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# WELMEC

European Cooperation in Legal Metrology

## Modular Evaluation of Gas Meters and Volume Conversion Devices



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European Cooperation in Legal Metrology

WELMEC is a cooperation between the legal metrology authorities of the Member States of the European Union and EFTA.

This document is one of a number of Guides published by WELMEC to provide guidance to manufacturers of measuring instruments and to Notified Bodies responsible for conformity assessment of their products.

The Guides are purely advisory and do not themselves impose any restrictions or additional technical requirements beyond those contained in relevant EU Directives.

Alternative approaches may be acceptable, but the guidance provided in this document represents the considered view of WELMEC as to the best practice to be followed.

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# 1. Foreword

Gas meters and volume conversion devices are often constructed from separate parts. Those parts are produced by different Original Equipment Manufacturers (OEMs), in this document referred to as “producers”.

This document provides guidance on the evaluation of the above mentioned parts of gas meters and electronic volume conversion devices.

This WELMEC guide 11.6 is used in combination with

- WELMEC guide 8.8, which provides guidance on the general and administrative aspects of the voluntary system of modular evaluation of a measuring instrument.
- WELMEC guide 7.2, which provides guidance on software requirements and validation

Other references:

- EN 12405-1/A2 (2010) “Gas meters – Conversion devices – Part 1: volume conversion”
- OIML R 137-1&2 (2012) Gas meters, Part 1: Metrological and technical requirements, Part 2: Metrological controls and performance tests
- EN 1359 (2017) “Gas meters – Diaphragm meters”
- EN 14236 (2007) “Ultrasonic domestic gas meters”
- EN 12480/A1 (2006) “Gas meters – Rotary displacement gas meters”
- EN 12261/A1 (2006) “Gas meters – Turbine gas meters”

## 2. Scope

This document provides guidance to the technical implementation of the modular approach as described in WELMEC 8.8, for parts of gas meters and volume conversion devices.

This guide covers the following:

- electronic volume conversion devices (EVCD's) type 2, as described in definition 3.1.18.2 of the EN 12405-1/A2, with the parts pressure transducers, temperature transducers and calculators;
- calculating devices or calculators including indicating devices (see 3.1.5, 3.1.6 and 6.3 of OIML R 137-1&2) of electronic gas meters, which are intended to be connected via a physical connection to the measuring part.
- measuring parts of a gas meter consisting of the measuring element/transducer, the gas containing meter body and the interface to the calculator. The measuring transducer may include electronics, which calculates a measuring signal for the interface to the calculator/ indicating device or may be purely a mechanical device

Parts of electronic volume conversion devices type 1 or parts of mechanical conversion devices are not under the scope of this document. Also ~~parts of~~ mechanical indicating devices are not under the scope of this document.

Even if modular evaluation is used, the manufacturer shall apply for a conformity assessment procedure for the complete measuring instrument.

It should be noted that it is the responsibility of the manufacturer of the complete instrument to be able to demonstrate the conformity to all applicable requirements of the MID even in case the modular evaluation is used.

This guide covers only issues related to the MID. A part may bear the CE marking according to European directives other than the MID and the EC or PC number, but it cannot bear the supplementary metrology marking and Notified Body number relating to the MID.

Only a complete measuring instrument (or sub-assembly if foreseen in the MID) may bear the supplementary metrology marking and Notified Body number relating to the declaration of conformity to the MID.

### 3. Definitions, abbreviations and symbols

The definitions of the EN 12405-1/A2 and OIML R 137-1&2 apply to this guide together with the definitions given in WELMEC guide 8.8 and 7.2.

Abbreviations:

MI	Measuring Instrument
Part	A part of a MI which performs a specific function and can be evaluated separately.
Checking facility	facility incorporated in a measuring instrument which enables significant faults to be detected and acted upon
MID	MID, directive 2014/32/EU
NB	Notified Body
TEC	Type- or Design examination certificate
EC	Evaluation Certificate as defined in WELMEC guide 8.8
PC	Parts Certificate as defined in WELMEC guide 8.8
EN 12405-1/A2	EN 12405-1:2005+A2:2010 “Gas meters – Conversion devices – Part 1: volume conversion”
OIML R 137-1&2	“Gas meters”, Edition 2012, Part 1: Metrological and technical requirements, Part 2: Metrological controls and performance tests

## 4. Evaluation procedure of the parts

For the evaluation the following procedure should be followed.

