |
| | 6 | 3 | Event switching |
| | 6 | 4 | Time schedule |
| | 6 | 5 | Optimum start / stop |
| | 6 | 6 | Duty cycling |
| | 6 | 7 | Night cooling |
| | 6 | 8 | Room temperature limitation |
| | 6 | 9 | Energy recovery |
| | 6 | 10 | Backup power operation |
| | 6 | 11 | Main power recovery pogram |
| | 6 | 12 | Peak load limitation |
| | 6 | 13 | Energy tariff dependent switching |
| Management functions | 7 | 1 | Input / Output / Value object types x) |
| | 7 | 2 | Complex object types 8), x) |
| | 7 | 3 | Event storage |
| | 7 | 4 | Historical database |
| Operator functions | 8 | 1 | Graphic / Plant schematic |
| | 8 | 2 | Dynamic display |
| | 8 | 3 | Event instruction text |
| | 8 | 4 | Remote messaging |

**Remarks**

Definition of functions in EN ISO (FDIS) 16484-3; indicate project specific function descriptions in the points row as e.g.: s.c) X spec.# s = section; c = column; X = non standard function description

Row No.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

**Totals**

| Issue date jj-mm-dd | Author | Approved | Company | Project | Location of controls | File [ISO(FDIS)16484-3en-annexA_Info-List-i.xls] |
|---|---|---|---|---|---|---|
| Rev. 1 | | | | | | |
| Rev. 2 | | | | | Control Diag. No. | Page No. |
| Rev. 3 | | | | | Doc. for add. Remarks | of |

© 1996-2002 ISO/TC205_CEN/TC247_VDI-TGA_GAEB071

# Annex B
(informative)

# Examples for plant/control schematics and BACS points lists

## B.1 Example 1, AHU

### B.1.1 Abbreviations used in example 1

GSA End position switch alarm

max Maximum value selection

P Pressure

P P control loop function (in graphical controller symbol)

PI PI control loop function (in graphical controller symbol)

PDS Pressure differential switch

T Temperature ABS/H Absorption chiller/heater

TZ Frost protection safety control

NOTE Graphical symbols are according to EN ISO 10628.

### B.1.2 Plant/control schematic example 1

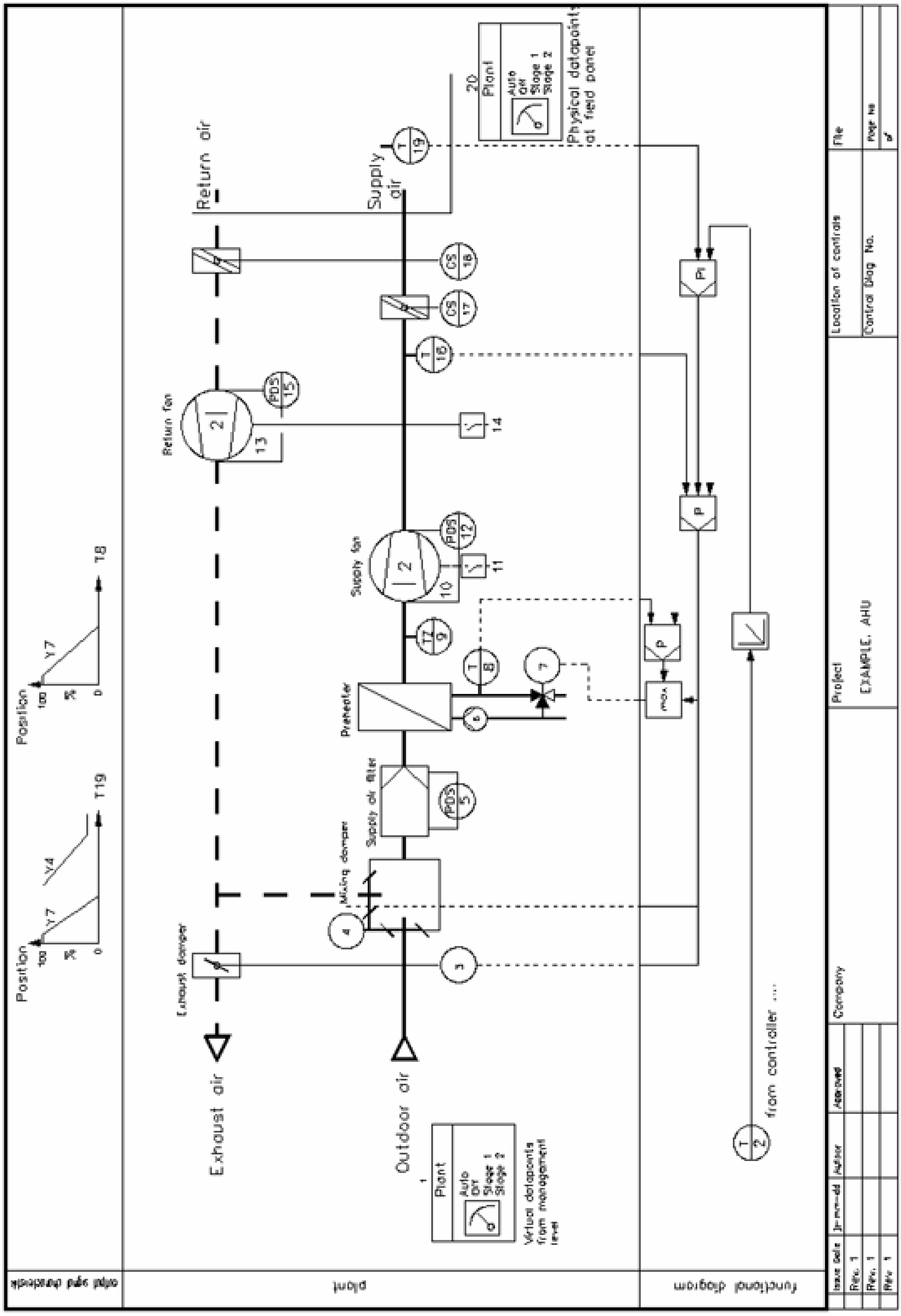



Figure B.1 – Control schematic example 1

### B.1.3 BACS points list example 1

**Table B.1 – BACS points list example 1**

1) Steady state output, e.g.: 0,I,II=2 BO
Pulsed output, e.g.: 0,I,II=3 BO
Positioning outp. close-0-open=2 BO
Puls width modulation output=1 BO
2) Active or passive
3) Only shared (networked) I/O data points from third party systems for interoperable functions
4) Per input point address for collected, delayed or suppressed informations
5) Per output point address
6) For cooling / heating use 2x on / off conversions
7) Per input point address
8) e.g. Schedule, Life safety, Loop, File (see ISO 16484-5)
9) if required, indicate for dedication of client devices "A" or server devices "B"; (see BIBBs in EN ISO (FDIS) 16484-5)

