BS EN 12098-3:2013

BSI Standards Publication

Controls for heating systems

Part 3: Control equipment for electrical heating systems

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National foreword

This British Standard is the UK implementation of EN 12098-3:2013. It supersedes BS EN 12098-3:2002 and BS EN 12098-4:2005 which are withdrawn.

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

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2013

ISBN 978 0 580 75431 9
ICS 97.100.10; 97.120

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2013.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12098-3

October 2013

ICS 97.100.10; 97.120

Supersedes EN 12098-3:2002, EN 12098-4:2005

English Version

Controls for heating systems - Part 3: Control equipment for electrical heating systems

Régulation pour les systèmes de chauffage - Partie 3: Équipement de régulation pour les systèmes de chauffage électrique

Mess-, Steuer- und Regeleinrichtungen für Heizungen - Teil 3: Regeleinrichtungen für Elektroheizungen

This European Standard was approved by CEN on 14 September 2013.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 12098-3:2013: E

Contents

Page

Foreword

This document (EN 12098-3:2013) has been prepared by Technical Committee CEN/TC 247 “Building, Automation, Controls and Building Management”, the secretariat of which is held by SNV.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2014, and conflicting national standards shall be withdrawn at the latest by April 2014.

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

This document supersedes EN 12098-3:2002 and EN 12098-4:2005.

The following modifications have been made:

— update of the state of the art of the platform used for the controllers (between first edition – still analogical technology – to day full DDC with µC);

— test specification has been revised and described more precisely;

— block diagram for functions has been added;

— graphical symbols have been added.

This standard is for products for Outside Temperature Compensated Controls for mechanical building services and covers Outside Temperature Compensated Controls in residential and non-residential buildings. This standard is part of a series of European Standards for Control for HVAC Applications. This standard, therefore, contributes to the general European policy for energy saving, particularly in the fields of the Construction Products Directive (89/106/EEC) Essential Requirements n°6 "Energy economy and heat retention" (and its interpretative document) and of the Energy Performance of Building Directive (2002/91/CE).

EN 12098, *Controls for heating systems*, consists of the following parts:

— *Part 1: Control equipment for hot water heating systems*

— *Part 3: Outside temperature compensated control equipment for electrical heating systems* (the present document)

— *Part 5: Start-stop schedulers for heating systems*

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

Introduction

Equipment which controls the heating supply in buildings according to outside temperature and time is necessary for the reduction of the energy consumption of heating plants. This equipment can bring about improved comfort and energy savings.

For this purpose, an outside temperature compensated function like that provided by an outside temperature compensated (OTC) controller is necessary.

This standard describes the main equipment characteristics and functions for reaching energy saving and comfort objectives.

This standard covers also controllers which contain an integrated optimum start or an optimum start-stop control function.

1 Scope

This European Standard applies to electronic control equipment for heating systems with direct electrical emission, which do not have an integrated outdoor compensated function and or optimum start/stop function.

This control equipment controls and regulates the distribution and/or the generation of heat in relation to the outside temperature and time and other reference variables.

This European Standard also covers controllers which contain an integrated optimum start or an optimum start-stop control function. The controller modulates heating or control modes of electronic individual zone or emitter control equipment.

Safety requirements on heating systems remain unaffected by this standard. The dynamic behaviour of the local thermostats, sensors, or actuators is not covered in this standard.

A multi-distribution and/or multi-generation system needs a coordinated solution to prevent undesired interaction and is not part of this standard.

2 Normative references

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

CEN/TS 15810, *Graphical symbols for use on integrated building automation equipment*

EN 60038, *CENELEC standard voltages (IEC 60038)*

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

EN 60730-1, *Automatic electrical controls for household and similar use — Part 1: General requirements (IEC 60730-1)*

3 Terms and definitions

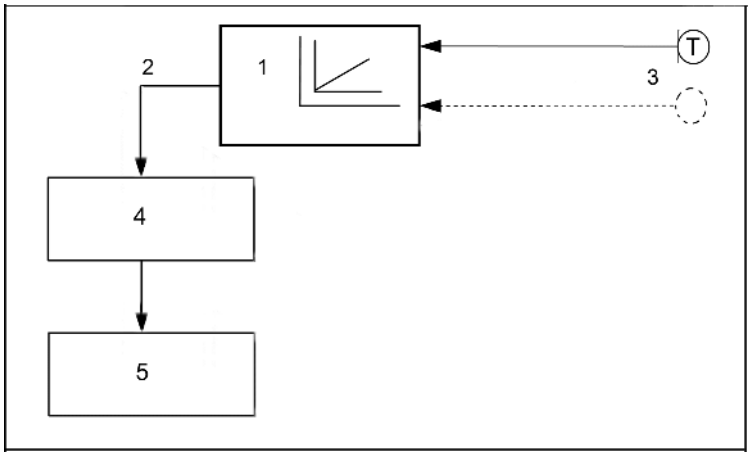
For the purposes of this document, the following terms and definitions apply.

3.1
outside temperature compensated controller
OTC controller
controller optimising and/or regulating the generation of heat in relation to the outside temperature, time and optionally other reference variables (e.g. room temperature)

Note 1 to entry: The outside temperature compensated function calculates the heating power in relation to the outside temperature, based on the heating curve.

Note 2 to entry: The outside temperature optimum start-stop function calculates the pre-heat time and/or stop time to reach the comfort temperature level in relation with the outside temperature, switch time and several parameters (e.g. room temperature, tariff).

3.2
control equipment
equipment, consisting of OTC controller sensor input signals and output signals but not including the sensors and actuating equipment (see Figure 1)



Key

1 OTC controller
2 output signals
3 input signals: reference variables
4 actuating equipment
5 heat generation and distribution

Figure 1 — Control equipment for electrical heating systems

3.3
actuating equipment
equipment by which the controller affects the controlled variable

3.4
controlled variable
heating emitted power

3.5
output signals
signals generated by the OTC controller for operating the local thermostat or the actuating equipment

3.6
reference variables (input signal)
outside temperature with or without other influences or variables (e.g. room temperature) used to determine the set point of the controlled variable

3.7
outside temperature
reference variable that is measured with a sensor fitted outside the building, mainly intended to measure the air temperature

3.8
room temperature
resulting temperature in the building arising in comfort, economy or building protection operation mode of the OTC controller

Note 1 to entry: Room temperature can be different for individual rooms.

3.9
characteristic heating curve
relation between the set point value of the controlled variable (heating) and the reference variables (outside temperature) defined by two or more parameters and depending on operation mode and additional variables

Note 1 to entry: The heating is calculated as a function of the heating curve, based on the outside temperature and the present room temperature set point.

3.10
comfort operation mode
mode of operation between the switch-on time and the switch-off time, maintaining comfort room temperature

Note 1 to entry: Mode of operation for normally occupied rooms.

