



BSI Standards Publication

Gas meters — Conversion devices

Part 1: Volume conversion

National foreword

This British Standard is the UK implementation of EN 12405-1:2021. It supersedes BS EN 12405-1:2018, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GSE/25, Gas Meters.

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

This publication has been prepared under a mandate given to the European Standards Organizations by the European Commission and the European Free Trade Association. It is intended to support requirements of the EU legislation detailed in the European Foreword. A European Annex, usually Annex ZA or ZZ, describes how this publication relates to that EU legislation.

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: Conversion de volume

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European foreword

This document (EN 12405-1:2021) has been prepared by Technical Committee CEN/TC 237 “Gas meters”, the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by April 2022, and conflicting national standards shall be withdrawn at the latest by April 2022.

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 supersedes EN 12405-1:2018.

The main changes in EN 12405-1:2021 compared with the previous edition EN 12405-1:2018 are:

- new table for relevant tests for the conversion device;
- reference added to natural gas according to EN 16726 and biomethane according to EN 16723-1;
- additional information on service life of battery;
- modification of parameters during installation and adjustment in the factory or on site;
- new optional functionality “Error curve correction” of a gas meter;
- new normative annex “Individual testing before putting into service”.

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

For relationship with EU Directive(s) / Regulation(s), see informative Annex ZA, which is an integral part of this document.

EN 12405 consists of the following parts:

- Part 1: Volume conversion (this European standard);
- Part 2: Energy conversion;
- Part 3: Flow computer.

In the preparation of this European standard, the content of OIML Publication, “International Document 11 D11:2013”, and “International Recommendations 140” and the content of member bodies' national standards on gas-volume electronic conversion devices have been taken into account.

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This document specifies the requirements and tests for the construction, performance, safety and conformity of gas-volume electronic conversion devices associated to gas meters, used to measure volumes of fuel gases of the 1st and 2nd families according to EN 437.

This document is intended for type testing, the detailed relevant provisions of which are given in Annex A.

Only three kinds of conversion are treated in this document:

- conversion as a function of temperature only (called T conversion);
- conversion as a function of the pressure and of the temperature with constant compression factor (called PT conversion);
- conversion as a function of the pressure, the temperature and taking into account the compression factor (called PTZ conversion).

This document is not relevant to temperature conversion integrated into gas meters which only indicate the converted volume.

Gas-volume conversion devices consist of a calculator and a temperature transducer or a calculator, a temperature transducer and a pressure transducer locally installed.

For application of this document, a conversion device may be, as a choice of the manufacturer, considered as a complete instrument (Type 1) or made of separate elements (Type 2), according to the definitions given in 3.1.20.1 and 3.1.20.2.

In this last case, the provisions concerning pressure transducers, temperature sensors and temperature transducers are given in Annexes B, C and D respectively.

Any conversion device can provide an error curve correction for a gas meter.

NOTE When rendering an account to an end user the readings from the conversion device can be used in conjunction with the readings from a gas meter conforming to EN 1359, EN 12480, or EN 12261, as appropriate, or to any other appropriate and relevant international or national standard for gas meters, without prejudice of national regulations.

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 437:2018, *Test gases — Test pressures — Appliance categories*

EN 1776:2015, *Gas infrastructure — Gas measuring systems — Functional requirements*

EN 16723-1:2016, *Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network — Part 1: Specifications for biomethane for injection in the natural gas network*

EN 16726:2015+A1:2018, *Gas infrastructure — Quality of gas — Group H*

EN 55011:2016,¹⁾ *Industrial, scientific and medical equipment — Radio-frequency disturbance characteristics — Limits and methods of measurement (CISPR 11:2015, modified)*

¹⁾ As impacted by EN 55011:2016/A1:2017, EN 55011:2016/A11:2020.

