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Thermal solar systems and components - Custom built systems - Part 5: Performance test methods for control equipment

Thermal solar systems and components - Custom built systems - Part 5: Performance test methods for control equipment

Thermische Solaranlagen und ihre Bauteile - Kundenspezifisch gefertigte Anlagen - Teil 5: Prüfmethode für Regeleinrichtungen

Installations solaires thermiques et leurs composants - Installations assemblées à façon - Partie 5 : Exigences générales

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**Thermal solar systems and components - Custom built systems
- Part 5: Performance test methods for control equipment**

Installations solaires thermiques et leurs composants -
Installations assemblées à façon - Partie 5 : Exigences
générales

Thermische Solaranlagen und ihre Bauteile -
Kundenspezifisch gefertigte Anlagen - Teil 5: Prüfmethoden
für Regeleinrichtungen

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (prCEN/TS 12977-5:2008) has been prepared by Technical Committee CEN/TC 312 “Thermal solar systems and components”, the secretariat of which is held by ELOT.

This document is currently submitted to the Technical Committee Approval.

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Introduction

One main purpose of this document is to define how to check whether a controller in combination with its equipment (e. g. sensors, pumps and other actuators) is behaving as it is intended to do. In addition function testing of differential thermostats and so-called "multi-function" controllers to determine starting and stopping differentials and control algorithms depending on temperature differences, temperature levels and operation/surroundings conditions of the system is described. For all functions and operations it shall be tested and documented, whether the controller and control equipment comply with the manufacturer's guidance.

In addition the capability for all sensors to resist to extreme operating conditions and shift in accuracy caused by this reason shall be tested. Supplementary the energy consumption of the controller and the control equipment, e. g. actuators shall be documented.

Particularly to carry out performance predictions for the system the control equipment belong to, for the determination of the component parameters, e.g. to be apply the CTSS method as specified in prCEN/TS 12977-2, a detailed investigation of all relevant algorithms, features and parameters in charge to control the system is mandatory.

NOTE The most widely used control equipment for solar heating systems is described in prCEN/TS 12977-5. For control equipment not widely used in solar heating systems or auxiliary heaters, if part of the system, accompanying standards should be applied.

In respect of potential adverse effects human health or life (e.g. drinking water quality) caused by the products covered by prCEN TS 12977-5 it should be noted that:

-This document provides no information as to whether the product may be used without restriction in any of the Member States of the EU or EFTA.

-While awaiting the adoption of verifiable European criteria, existing national regulations concerning the use and/or the characteristics of this product remain in force.

1 Scope

This document (prCEN/TS 12977-5:2008) specifies performance test methods for control equipment. Furthermore this document contains requirements on accuracy, durability and reliability of control equipment.

The tests described in prCEN/TS 12977-5 are limited to components delivered with or for the system by the final supplier. For the purposes of this document (prCEN/TS 12977-5) controller and control equipment for solar heating systems and auxiliary heaters, if part of the system, are restricted to:

- Controllers as
 - system clocks, timers and counters,
 - differential thermostats,
 - multi-function controllers.
- Sensors as
 - temperature sensors,
 - irradiance sensors (for short wave radiation),
 - pressure sensors,
 - level sensors,
 - flow meters or
 - heat meters.
- Actuators as
 - pumps,
 - solenoid and motor valves or
 - relays.

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Furthermore combinations of controllers, sensors and actuators listed above.

An additional objective of the procedures described in this document is to verify control algorithms and, together with the accuracy of sensors, to determine control parameters. Beside results of verification of the functioning of a controller, its equipment and actuators, the determined parameters may be used for numerical system simulations.

Typically electrical anodes are not part of the control equipment and are not controlled by the control equipment. However, because they are electrical appliance, electrical anodes are included in this document.

This document is valid for control equipment of solar heating systems for the purpose of hot water preparation and/or space heating. If the solar system is connected to or part of a conventional heating system, the validity is extended to the entire system. In combination with the standards EN 12976-1, EN 12976-2 as well as prCEN/TS 12977-1, prCEN/TS 12977-2, prEN 12977-3 and prCEN/TS 12977-4 this document is valid for:

- a) Factory made solar heating systems,
- b) small custom built solar heating systems,
- c) large custom built solar heating systems and
- d) auxiliary heater equipment used in connection with a), b) and c).

NOTE Factory Made and Custom Built solar heating systems.

The standards EN 12976-1, EN 12976-2 as well as prCEN/TS 12977-1, prEN/TS 12977-2, prEN 12977-3, and prCEN/TS 12977-4 distinguish two categories of solar heating systems:

- Factory Made solar heating systems and
- Custom Built solar heating systems.