Type of service — Plant: Informative example for HVAC-plant

| Row No. | Point description / point name or No. | Binary output switching/positioning1) | Analog output positioning | Binary input state | Binary input counting | Analog input 2) | Binary value (output), switching | Analog value (output), positioning/setpt. | Binary value (input), state | Accumulated/totalized value (input) | Analog value (input), measuring | Fixed limit | Sliding limit | Run time totalization | Event counting | Command execution check | State processing 4) | Plant control | Motor control | Switchover 5) | Step control 5) | Safety / Frost protection control | P control loop | PI / PID control loop | Sliding- / Curve setpoint | Proportional output stage | Proportional to on/off conversion 6) | Proportional to pulse width modulation | Setpoint / Output limitation | Switchover of parameters | h,x directed control 7) | Arithmetic calculation 7) | Event switching | Time schedule | Optimum start / stop | Duty cycling | Night cooling | Room temperature limitation | Energy recovery | Backup power operation | Main power recovery pogram | Peak load limitation | Energy tariff dependent switching | Input / Output / Value object types 9) | Complex object types 8) 9) | Event storage | Historical database | Graphic / Plant schematic | Dynamic display | Event instruction text | Remote messaging | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Group | I/O functions – Physical | | | | | I/O functions – Shared I/O 3), 9) | | | | | Processing functions – Monitoring | | | | | | Interlocks | | | | | Closed loop control | | | | | | | | Calculation / Optimization | | | | | | | | | | | | | Management functions | | | | Operator functions | | | | NOTE: Definition of functions in EN ISO (FDIS) 16484-3; indicate project specific function descriptions in the points row as e.g.: s.c) X spec.# s=section; c=column; X=non standard function description; BIBBs=BACnet Interoperability Building Blocks |
| | Section No. | 1 | | | | | 2 | | | | | 3 | | | | | | 4 | | | | | 5 | | | | | | | | 6 | | | | | | | | | | | | | 7 | | | | 8 | | | | |
| | Column No. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| 1 | plant st.1/st.2/off/auto | | | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | | | 2 | 1 | | 1 | | | | 1 | 1 | | 4 | | | | 1 | 4 | | | 4.1) off by rep.swi., fire damper, frost;<br>7.1) switching + operating mode; |
| 2 | outdoor air temperature | | | | | | | | | | | 1 | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | 2 | 1 | | | | 3 | | | virtual datapoint (A) from controller .....<br>3.1) switching preheater pump |
| 3 | exhaust damper | | 1 | 3 | | | | | | | | | | | | 1 | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | 4 | | | | | 4 | | | 1.3)+7.1) position indicating |
| 4 | mixing damper | | 1 | 3 | | | | | | | | | | | | 1 | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | 4 | | | | | 4 | | | 1.3)+7.1) position indicating<br>5.7) minimum fresh air |
| 5 | supply air filter | | | 1 | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | 3.6) delayed |
| 6 | preheater pump (on/off + fault) | 1 | | 3 | | | | | | | | | | 1 | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 5 | | | | | 5 | | | 1.3) state+fault; 6.3) row2, fct.3.1 out-lim;<br>4.2) incl. pump stall protection |
| 7 | preheater valve | | 1 | 1 | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | 2 | | | 3.1) <3% preheater pump out<br>7.1) position indicating, state |
| 8 | preheater temperature | | | | | 1 | | | | | | | | | | | | | | | | 1 | 1 | | | 1 | | | | | | | | | | | | | | | | | | 2 | 1 | | | | 3 | | | 5.1) frost protection by ph-water |
| 9 | preheater frost protection | | | 1 | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | |
| 10 | supply fan | 2 | | 4 | | | | | | | | | | | | 2 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 6 | | | | | 6 | | | 1.3) on/off state+ fault<br>7.1) = 8.2+1.3+3.5 |
| 11 | supply fan rep.-switch | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | 3.1) switch off plant |
| 12 | supply fan belt | | | 1 | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | 3.1) switch off plant<br>3.6) delayed |
| 13 | return fan | 2 | | 4 | | | | | | | | | | | | 2 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 6 | | | | | 6 | | | 1.3) on/off state+ fault<br>7.1) = 8.2+1.3+3.5 |
| 14 | return fan rep.-switch | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | 3.1) switch off plant |
| 15 | return fan belt | | | 1 | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | 3.1) switch off plant<br>3.6) delayed |
| 16 | supply air temperature | | | | | 1 | | | | | | 1 | | | | | | | | | | | 1 | | 1 | 2 | | | | | | | | | | | | | | | | | | 2 | 1 | | | | 3 | | | 5.4) sequence damper-preheater<br>7.2) loop |
| 17 | supply fire damper | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | 3.1) switch off plant |
| 18 | return air fire damper | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | | | 3.1) switch off plant |
| | Totals | 5 | 3 | 26 | | 2 | | | | | | 3 | | 2 | | 7 | 3 | 1 | 3 | | | 2 | 3 | | 2 | 3 | | | 2 | | | | | 2 | 1 | | 1 | | | | 1 | 1 | | 45 | 3 | | | 1 | 48 | | | 170 |

| Issue Date jj-mm-dd | | Author | Approved | Company | Project | Location of controls (MER) | File |
|---|---|---|---|---|---|---|---|
| Rev. 1 | | VDI | HAK | | | | [B1-BACS-PL-ISO-xpl1.xls] |
| Rev. 2 | | | | | Example: AHU | Control diag. No. Example | page No. 1 |
| Rev. 3 | | | | | | Add. rem.: Spec. for funct. 6.5) X in doc. No.xx | of 2 |

## Table B.1 – BACS points list example 1 (continued)

1) Steady state output, e.g.: 0,I,II=2 BO
Pulsed output, e.g.: 0,I,II=3 BO
Positioning outp. close-0-open=2 BO
Puls width modulation output=1 BO

2) Active or passive

3) Only shared (networked) I/O data points from third party systems for interoperable functions

4) Per input point address for collected, delayed or suppressed informations

5) Per output point address

6) For cooling / heating use 2x on / off conversions

7) Per input point address

8) e.g. Schedule, Life safety, Loop, File (see ISO 16484-5)