- EN 60068-2-1:2007, *Environmental testing — Part 2-1: Tests — Tests A: Cold* (IEC 60068-2-1:2007)
- EN 60068-2-2:2007, *Environmental testing — Part 2-2: Tests — Tests B: Dry heat* (IEC 60068-2-2:2007)
- EN 60068-2-30:2006, *Environmental testing — Part 2-30: Tests — Test Db: Damp heat, cyclic (12 h + 12 h cycle)* (IEC 60068-2-30:2005)
- EN 60068-2-31:2008, *Environmental testing — Part 2-31: Tests — Test Ec: Rough handling shocks, primarily for equipment-type specimens* (IEC 60068-2-31:2008)
- EN 60068-2-64:2008,²⁾ *Environmental testing — Part 2-64: Tests — Test Fh: Vibration, broadband random and guidance* (IEC 60068-2-64:2008)
- EN 60068-2-78:2013, *Environmental testing — Part 2-78: Tests — Test Cab: Damp heat, steady state* (IEC 60068-2-78:2012)
- EN 60068-3-1:2012, *Environmental testing — Part 3-1: Supporting documentation and guidance — Cold and dry heat tests* (IEC 60068-3-1:2011)
- EN IEC 60079-0:2018, *Explosive atmospheres — Part 0: Equipment — General requirements* (IEC 60079-0:2017)
- EN 60079-1:2014,³⁾ *Explosive atmospheres — Part 1: Equipment protection by flameproof enclosures "d"* (IEC 60079-1:2014)
- EN 60079-2:2014, *Explosive atmospheres — Part 2: Equipment protection by pressurized apparatus "p"* (IEC 60079-2:2014)
- EN 60079-5:2015, *Explosive atmospheres — Part 5: Equipment protection by powder filling "q"* (IEC 60079-5:2015)
- EN 60079-6:2015, *Explosive atmospheres — Part 6: Equipment protection by oil immersion "o"* (IEC 60079-6:2015)
- EN 60079-7:2015, *Explosive atmospheres — Part 7: Equipment protection by increased safety "e"* (IEC 60079-7:2015)
- EN 60079-11:2012, *Explosive atmospheres — Part 11: Equipment protection by intrinsic safety "i"* (IEC 60079-11:2011)
- EN 60079-25:2010,⁴⁾ *Explosive atmospheres — Part 25: Intrinsically safe systems* (IEC 60079-25:2010)
- EN 60529:1991,⁵⁾ *Degrees of protection provided by enclosures (IP code)* (IEC 60529:1989)

²⁾ As impacted by EN 60068-2-64:2008/A1:2019.

³⁾ As impacted by EN 60079-1:2014/AC:2018-09.

⁴⁾ As impacted by EN 60079-25:2010/AC:2013.

⁵⁾ As impacted by EN 60529:1991/AC:2006-12, EN 60529:1991/A1:2000, EN 60529:1991/A2:2013 and EN 60529:1991/A2:2013/AC:2019-02.

EN 60730-1:2016,⁶⁾ *Automatic electrical controls — Part 1: General requirements (IEC 60730-1:2013, modified + COR1:2014)*

EN 60751:2008, *Industrial platinum resistance thermometer and platinum temperature sensors (IEC 60751:2008)*

EN 60950-1:2006,⁷⁾ *Information technology equipment — Safety — Part 1: General requirements (IEC 60950-1:2005, modified)*

EN 61000-4-2:2009, *Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test (IEC 61000-4-2:2008)*

EN 61000-4-3:2006,⁸⁾ *Electromagnetic compatibility (EMC) — Part 4-3: Testing and measurement techniques — Radiated, radio-frequency, electromagnetic field immunity test (IEC 61000-4-3 COMPIL:2010)*

EN 61000-4-4:2013, *Electromagnetic compatibility (EMC) — Part 4-4: Testing and measurement techniques — Electrical fast transient/burst immunity test (IEC 61000-4-4:2012)*

EN 61000-4-5:2014,⁹⁾ *Electromagnetic compatibility (EMC) — Part 4-5: Testing and measurement techniques — Surge immunity test (IEC 61000-4-5:2014)*

EN 61000-4-6:2014, *Electromagnetic compatibility (EMC) — Part 4-6: Testing and measurement techniques — Immunity to conducted disturbances, induced by radio-frequency fields (IEC 61000-4-6:2013)*

EN 61000-4-8:2010, *Electromagnetic compatibility (EMC) — Part 4-8: Testing and measurement techniques — Power frequency magnetic field immunity test (IEC 61000-4-8:2009)*

EN 61000-4-11:2004,¹⁰⁾ *Electromagnetic compatibility (EMC) — Part 4-11: Testing and measurement techniques — Voltage dips, short interruptions and voltage variations immunity tests (IEC 61000-4-11:2004)*

EN 61000-4-29:2001, *Electromagnetic compatibility (EMC) — Part 4-29: Testing and measurement techniques — Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests (IEC 61000-4-29:2000)*

EN ISO 12213-2:2009, *Natural gas — Calculation of compression factor — Part 2: Calculation using molar-composition analysis (ISO 12213-2:2006)*

EN ISO 12213-3:2009, *Natural gas — Calculation of compression factor — Part 3: Calculation using physical properties (ISO 12213-3:2009)*

⁶⁾ As impacted by EN 60730-1:2016/A1:2019.