As defined in 12977 part 1, the classification of a system as factory made or custom built is a choice of the final supplier.

Custom Built solar heating systems are subdivided into two categories:

- Small Custom Built systems offered by a company are described in a so-called assortment file, in which all components and possible system configurations, marketed by the company, are specified.
- Large Custom Built systems are uniquely designed for a specific situation.

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2 Normative references

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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 809, *Pumps and pump units for liquids — Common safety requirements*

EN 982, *Safety of machinery — Safety requirements for fluid power systems and their components — Hydraulics*

EN 1151-1, *Pumps — Rotodynamic pumps — Circulation pumps having a rated power input not exceeding 200 W for heating installations and domestic hot water installations — Part 1: Non-automatic circulation pumps, requirements, testing, marking*

EN 12975-2, *Thermal solar systems and components — Solar collectors — Part 2: Test methods*

EN 12976-1:2006, *Thermal solar systems and components — Factory made systems — Part 1: General requirements*

EN 12976-2, *Thermal solar systems and components — Factory made systems — Part 2: Test methods*

prCEN/TS 12977-1:2006, *Thermal solar systems and components — Custom built systems — Part 1: General requirements for solar water heaters and combisystems*

IEC 60038, *IEC standard voltages / Note: This document and its separate amendments continue to be valid together with the consolidated version*

EN 60255 (all parts), *Electrical relays*

EN 60335-1, *Household and similar electrical appliances — Safety - Part 1: General requirements (IEC 60335-1:2001, modified)*

EN 60335-2-21, *Household and similar electrical appliances — Safety - Part 2-21: Particular requirements for storage water heaters (IEC 60335-2-21:2002,, modified)*

EN 60730 (all parts), *Automatic electrical controls for households and similar use*

IEC 62305-3, *Protection against lightning – Part 3: Physical damage to structures and life hazard*

EN ISO 9488:1999, *Solar energy — Vocabulary (ISO 9488:1999)*

ISO 9060, *Solar energy — Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*

ISO/TR 9901, *Solar energy — Field pyranometers — Recommended practice for use*

ISO 15218, *Pneumatic fluid power — 3/2 solenoid valves — Mounting interface surfaces*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12976-1:2006, prCEN/TS 12977-1:2006, EN ISO 9488:1999 and the following apply.

3.1 controller

device to control a solar heating system, sometimes in connection/combination with auxiliary heater(s)

NOTE For classification see Table 1.

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3.2 sensor

device to measure physical (or chemical) qualities/properties. With respect to solar heating systems, temperature, irradiance, flow/circulation, pressure and level sensors are most common

NOTE For classification see Table 2.

3.3 actuator

component and device designed to perform actions to operate a solar heating system or auxiliary heating system according to signals from the control equipment

NOTE For classification see Table 3.

3.4 reference device/measurement

device or measurement towards control equipment under test or measured quantities are compared or referred to.

3.5 control equipment assortment

complete list of components (controller, sensors, pumps, actuators etc.), which a company offers to control a solar heating systems, including auxiliary heater control equipment, if the auxiliary heater is part of the solar heating systems. For the purpose of this document (prCEN/TS 12977-5) the assortment is restricted to the following components:

— controllers,

- sensors and
- actuators

4 Symbols and abbreviations

G	hemispherical solar irradiance in the plane of the radiation sensor, in W/m ² ;
ϑ_{ref}	reference temperature, in °C;
ϑ_{amb}	surrounding air temperature, in °C;
ϑ_{max}	maximal (allowed) temperature of a temperature sensor, in °C;
ϑ_{tank}	temperature of the storage tank for heated water, in °C;
ϑ_{start}	start temperature, e.g. of pump in solar collector circuit, in °C;
ϑ_{stop}	stop temperature, e.g. of pump in solar collector circuit, in °C;
$\Delta\vartheta_{\text{hyst}}$	hysteresis, difference between ON- and OFF-temperature difference for switching an actuator, in K;
v_{air}	surrounding air speed, in m/s;
t	time, in s.

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5 Controller classification (including equipment classification)

5.1 Controller

Control device designed to control a solar heating system, sometimes in connection/combination with auxiliary heaters are classified according Table 1.

