BS EN 13203-5:2018

BSI Standards Publication

Gas-fired domestic appliances producing hot water

Part 5: Assessment of energy consumption of gas-fired appliances combined with electrical heat pump

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National foreword

This British Standard is the UK implementation of EN 13203-5:2018.

The UK participation in its preparation was entrusted to Technical Committee GSE/29, Gas-fired central heating boilers (domestic and non-domestic) and domestic gas-fired water heaters.

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.

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Gas-fired domestic appliances producing hot water - Part 5: Assessment of energy consumption of gas fired appliances combined with electrical heat pump

Appareils domestiques produisant de l'eau chaude sanitaire utilisant les combustibles gazeux - Partie 5 : Évaluation de la consommation énergétique des appareils utilisant les combustibles gazeux combinés à une pompe à chaleur électrique

Gasbeheizte Geräte für die sanitäre Warmwasserbereitung für den Hausgebrauch - Teil 5: Bewertung des Energieverbrauchs von Gasgeräten mit elektrischer Wärmepumpe

This European Standard was approved by CEN on 27 May 2018.

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European foreword

This document (EN 13203-5:2018) has been prepared by Technical Committee CEN/TC 109 “Central heating boilers using gaseous fuels”, the secretariat of which is held by NEN.

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of an identical text or by endorsement, at the latest by June 2019, and conflicting national standards shall be withdrawn at the latest by June 2019.

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

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, ZB, ZC or ZD, which are integral parts of this document.

The main purpose of this revision is to provide a means of conforming to requirements of Commission Delegated Regulation (EC) n° 813/2013, (EC) n° 811/2013, (EC) n° 812/2013 and (EC) n° 814/2013.

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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Introduction

The safety operation of the boiler or water heater is not covered by this standard. Safety should be proved by means of the essential safety requirements of the Gas Appliances Directive 2009/142/EC. This may be achieved by compliance with the appropriate existing harmonized standards.

NOTE 1 Useful standards are EN 26, EN 89 and series EN 15502.

NOTE 2 The Gas Appliances Directive 2009/142/EC has been replaced by the Gas Appliances Regulation 426/2016/EU.

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1 Scope

This European Standard is applicable to gas-fired appliances producing domestic hot water. It applies to both instantaneous and storage gas-fired combined with electrical heat pump.

It applies to a package marketed as single unit or fully specified by the manufacturer that have:

— a heat input not exceeding 400 kW; and

— a hot water storage tank capacity (if any) not exceeding 2000 l.

EN 13203-1 sets out in qualitative and quantitative terms the performance in delivery of domestic hot water for a selected variety of uses. It also gives a system for presenting the information to the user. The present document sets out a method for assessing the energy performance of gas fired appliances combined with heat pump with electrically driven compressor according to EN 16147. It defines a number of daily load profiles for each domestic hot water use, kitchen, shower, bath and a combination of these, together with corresponding test procedures, enabling the energy performances of different gas-fired appliances to be compared and matched to the needs of the user. Where other technologies are combined with a gas-fired boiler or a water heater to produce domestic hot water, specific parts of EN 13203 apply.

The present document does not apply for gas boilers with recovery systems using combustion products as heat source for the electrical heat pump.

When the electrical heat pump does not work for domestic hot water production in the summer period, the present standard is not applicable for energy performances assessing, EN 13203-2 should be used.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 14511-3:2018, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling - Part 3: Test methods*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
storage tank
reservoir for domestic hot water

3.2
nominal domestic hot water heat input of the boiler (Q_{nw})
value of the heat input of the boiler for the production of domestic hot water stated in the instructions, the symbol of which is Q_{nw} and the unit of which is kilowatt (kW)

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3.3
summer mode
conditions during which the appliance supplies energy only for the production of domestic hot water

3.4
winter mode
conditions during which the combination boiler supplies energy for the production of domestic hot water and space heating

3.5
domestic water test temperature
temperature of the delivered water at which the tests are conducted

3.6
control cycle
the time cycle for keeping components and/or the storage tank (if any) of the domestic hot water circuit at predetermined temperature level, consists of an «ON» duration time during which the heating of the domestic hot water (by gas energy and/or auxiliary energy) is operating, and an «OFF» duration time during which no heating occurs