3.11
economy operation mode (reduced mode)
mode of operation between the switch-off time and the switch-on time, maintaining a reduced room temperature compared to the comfort room temperature

3.12
building protection operation mode
mode of operation between the switch-off time and the switch-on time, maintaining a room temperature required for building protection

3.13
automatic operation mode
mode of operation of equipment when significant control functions are not overridden by the user

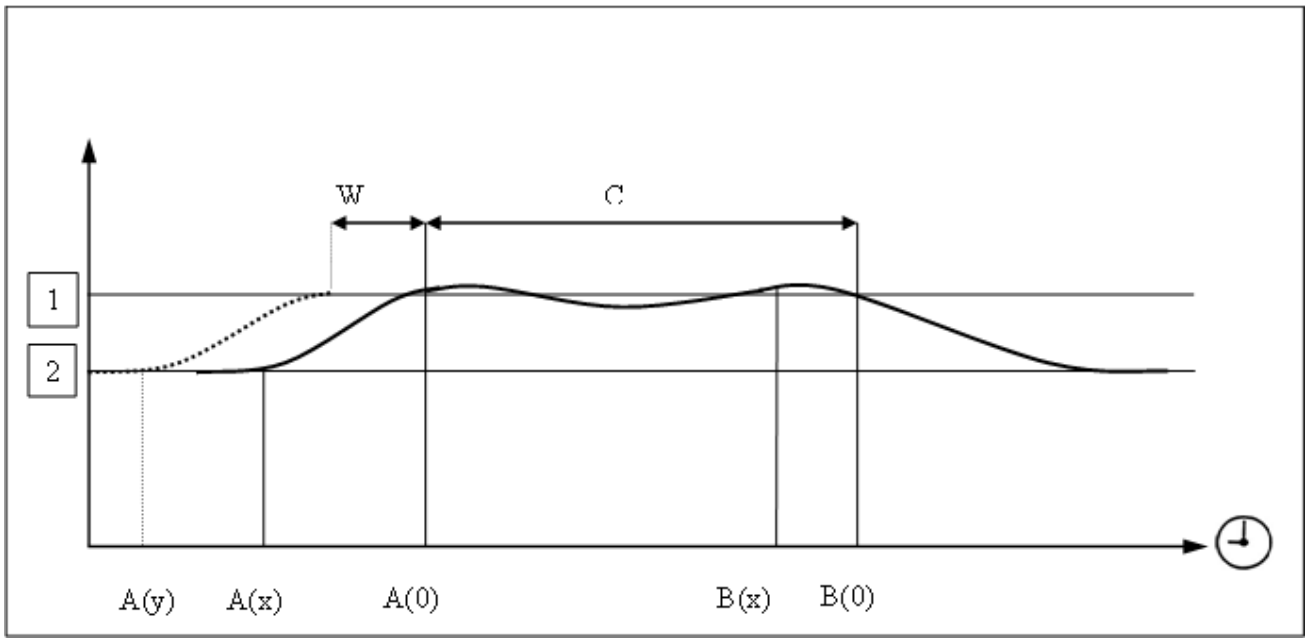
Note 1 to entry: During automatic operation mode, operation mode is selected automatically according to the scheduler, actual date and time.

3.14
summer/winter switch function
seasonal switch on/off of the heating depending on a function of the outside temperature

3.15
set back function
function, starting when the operation mode changes from comfort to economy or building protection mode

Note 1 to entry: During set back period, the heating is switched off until the calculated or measured room temperature drops below the economy or building protection set point; the operation mode switches back to comfort mode or the calculated switch-on time of the optimization start function is reached.

3.16
optimum start function
function, calculating the optimum pre-heat time to reach the comfort temperature level at the beginning of the comfort time period (see Figure 2) and possibly in relation with energy price rate (see Figure 5)



Key

1 comfort room temperature

2 reduced room temperature

A(0) beginning of comfort occupation period

A(x) switch-on time with start optimization (variable start)

A(y) switch-on time without start optimization (fixed start)

B(0) end of comfort occupation period without stop optimization (fixed stop)

B(x) switch-off time with stop optimization (variable stop)

C = A(0) - B(0): comfort occupation period

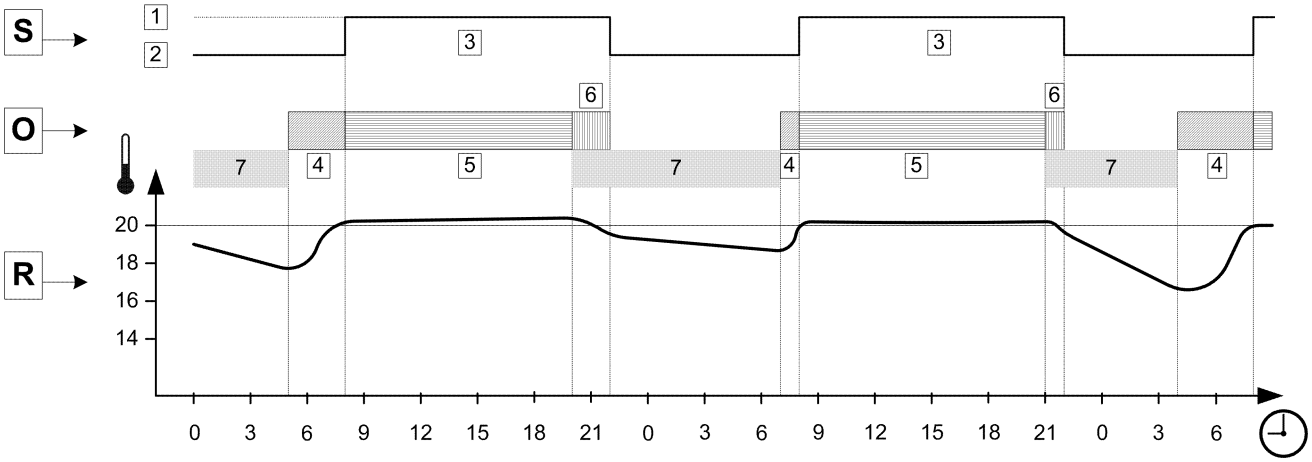
A(x) - A(0): optimum start period

B(x) - B(0): optimum stop period

W time period of wasted heat time (energy saving potential with start optimization)

Figure 2 — Temperature time curve with optimizer function

Note 1 to entry: The optimum start- and the optimum stop functions are illustrated by Figure 3. Heating periods are different from scheduled occupation periods. These differences, due to thermal inertia, depend mainly on heating loads (or temperature differences). A start and/or stop optimizer controls these switching points, using outside and/or room temperatures or their differences in relation to set points.



Key

S schedule occupation period
O heating operation status
R room temperature profile
1 comfort room temperature
2 reduced room temperature
3 comfort occupation period
4 optimum start period
5 main controller function
6 optimum stop period
7 set back period

Figure 3 — Example of optimum start- and stop function

3.17
adaptive optimum start function
added function to optimum start function, which recalculates the parameters used to determine the switch-on time, based on measured room temperature

3.18
optimum stop function
function, switching off or reducing the heat generation at the earliest possible point in time so that the room temperature will drop maximum 0,5 K below the comfort set point when the operation mode changes from comfort mode to economy or building protection mode (see Figure 2)

3.19
adaptive optimum stop function
added function to optimum stop function, which recalculates the parameters used to determine the switch-off time, based on measured room temperature

3.20
scheduler
function which switches heating modes affecting the heating control system (see Figure 3) according to a program

Note 1 to entry: The program includes memorized switch times, reproducing periods or periodic cycles, daily, weekly or yearly. The program may include periods of derogation.