9) if required, indicate whether applies to client devices "A" or server devices "B"; (see BIBBs in EN ISO (DIS) 16484-5)

| Row No. | Type of service / Plant: Informative example for HVAC-plant | Binary output switching/positioning1) | Analog output positioning | Binary input state | Binary input counting | Analog input 2) | Binary value (output), switching | Analog value (output), positioning/setpt. | Binary value (input), state | Accumulated/totalized value (input) | Analog value (input), measuring | Fixed limit | Sliding limit | Run time totalization | Event counting | Command execution check | State processing 4) | Plant control | Motor control | Switchover 5) | Step control 5) | Safety / Frost protection control | P control loop | PI / PID control loop | Sliding- / Curve setpoint | Proportional output stage | Proportional to on/off conversion 6) | Proportional to pulse width modulation | Setpoint / Output limitation | Switchover of parameters | h,x directed control 7) | Arithmetic calculation 7) | Event switching | Time schedule | Optimum start / stop | Duty cycling | Night cooling | Room temperature limitation | Energy recovery | Backup power operation | Main power recovery pogram | Peak load limitation | Energy tariff dependent switching | Input / Output / Value object types 9) | Complex object types 8) 9) | Event storage | Historical database | Graphic / Plant schematic | Dynamic display | Event instruction text | Remote messaging | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | I/O functions – Physical | | | | | I/O functions – Shared I/O 3), 9) | | | | | Processing functions – Monitoring | | | | | | Interlocks | | | | | Closed loop control | | | | | | | | Calculation / Optimization | | | | | | | | | | | | | Management functions | | | | Operator functions | | | | NOTE: Definition of functions in EN ISO (FDIS) 16484-3; indicate project specific function descriptions in the points row as e.g.: s.c) X spec.# s=section; c=column; X=non standard function description; BIBBs=BACnet Interoperability Building Blocks |
| | Point description / Section No | 1 | | | | | 2 | | | | | 3 | | | | | | 4 | | | | | 5 | | | | | | | | 6 | | | | | | | | | | | | | 7 | | | | 8 | | | | |
| | point name or No. / Column No | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| | Übertrag: | 5 | 3 | 26 | | 2 | | | | | | 3 | | 2 | | 7 | 3 | 1 | 3 | | | 2 | 3 | | 2 | 3 | | | 2 | | | | | 2 | 1 | | 1 | | | | 1 | 1 | | 45 | 3 | | | 1 | 48 | | | |
| 18 | room temperature | | | | | 1 | | | | | | | 1 | | | | | | | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | 2 | 1 | | | | 3 | | | 7.1) value + limits<br>7.2) loop |
| 19 | field panel | 2 | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | 2 | | | local: on/off state |
| | Totals | 7 | 3 | 28 | | 3 | | | | | | 3 | 1 | 2 | | 7 | 3 | 1 | 3 | | | 2 | 3 | 1 | 3 | 3 | | | 2 | | | | | 2 | 1 | | 1 | | | | 1 | 1 | | 49 | 4 | | | 1 | 53 | | | 188 |

| Issue Date | jj-mm-dd | Author | Approved | Company | Project | Location of controls (MER) | File |
|---|---|---|---|---|---|---|---|
| Rev. 1 | | VDI | HAK | | | | [IB1-BACS-PL-ISO-xpl1.xls] |
| Rev. 2 | | | | | Example: AHU | Control Diag. No. Example | Page No. 2 |
| Rev. 3 | | | | | | Add. rem.: Spec. for funct. 6.5) X in doc. No.xx | of 2 |

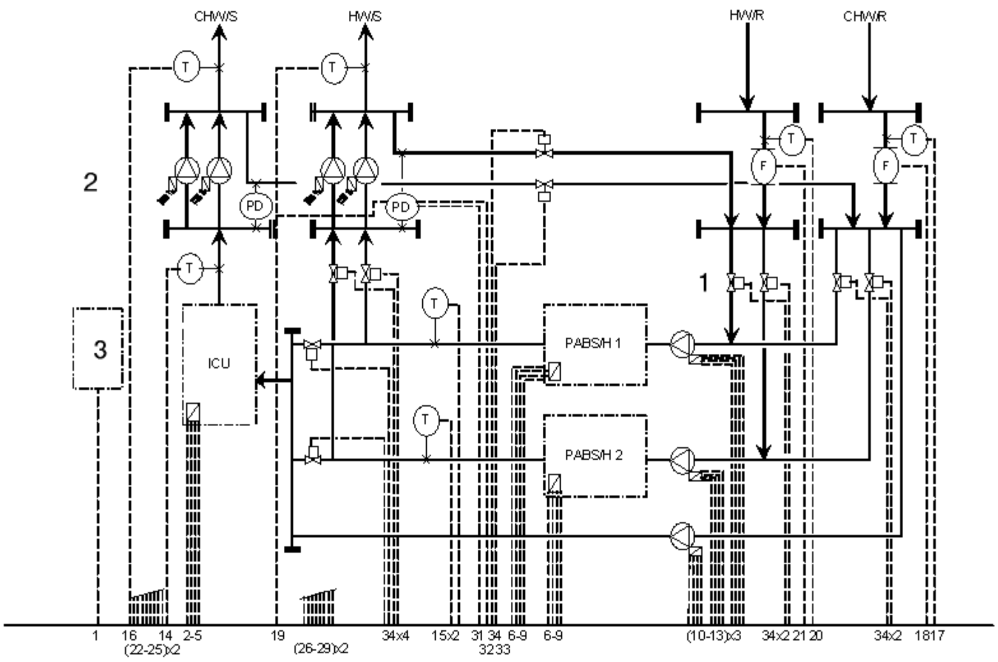
## B.2 Example 2, energy plant

### B.2.1 Abbreviations used in example 2

| | |
|---|---|
| ABS/H | Absorption chiller/heater |
| CHW | Chilled water |
| FCU | Fan coil unit |
| ICU | Ice storage system unit |
| LTHW | Low temperature heated water |
| PABS | Packaged absorption chiller/heater/cooling tower unit |

NOTE For further abbreviations see key in the plant/control schematic and control flow chart diagrams

### B.2.2 Plant/control schematic example 2




**Key**

| | |
|---|---|
| 1 | Primary pumps |
| 2 | Secondary pumps |
| 3 | Plant |
| CHW/R | Chilled water return |
| CHW/S | Chilled water supply |
| PD | Pressure differential |
| F | Flow meter |
| HW/R | Hot water return |
| HW/S | Hot water supply |
| T | Temperature sensor |

**Figure B.2 – Control schematic example 2**

### B.2.3 Plant description example 2

As heat generating and delivery plant for HVAC system, PABSs, a packaged air cooled brine chiller and an ICU are applied jointly together. Both chilled water and LTHW are supplied by the PABSs and chilled water is supplied by the ICU. When these two units are connected together in series, approximately 4°C of low temperature chilled water is produced and supplied to AHUs and FCUs with large temperature difference between inlet and outlet.