### 4.1 Application

There shall be a written application from the producer of the part for an EC or PC. The application shall contain the following:

- Producers name and address;
- A declaration that the part cannot be disturbed or fraudulently manipulated through its interfaces without being made evident;
- A declaration that the producer is aware of his obligations as specified in WELMEC guide 8.8, specifically related to the availability of the technical documentation;
- Complete technical documentation in accordance with article 18 of the MID, for example but not limited to:
  - General description of the type, and explanations necessary to understand the functioning of the part;
  - Technical documentation to ensure consistent production;
  - Description and characteristic data of the part;
  - Description of the checking facilities of the part;
  - Information on compatibility in respect to interfaces, power supply etc.
  - Software description, communication protocols, means for securing the software;
  - Information concerning special cases (if applicable), such as but not limited to:
    - Special operating conditions;
    - Reaction of the part to significant faults;
    - Functioning of the part after switch on.
  - A declaration of conformity stating that the hardware of the part complies with the relevant parts of the applicable directives, in particular with the EMC directive.

## 4.2 Test requirements

### 4.2.1 Technical requirements

The part shall comply with the technical requirements as specified in relevant Annexes A, B, C and D.

### 4.2.2 Requirements concerning software

The legally relevant software running on the part shall be tested in accordance with WELMEC guide 7.2: Software Guide (Measuring Instruments Directive 2014/32/EU), risk class C.

The correct functioning of the checking facilities may be tested by means of simulation.

In the case that the part is not equipped with a display, the software identification should be transmitted to another part of the measuring instrument that has a display and can indicate the software identification on request.

With respect to the reliability of volume conversion devices, chapter 6.6 of EN 12405-1/A2 applies.

### **4.2.3 Requirements concerning markings**

The part should either be inscribed with the following markings or these marking should be permanently visible on the display or a combination of both:

- EC or PC number of the device
- Producers identification mark, trademark or name
- Type designation
- Year of manufacture
- Serial number

The EC should state the position of the markings or refer to drawings that indicate the position.

## **4.3 Evaluation**

The test institute shall evaluate whether

- the documentation is confirmed to be in accordance with article 18 of the MID;
- the part is confirmed to be constructed in accordance with the documentation, in particular if the part is equipped, when applicable, with a clearly readable display, a properly operating legally relevant software, and the necessary checking facilities;
- the part is confirmed to be in accordance with the test requirements as specified in chapter 4.2.

The test institute shall issue an Evaluation Report (ER) that specifies the examinations and tests that have been performed and what the outcome of the examinations and tests were.

If the part complies with all the applicable requirements of this guide an EC or PC can be issued.



## 5. Certificates

### 5.1 EC or PC

The EC or PC should be in compliance with WELMEC guide 8.8.

In particular the EC or PC should contain:

- a description of the legally relevant characteristics of the part, including its compatibility with other devices or parts
- environmental conditions
- rated operating conditions
- a description how the software identification can be obtained
- documentation that allows the conformity of the part including the software to be checked
- a reference to the applied harmonized standard or normative document, the WELMEC 7.2 and this WELMEC 11.6;
- a reference to the *Evaluation Report* or *Test Report* with the appertaining test data.

### 5.2 TEC

There are two administrative ways for including a part in the TEC:

1. All references and complete description of a specific type of a part are included in the TEC of the measuring instrument, or
2. The modular approach is used
  - to allow the possibility of using parts with an EC or PC by making reference to that EC or PC
  - with the possibility of a general statement concerning the use of any part with a PC, with the appertaining compatibility conditions .