3.7
useful water
quantity of water delivered at the tap for which the temperature increase is in accordance with the requirement fixed for each individual delivery of the load profiles

3.8
wasted water
quantity of water delivered at the tap for which the temperature increase is not in accordance with the requirement fixed for each individual delivery of the load profiles

3.9
standby mode
operating state in which the appliance can provide domestic hot water at any time

Note 1 to entry: In the case of an appliance with a control cycle for keeping components and/or the storage tank (if any) of the domestic hot water circuit at predetermined temperature level no draw-off is made.

3.10
off mode
state of an appliance, selected by the user, in which domestic hot water cannot be provided

3.11
useful water flow rate
D_{useful}
quantity of water delivered by unit time at the tap for which the temperature increase is in accordance with the requirement fixed for each individual draw-off of the load profiles

3.12
useful water temperature
water temperature, expressed in degrees Celsius, delivered at the tap

3.13
appliance flow rate
quantity of water delivered by the appliance by unit time before the mixing device, if applicable

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3.14
appliance water temperature
T_d
water temperature, expressed in degrees Celsius, delivered by the appliance before the mixing device

3.15
water temperature rise in K
ΔT_m
difference between the useful water temperature and the cold water temperature, at which hot water is contributing to the reference energy as specified in the load profiles

3.16
water temperature rise for basin draw-off types in K
ΔT_p
difference between the useful water temperature and the cold water temperature, to be achieved during the water draw-offs, with a minimum value as specified in the load profiles

Note 1 to entry: The minimum temperature difference for basin draw-offs as specified in the load profiles shall be achieved at least during the water draw-offs.

3.17
rapid response temperature sensor
measuring instrument with a response time such that 90 % of the final temperature rise, from 15 °C to 100 °C, is obtained within about 1 s, when the sensor is plunged into still water.

3.18
indoor air
heat source for a heat pump which absorbs heat by a heat exchanger in direct contact with the air inside a building

3.19
brine
heat transfer medium which has a freezing point depressed relative to water

3.20
gas-fired appliance combined with electrical heat pump air/water
appliance which is either placed on the market or specified as a complete package to deliver domestic hot water or domestic hot water and heating, comprising as relevant:

— electrical heat pump;

— gas-fired appliance;

— ducts if appropriate;

— thermal store.

3.21
exhaust air
air from the air conditioned space entering the outdoor heat exchanger

[EN 14511-1:2018, 3.22]

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3.22
external static pressure difference
Δp_{ext}
positive pressure difference measured between the air (or water) outlet section and the air (or water) inlet section of the unit, which is available for overcoming the pressure drop of any additional ducted air (or water) circuit

3.23
internal static pressure difference
Δp_{int}
negative pressure difference measured between the air (or water) outlet section and the air (or water) inlet section of the unit, which corresponds to the total pressure drop of all components on the air (or water) side of the unit

4 General test conditions

4.1 Reference conditions

Unless otherwise stated, the general test conditions shall be as follows:

— cold water temperature: 10 °C;

  — maximum average variation over the test period: ± 2 K;

— cold water pressure: (2 ± 0,1) bar;

— ambient air temperature: 20 °C;

  — maximum average variation over the test period ± 2 K;

  — maximum variation during the tests ± 2 K;

— electrical supply voltage: (230 ± 2) V (single phase) or (410 ± 4) V (three phase).

4.2 Specific heat source temperature conditions

The tests shall be carried out at the test conditions specified in Table 1 as appropriate.

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Table 1 — Test conditions for particular types of systems

Type of heat source	Heat source temperature (°C)	Range of ambient temperature for heat pump (°C)	Ambient temperature of storage tank (°C)
Outside air (heat pump indoor) with air duct	7 ± 0,2	20 ± 3	20 ± 3
	(6 ± 0,3)		
Outside air (heat pump outdoor)	7 ± 0,2	7 ± 3 [a)]	20 ± 3
	(6 ± 0,3)		
Exhaust air	20 ± 0,2	20 ± 3 [a)]	20 ± 3 [a)]
	(12 ± 0,3)		
Water (inlet)	10 ± 0,15	20 ± 3	20 ± 3
Brine (inlet)	0 ± 0,15	20 ± 3	20 ± 3
Direct evaporation	4 ± 0,5	20 ± 3	20 ± 3

[a)] In this case, the ambient temperature of the heat pump is the same as the temperature of the heat source. The difference with EN 16147 is justified because of the possible installation of the appliance into a living room.