3.21
switch points and time periods

3.21.1
switch on time
point in time at which the controller increases the heating in order to reach the comfort room temperature

Note 1 to entry: If the optimum start function is applied, the switch on time is automatically determined by the controller; otherwise it is determined by the scheduler.

3.21.2
optimum start period
operating pre heat period between the switch on time and the beginning of comfort occupation period

3.21.3
beginning of comfort occupation period
user programmed switch point when the comfort room temperature is reached

3.21.4
comfort occupation period
operating period during which comfort room temperature is maintained

3.21.5
end of comfort occupation period
user programmed switch point when the room temperature is allowed to decrease under the comfort room temperature

Note 1 to entry: The room temperature set point is switched to Economy and/or Building Protection set point.

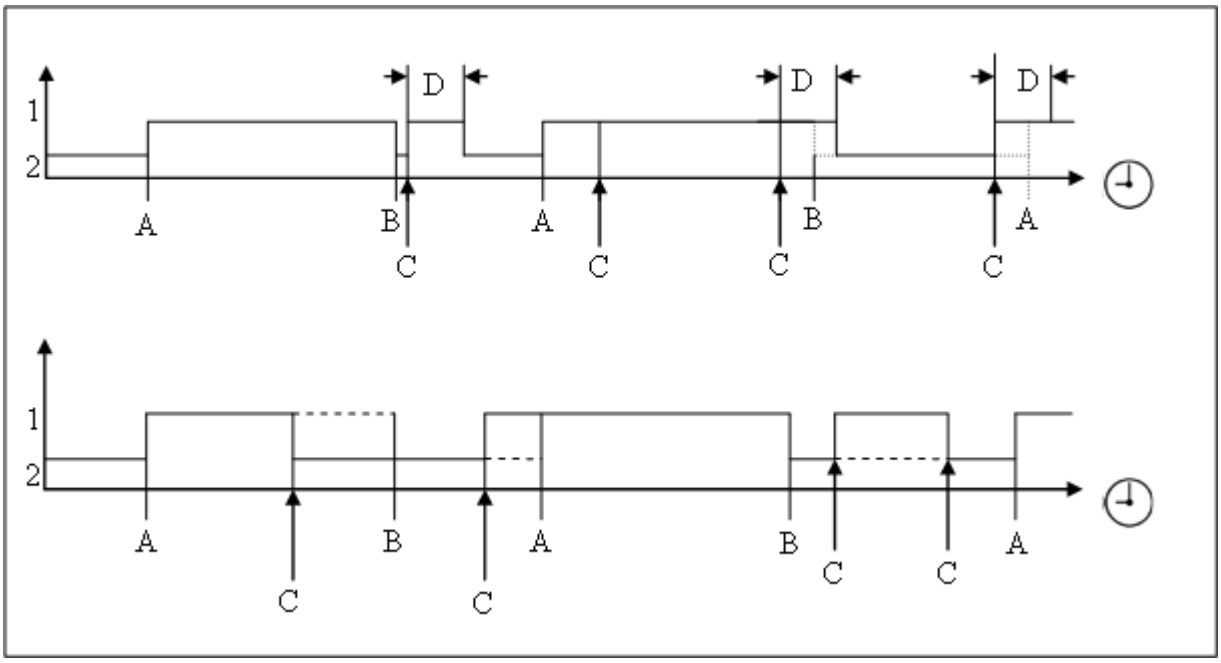
3.21.6
switch off time
point in time at which the controller switches off the heating

Note 1 to entry: If the optimum stop function is applied, the switch off time is automatically determined by the controller; otherwise it is determined by the scheduler.

3.21.7
optimum stop period
operating period between the optimal switch off time and the end of comfort occupation period

3.21.8
derogation function
temporary override of the program

Note 1 to entry: There are different possibilities for derogation functions. Two examples of temporary override of the program by derogation and recovery of the periodic program are shown in Figure 4:



Key

1 comfort room temperature

2 reduced room temperature

A and B are programmed switch times

C derogation manual start

D programmable duration

Upper Diagram: “derogation manual start” initiates a predefined timer which switches the mode to comfort. After the timer is elapsed, the mode defined by the scheduler is applied.

Lower Diagram: “derogation manual start” changes the mode until the next programmed switch time.

Figure 4 — Examples of derogation

3.22
rise in prices time
point in time at which the electricity cost rises (see Figure 5)

Note 1 to entry: If the price rate is provided to the controller, optimum start period may be anticipated for the lowest energy cost. This anticipation (high tariff optimum start) is calculated in relation with energy price rate and the period between rise in price time and the beginning of comfort occupation period.

3.23
energy price rate
rate of increasing price at rise in price time

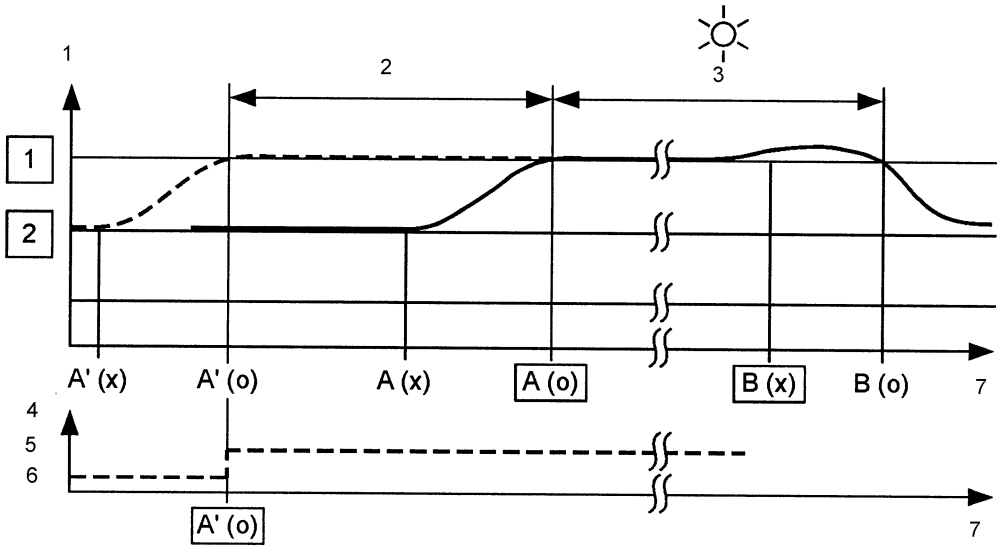
$$E_{PR} = \frac{P_2 - P_1}{P_2} \quad (1)$$

where

E_{PR} is the energy price rate;

P_1 is the low price of the energy;

P_2 is the high price of the energy.