The PABS is a self-contained packaged system wherein the components including an ABS, a cooling tower, a cooling water circulation pump, a chilled water/LTHW circulation pump, and piping, wiring, controls which connect all the components functionally. The ABS consists of an absorber, an evaporator, a condenser, a high temperature generator, a low temperature generator, a burner, a high temperature heat exchanger, a low temperature heat exchanger, an absorbent pump, a water refrigerant pump and a control panel.

The ICU is a system that allows users to produce and store ice using relatively cheaper electric power during the night-time and to utilize such heat for cooling operation during the daytime, on the basis of a contractual agreement with the power supply company. The system is for dedicated use for thermal storage operation only during nighttime for the purpose of electrical power peak demand shedding. The ICU consists of an air cooled brine chiller, an ice storage tank, a brine-water heat exchanger, a primary brine circulation pump, a secondary brine circulation pump and piping, wiring and controls which connect all the components functionally. The air cooled brine chiller is equipped with super-chiller that super cools diluted solution of brine and produces sherbet like ices with high fluidity to be stored in the ice storage tank.

### B.2.4 Controls description example 2

There are 3 operating modes during a year, the summer mode, intermediate season mode and winter mode. The selection of the mode depends on calculated cooling and heating load prediction.

**In the summer mode** all the units are operated for cooling. Chilled water from the return is cooled by the PABSs, and booster-cooled in the heat exchanger of the ICU, and then sent as chilled water to the cooling loads. The number of the operating PABS is controlled depending on the cooling load. Under this operating mode, LTHW is neither generated nor delivered.

A stand-by PABS, if any, is operated when remained heat capacity of ice is predicted less than the rest of daily cooling load at that time, if it is on the condition to enable safe operation from the protective point of view. If chilled water temperature delivered to AHU exceeds high limit, stand-by PABS, is operated, if it is on the condition to enable safe operation. This is reviewed at the next control cycle.

**In the intermediate season mode** the operating mode of one PABS is set to heating operation to produce and deliver LTHW for heating demand through heated water supply and return pipes. The other PABS produces chilled water, which is booster-cooled at the ICU heat exchanger and then sent to AHUs and FCUs through the chilled water supply pipes.

**In the winter mode** both PABS are operated for heating to produce LTHW for large heating demand. The number of the operating PABSs is controlled depending on the heating load. The number of PABSs for cooling operation is decided by the predicted maximum cooling load. In case the required number of PABSs exceeds 2 units, priority is given to the number for heating operation.

The cooling demand in the winter is treated only with the ICU. Ice generation quantity during the night is controlled by predicted cooling load for following 24 h.

The ICU generates ice during the night for cooling. The amount of ice to be generated follows the predicted daily cooling load and maximum amount of ice is stored when predicted load is more than that. During the daytime the ICU delivers chilled water at 4°C for CHWS. The ICU is started to generate ice at 10 p.m.

The operating mode is reviewed when cool storage capacity is predicted and when chilled water supply temperature and heating water supply temperature are checked every ten minutes. A change of the PABS's operating mode is restricted at least to 1 h of interval in order to protect the PABS and to avoid energy mixing loss.

The PABSs are operated when the remained heat capacity of ice is predicted less than the rest of daily cooling load at that time under sequential control by the cooling demand of the secondary circuit. In cooling mode the PABS deliver chilled water at 7°C for CHWS. Whenever a stand-by PABS is requested to operate, it is actually operated only on the condition to enable safe operation, and otherwise, it is reviewed at the next control cycle.

In the heating operation, PABSs are operated under sequential control by the demand of the heat load of the secondary circuit and by the allowable heating water temperature to and from the AHU. In heating mode the PABS deliver heated water at 55°C for LTHW. Each primary chilled/heated water circulation pump is interlocked with each PABS.

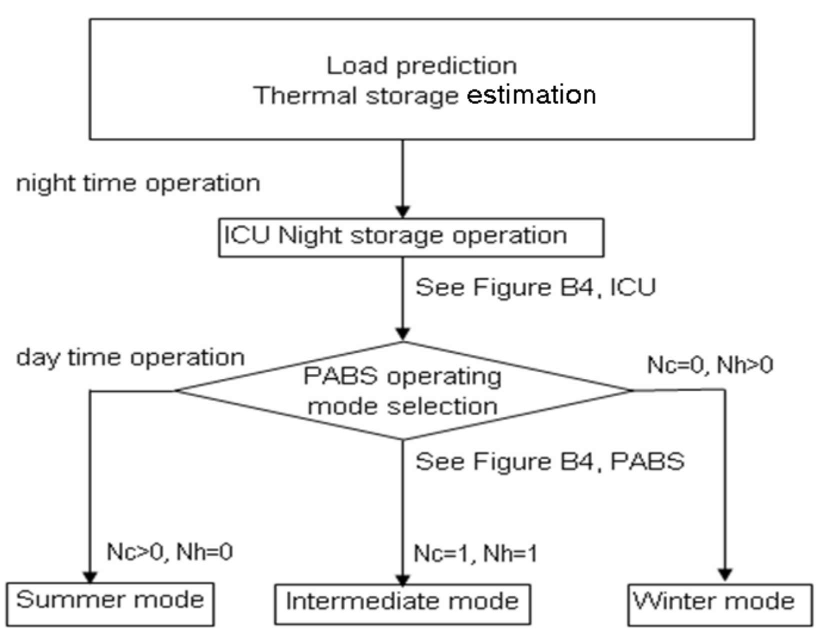
The secondary chilled water circulation pumps are operated under sequential control by the demand flow of the secondary circuit. The by-pass valves between chilled water supply and return are operated under PI control according to the differential pressure between the pipes. Controls for the secondary LTHW circulation pumps are the same as for the chilled water circulation pumps.

## B.2.5 Control flow chart diagram example 2

### B.2.5.1 General

The control flow chart method can be used for description and documentation of control interlocks.