⁷⁾ As impacted by EN 60950-1:2006/AC:2011, EN 60950-1:2006/A11:2009, EN 60950-1:2006/A1:2010, EN 60950-1:2006/A12:2011, EN 60950-1:2006/A12:2013.

⁸⁾ As impacted by EN 61000-4-3:2006/A1:2008 and EN 61000-4-3:2006/A2:2011.

⁹⁾ As impacted by EN 61000-4-5:2014/A1:2017.

¹⁰⁾ As impacted by EN 61000-4-11:2004/A1:2017.

3 Terms, definitions and symbols

3.1 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 <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1.1

absolute static pressure

value of the static pressure of the gas relative to vacuum

3.1.2

adjustment

set of operations carried out on a measuring system so that it provides prescribed indications corresponding to given values of a quantity to be measured

3.1.3

base conditions

fixed conditions to which a volume of gas is converted (e.g. base gas temperature 273,15 K plus 15 K at base gas pressure of 1 013,25 mbar)

3.1.4

calculator

electronic device that receives the output signals from the associated gas meter and transducers and processes them

3.1.5

conversion factor

factor equal to the volume at base conditions divided by the corrected volume, or if there is no gas meter correction, equal to the volume at base conditions divided by the volume at measurement conditions

3.1.6

conventional true value (of a quantity)

value attributed to a particular quantity and accepted, sometimes by convention, as having an uncertainty appropriate for a given purpose

3.1.7

corrected volume

volume at measurement conditions corrected for the error curve of the gas meter

3.1.8

correction

value added algebraically to the uncorrected result of a measurement to correct the systematic error

3.1.9

correction factor

numerical factor by which the measured volume is multiplied to correct it to compensate the error curve of the gas meter

3.1.10

display

device which shows information from the meter (e.g. liquid crystal that displays registers, volume or flags)

3.1.11

disturbance

influence quantity having a value within the limits specified but outside the specified rated operating conditions of the measuring instrument

Note 1 to entry: An influence quantity is a disturbance if the rated operating conditions for that influence quantity are not specified.

3.1.12

durability

ability of an instrument to maintain its performance characteristics over a specified period of use

3.1.13

environmental class

class referring to the ambient temperature, humidity and power supply

3.1.14

error of conversion

difference between the conversion factor C displayed by a conversion device and the conventional true value of the conversion factor C_{CV} , expressed as a percentage of the conventional true value of the conversion factor

3.1.15

error of indication

value which shows the relationship in percentage terms of the difference between the volume indicated by the meter and the volume which has actually flowed through the meter, to the latter value

Note 1 to entry:

$$E = 100 \frac{V_i - V_c}{V_c}$$

where

V_i is the indicated volume;

V_c is the volume which has actually flowed through the meter.

3.1.16

error of the calculator unit

error of the indicated volume at base conditions V_b , when the gas volume, pressure and temperature are simulated by signals, in accordance to the manufacturer specification of interfaces

Note 1 to entry: The calculator error includes all conversion errors with the exception of the pressure and temperature transducer errors (i.e. signal conditioning, Z factor calculation (if applicable), other mathematical calculations, etc.).

3.1.17

error of the pressure transducer

difference between the measured output signals from the pressure transducer and the nominal signal at the applied physical value

3.1.18**error of the temperature transducer**

difference between the measured output signals from the temperature transducer and the nominal signal at the applied physical value

3.1.19**gas-volume conversion device**

device that computes, integrates and indicates the volume increments measured by a gas meter if it were operating at base conditions, using as inputs the volume at measurement conditions as measured by the gas meter, and other parameters such as gas temperature and gas pressure

Note 1 to entry: The conversion device can also compensate for the error curve of a gas meter and associated measuring transducers.

Note 2 to entry: The deviation from the ideal gas law can be compensated by the compression factor.

3.1.20.1**gas volume conversion device type 1 (complete system)**

conversion device with specific types of transducers for pressure and temperature or for temperature only

3.1.20.2**gas volume conversion device type 2 (separate component)**

conversion device with external separate transducers for pressure and temperature or for temperature only and for separate calculator, which may be approved separately

Note 1 to entry: The matching of the various elements constituting a conversion device type 2 is subjected to verification.