Key

1 comfort room temperature

2 reduced room temperature

1 room temperature

2 high tariff optimum start period

3 schedule occupation period

4 tariff

5 high

6 low

7 time

A(o): beginning of the schedule occupation period (set by the user)

B(o): end of the schedule occupation period (set by the user)

A'(o): tariff increase time

B(x) : switch-off time with stop optimization (variable stop)

A(o) — B(o): comfort occupation period

A(x) — A(o) or A'(x) — A'(o): Optimum start period

B(x) — B(o): optimum stop period

A(x) or A'(x): switch-on time with start optimization (variable start)

A(o) — A'(o): High tariff period preceding the schedule occupation period (variable start)

Figure 5 — Temperature time curve for optimum switch on taking account of energy price

3.24
manual override operation
mode in which the controller is inactive and the actuating equipment can be manipulated manually

4 Functionality

4.1 Functional objective

The objective of outside temperature compensated control equipment is to save energy by performing these two main functions:

a) to control the generation and/or distribution of heat so that the room temperature is maintained at the desired level as determined by comfort and energy optimization criteria, estimating the heat demand from measurements of the outside temperature with or without other reference variables;

b) to alter the heat generation to follow a scheduled change in order to match occupancy patterns.

OTC control equipment also incorporates a frost protection function and a manual emergency operation mode.

4.2 Control equipment functionality

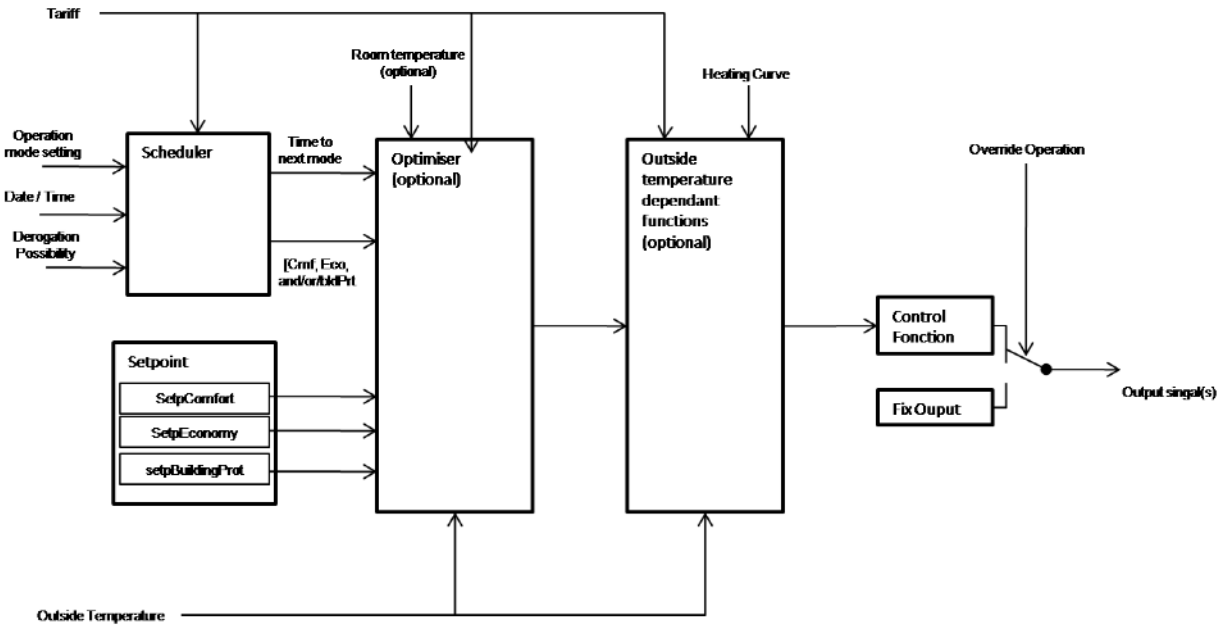


Figure 6 — Block-scheme of control equipment

5 Graphical symbols

Graphical symbols are described in CEN/TS 15810. Plain language may be used instead of, or in conjunction with, graphical symbols.

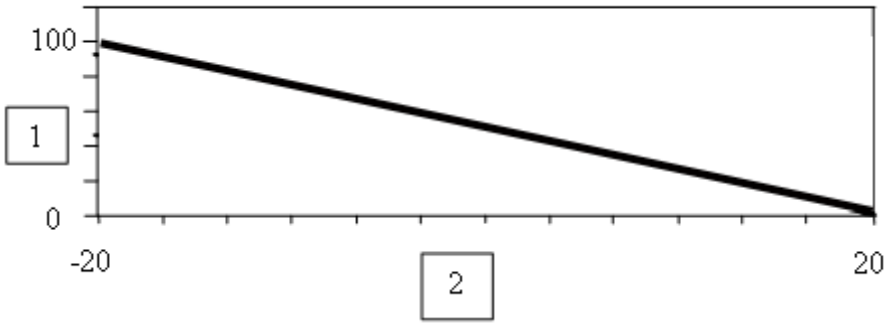
6 Requirements

6.1 Data protection

The actual time and date shall be retained for at least 12 h on failure of the power supply. All other data input on commissioning shall be retained.

6.2 Characteristic heating curve

The range of characteristic heating curve(s) shall be displayed graphically by the manufacturer on the unit and/or in the technical documents, e.g. as shown in Figure 7.



Key

1 heating power, % relative to maximum value

2 outside temperature

NOTE The graphical representation using a reversed temperature axis is also often used.

Figure 7 — Example of characteristic heating curves

The relations between the adjustable setting parameters and the characteristic heating curves shall be shown. The heating power shall not deviate from the characteristic heating curve by more than ± 5 %.

The characteristic heating curves shall be adaptable to the related building.

6.3 Input signal – Sensors

Table 1 — Sensor accuracy

	Temperature range	Sensor accuracy
Room temperature	+15 to +25 °C	±0,8 K
Outside temperature	-10 to +18 °C	±1,0 K

Outside these temperature ranges, no sensor accuracy is specified in this European Standard.

6.4 Controller operation modes

6.4.1 General

Controllers shall facilitate at least automatic operation mode, comfort operation mode and one reduced operation mode (economy / building protection). The current operation mode shall be displayed.

The following operation modes shall be available by switching manually:

— comfort,

— economy and/or building protection,

— automatic.

6.4.2 Comfort operation mode

Operation mode of occupied rooms. The heating power is a function of the heating curve, based on the outside temperature and the comfort room temperature set point.

6.4.3 Economy operation mode

Operation mode for rooms which do not need to be in the comfort operation mode for an extended period of time for energy saving.

The heating power is a function of the heating curve, based on the outside temperature and the economy room temperature set point.

For the change from comfort to economy operation mode, the controller shall allow a reduction of the heating power of at least 20 %.

6.4.4 Building protection operation mode

Mode of operation to protect the building from damages caused by low temperatures and humidity.

The controlled variable (i.e. heating power) is a function of the heating curve, based on the outside temperature and the building protection room temperature set point. The building protection set point temperature is below the economy set point temperature.

6.4.5 Automatic operation mode

The operation mode (Comfort, Economy and/or Building Protection) is selected automatically according to the scheduler, actual date and time.