Option 2 is only possible in case the EC's or PC's are issued by a test institute that can also act as a Notified Body under module B of the MID Annex IV (MI-002).

#### 5.2.1 Wording in the TEC of the MI

In the application for a type-examination certificate the manufacturer of the MI may apply for the possibility of using any part evaluated under this guide.

If the manufacturer requests a general statement for the use of any part evaluated under this guide with a PC, the following conditions should be stated in the TEC:

- The part has a PC issued by a test institute that can also act as a Notified Body under module B of the MID Annex IV (MI-002);
- The connection shall be made in such a way that the presentation of the results meets the essential requirements of the MID; and
- The connection shall be made through the interfaces with the specified protocols as mentioned in the TEC, and/or the PC.
- The connection to the part is secured as mentioned in the TEC, and/or the PC.

### 5.3 Revision of certificates

The applicant shall keep the Notified Body that has issued the TEC or EC or PC informed of all modifications to the instrument or part that may affect the conformity of the instrument with the (essential) requirements or the conditions for validity of the certificate.

The required actions for both Notified Body and manufacturers are listed in WELMEC 8.8.

## Annex A - General requirements for gas meters and volume conversion devices

The producer shall specify the upper temperature limit and the lower temperature limit of the environment from any of the values in table mentioned down:

	Temperature limits			
Upper temperature limit	30°C	40°C	55°C	70°C
Lower temperature limit	5°C	-10°C	-25°C	-40°C

A minimum temperature range is 50°C for the climatic environment.

A minimum temperature range of measured gas is 40°C.

## **Annex B - Technical requirements for parts of volume conversion devices**

The different parts of the conversion device type 2 are examined as indicated below in chapter B.1 up to B.4.

### **B.1 Calculator**

The calculator is examined in accordance with the EN 12405-1/A2, chapter A.1.3. The maximum permissible errors are stated in the EN 12405-1/A2, Annex A.

### **B.2 Pressure transducers**

The pressure transducers are examined in accordance with the EN 12405-1/A2, Annex B.

The performance criteria are stated in the EN 12405-1/A2, chapter B.4.

### **B.3 Platinum resistance thermometer sensors**

The platinum resistance thermometer sensors are examined in accordance with the EN 12405-1/A2, Annex C.

The maximum permissible errors are stated in the EN 12405-1/A2, chapter C.4.

### **B.4 Temperature transducers**

The temperature transducers are examined in accordance with the EN 12405-1/A2, Annex D.

The maximum permissible errors are stated in the EN 12405-1/A2, chapter D.4.

## **Annex C - Technical requirements for calculators and calculating/indicating devices for electronic gas meters**

The definitions of a “calculator” and of an “indicating or displaying device” are mentioned in OIML R 137-1&2, articles 3.1.5 and 3.1.6.

Remark: In the text below the links are given to the applicable requirements of the OIML R 137. Alternatively the EN 16314 provides requirements for Additional Functionalities including electronic indexes. In a later version of this document the specific requirements of the EN 16314 will be included.

### **C.1 Construction requirements**

The construction requirements of a “calculator” and of an “indicating or displaying device” are mentioned in OIML R 137-1&2, article 6.1 and 6.2. The following items shall be assessed:

- Materials
- Soundness of cases
- Protection against external interference
- Connections between electronic parts
- Components
- Zero flow

The manufacturer has to provide documentation on the constructional methods which are applied for the connection to other parts.

The EC or PC shall give information about the possibility to handle bi-directional flow (if applicable). In that case also the method shall be described.

If applicable, a dedicated power source of a “calculator” and of an “indicating or displaying device” shall have a lifetime of at least five years. After 90 % of its lifetime an appropriate warning shall be shown.

Relevant provisions of article 6.3 of OIML R 137-1&2 for electronic indicating device shall be met. In addition, the indicating device shall be able to record and display the indicated quantity of gas corresponding to at least 8000 hours of operation at the maximum flow rate  $Q_{max}$ , without returning to the original reading.

The quantity corresponding to the least significant digit shall not exceed the quantity of gas passed during one hour at  $Q_{min}$ .