3.1.21**indicating device**

part of a measuring instrument that displays an indication (alphanumeric string)

3.1.22**influence factor**

influence quantity having a value within the specified rated operating conditions of the measuring instrument

3.1.23**influence quantity**

quantity that is not a measurand but that affects the result of the measurement (e.g. ambient temperature)

3.1.24**intrinsic error**

error of a measuring instrument, determined under reference conditions

3.1.25**maximum operating pressure*****MOP***

maximum pressure at which a system can be operated continuously under normal conditions

Note 1 to entry: Normal conditions are: no fault in any device or stream.

3.1.26**measurement conditions**

conditions of the gas, the volume of which is measured at the point of measurement (e.g. the temperature and the pressure of the gas)

3.1.27

measuring transducer

device that provides an output quantity having a determined relationship to the input quantity

Note 1 to entry: The transducer can include a transmitter that provides an output to the calculator.

3.1.28

memory

element which stores digital information

3.1.29

overpressure

maximum static pressure to which the transducer may be submitted without durable alteration of its metrological characteristics: it is set in accordance with the maximum allowable pressure

3.1.30

rated operating conditions

values for the measurand and influence quantities making up the normal working conditions of an instrument

3.1.31

reference conditions

condition of use prescribed for testing the performance of a measuring instrument or for inter-comparison of results of measurements

3.1.32

sensor

element of a measuring instrument or measuring chain that is directly affected by the measurand

3.1.33

specified measuring range of transducers

set of values of measurands (the pressure for the pressure transducer or temperature for the temperature transducer) for which the errors of the conversion device are intended to lie within the limits specified in this European standard

Note 1 to entry: The upper and lower limits of the specified measuring range are called maximum value and minimum value respectively.

EXAMPLE Maximum absolute pressure: 12 bar; minimum absolute pressure: 4 bar.

3.1.34

specified field of measurement of a conversion device

set of values at measurement conditions for which the errors of the conversion device are within specified limits

Note 1 to entry: A conversion device has a measuring range for every quantity that it processes.

Note 2 to entry: The specified field of measurement applies to the characteristic quantities of the gas that are used to determine the conversion factor.

3.1.35

static gauge pressure

value of the static pressure of the gas relative to the ambient atmospheric pressure

3.1.36**uncertainty of value**

parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand

3.1.37**volume**

volume without specifying whether it is a corrected volume at measurement conditions or an uncorrected volume at measurement conditions

3.1.38**measurand**

particular quantity subject to measurement

3.1.39**critical change value**

value at which the change in the measurement result is considered undesirable

3.2 Symbols

For the purposes of this document, the symbols listed in Table 1 apply.

Table 1 — Symbols

Symbols	Represented quantity	Units
V	volume: V_m or V_c	m^3
V_m	volume at measurement conditions	m^3
V_c	corrected volume (gas meter error)	m^3
V_b	volume at base conditions	m^3
V_{CV}	conventional true value of the volume	m^3
C	conversion factor	-
C_c	calculator conversion	-
C_f	correction factor	-
C_{CV}	conventional true value of the conversion factor	-
$f(Q)$	correction function	-
K or K'	coefficients	-
p	absolute pressure at measurement conditions	bar or MPa
p_b	absolute pressure at base conditions	bar or MPa
p_g	gauge pressure	bar or MPa
p_{CV}	conventional true value of the absolute pressure	bar or MPa
T	absolute temperature at measurement conditions	K
T_b	absolute temperature at base conditions	K
T_{min}	minimum absolute temperature	K
T_{max}	maximum absolute temperature	K
T_{CV}	conventional true value of the absolute temperature	K
Z	compression factor of the gas at measurement conditions	-
Z_b	compression factor of the gas at base conditions	-
Z_{CV}	conventional true value of the compression factor	-
p_{atm}	atmospheric pressure	bar or MPa
p_{max}	maximum absolute gas pressure	bar or MPa
p_{min}	minimum absolute gas pressure	bar or MPa
Q	flowrate	m^3/h
Q_{max}	maximum flowrate	m^3/h
Q_{min}	minimum flowrate	m^3/h
t_{am}	ambient temperature	$^{\circ}C$
$t_{am, max}$	maximum ambient temperature	$^{\circ}C$
$t_{am, min}$	minimum ambient temperature	$^{\circ}C$
t	gas temperature	$^{\circ}C$
t_{max}	maximum gas temperature	$^{\circ}C$
t_{min}	minimum gas temperature	$^{\circ}C$
U_{nom}	nominal supply voltage	V
f_{nom}	nominal supply frequency	Hz
e	total conversion factor error	%
e_f	error on the calculation of conversion factor	%
e_p	error on the pressure measurement	%
e_t	error on the temperature measurement	%
e_c	error on the conversion factor	%
e_v	error on the converted volume	%

3.3 Classification

3.3.1 Mechanical classes

M1 This class applies to instruments used in locations with vibration and shocks of low significance, e.g. for instruments fastened to light supporting structures subject to negligible vibrations and shocks transmitted from local blasting or pile-driving activities, slamming doors, etc.