NOTE 1 All heat source temperatures are inlet temperatures in °C.

NOTE 2 All air temperatures in (brackets) are wet bulb temperatures in °C.

NOTE 3 Permissible external pressure difference or associated internal pressure difference at the outdoor heat exchanger as stated in the installation and/or operation manual in Pascal (Pa) for appliances with duct connection.

4.3 Measurement uncertainties

4.3.1 General

Except where otherwise stated in the clauses describing the tests, the uncertainties of measurements carried out shall not be greater than the maximum uncertainties indicated below.

The standard deviations shall be evaluated taking into account the various sources of uncertainty: contribution from the instrument, repeatability, calibration, ambient conditions, etc.

— water flow rate: ± 1 %;

— gas flow rate: ± 1 %;

— time: ± 0,2 s;

— temperatures:

  — ambient: ± 1 K;

  — air as heat source dry bulb temperature: ± 0,2 °C;

  — air as heat source wet bulb temperature: ± 0,3 °C;

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  - water/brine as heat source: ± 0,15 K;
  - water: ± 0,5 K;
  - gas: ± 0,5 K;
- gas pressure: ± 1 %;
- gas calorific value: ± 1 %;
- gas density: ± 0,5 %;
- electrical energy: ± 2 %.

The stated measurement uncertainties relate to individual measurements. For measurements that combine a number of individual measurements, smaller uncertainties on the individual measurements may be necessary to ensure a total uncertainty within ± 2 % under the steady-state conditions as defined by 4.3.2.

These uncertainties correspond to two standard deviations (2σ).

4.3.2 Steady-state conditions

Steady-state operating conditions are regarded as established when the appliance operates for sufficient time to reach thermal stabilization.

To reach the steady-state the water temperature at the outlet of the appliance shall not vary by more than ± 0,5 K.

NOTE This condition can be reached with a gas which is different from the reference gas, provided that the appliance is supplied with the reference gas for at least 5 min before the requirements are verified.

4.4 Test conditions

4.4.1 General

Except where otherwise stated, the appliance is tested under the following conditions.

The tests shall be carried out only in summer mode as defined in 3.3, and the appliance shall be set in summer mode.

If liquid heat transfer media other than water are used, the specific heat capacity and density of such heat transfer media shall be determined and taken into consideration in the evaluation.

For all tests defined by this standard, the same adjustment of the appliance shall be maintained.

The load profile used for the measurement shall be the one declared according to the technical instruction of the appliance (see also Annex C).

The test shall be performed in the setting in which the appliance is delivered, and which is documented as such in the technical instructions.

If there are temporary user's settings (automatically self-resetting within 24 h), these shall not be active.

4.4.2 Test room

The package shall be installed in a well-ventilated, draught-free room (air speed less than 0,5 m/s).

The package shall be protected from direct solar radiation and radiation from heat generators.

If the package incorporates an air source outdoor heat exchanger a further test room is needed. The size of this test room shall be designed to avoid any resistance to air flow at the air inlet and air outlet orifices of the

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test object. The air flow through this room shall not cause any short circuit between the two orifices, and therefore the velocity of air flow at these two locations shall not exceed 1,5 m/s when the test object is switched off. The air velocity in the room shall also not be greater than the mean velocity through the unit inlet.

Unless otherwise stated in the technical documentation, the air inlet and air outlet orifices shall not be less than 1m from the surfaces of the test room; this also applies to any measuring ducts.

The setting of the external static pressure difference on the air side for heat pumps with duct connection is described by 4.4.1.4 of EN 14511-3:2018.

For heat pumps separated from the tank, the liquid flow rate has to be set on the liquid outlet side of the heat pump to the nominal flow rate specified in the technical documentation.