Table 1 — Classification of controllers for solar heating systems

	Controller
C1	System clock, Timer and Counter Controlling the operation of one or more actuators by means of real or relative time. Timers and counters might be connected with different kinds of sensors influencing their behaviour by superposition of the commands. Beside time intervals counter might count and sum up events or quantities.
C2	Differential thermostat Control of one or more actuators by means of a temperature difference between two temperature sensors. In most cases a hysteresis between switching ON and OFF is inserted. Differential controllers are sometimes used with other signals, e.g. solar irradiation, pressure or level sensors.
C3	Multi-function controller Controller designed to control one or more actuators based on measured quantities delivered by different kinds of sensors, real time or relative time and/or control concepts including specific control algorithms. With regard to this document multi-function controllers are used to control and operate a solar heating system, optional in combination with hot water preparation, space heating, heat distribution and any kind of auxiliary heating, if more than one differential algorithm is used in one unit and/or at least one operation is caused by more than a simple differential algorithm. If a device, e.g. a differential thermostat operates its output(s) depending on more than one (temperature) difference and/or not only in ON/OFF mode, a controller incorporating such differential algorithm (thermostat) should be treated as a multi-function controller.

5.2 Sensor

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Typical sensors used for controllers listed in Table 1 are summarized in Table 2.

Table 2 — Common sensors for solar heating systems

	SIST-TS CEN-12977-5:2010 Sensor
S1	Temperature sensor Sensing of temperatures of different parts in the system. In connection with the electronic layout of a controller or accessory measuring device determination of temperatures, e.g. in degree centigrade.
S2	Irradiance sensor Instrument measuring the hemispherical solar irradiance in the plane of the radiation sensor within a spectral range of approx. 0,3 µm to 3 µm. To control a (solar) heating system irradiance sensors and accessory control equipment might have special designs to meet the specific requirements to solar energy utilization. With respect to this document both, irradiance sensors with thermoelectric sensor and irradiance sensors based on the photoelectrical effect are included. Supplementary photocells or other devices used to measure the solar irradiance are treated equate to solar irradiance sensor.
S3	Flow/circulation sensors Sensing of the flow/circulation of a fluid. In connection with the electronic layout of a controller or accessory measuring device determination of the volume and/or mass flow.
S4	Pressure sensor Sensing of absolute or relative pressure. In connection with the electronic layout of a controller or accessory measuring device determination of absolute pressure or pressure differences.
S5	Level sensor Sensing of the level of a fluid within a vessel or a store.
<p>NOTE 1 The controller or accessory-measuring devices shall enable the conversion of sensor signals to values suitable to serve as control criterion for functioning and supervising of the system.</p> <p>NOTE 2 Values serving as control criterion should be displayed by a control device or, at least, a read back of data shall be possible.</p> <p>NOTE 3 If other quantities or conditions than listed under S1, S2, S3, S4 or S5 are measured, the use of those sensors and the data processing might be in accordance to S1, S2, S3, S4 or S5.</p>	

5.3 Actuator

Table 3 gives a selection of the most common actuators that can be found in solar heating systems.

Table 3 — Most common actuators for solar heating systems

	Actuator
A1	Pump Device to circulate a heat transfer medium and/or water in a forced-circulation system, e.g. a collector circuit, a circuit for space heating/cooling and/or hot water preparation.
A2	Solenoid and motor valve Electric driven device to start and/or to stop flow/circulation as well as to join, divide and/or to divert flow streams.
A3	Relay / Contactor Device to connect and/or to switch electrical loads and/or actuators, e.g. when using a low level signal (voltage and/or current) of a controller to start and stop a high voltage/power pump.

6 Requirements

6.1 General requirements

6.1.1 Durability - Reliability

Any part of the control equipment has to be suited for the application it should be applied to and has to be suited for all conditions it might come in touch with. Any part of the control equipment mounted outdoors shall be resistant to UV radiation and ozone. For indoor and outdoor mounted control equipment harmful impact and mechanical damage, e. g. caused by birds or rodents and other operation conditions shall be prevented (see EN 60730). If any maintenance or replacement of the control equipment is required in order to maintain the system working, this shall be clearly stated in the documents for the user. The durability to withstand all operation condition, which might occur during operation, and depending on the mounting location, is mandatory. All equipment, particularly parts installed outside, has to be protected against corrosion and mechanical impact at least over the prescribed lifetime or maintenance interval specified by the manufacturer or final supplier.

6.1.2 Electrical safety

The control equipment shall fulfil general safety requirements.

See EN 60335-1, EN 60335-2-21, EN 60730.

6.1.3 Freeze damage protection

If the control equipment includes algorithms and/or devices for freeze damage protection, e. g. preventing heat transfer medium in the collector circuit to freeze, those algorithms and/or devices shall be reliable.

6.1.4 Scald protection

If the control equipment includes algorithms and/or devices for scald protection, this algorithms and/or control equipment shall be reliable. The default value of the temperature for domestic hot water delivered to the user shall at maximum be 60 °C.