M2 This class applies to instruments used in locations with significant or high levels of vibration and shock, e.g. transmitted from machines and passing vehicles in the vicinity or adjacent to heavy machines, conveyor belts, etc.

Test listed in A.12 and A.13 are only required for Mechanical class M2.

3.3.2 Electromagnetic environmental classes

E1 This class applies to instruments used in locations with electromagnetic disturbances corresponding to those likely to be found in residential, commercial and light industrial buildings.

E2 This class applies to instruments used in locations with electromagnetic disturbances corresponding to those likely to be found in other industrial buildings.

4 Principle of measurement

4.1 Conversion as a function of temperature

In this case the conversion device consists of a calculator and a temperature transducer and it converts the volume to the base conditions.

The pressure is not measured, but may be included as a fixed value in the processing of the conversion factor.

The compression factor is not calculated, but may be included as a fixed value in the processing of the conversion factor.

The error of a gas volume conversion device, measuring only temperature, is calculated referring to the reference conversion factor as calculated taking into account the compression factor at a fixed set pressure and measured temperature.

The volume at base conditions is obtained from the relationship:

$$V_b = C \times V$$

where C is the conversion factor given from the relationship:

$$C = \frac{K}{T}$$

where K is a fixed value obtained from the relationship:

$$K = \frac{p}{p_b} \times T_b \times \frac{Z_b}{Z}$$

4.2 Conversion as a function of pressure and temperature

In this case, the conversion device consists of a calculator, a pressure transducer and a temperature transducer.

The compression factor may be considered as a fixed value calculated from mean measurement conditions and a determined gas composition.

The volume at base conditions is obtained by the relationship:

$$V_b = C \times V$$

where C is the conversion factor given from the relationship:

$$C = K' \times \frac{p}{T}$$

where K' is a fixed value obtained from the relationship:

$$K' = \frac{1}{p_b} \times T_b \times \frac{Z_b}{Z}$$

An absolute pressure transducer shall be used for absolute pressures below 21 bar.

For absolute pressures equal to or greater than 21 bar a gauge pressure transducer may be used.

In this case the value of the atmospheric pressure shall be the average value calculated taking into account the altitude of the installation site. This value shall be pre-set.

4.3 Conversion as a function of pressure, temperature and deviation from the ideal gas law

In this case, the conversion device consists of a calculator, a pressure transducer and a temperature transducer.

The general requirements indicated in 4.2 shall be enforced.

The deviation from the ideal gas law is compensated by the calculation of the compression factor using an appropriate equation as a function of pressure and temperature:

$$Z = f(p, T)$$

Settable gas properties and components inputs are used for the compression factor calculation.

The volume at base conditions is obtained from the relationship:

$$V_b = C \times V$$

where C is the conversion factor given by the relationship:

$$C = \frac{p}{p_b} \times \frac{T_b}{T} \times \frac{Z_b}{Z}$$

The manufacturer shall specify the method used for compression factor calculation.

An absolute pressure transducer shall be used for absolute pressures below 21 bar.

For absolute pressures equal to or greater than 21 bar, a gauge pressure transducer may be used.

In this case, the value of the atmospheric pressure shall be the average value calculated taking into account the altitude of the installation site. This value shall be pre-set.

4.4 Correction of the volume at measurement conditions

The object of the correction function is to compensate the error of the gas meter, as determined in the calibration certificate.

The conversion device may be able (optionally) to correct the error of the gas meter.

When using this option it shall be ensured that the error curve to be used is relevant to the actual operational conditions.

If this correction is available, it shall be integrated in the configurations stated in 4.1, 4.2 and 4.3; in those cases, the volume marked as V means V_c .

The correction function of the conversion device shall be able to correct deviations recorded when calibrating the gas meter to which it is connected.

The error of the meter will be corrected by the use of a function $f(Q)$ in such a way that for each operating point:

$$V_c = V_m \times f(Q)$$

The manufacturer shall specify the method used.

If a nonlinear interpolation between the calibration points is used, the manufacturer shall provide proof that the method has a better weighted (by flow) accuracy than the linear interpolation.

The choice of the parameters shall be so that the correction function $f(Q)$ remains, at all points, definite, continuous and derivable for rates of flow between $Q_{\min}$ and $Q_{\max}$ of the gas meter.