### B.2.5.2 Predicted operating mode selection



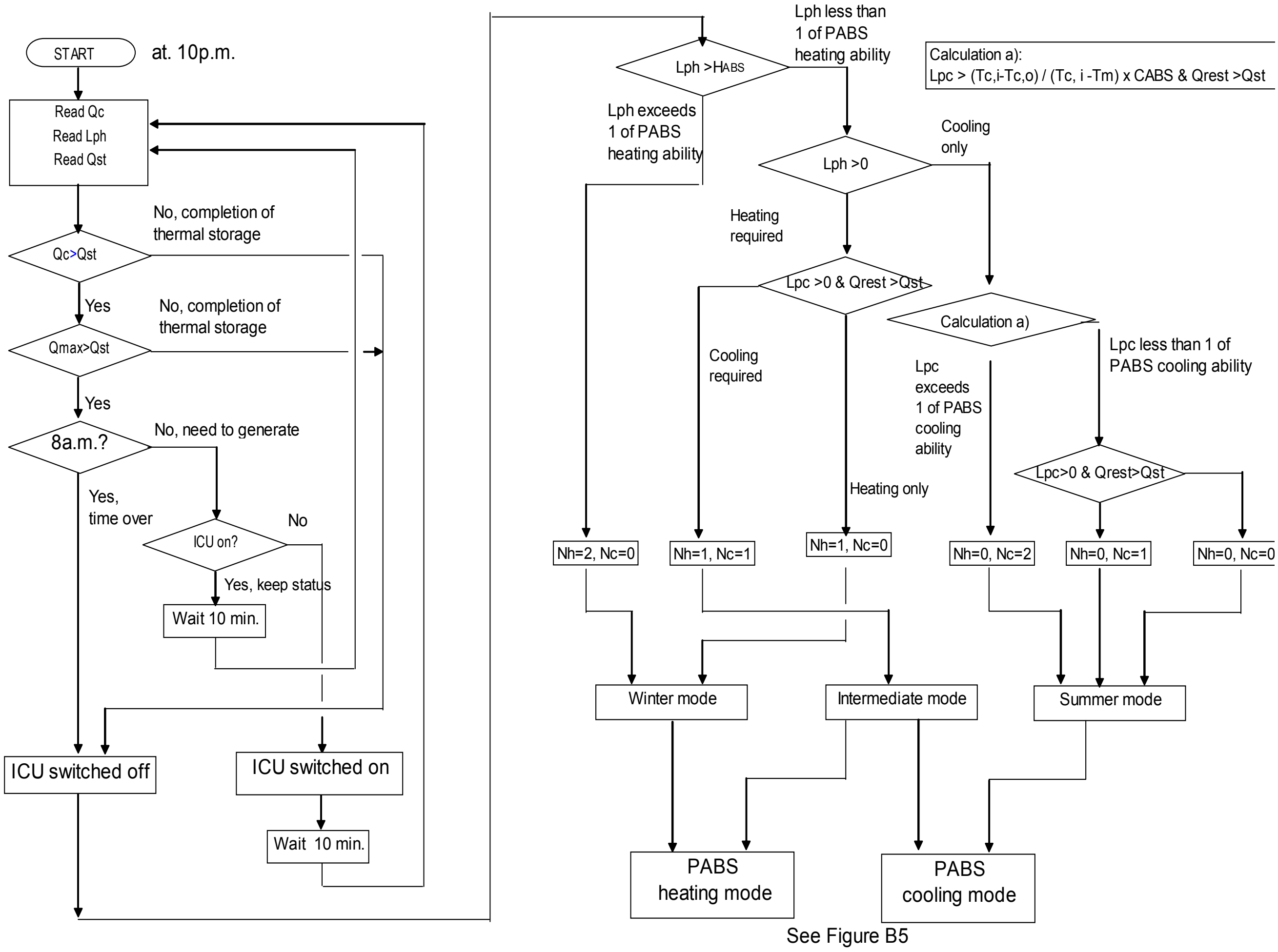

**Key**

Nc Number of PABS in operation on cooling mode
Nh Number of PABS in operation on heating mode

NOTE Cooling/heating load is predicted up to next 24 h at every one hour
Daily cooling load is total cooling load that is predicted in next 24 h
Maximum cooling load is peak cooling demand that is predicted until the end of daytime operation
Maximum heating load is peak heating demand that is predicted until the end of daytime operation
Present amount of ice is estimated every 10 min.

**Figure B.3 – Control flow chart for operating mode prediction**

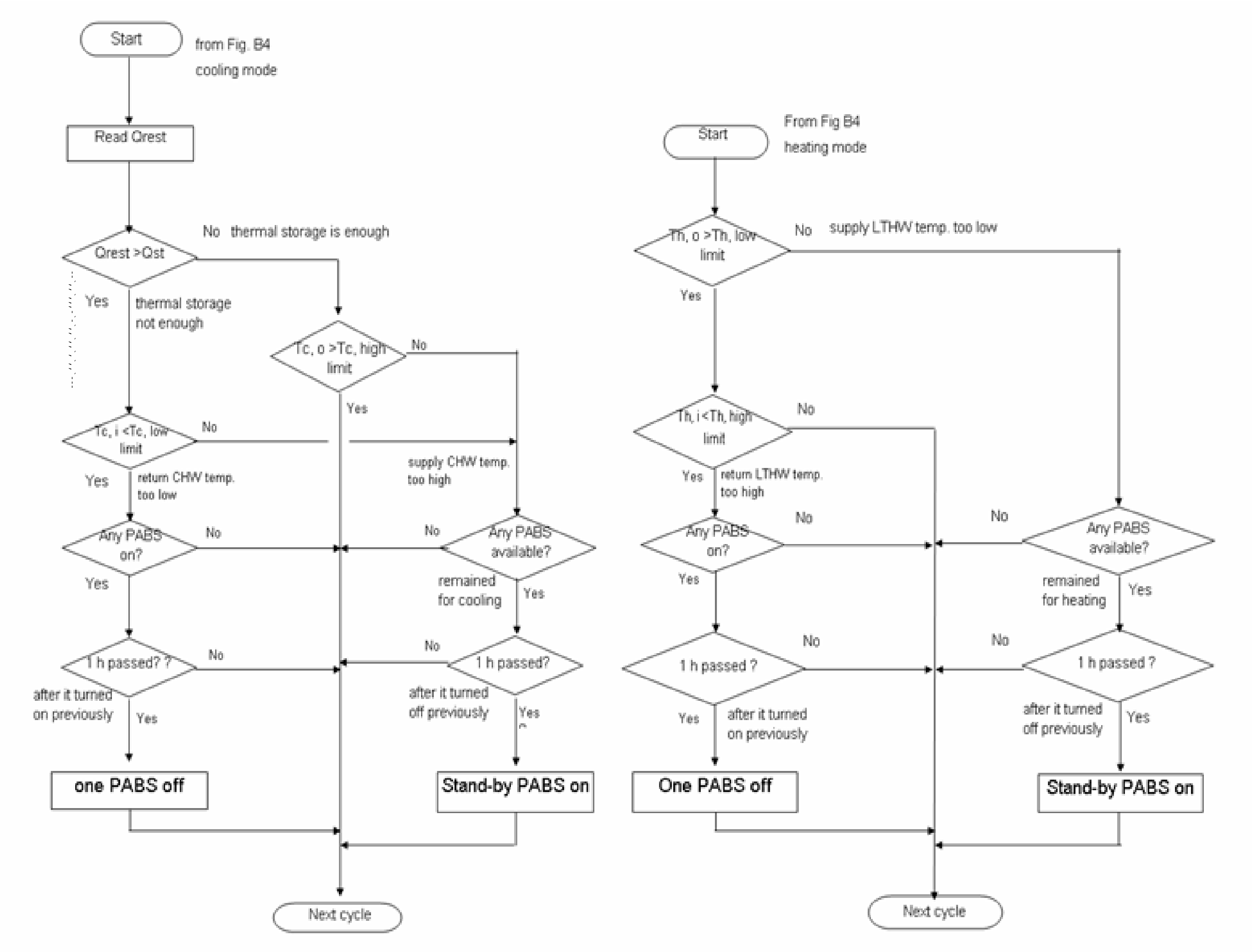
### B.2.5.3 ICU operation and operating mode heating /cooling for PABS