The package shall be installed and connected for the test as specified in the installation instructions.

Temperature and pressure measuring points shall be situated in order to obtain significant mean values.

Set points for internal control equipment of the unit such as thermostats, pressure switches or mixing valves shall be set to the values stated in the technical documentation.

Air and entrained gases shall be removed from all water and other heat transfer liquid systems

In the case of package incorporating a single split heat pump, the following installation conditions shall be complied with for the tests:

a) each refrigerant pipe shall be installed in accordance with the installation instructions;

b) the connecting pipes shall be installed so that the difference in elevation does not exceed 2,5 m. The length of each connecting pipe shall be between 5 m and 7,5 m;

c) thermal insulation shall be applied to the pipes in accordance with the installation instructions;

d) unless constrained by the design at least half of the interconnecting pipes shall be exposed to the outdoor conditions with the rest of the pipes exposed to the indoor conditions.

For indirect systems each water pipe shall be installed in accordance with the installation instructions to the maximum stated length or 5 m whichever is shorter. Thermal insulation shall be applied to the pipes in accordance with the installation instructions.

4.4.3 Water supply

For the tests:

— the domestic water pressure is the static inlet pressure under dynamic conditions measured as close as possible to the appliance (see Figure B.2);

— the inlet and outlet temperatures of the domestic water shall be measured in the centre of the flow and as close as possible to the appliance (see Figure B.3) or at the tap.

The inlet temperatures shall be measured immediately upstream of the water inlet connection. Except where otherwise stated, the outlet temperatures shall be measured immediately downstream of the outlet connection or, in the case of an appliance with spout delivery, by means of an immersed temperature measuring device, e.g. a u-tube fitted at the outlet of a tube of the same length as the minimum length of the spout normally supplied together with the appliance.

Water temperatures shall be measured with a rapid response temperature sensor.

4.4.4 Initial adjustment of the appliance

The appliance shall be installed in accordance with the installation instructions.

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The heat input shall be adjusted to within ± 2 % of the nominal domestic hot water heat input.

The adjustment of the appliance water temperature (T_d) shall be as follows (see Figure A.1 and Figure A.2):

a) Appliances with an adjustable temperature: the tests shall be carried out at a temperature not greater than 65 °C, with a minimum temperature increase than 45 K above water inlet temperature. For the load profile XS the minimum temperature setting shall be equal to or greater than 35°C (ΔT 25 K above water inlet temperature).

b) Appliances with a fixed temperature: the tests shall be carried out at the temperature specified in the appliance documentation, with a minimum temperature increase equal to or greater than 45 K above the water inlet temperature. For the load profile XS the minimum temperature setting shall be equal to or greater than 35°C (ΔT 25 K above water inlet temperature).

NOTE The test conditions of 4.4.1 are applicable.

The same conditions of initial adjustment stated in the appliance documentation shall be used for all the tests.

These conditions shall be included in the test report.

4.4.5 Conditions for the determination of the maximum load profile

The measurement of the domestic hot water efficiency shall be performed with the maximum load profile or the one just below this load profile:

a) Instantaneous appliances shall be set to the nominal heat input as stated on the data plate. If the user instructions specify that it is possible to adjust the outlet temperature, this temperature shall be set to the maximum possible value not exceeding 65°C.

b) Storage appliances shall be set to the nominal heat input as stated on the data plate. If the user instructions specify that different modes are possible to be selected, the one that is able to store more energy that delivers more hot water during 24 h period shall be used.

NOTE 1 See Annex C (informative).

NOTE 2 In case of maximal load profile 3XL or 4XL the label testing should be XXL.

The load profile used for the domestic hot water performance test shall be stated in the user instructions.

4.4.6 Electrical supply

The appliance shall be supplied with the nominal voltage stated in the installation instructions.

5 Determination of the energy consumption of the appliance

5.1 General

This clause defines the test methods to be employed in determining the energy consumption of appliances.

5.2 Load profiles

All patterns define a 24 h measurement cycle and within that cycle the starting times and the total energy content (in kWh equivalent of hot water tapped) of each draw-off are defined.