The correction can only be applied if the gas meter produces at least 10 Hz at $Q_{\min}$. Below $Q_{\min}$, the correction function shall remain at the value obtained at $Q_{\min}$ or equal to 1 and above $Q_{\max}$, the correction factor shall remain at the value obtained at $Q_{\max}$.

5 Rated operating conditions

5.1 Specified field of measurement

5.1.1 General

The field of measurement of the complete instrument shall be specified by the manufacturer.

5.1.2 Specified measurement range for gas pressure

The transducer shall be calibrated over the range specified by the manufacturer which shall be at least:

$$\frac{p_{\max}}{p_{\min}} > 2$$

5.1.3 Specified measurement range for gas temperature

The manufacturer shall specify the gas temperature range according to the following:

- normal range: -20 °C to $+50\text{ °C}$;
- limited range: a minimum range of 40 °C anywhere between the limits of the normal range;
- extended range: to be specified by the manufacturer.

5.1.4 Gas characteristics

Fuel gases of the first and second families according to EN 437:2018.

The manufacturer shall indicate the:

- gas family or group;
- maximum operating pressure.

5.1.5 Base conditions

The manufacturer shall specify the base conditions, or range of base conditions for converted quantities.

5.2 Environmental conditions

5.2.1 Ambient temperature range

The manufacturer shall specify the ambient temperature range of the gas-volume conversion device with a minimum temperature range of 50 °C for the climatic environment, and the minimum temperature limit being either -40 °C, -25 °C, -10 °C or 5 °C, and the maximum temperature limit being either 30 °C, 40 °C, 55 °C or 70 °C.

5.2.2 Humidity range

The instrument shall operate in a relative humidity range of 10 % to 93 %.

The manufacturer shall indicate whether the instrument is designed for condensing or non-condensing humidity as well as the intended location for the instrument.

If designed for non-condensing humidity, the device shall meet the requirements of Test A.4.

If designed for condensing humidity, the device shall meet the requirements of Test A.5.

5.2.3 Mechanical environment

The manufacturer shall specify the mechanical class for which the device is intended (M1 or M2) (see 3.3.1).

5.2.4 Electromagnetic environment

The manufacturer shall specify the electromagnetic environmental classe E2 (see 3.3.2).

5.3 Power supply

The manufacturer shall specify the nominal value of the AC supply and/or the limits of DC supply.

The limits of DC supply shall be compatible with customers' requirements and/or the electricity supply of country of destination.

6 Construction requirements

6.1 General

6.1.1 All the constituent elements of a gas-volume conversion device shall be constructed of materials having appropriate quality to resist the various forms of degradation which may occur under normal operating conditions as specified by the manufacturer. A gas-volume conversion device shall, in all circumstances, withstand the influence factors and disturbances defined in 8.5 and 8.6.

6.1.2 The conversion devices shall be used for natural gas according to EN 16726:2015+A1:2018 and biomethane according to EN 16723-1:2016.

The interface with a calorific value determination device is described in EN 12405-2.

All the constituent elements of a gas-volume conversion device shall be designed in such a way that it does not degrade the accuracy of the measurement of the gas meter with which it is associated.

6.1.3 The gas-volume conversion device shall be constructed in such a way that any interference and intervention, liable to influence the results of measurement, shall cause permanently visible damage to the conversion device or its protective seals, or set an alarm which shall be memorized in the event register. The seals shall be visibly fixed, and easily accessible.

Electronic seals shall comply with the following requirements:

- access shall only be obtained by using a password or a code that can be updated or by using a specific device;
- the last intervention, at least, shall be registered in the memory, including date and time of intervention and a specific element to identify the intervention;
- it shall be possible to have access to the intervention(s) registered in the memory.

For gas volume conversion devices, where the given inputs may be dismantled or replaced, all connections and interfaces between the calculator and transducers or meter should be protected by separate seals to avoid the breaking of the main metrological seal in case of component replacement. Access to parameters which take part in the determination of the measured results or to the measured results themselves shall not be possible through the disconnected points, except if the conditions given in this paragraph are fulfilled.

NOTE More information on seals can be found in WELMEC 11.3.

6.1.4 The conversion factor shall be recalculated at intervals between the volume pulses not exceeding 1 min for a temperature conversion device and at intervals not exceeding 30 s for the other types of gas-volume conversion devices.

However, when no volume signal has been received from the gas meter for:

- over 1 min for a temperature conversion device; or
- over 30 s for other types,

recalculation is not required until the next volume signal is received.