6.5 Frost protection

In all operating modes (except for manual emergency operation mode operation), a frost protection function shall be effective if the outdoor temperature falls below 2 °C.

6.6 Additional functions

6.6.1 General

These functions are optional. If implemented, the requirements of the corresponding function in this subclause have to be fulfilled.

6.6.2 Summer/winter switch function

When the attenuated outside temperature exceeds the summer/winter heating limit, a change to summer operation will take place. When the attenuated outside temperature falls below the summer/winter heating limit, a change to winter operation will take place. The summer/winter heating limit shall be adjustable.

6.6.3 Set back function

During set back period, the reduced controlled variable (heating power) is valid. The function switches off the heat generation.

6.6.4 Optimum start function

The optimum start function calculates the pre-heat time to reach the comfort temperature level at the beginning of the comfort time period within a limit of +/- 30 min. Once the comfort level has been reached, the room temperature shall stay within +/- 0,5 K around the comfort room temperature.

6.6.5 Optimum stop function

The optimum stop function calculates the optimum switch-off time so that the room temperature at the end of the comfort period is within the allowable temperature decrease of -0,5 K of the comfort temperature level.

6.7 Switching times

An internal or external time switching function is required for changing operating modes. Setting and accuracy requirements for the switching times and clock are shown in Table 2.

Table 2 — Switching time and clock

	Switching Times			Clock	
	Minimum number of settings	**Resolution of settings**	**Accuracy**	**Resolution of settings**	**Accuracy**
Daily Clock	2/d	≤ 1 h	± 10 min	≤ 10 min	± 30 min/y
	4/d	≤ 15 min	± 10 min	≤ 1 min	± 30 min/y
Weekly Clock	2/d	≤ 2 h[a]	± 20 min	≤ 10 min	± 30 min/y
	4/d	≤ 15 min	± 10 min	≤ 10 min	± 30 min/y
Yearly Clock	2/d	≤ 2 h [a]	± 20 min	≤ 10 min	± 30 min/y
[a] The minimum switching period shall not be longer than 4 h.					

6.8 Override mode

Due to a failure of the connected hardware, like a sensor error or an abnormal operation of the control equipment, the heat flow may be interrupted.

For such abnormal situations, the control equipment shall have an override mode providing a possibility to restart the heat distribution.

This override mode shall be activated in a user-friendly way like a switch or an easy available parameter.

6.9 Parameter settings

The following setting facilities shall be provided for the user:

— actual time,

— switching times,

— characteristic heating curve parameters (e.g. gradient, offset, temperature set points).

6.10 Factory settings / default values

6.10.1 Characteristic heating curve

A factory setting of the heating curve has to be implemented in the OTC controller and described in the technical documentation.

6.10.2 Switching times / operating condition

The default time for a reduced temperature shall be a minimum of 8 h per day (e.g. 10 pm to 6 am). The default setting shall be described in the technical documentation.

6.11 Switching relays

The ratings of the relay contacts are to be declared in the technical documentation and shall be designed for the following minimum number of switching operations in Table 3.

Table 3 — Switching operations

Actuating equipment	Cycle during time	Number of switching operations
Switching Relays	See EN 60730-1	100 000

6.12 Electrical requirements

6.12.1 Electrical connections

The electrical connections to the main power supply and external cables shall be designed according to EN 60730-1.

6.12.2 Supply voltage

EN 60038 shall be applied for the selection of the nominal voltage of the controller.

6.12.3 Electrical safety

The controller shall be designed to comply with one of the following protective classes to EN 60730-1:

— Protective class I

— Protective class II

— Protective class III

6.12.4 Electromagnetic compatibility

The emissions of and immunity to electromagnetic interference shall satisfy the requirements of the EMC Directive.

6.13 Degree of protection

The degree of protection of the controller shall comply with EN 60529. The OTC controller shall fulfil at least IP 20.

6.14 Environmentally induced stress due to temperature

The OTC controller shall withstand the stress due to temperature according to Table 4.

Table 4 — Ambient temperatures

Product	Ambient temperature in operation	Ambient temperature transport and storage
Controller	+5 °C to + 50 °C	-20 °C to + 60 °C

6.15 Materials

The heat and fire resistance, creeping current and corrosion resistance shall correspond with the requirements of EN 60730-1.

6.16 Use of graphical symbols

Used graphical symbols shall be in accordance with CEN/TS 15810.

7 Test methods

7.1 Data Protection

The control unit shall be supplied with nominal voltage and put into operation. The data shall be set according to the manufacturer information. In case of control units with a re-chargeable power storage, the minimum charging time shall be completed before testing. The supply voltage shall be switched off for 12 h. It shall then be switched on again and tested for correct retention of data as time, date and parameters of heating curve.

7.2 Controller operation modes

Check if automatic, comfort and at least one reduced operation mode is provided by the controller.

To check the reduced operation mode, test points should be selected of the highest and lowest heating curve at an outside temperature of -10 °C.

7.3 Controller characteristic heating curve

This test will check the ability to adapt the controller to the building types and heating systems and confirms the accuracy of the equipment in controlling the manipulated variable to a selected manufacturer's curve.

The ability to adapt the controller to the building types and heating systems is tested using reference characteristic heating curves. Four reference characteristic heating curves were defined to represent the demand for heating energy of a reference building in relation to the temperature ranges defined in 6.2. They were derived from a thermal building simulation.

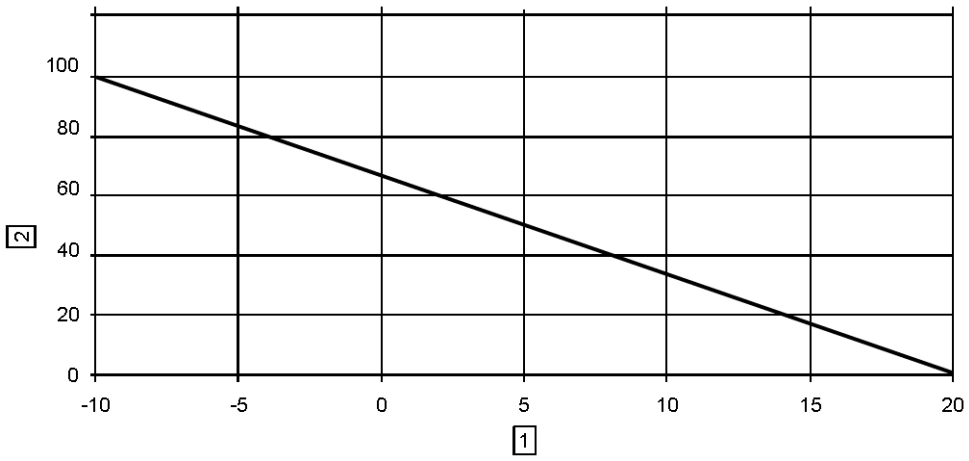
For the heating system to which the manufacturer claims support, the test has to be performed with the corresponding reference characteristic heating curve. For each of these referenced characteristic heating curves, a heating curve of the controller has to be selected. The heating curve in the controller has to be higher or equal to the corresponding reference characteristic heating curve.