Metered quantity shall be displayed in cubic metre, or in kilogram.

## C.2 Overview of requirements and applicable evaluation tests

The correct functioning of the calculator and/or the calculating / indicating device may be tested by means of simulation.

The following types of interfaces between the measuring part and the calculator and/or calculating/indicating device can be applied as indicated below, with the appertaining fractional error:

Connection between measuring part and calculator and/or calculating / indicating device	fractional error
Pulses	0,00% *)
Digital, serial communication	0,00% **)
Rotating movement, which is translated into pulses (for the resolution of the pulses, see WELMEC 11.1, chapter 2.4.4)	0,00% *)

\*) A deviation of 1 pulse may occur due to the applied test method (running start and stop).

\*\* ) Apart from rounding and resolution issues.

The fractional error is the contribution of the part to the total error (MPE) of the complete measuring instrument.

Remark: the analogue input can be used for example in case of an additional temperature sensor.

The calculator and/or the calculating / indicating device is examined in accordance with paragraph 5.13.7 of the OIML R 137-1&2, while the limits are applied as indicated in Table 4 and 5.

The software shall be tested conform WELMEC Guide 7.2.

In case of digital transmission the correctness of the transmission shall be checked by the calculator or calculating/indicating device, by checking all implemented protection mechanisms.

In case of pulse transmission the correctness of this transmission shall be checked, as indicated in the OIML R 137-1/2, chapter 6.7.1. Specific pulse characteristics including the acceptable highest pulse frequency by the calculating / indicating device shall be mentioned in the EC or PC.

Remark: if a specific pulser is applied, it can be included either in the examination of the measuring part or in the examination of the calculating / indicating device.

If a correction device is included this has to be examined (see R 137-1/2 chapter 5.3.3).

If a temperature compensation is applied the temperature sensor shall be tested in combination with the calculating / indicating device.

The *Evaluation Report* or *Test Report* shall contain the test data from all the above mentioned relevant tests.



## Annex D - Technical requirements for “measuring transducer/ measuring part” for gas meters

The definition of a “measuring transducer” (VIM 3.7) is mentioned in OIML R 137-1&2, article 3.1.4

The measuring part of a meter consist of the measuring element / transducer, the gas containing meter body and the interface to the calculator / indicating device.

The measuring transducer may include electronics, which generate a measuring signal for the interface to the calculator / indicating device. The metering part may include a correction device.

### D.1 Metrological requirements

The flow rate ranges and MPE are taken from OIML R 137-1&2, article 5.2 and 5.3 or the applicable harmonised standard as listed in the Foreword.

In order to fulfil the requirements of MID the following values have to be chosen due to the fact the OIML R 137-1&2 allows other options:

- for class 1.5 a ratio of  $Q_{max}/Q_{min} \geq 150$
- for class 1 a ratio of  $Q_{max}/Q_{min} \geq 20$
- for temperature compensated gas meter the selected temperature  $t_{sp}$  shall lay between 15 °C and 25 °C.

Inside the rated operating conditions the metering part shall provide a signal which it allows to realise an adjustment by the calculator device as described in OIML R 137-1&2, article 5.4 or the applicable harmonised standard as listed in the Foreword.

The producer shall specify the adjustment range and adjustment method (factor, polynomial, spline method) necessary to be provided by the correction device of the calculator / indicating device.

The requirements for the evaluation tests given in OIML R 137-1&2, article 5.5 up to and including 5.13 or the applicable harmonised standard as listed in the Foreword shall be fulfilled in order to show the suitability of the measuring transducer/ measuring part for the rated operating conditions and for the specified environmental conditions.

### D.2 Construction requirements

The construction requirements of a “measuring transducer/ measuring part” are mentioned in:

Measuring part	Harmonised standard	Normative document
Diaphragm gas meter	EN 1359, chapter 6 and 7	R 137-1&2, article 6.1 and 6.2
Ultrasonic domestic gas meter	EN 14236, chapter 6 and 7	
Rotary displacement gas meter	EN 12480, chapter 6	
Turbine gas meter	EN 12261, chapter 6	
Other gas meters		



Remark: Only those tests listed in the cross reference of the applicable normative document or harmonised standard (ZA Annex) are required to be tested for the part under consideration.