**Key**

| | |
|---|---|
| CABS | Cooling ability of one PABS unit |
| HABS | Heating ability of one PABS unit |
| Lpc | Maximum cooling load |
| Lph | Maximum heating load |
| Nc | Number of PABS in operation on cooling mode |
| Nh | Number of PABS in operation on heating mode |
| Qc | Daily cooling load |
| Qmax: | Maximum capacity of thermal storage |
| Qrest: | Predicted sum of cooling load for residual time of the day |
| Qst | Present amount of ice storage |
| Tc, o: | Delivery chilled water temperature from ICU; (14) |
| Tc, i: | Returned chilled water temperature to PABS (17) |
| Tc, i, low limit | Allowable lowest chilled water inlet temperature to PABS |
| Tc, s, hi. limit | Allowable highest delivery temperature from ICU to AHU |
| Tm: | Delivery chilled water temperature from PABS (15) |

**Figure B.4 – ICU operation and operating mode heating /cooling for PABS**




**Key**

| | |
|---|---|
| Tc, o | Delivery chilled water temperature from ICU (14) |
| Tc, i | Returned chilled water temperature to PABS (17) |
| Tc, high limit | Allowable highest delivery temperature from ICU to AHU |
| Tc, low limit | Allowable lowest chilled water inlet temperature to PABS |
| Th | Temperature in operating mode heating |
| Th, i | Returned heating water temperature to PABS (20) |
| Th, o | Delivery heating water temperature from PABS (15) |
| Th, high limit | Allowable highest returned heating water temperature from AHU to PABS |
| Th, low limit | Allowable lowest delivery heating water temperature to AHU |
| Qrest | Predicted sum of cooling load for residual time of the day |

**Figure B.5 – Selection of cooling/heating operation**

## B.2.6 BACS points list example 2

**Table B.2 – BACS point list example 2**

1) Steady state output, e.g.: 0,I,II=2 BO
Pulsed output, e.g.: 0,I,II=3 BO
Positioning outp. close-0-open=2 BO
Puls width modulation output=1 BO

2) Active or passive

3) Only shared (networked) I/O data points from third party systems for interoperable functions

4) Per input point address for collected, delayed or suppressed informations

5) Per output point address

6) For cooling / heating use 2x on / off conversions

7) Per input point address

8) e.g. Schedule, Life safety, Loop, File (see ISO 16484-5)

9) if required, indicate whether applies to client devices "A" or server devices "B"; (see BIBBs in EN ISO (DIS) 16484-5)

Type of service: HVAC

Plant: Example for energy plant with double effect absorption heat pump for heating and cooling

**Part 1 – I/O functions and processing functions (Monitoring, Interlocks)**

| Row No. | Point description and Pt.No. or name | I/O functions – Physical | | | | | I/O functions – Shared I/O 3), 9) | | | | | Monitoring | | | | | | Interlocks | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Binary output switching/positioning 1) | Analog output positioning | Binary input state | Binary input counting | Analog input 2) | Binary value (output), switching | Analog value (output), positioning/setpt. | Binary value (input), state | Accumulated/totalized value (input) | Analog value (input), measuring | Fixed limit | Sliding limit | Run time totalization | Event counting | Command execution check | State processing 4) | Plant control | Motor control | Switchover 5) | Step control 5) | Safety / Frost protection control |
| | Section No. | 1 | | | | | 2 | | | | | 3 | | | | | | 4 | | | | |
| | Column No. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 |
| 1 | Energy plant general | | | | | | | | | | | | | | | | | 1 | | | | |
| 2 | ICU manual - automatic | | | 1 | | | | | | | | | | | | | | | | | | |
| 3 | ICU autom. on-off | 1 | | | | | | | | | | | | | | 1 | | | 1 | | 1 | |
| 4 | ICU state | | | 1 | | | | | | | | 1 | | 1 | | | | | | | | |
| 5 | ICU fault | | | 1 | | | | | | | | | | | | | | | | | | |
| 6 | Absorption chiller/heater 1-2 m-a | | | 2 | | | | | | | | | | | | | | | | | | |
| 7 | Absorption chiller/heater 1-2 aut. on-off | 4 | | | | | | | | | | 2 | | 2 | | 4 | | | 4 | 2 | 4 | |
| 8 | Absorption chiller/heater 1-2 state | | | 4 | | | | | | | | | | | | | | | | | | |
| 9 | Absorption chiller/heater 1-2 fault | | | 2 | | | | | | | | | | | | | | | | | | |
| 10 | Primary pump 1-3 m-a | | | 3 | | | | | | | | | | | | | | | | | | |
| 11 | Primary pump 1-3 automatic on-off | 3 | | | | | | | | | | 3 | | 3 | | 3 | | | 3 | | | |
| 12 | Primary pump 1-3 state | | | 3 | | | | | | | | 3 | | 3 | | | | | | | | |
| 13 | Primary pump 1-3 fault | | | 6 | | | | | | | | | | | | | 3 | | | | | |
| 14 | Temperature ICU output | | | | | 1 | | | | | | 1 | | | | | | | | | | |
| 15 | Temperature ABS/H1-2 output | | | | | 2 | | | | | | 4 | | | | | | | | | | |
| 16 | Temperature CHW supply | | | | | 1 | | | | | | 2 | 1 | | | | | | | | | |
| 17 | Temperature CHW return | | | | | 1 | | | | | | 1 | | | | | | | | | | |
| 18 | Flow rate CHW / heat capacity | | | | | 1 | | | | | | 1 | | | | | 1 | | | | | |
| | Over / Totals | 8 | | 23 | | 6 | | | | | | 18 | 1 | 9 | | 8 | 4 | 1 | 8 | 2 | 5 | |