6.1.5 Any interfaces and connections fitted within the conversion device allowing the connection of complementary devices shall not corrupt the metrological behaviour of the conversion device.

6.1.6 The interconnections and any interfaces between the calculator and the transducers are integral parts of the conversion device.

The manufacturer shall specify the length and characteristics of the interconnections and of any interfaces where these may affect the accuracy of measurement of the gas-volume conversion device.

6.1.7 Equipment used in hazardous areas shall meet the electrical requirements specified in the appropriate standards: EN IEC 60079-0:2018, EN 60079-1:2014³⁾, EN 60079-2:2014, EN 60079-5:2015, EN 60079-6:2015, EN 60079-7:2015, EN 60079-11:2012, EN 60079-25:2010⁴⁾.

6.1.8 All the constituent elements of a conversion device shall be constructed in such a way that the compatibility of electromagnetic disturbances conforms the requirements specified in EN 55011:2016¹⁾.

6.1.9 Casings shall meet the requirements concerning the security of the equipment as specified in EN 60950-1:2006⁷⁾.

6.2 Casings

The casings of all the constituent elements of a conversion device shall have an ingress protection index (IP), specified in EN 60529:1991⁵⁾, complying with the installation conditions specified by the manufacturer.

Any part of the conversion device designed for outdoor use and not intended to be installed in a weatherproof housing shall be at least in accordance with the severity level IP 65, specified in EN 60529:1991⁵⁾.

All additional components forming the measuring chain (interfaces, signal convertors, power supply, cabling, etc.) shall be protected according to EN 1776:2015.

6.3 Indications

6.3.1 General

6.3.1.1 The calculator shall be fitted with an indicating device that indicates:

- the incremented volume at base conditions V_b ;
- the incremented volume at measurement conditions V_m ;
- the incremented corrected volume V_c if applicable;
- the alarms' indications as defined in 6.6.

6.3.1.2 Additionally, the following information shall be indicated by a method described in 6.3.1.3:

- the base conditions in the form:
 - $T_b = \dots$ K;
 - $p_b = \dots$ bar;
- the conversion factor C ;
- the compression factor Z if applicable;
- the parameter values measured by the transducers (e.g. pressure p in bar, temperature t in °C);
- the correction factor C_f if applicable;
- the correction function $f(Q)$ if applicable;
- alarm(s) indication(s) additional to those defined in 6.6 if applicable;
- the entered data which affect the metrological result;
- gas properties used in Z computation if applicable;
- the reference to the method by which the compression factor is calculated or the constant, if applicable;
- the serial number of the transducers as appropriate;
- the upper and the lower limits of the specified measuring range of the temperature transducer in K or °C and the gauge or absolute pressure, in bar, of the pressure transducer as appropriate;

- the value of one volumetric pulse at measurement conditions in the form:
 - 1 imp $\hat{=}$... m³ (or dm³); or
 - 1 m³ (or dm³) $\hat{=}$... imp;
- the parameters for gas meter error correction curve if applicable;
- the indication of the end of life of the battery, if applicable;
- the software version and its intrinsic identification.
- It shall also be possible, at the time of the control operations described in Annex A, to display the values of the conversion factor and of the various quantities measured or calculated.

6.3.1.3 The information shown in 6.3.1.2 shall be indicated either on:

- the indicating device of the gas volume conversion device;
- a permanently attached information plate with indelible markings;
- an external attached indicating device;
- a combination of the above.

6.3.1.4 The volume at base conditions shall be preferentially displayed.

6.3.1.5 The method by which the quantities described in 6.3.1.2 may be displayed on the indicating device of the gas volume conversion device shall take one of the following forms:

- by means of direct operator input (e.g. the depression of push buttons, whereby each quantity may be selected by sequential operator inputs or combination of operator inputs. Each operator input shall select the current value of the quantity. If after 255 s there has been no operator input, the display shall revert to showing the volume at base conditions, or to visualizing V_b by a simple operation (e.g. the depression of a push button);
- by means of automatic and sequential scrolling through the quantities that may be continuous, or initiated by an operator input. In this case the display shall show each parameter for 5 s and the volume at base conditions shall be shown every 15 s.

6.3.1.6 The identification and the unit of each quantity or parameter that can be indicated shall be clearly shown next to or upon the display unit of the calculator.

EXAMPLE Volume at base conditions, V_b , ...m³.

6.3.1.7 The scale interval of the display of the volume at base conditions shall be of the form 10ⁿ units of volume. The value of the scale interval shall be clearly stated in the vicinity where the volume at base conditions is displayed.