Furthermore, the draw-off can be characterized in two ways, either “basin” type draw-off versus “continuous flow” draw-off.

The aim of the “basin” type is to arrive at an average temperature of the tub, so all supplied energy can be considered useful from the very beginning of the draw-off (minimum useful temperature increase is 0 K). The

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temperature rise (ΔTp) to be achieved during tapping, shall be 30 K for floor cleaning and bath and 45 K for the dish washes.

The aim of the "continuous flow" type is to use only the water with a minimum temperature. For the shower, household cleaning and large draw-offs a temperature rise of 30 K shall be reached before counting the useful energy. For the small draw-offs a temperature rise of 15 K shall be reached.

NOTE The temperature rises (in K) based on 10 °C inlet water temperature stated above are equivalent to the temperatures (in °C) given by the load profiles tables in Regulations n° 811/2013, n° 812/2013, n° 813/2013 and n° 814/2013. The tapping flow rates used to perform the different draw-offs of each of the eight load profiles are defined by Tables 2 to 9.

When these water draw-off flow rates result in a tapping period of less than 15 s the water flow rate should be decreased such that the tapping period is (16 ± 1) s.

In the load profiles, the requirements for water flow rate and temperatures are based on the delivery at the tap in a mix of hot and cold water. Under the conditions of the initial adjustment, the appliance itself produces hot water with a minimum temperature rise of 45 K. For the load profile XS the minimum temperature setting shall be equal to or greater than 35°C (ΔT 25 K above water inlet temperature).

To fulfil the requirements stated in Tables 2 to 9 mixing hot water from the appliance with cold water of 10 °C at the tap is allowed either by using a mixing device (see Figures B.1 and B.5) or by recalculating the appliance flow rate ($D_{\min}$) according to the following formula:

$$D_{min} = D_{useful} \frac{\Delta T_{useful}}{\Delta T_d} \tag{1}$$

where

$D_{\min}$	is the minimum test rig setting for the appliance flow rate of each individual draw-off at temperature rise corresponding to ΔT_{d}, in l/min;
D_{useful} (ΔT)	is the useful water flow rate according to Tables 2 to 9, in l/min;
ΔT_{d}	is the appliance water temperature rise, with a minimum of 30 K;
$\Delta T_{\mathrm{useful}}$	is the higher value between the temperature rise to be achieved and the minimum temperature rise for counting the useful energy according to Tables 2 to 9.

If the appliance cannot deliver these flow rates, for instance due to the flow restrictor, it shall be checked that the requirements are fulfilled by checking that ($D_{\min}$) is delivered.

If by design the appliance is fitted with a flow restrictor, the tests shall be carried out with this flow restrictor.

The tests shall be performed by using the useful water flow rates defined by Tables 2 to 9.

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Table 2 — Load profile XS

Draw-off n°	Start (h.min)	Energy (kWh)	Type of draw-off	Useful water flow rate at the tap (l/min)	ΔTp to be achieved during tapping (K)	Minimum ΔTm for counting useful energy (K)
1	07.30	0,525	Medium	3		25
2	12.45	0,525	Medium	3		25
3	20.30	1,050	Large	3		25
Q_{ref}		2,100				

Equivalent hot water litres at 60°C | 36 |

Table 3 — Load profile S

Draw-off n°	Start (h.min)	Energy (kWh)	Type of draw-off	Useful water flow rate at the tap (l/min)	ΔTp to be achieved during tapping (K)	Minimum ΔTm for counting useful energy (K)
1	07.00	0,105	Small	3		15
2	07.30	0,105	Small	3		15
3	08.30	0,105	Small	3		15
4	09.30	0,105	Small	3		15
5	11.30	0,105	Small	3		15
6	11.45	0,105	Small	3		15
7	12.45	0,315	Dish washing n°1	4	45	0
8	18.00	0,105	Small	3		15
9	18.15	0,105	Household cleaning	3		30
10	20.30	0,420	Dish washing n°2	4	45	0
11	21.30	0,525	Large	5		35
Q_{ref}		2,100				

Equivalent hot water litres at 60°C | 36 |

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