**Part 2 – Processing functions (Closed loop control, Calculation / Optimization), Management functions, Operator functions, Remarks**

| Row No. | Point description and Pt.No. or name | Closed loop control | | | | | | | | Calculation / Optimization | | | | | | | | | | | | | Management functions | | | | Operator functions | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P control loop | PI / PID control loop | Sliding- / Curve setpoint | Proportional output stage | Proportional to on/off conversion 6) | Proportional to pulse width modulation | Setpoint / Output limitation | Switchover of parameters | h,x directed control 7) | Arithmetic calculation 7) | Event switching | Time schedule | Optimum start / stop | Duty cycling | Night cooling | Room temperature limitation | Energy recovery | Backup power operation | Main power recovery pogram | Peak load limitation | Energy tariff dependent switching | Input / Output / Value object types 9) | Complex object types 8) 9) | Event storage | Historical database | Graphic / Plant schematic | Dynamic display | Event instruction text | Remote messaging | NOTE: Definition of functions in EN ISO (FDIS) 16484-3; indicate project specific function descriptions in the points row as e.g.: s.c) X spec.# s=section; c=column; X=non standard function description; BIBBs=BACnet Interoperability Building Blocks |
| | Section No. | 5 | | | | | | | | 6 | | | | | | | | | | | | | 7 | | | | 8 | | | | |
| | Column No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| 1 | Energy plant general | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | Interlocks from Row 34 load prediction and Row 35 |
| 2 | ICU manual - automatic | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 | | | (for manual op. state see state Row 4) |
| 3 | ICU autom. on-off | | | | | | | | | | | 1 | 1 | | | | | | | | | | | | 2 | | | 2 | | | 4.2) interlocks (no motor); 4.4) with PABS 1+2<br>6.3) off - from prediction calculation R34, C3.1 |
| 4 | ICU state | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | 2 | | | |
| 5 | ICU fault | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | 1 | | 1 | 8.4) pager |
| 6 | Absorption chiller/heater 1-2 m-a | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | 2 | | | (for manual op. state see state Row 8) |
| 7 | Absorption chiller/heater 1-2 aut. on-off | | | | | | | | | | | 2 | | | | | | | | 2 | | | | | 5 | | | 5 | | | 4.2) interlocks (no motor); 1.1, 4.2, 4.4) per mode heat./chill.<br>6.3) off from prediction calculation R34, C3.1 |
| 8 | Absorption chiller/heater 1-2 state | | | | | | | | | | | | | | | | | | | | | | | | 4 | | | 4 | | | **1.3) per mode heat / chill.** |
| 9 | Absorption chiller/heater 1-2 fault | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | 2 | | 4 | **8.4) pager and fax to producer** |
| 10 | Primary pump 1-3 m-a | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | 3 | | | **(for manual op. state see state Row 12)** |
| 11 | Primary pump 1-3 automatic on-off | | | | | | | | | | | 3 | | | | | | | | | | | | | 3 | | | 3 | | | 4.2 interlocked with PABS/ICU<br>6.3) off from prediction calculation R34, C3.1 |
| 12 | Primary pump 1-3 state | | | | | | | | | | | | | | | | 3 | | | | | | | | 3 | | | 3 | | | |
| 13 | Primary pump 1-3 fault | | | | | | | | | | | | | | | | | | | | | | | | 6 | | | 6 | | 3 | **3.6) for collected alarm to pager** |
| 14 | Temperature ICU output | | | | | | | | | | 1 | | | | | | | | | | | | | | 1 | 1 | | 2 | | | for CHW output temp.; 3.1) high lim.<br>control is internal of packaged unit |
| 15 | Temperature ABS/H1-2 output | | | | | | | | | | 1 | | | | | | | | | | | | | | 4 | 2 | | 6 | | | for CHW/HW output temp.; 3.1) high/low lim;<br>control is internal of packaged units |
| 16 | Temperature CHW supply | | 1 | | 1 | | | | | | 2 | | | | | | | | | | | | | | 1 | 1 | | 2 | | | 3.1 high+low limit.; 6.2) heat capacity calculation and PABS mode sel.; 5.4) to Row 32 CHW valve |
| 17 | Temperature CHW return | | | | | | | | | | 2 | | | | | | | | | | | | | | | 1 | | 1 | | | 3.1 low lim. to Row 35; 6.2) heat capacity calculation and PABS mode selection; |
| 18 | Flow rate CHW / heat capacity | | | | | | | | | | 1 | | | | | | | | | | | | | | | 2 | | 2 | | | 3.1, 3.6) to Row 23, 4.4; 6.2) heat capacity calculation; |
| | Over / Totals | | 1 | | 1 | | | | | | 7 | 6 | 1 | | | | 3 | | | 2 | | | | | 40 | 7 | 1 | 48 | | 8 | 218 |

| Issue Date jj-mm-dd | Author | Approved | Company | Project | Location of controls (MER) | File |
|---|---|---|---|---|---|---|
| Rev. 1 | JPN | HAK | | | | [B2-BACS-PL-ISO-xpl2.xls] |
| Rev. 2 | | | | Example: energy plant | Control diag. No. Example:<br>Rem.: for funct. R34/35, 6.2) see flow chart | page No. 1 |
| Rev. 3 | | | | | | of 2 |

## Table B.2 – BACS points list, example 2 (continued)

1) Steady state output, e.g.: 0,I,II=2 BO
Pulsed output, e.g.: 0,I,II=3 BO
Positioning outp. close-0-open=2 BO
Puls width modulation output=1 BO

2) Active or passive

3) Only shared (networked) I/O data points from third party systems for interoperable functions

4) Per input point address for collected, delayed or suppressed informations

5) Per output point address

6) For cooling / heating use 2x on / off conversions

7) Per input point address

8) e.g. Schedule, Life safety, Loop, File (see ISO 16484-5)