6.3.1.8 The indicating device shall have at least 8 significant digits. The number of bits used for the internal calculation shall be enough to guarantee the accuracy of the measurement.

6.3.2 Electronic indicating device

6.3.2.1 The device indicating the volume at base conditions shall be provided with means for checking to ensure that the display is operating correctly.

6.3.2.2 The minimum height of the numerals for the display of converted volume V_b shall be 4 mm and the minimum width shall be 2,4 mm.

6.3.2.3 It shall be possible to read the index clearly and correctly, within an angle of 15° from normal to the window.

6.3.2.4 When all the digits of the indicating device are not used for the indication of the volume, every unused digit to the left of the significant digit shall indicate zero.

6.3.2.5 The number of digits shall allow the on-site verification.

6.3.2.6 Software embedded in the calculator should fulfil requirements defined in appropriate and relevant international or national reference standards.

NOTE WELMEC Guide 7.2 and extension I may be used.

6.4 Inputs for volume conversion

The volume conversion device shall have an input that shall be able to process a signal from the associated gas meter. The input shall respond to every pulse in such a manner that no pulses are gained or lost by the volume conversion device.

The manufacturer shall specify the pulse input characteristic of the gas volume conversion device and the maximum frequency.

For a conversion device type 2, the interfaces between the calculator unit and the transducer shall be specified in terms of all parameters that may influence that measurement.

The VCD may be interfaced with calorific value determination device as described in EN 12405-2.

The parameters which contribute to the calculation of Z (for example the parameters of gas composition) may be changed also remotely, tracking the change by recording the old value of each modified parameter in the event register. For this, the reset of the event register shall be sealed. The VCD shall at least provide, without any supplementary device, the date of the last reset of the event register.

NOTE 1 WELMEC 7.2 may be used for remote change management.

The EVCD relevant software, including metrological software, may be upgraded. It shall be possible to view on the display the software version in use at that time.

NOTE 2 The EVCD relevant software may be upgraded conforming to WELMEC 7.2 Extension D. For this, methods for the traceability of relevant software download should comply with WELMEC 7.2 Clause D4.

NOTE 3 Meters can often be subject to considerable periods of time where there is no gas flow. During such periods, conventional LF and HF pulse outputs will, in effect, be operating at 0 Hz. Conversely, at maximum throughput, a typical meter's LF output could rise to 2 Hz and its HF output up to 5 kHz or higher. Any pulse input circuitry in a volume conversion device will have to be capable of dealing with such frequency ranges.

6.5 Battery powered conversion device

6.5.1 The manufacturer shall declare the service life of the battery for a typical usage profile and the conditions under which the tests are undertaken. The typical usage profile shall cover at minimum the following:

- frequency for all inputs;
- ambient range with % of time spent at $t_{\text{amb,min}}$;
- interval of acquisition for pressure and temperature;
- communication time for all ports;
- pulse outputs configuration.

The service life of the battery dedicated for the metrological function for this typical usage profile shall be greater than 5 years.

Where the same battery is used to operate the metrological part of the meter and the additional functionalities, the manufacturer shall also declare the measures that have been taken to protect the metrological part.

The manufacturer shall specify the type of the battery and whether the battery can be changed in a hazardous area and if so, under which conditions.

The battery compartment should make provisions to prevent unauthorised access. Batteries shall be replaced only after the breaking of a seal different from the metrological seal.

6.5.2 Only an indication shall be provided when 10 %, or less, of the life, or estimated life of the battery is remaining. All functions shall nevertheless be preserved.

When the estimated life is calculated, the calculation shall be done taking into account the actual operating conditions specified by the manufacturer of the conversion device.

The VCD shall maintain the full functionality until the battery reaches the “expiring level”, defined by the manufacturer. When reaching the “expiring level”, the VCD may lose any or all of its functionality, including measurement. When the “expiring level” is reached, the information specified in 6.5.3 shall be memorized.

EXAMPLE Non Volatile Ram - NVRAM may be stated as retention area and values input may be auto recoverable.

6.5.3 A battery exchange (if the battery is replaceable) shall be possible without breaking any metrological seals of the conversion device.

During the battery exchange the following information shall be retained:

- the volume at base conditions;
- the volume at measurement conditions;
- the corrected volume if applicable;
- the alarms' indications;
- the entered data which affect the metrological results;
- the last intervention, at least, as specified in 6.1.3.

The battery specified by the manufacturer shall be used.

6.6 Security devices and alarms

6.6.1 The devices shall be capable of detecting:

- if any of the measured or calculated values is outside the specified measurement ranges;