The conformance of the implemented heating curve with the reference characteristic heating curve is tested for four load scenarios (outside temperatures).

All test conditions are listed in Table 5.

Table 5 — The reference heating curves for the four outside temperatures

Outside temperature	Heating on the reference heating curve
(T_O) [°C]	Heating relative to the maximum value %
-10	100 %
-2,5	75 %
5	50 %
12,5	25 %



Key

1 outside temperature

2 heating P % relative to the maximum value

Figure 8 — Graphical representation of the reference characteristic heating curves

The controller is connected to an outside temperature simulator which can either be a signal directly connected to the sensor input or a sensor placed in a controlled liquid bath.

In case of attenuated outside temperature, it is essential that the tester makes sure that the outside temperature value used to control the controlled variable is the required one.

For all of the selected scenarios of Table 5, the deviation of the measured relative heating power to the reference relative heating is calculated as follows:

$$\Delta P\ (T_0) = P\ (T_0) - P_{\text{Ref}}\ (T_0) \qquad (2)$$

where

$P\ (T_0)$ is the heating at outside temperature;

$P_{\text{Ref}}(T_0)$ is the heating power on the reference heating curve at the outside temperature;

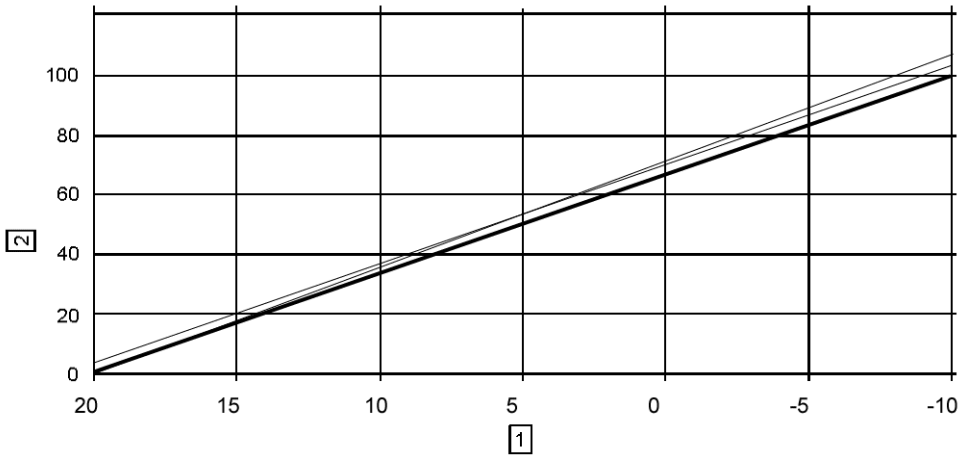
T_0: is the outside temperature.

The ability to adapt the heating curves to building types and heating systems is given, when the following criteria are met:

a) $\Delta P(T_0) > 0$;

b) $\Delta P(T_0) < 8$ % of $P_{\text{Ref}}(T_0)$; or

c) $\Delta P(T_0) < 4$ %.



Key

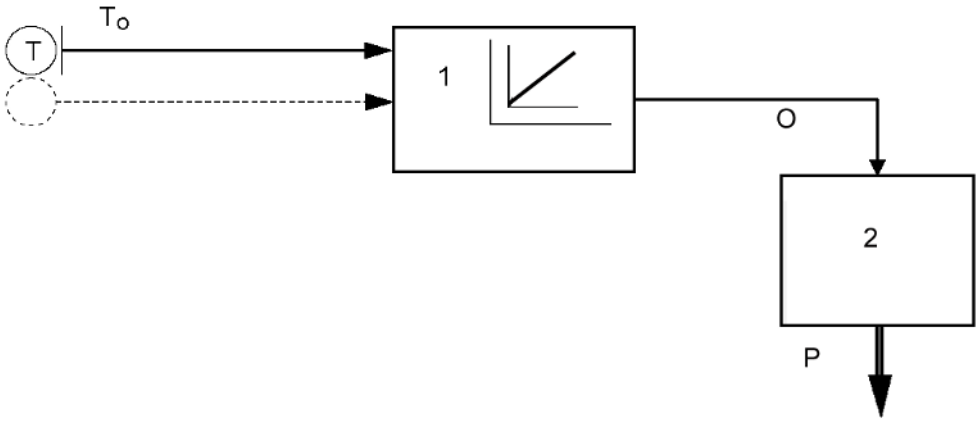
1 outside temperature T_0

2 heating relative to the maximum value P %

- lower limit: reference heating curve
- upper limit: highest of $\Delta P(T_0)$ criteria: 4 % or 8 % of $P_{\text{Ref}}(T_0)$

Figure 9 — Limits test of the accuracy of the heating curve

Figure 9 shows an example with limits of the accuracy of the selected heating curve in the controller compared to the reference heating curve. The controller heating curve test has passed successfully if it is included between reference heating curve and highest value of $\Delta P(T_0)$ = 4 % or $\Delta P(T_0)$ = 8 %.$P_{\text{Ref}}(T_0$ – 20 °C).



Key

1 OTC control device (device under test)

2 actuating equipment

O output signals

P measured relative heating

T_O outside temperature

Figure 10 — Test system block diagram

7.4 Frost protection

All relevant signals shall be on or fully open in all operating modes, except in override operation.

7.5 Switching times

The number of switching times per day and per week and their switching resolution and accuracy shall be visually checked to be in conformity with the requirements of Table 2 in 6.7.

The accuracy of the switching times is to be confirmed by switching from comfort mode to a reduced mode and reverse (complete cycle) by observing relevant output(s).

The resolution of settings and the accuracy of the clock have to be checked against the requirements of Table 2 in 6.7.

7.6 Manual override mode

When the OTC controller is set to manual override mode, the outputs of the system has to be checked against the requirement in 6.8.

7.7 Optimum start-stop function

7.7.1 General

This test checks if the controller is able to optimize the switch on and switch off times for the heating system.

The start-stop optimization test is done in a simulation environment. The real controller is connected to a simulated environment of the heating system and the building (represented by one single room). The simulation setup is illustrated in Figure 11.