The producer shall provide documentation on the constructional methods which are applied for the connection to other parts.

If applicable, the EC or PC shall give information about the possibility to handle bi-directional flow. In that case also the method shall be described.

If applicable, the power consumption of a “measuring transducer/measuring part” shall be specified by the producer, which is necessary for running the meter. If a battery is used a lifetime of at least five years shall be guaranteed. After 90 % of its lifetime an appropriate warning shall be provided to the “metering part” via the interface.

The battery management may be handled by the calculator / indicating device for the whole gas meter.

The interface shall be designed such that frequency of updating and quantity resolution (number of digits) are sufficient to meet the requirements given in clause 2.4.4 of WELMEC 11.1 for the indicating device and testing of the gas meter.

The following types of interfaces between the measuring part and the calculator and/or calculating/indicating device can be applied:

<b>Connection between measuring part and calculator and/or calculating / indicating device</b>
Pulses
Digital, serial communication
Rotating movement, which is translated into pulses (for the resolution of the pulses, see WELMEC 11.1, chapter 2.4.4)

Remark: an analogue output can be used for example in case of an additional temperature sensor.

The metering part may provide digital signals for alarms and warnings.

In case of digital or pulse transmission it shall be possible to check the correctness of the transmission by the calculator or calculating/indicating device (e.g. by means of double pulse transmission).

The pulse characteristics including the highest provided pulse frequency shall be mentioned in the EC or PC.

### **D.3 Overview about applicable evaluation tests**

The requirements as mentioned in the clauses indicated in the table below which are applicable for the gas meter as a whole, shall be applied to the “measuring transducer / measuring part”:

Measuring part	Harmonised standard	Normative document
Diaphragm gas meter	EN 1359, chapter 5	R 137-1&2, Table C.1
Ultrasonic domestic gas meter	EN 14236, chapter 5, 13 and 14	
Rotary displacement gas meter	EN 12480, chapter 5 and 7	
Turbine gas meter	EN 12261, chapter 5 and 7	
Other gas meters		

For temperature compensation there are 2 distinct solutions:

- a) temperature compensation as part of the measuring element / measuring transducer; in this case the temperature compensation shall be examined in combination with the measuring element / measuring transducer; the requirements as listed in the table above are fully applicable.
- b) temperature compensation is realised by the calculator / indicating device; in this case the effect of the temperature compensation on the metering results shall be examined for the meter as a whole. In this case the fractional errors for both the measuring part and temperature compensation have to be evaluated by the Notified Body.

The fractional error of the connection of a calculator / indicating device is zero due to the requirements to the interface between metering part and calculator / indicating device (see Annex C).

The correct functioning of the measuring element / transducer may be tested by using a compatible calculator/ indication device. The acquisition of the interface signals and analysis of data by software may be used if the same interface and settings of the measuring element / transducer are used as foreseen for the application and described in the EC or PC.

The software shall be tested conform WELMEC Guide 7.2, risk class C.

If a correction device is included this shall be examined in conformity with OIML R 137-1/2 chapter 5.3.3 or the applicable clauses of the harmonised standard as listed in the Foreword.

## D.4 Documentation

The producer shall provide a manual for the measuring transducer/measuring part which it allow to fulfil the requirements in respect to R 137-1/2 chapter 8.1 and 8.2.

The *Evaluation Report* or *Test Report* shall contain the test data from all the above mentioned relevant tests.

## D.5 Security provisions

The producer shall describe how to secure the part including the facilities to secure the connection with the calculator / indicating device. The software security shall be conform WELMEC 7.2.

## Change history

Issue 2018

chapter	added	removed
Annex D	Annex D - Technical requirements for “measuring transducer/ measuring part” for gas meters	