9) if required, indicate whether applies to client devices "A" or server devices "B"; (see BIBBs in EN ISO (DIS) 16484-5)

| Row No. | Type of service: HVAC; Plant: Example for energy plant with double effect absorption heat pump for heating and cooling | I/O functions | | | | | | | | | | Processing functions | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Management functions | | | | Operator functions | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Physical | | | | | Shared I/O 3), 9) | | | | | Monitoring | | | | | | Interlocks | | | | | Closed loop control | | | | | | | | Calculation / Optimization | | | | | | | | | | | | | | | | | | | | | |
| | | Binary output switching/positioning 1) | Analog output positioning | Binary input state | Binary input counting | Analog input 2) | Binary value (output), switching | Analog value (output), positioning/setpt. | Binary value (input), state | Accumulated/totalized value (input) | Analog value (input), measuring | Fixed limit | Sliding limit | Run time totalization | Event counting | Command execution check | State processing 4) | Plant control | Motor control | Switchover 5) | Step control 5) | Safety / Frost protection control | P control loop | PI / PID control loop | Sliding- / Curve setpoint | Proportional output stage | Proportional to on/off conversion 6) | Proportional to pulse width modulation | Setpoint / Output limitation | Switchover of parameters | h,x directed control 7) | Arithmetic calculation 7) | Event switching | Time schedule | Optimum start / stop | Duty cycling | Night cooling | Room temperature limitation | Energy recovery | Backup power operation | Main power recovery pogram | Peak load limitation | Energy tariff dependent switching | Input / Output / Value object types 9) | Complex object types 8) 9) | Event storage | Historical database | Graphic / Plant schematic | Dynamic display | Event instruction text | Remote messaging | NOTE: Definition of functions in EN ISO (FDIS) 16484-3; indicate project specific function descriptions in the points row as e.g.: s.c) X spec.# s=section; c=column; X=non standard function description; BIBBs=BACnet Interoperability Building Blocks |
| | Point description — Section No. | 1 | | | | | 2 | | | | | 3 | | | | | | 4 | | | | | 5 | | | | | | | | 6 | | | | | | | | | | | | | 7 | | | | 8 | | | | |
| | point name or No. — Column No. | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | |
| | Over | 8 | | 23 | | 6 | | | | | | 18 | 1 | 9 | | 8 | 4 | 1 | 8 | 2 | 5 | | | 1 | | 1 | | | | | | 7 | 6 | 1 | | | | 3 | | | 2 | | | | | 40 | 7 | 1 | 48 | | 8 | 218 |
| 19 | Temperature HW supply | | | | | 1 | | | | | | 2 | 1 | | | | | | | | | | | 1 | | 1 | | | | | | 2 | | | | | | | | | | | | | | | 1 | 1 | | 2 | | | 3.2 high+low limit.; 6.2) heat capacity calculation and PABS mode sel.; 5.4) to Row 32 HW valve |
| 20 | Temperature HW return | | | | | 1 | | | | | | 1 | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | 1 | | 1 | | | 3.1 low lim. to Row 35; 6.2) heat capacity calculation and PABS mode selection; |
| 21 | Flow rate HW / heat capacity | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | 2 | | 2 | | | 6.2) heat capacity calculation; 8.2) flow and heat capacity |
| 22 | Secondary CHW pump 1-2 m-a | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | 2 | | | (for manual op. state see state Row 24) |
| 23 | Secondary CHW pump 1-2 aut.on-off | 2 | | | | | | | | | | | | | 2 | 2 | | | 2 | 2 | 2 | | | | | | | | | | | | | | | | | | | | 2 | | | | | 5 | | | 4 | | | 4.4) from Row 18; 7.3) state, starts count, runtime, runtime limit, exec. check alarm |
| 24 | Secondary CHW pump 1-2 state | | | 2 | | | | | | | | 2 | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 1 | | 4 | | | |
| 25 | Secondary CHW pump 1-2 fault | | | 4 | | | | | | | | | | | | | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | | | 4 | | 1 | 3.6) for collected alarm to pager |
| 26 | Secondary HW pump 1-2 m-a | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | 2 | | | (for manual op. state see state Row 28) |
| 27 | Secondary HW pump 1-2 autom. on-o | 2 | | | | | | | | | | | | | 2 | 2 | | | 2 | 2 | 2 | | | | | | | | | | | | | | | | | | | | 2 | | | | | 5 | | | 4 | | | 4.4) from Row 21; 7.3) state, starts count, runtime, runtime limit, exec. check alarm |
| 28 | Secondary HW pump 1-2 state | | | 2 | | | | | | | | 2 | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 1 | | 4 | | | |
| 29 | Secondary HW pump 1-2 fault | | | 4 | | | | | | | | | | | | | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | 1 | 3.6) for collected alarm to pager |
| 30 | Differential Pressure gauge CHW | | | | | 1 | | | | | | | 1 | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | 1 | 1 | | 3 | | | **5.4) to Row 32; 8.2) value, limit, loop** |
| 31 | Differential Pressure gauge HW | | | | | 1 | | | | | | | 1 | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | 1 | 1 | | 3 | | | **5.4) to Row 33; 8.2) value, limit, loop** |
| 32 | By-pass valves CHW / HW | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | 1.2) CHW from 5.4, Row 16, and HW from Row 19 |
| 33 | Change over valves | 8 | | | | | | | | | | | | | | | | | | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | 8 | | | 7.3) heating/cooling mode |
| 34 | Weather station / load prediction | | | | | 5 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | 5 | | | | | | | | | | | | | | | 5 | | 5 | | | 1.4) temp, humid.,. pessure, wind, radiation 3.1) off event for ICU and PABS h/c mode |
| 35 | Load prediction for operating modes | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 | | | 5 | | | 7.3/8.2) op.mode: day, night, summer, intermed. winter, heatg, coolg., input Row 14-17, 19,20, 34 |
| | **Totals** | 20 | 2 | 39 | | 16 | 5 | | | | | 25 | 4 | 13 | 4 | 12 | 12 | 1 | 12 | 14 | 9 | | | 4 | | 4 | | | | | | 17 | 6 | 1 | | | | 3 | | | 6 | | | | | 76 | 20 | 1 | 103 | | 10 | 439 |

| Issue Date jj-mm-dd | | Author | Approved | Company | Project | Location of controls (MER) | File [B2-BACS-PL-ISO-xpl2.xls] |
|---|---|---|---|---|---|---|---|
| Rev. 1 | | JPN | HAK | | Example: energy plant | Control diag. No. Example: | Page No. 2 |
| Rev. 2 | | | | | | Rem.: for funct. R34/35, 6.2) see flow chart | of 2 |
| Rev. 3 | | | | | | | |

# Bibliography

[1] IEC 60050-351; *International Electrotechnical Vocabulary - Part 351: Automatic control*.

[2] ANSI/ASHRAE Standard 135-2001; *BACnet A Data Communication Protocol for Building Automation and Control Networls.*

[3] EN 61131-3; *Programmable controllers – Part 3: Programming languages (IEC 61131-3:1993).*

[4] EN ISO 10628, *Flow diagrams for process plants – General rules (ISO 10628:1997).*

**ICS 91.040.01**

Price based on 74 pages