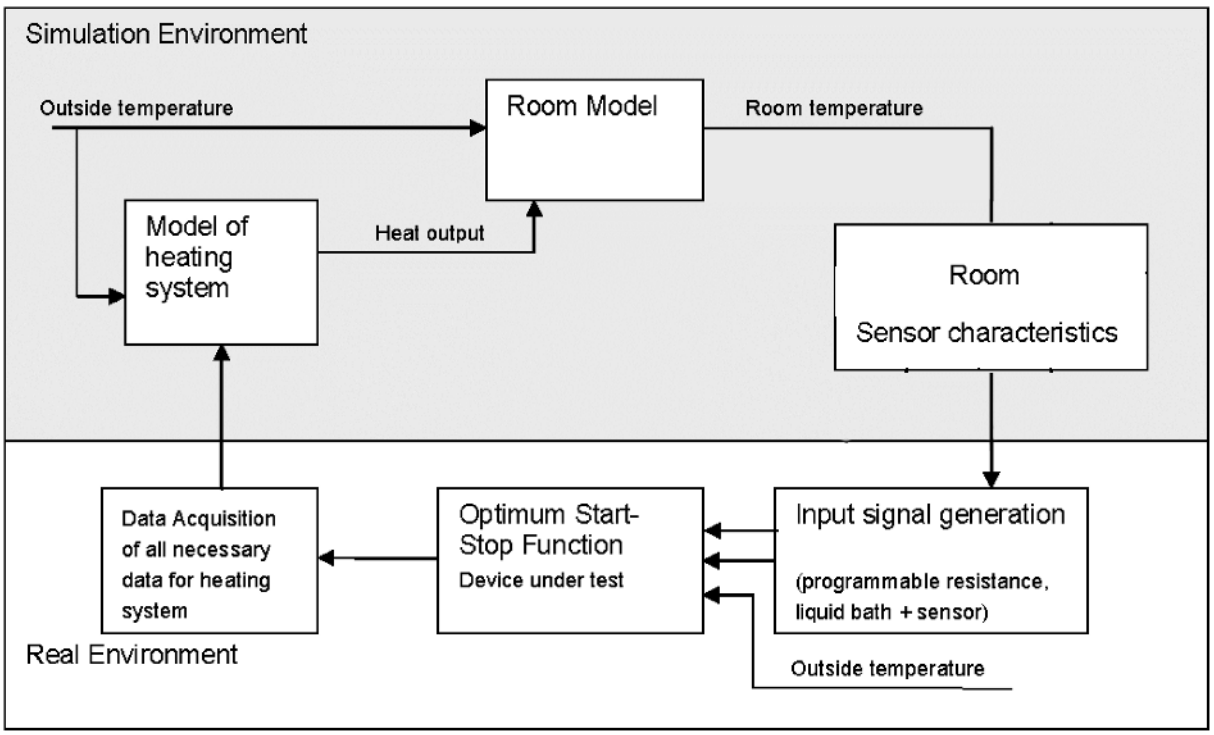
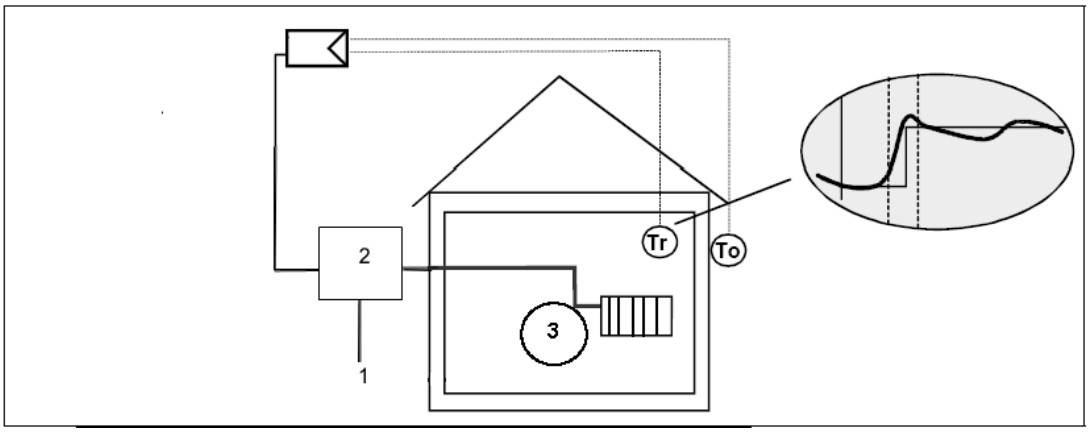


Figure 11 — Concept of the optimum start-stop simulation test

The block “Model of heating system” consist of the heat emission of an electrical emitter model.



Key

T_r room temperature

T_o outside temperature

1 mains electrical supply

2 actuating equipment

3 heat generation and distribution

Figure 12 — Model of the heating system

7.7.2 Test conditions

The test is performed for two different outside temperatures of +5 °C and -5 °C. The outside temperature is constant during a test run. The test shall be possible for controllers with and without a room temperature input.

7.7.3 Test run

The same constant outside temperature is applied to the controller and the simulation environment. The test starts during comfort operation mode. The test runs in real time.

The rise in prices time is placed during the comfort occupation period.

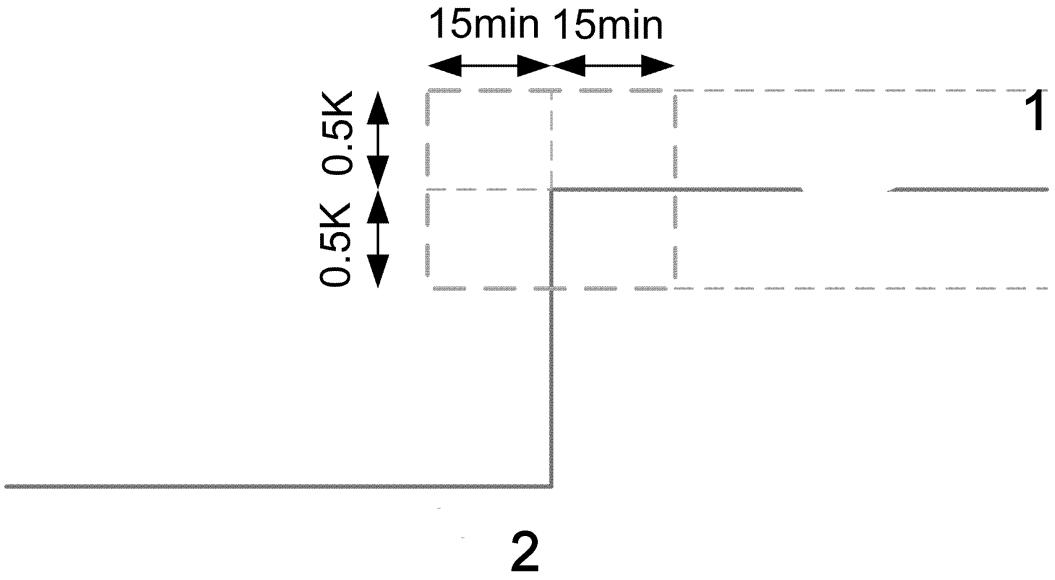
During an initialization phase, the controller and the simulation model shall be harmonized and the controller shall control the heating, according to the selected heating curve and outside temperature. The model calculates the heating. During the last two test hours, the comfort operation mode conditions are simulated. Then the test is performed according to the time table in Table 6.

Table 6 — Time table of optimization test

17:00	Test start – Comfort mode
22:00	Start of Economic mode
7:00	Start of Comfort mode
9:00	Test end – Comfort mode

7.7.4 Test results start optimization

The test result is the verification if the function is working properly. The time difference between the comfort temperature level is reached and the start of the comfort period shall be within +/- 30 min. Once the comfort level is reached, the room temperature shall stay within +/- 0,5 K around the comfort room temperature. The interpretation of the test results is illustrated in the following Figure 13 and Figure 14.

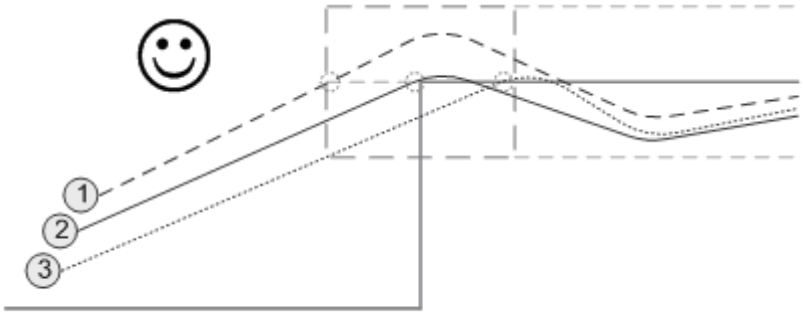


Key

1 comfort temperature level

2 beginning of the comfort time period

Figure 13 — Tolerances for time and temperature at the beginning of the comfort time period for an optimum start function

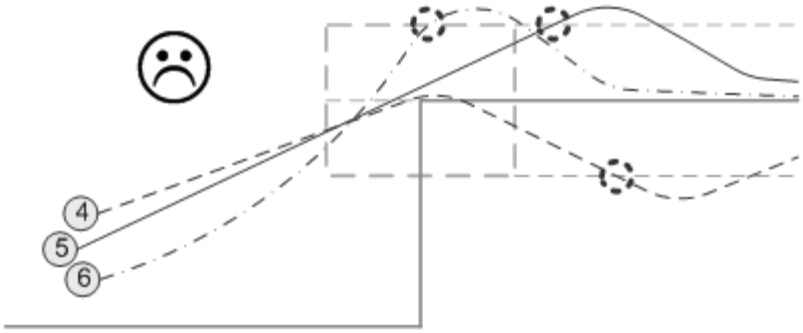


Key

1 The comfort level is reached before the comfort period within the time tolerance. The room temperature exceeds the set point and remains within the temperature tolerance.

2 The comfort level is reached at the beginning of comfort period. The room temperature falls below the comfort set point and remains within the tolerances.

3 The comfort level is reached after the beginning of the comfort period within the time tolerance. The room temperature remains within the tolerances.

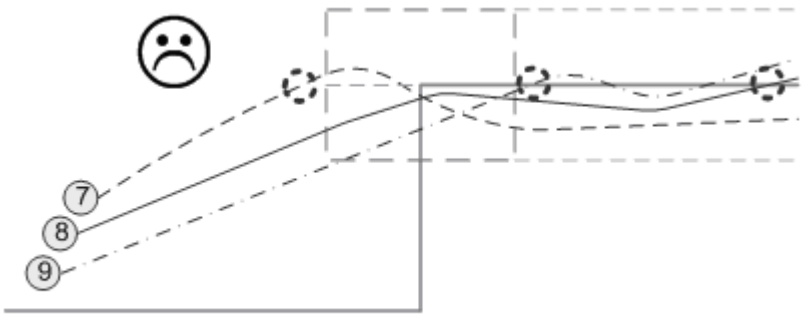


Key

4 The comfort level is reached at the beginning of the comfort period, but the room temperature sinks below the lower limit of the temperature after the time tolerance period.

5 The comfort level is reached before the comfort period within the time tolerance, but the room temperature exceeds the temperature tolerance after the time tolerance period.

6 The comfort level is reached before the comfort period within the time tolerance, but the room temperature exceeds the temperature tolerance within the time tolerance period.



Key

7 The comfort level is reached too early.

8 The comfort level is reached too late.

9 The comfort level is reached too late.

Figure 14 — Interpretation of the results of the optimum start tests

7.7.5 Test results stop optimization

The test result is the verification that the function is working properly. The function is working properly when:

— the switch-off time is before the end of the comfort period;

— the room temperature at the end of the comfort period is below the temperature set point in comfort mode but not more than the defined value of the acceptable temperature reduction (-0,5 K);

— the switch-off time is not identical for the simulation at -5 °C and 5 °C.

7.8 Set back

The set back test is performed during the start-stop optimization test for an outside temperature of -5 °C.

The test checks the signal of the controller. The switch off time is recorded. The room temperature when the heating switches on is detected.

The test result is the verification that the function is working properly.

The requirements of the function are fulfilled when:

— the heating is switched off within 15 min after the start of the reduced period;

— the heating is switched on again when the room temperature reaches the reduced temperature set-point (+/- 1 K).

7.9 Parameter settings

The setting facilities as described in 6.9 have to be checked if they are available and clearly indicated.

7.10 Factory settings

The default settings described in the technical documentation shall be checked against the minimum settings described in 6.10.

7.11 Switching relays

The technical documentation has to be checked against the requirements in 6.11.

7.12 Electrical test

The technical documentation has to be checked against the requirements in 6.12.

7.13 Degrees of protection

The technical documentation has to be checked against the requirements in 6.13.

7.14 Environmental individual stress due to temperature

The technical documentation has to be checked against the requirements in 6.14.

8 Marking

Controllers shall be marked, at least, with the following data:

— Manufacturers name / trade mark or product identification;

— reference or type designation;

— power supply (voltage and consumption);

— frequency;

— terminal blocks: each terminal clearly designated.

9 Documentation

9.1 Technical documents

The following information shall be provided in the technical documentation:

— Technical Specifications;

— Instructions for installation;

— User guidelines.

This information shall be referenced to the marking on the equipment.

9.2 Technical Specifications

9.2.1 Controller

— Dimension [mm]

— Power supply voltage (AC or DC) [V]

— Frequency [Hz]

— Power consumption [W]

— Electrical protection class

— Degree of protection (IP)

— Range of ambient conditions (operation and storage temperature [°C] and humidity [%])

— Maximum clock: cycle per day

— Clock: setting switch resolution [min]

9.2.2 Output signals

— Type and Specification of Output signal (Transistor Output) [A], [V]

— Type and Specification of Output signal (Relay Output)

— Maximum rating, for resistive and inductive load [A], [V]

— Specification of Output signal (0 – 10 V)

9.2.3 Input signals (sensors)

Specifications for outside temperature sensor and other applied compensating sensors.

— Type, e.g. variable resistance sensors, thermistor, corresponding standard

— Range (minimum-maximum) [°C]

9.3 Instruction installation

— Application and purpose of the controller: heat generators, emitters;

— mounting instructions;

— wiring plan;

— wire cross section, minimum/maximum for external wiring [mm^2]. Complete instruction concerning control parameters and information on manual adjustment possibilities.

9.4 User guideline

— Indications of temperatures, date and time;

— default program settings and adjustments;

— selection of operating modes;

— instruction for setting temperatures, date, time, on-off scheduling, derogation function;

— indication of failure states and how to react;

— meaning of graphical symbols.

Bibliography

[1] EN 12098-5, *Controls for heating systems — Part 5: Start-stop schedulers for heating systems*

[2] EN 15500, *Control for heating, ventilating and air-conditioning applications — Electronic individual zone control equipment*

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