

 <b>Eskom</b>	<b>Standard</b>	<b>Technology</b>
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Title: **STANDARD FOR SINGLE  
PHASE PROGRAMMABLE  
ENERGY METERS**

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## **1. Introduction**

This document specifies the requirements for single phase programmable meters which can be utilised as manual read meters or can be interfaced through to a Data Acquisition System (DAS) for the remote downloading of billing data. This specification does not cater for AMI (advanced metering infrastructure) applications and is purely there for a metering only application.

## **2. Supporting clauses**

### **2.1 Scope**

#### **2.1.1 Purpose**

This standard sets out the requirements for all programmable single phase energy meters. Since some part of the metering equipment is programmable, configuration software is required. This document describes the requirements for the hardware, the software, support for the equipment, and training required for the correct use of the metering equipment.

#### **2.1.2 Applicability**

This document shall apply throughout Eskom Holdings Limited Distribution Division.

### **2.2 Normative/informative references**

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

#### **2.2.1 Normative**

- [1] ISO 9001 Quality Management Systems.
- [2] 240-69387766 (old DST 34-391), Standard for programmable meter configuration.
- [3] SANS 62052 part 11, Electricity metering equipment (AC) - General requirements, tests and test conditions
- [4] SANS 62053 part 21, Electricity metering equipment (a.c.) - Particular requirements: Static meters for active energy (classes 1 and 2) (Old SABS IEC 61036)
- [5] IEC 62053 part 31, Electricity metering equipment (a.c.) - Particular requirements: Pulse output devices for electromechanical and electronic meters (two wires only)
- [6] SANS 62056 part 21, Electricity metering - Data exchange for meter reading, tariff and load control: Direct local data exchange
- [7] IEC 62058-31: Electricity metering equipment (AC) – Acceptance inspection – Part 31: Particular requirements for static meters for active energy (classes 0,2 S, 0,5 S, 1 and 2)
- [8] BS 5685-1, Electricity meters — Part 1: Specification for class 0,5, 1 and 2 single-phase and polyphase, single rate and multi rate watt-hour meters
- [9] 240-76624509, The control of new products and version changes in technical software, firmware and hardware in the measurement field
- [10] SANS 474, Code of practice for electricity metering
- [11] 240-56364444, Standard minimum requirements for the metering of electrical energy and demand.
- [12] 240-76628631, Standard for sealing metering equipment.

**2.2.2 Informative**

None

**2.3 Definitions****2.3.1 General**

Definition	Description
<b>“Tested” sticker</b>	A sturdy label applied to the side of the meter cover, indicating that the meter was calibrated by whom, and when.
<b>Activation date</b>	The date on which a new tariff or season or year becomes active. <b>Note:</b> All the rate period totals for the billing month up to this date shall be saved and the new totals created and used for the remaining period of the billing month.
<b>Active energy</b>	The integration with respect to time, of active power measured in kilowatt-hours (kWh).
<b>Auxiliary input/output</b>	The input/output from the relay contacts in the meter or the power supply provided to the meter for the meter to operate. This power is used, for example, to light up the display or to energize internal components of the metering device without burdening the voltage transformer.
<b>Basic current (I<sub>b</sub>)</b>	Basic current is that value of the current in accordance with which the relevant performance of the meter is fixed.
<b>Billing period</b>	(Also referred to as billing month) The time between consecutive billing dates, nominally in months (e.g. one, three or six months) but in practice defined as a number of days (e.g. 28, 31, 60, 89, 90, 91).
<b>Calibration</b>	Comparison of the indication of an instrument under test, or registration of the meter under test, with an appropriate standard.
<b>Channel</b>	An input or register for raw data corresponding to a specific meter. <b>Note:</b> If the encoder has built-in meters, the meter shall be considered to have four channels with values corresponding to kWh import and kWh export, and kvarh leading and kvarh lagging.
<b>Data Acquisition System (DAS)</b>	A software package capable of reading the data from all meter types for the transfer to other applications such as the billing system.
<b>Demand</b>	The average value of power or a related quantity over a specified interval of time.
<b>Demand integration period</b>	The interval of time upon which the demand measurement is based. EXAMPLE: 15 min, 30 min.
<b>Electronic interface</b>	A medium for communication, used between electronic metering equipment and master stations, where metering information is stored in memory and/or where the metering device can be configured in some way. In the case of optical interfaces, this is defined in various international standards i.e. SANS 62056 part 21, but is not limited to this specification
<b>Historical readings (stack)</b>	Meter readings of the previous season or previous billing month.
<b>kVA (Demand)</b>	$\sqrt{\text{kW}^2 + \text{kvar}^2}$

Definition	Description
<b>Mass memory</b>	Mass memory in the meter is used as a load-profiling tool. Half hourly, or any other duration specified in the relevant enquiry specification, energy values and power quality values are stored in this memory in the meter for later retrieval.
<b>Maximum demand</b>	The average value of power (active or apparent) over a specified interval of time. Demand can be based either on active or apparent demand, depending on the tariff in use. Maximum demand is relevant only on tariffs which have a demand component. The maximum demand is the highest value of demand which occurred during a billing period.
<b>Meter constant</b>	Value expressing the relation between the energy registered by the meter and the corresponding value of the test output. If the test output is pulses, the constant should be either pulses per kilowatt-hour (imp/kWh) or watt-hours per pulse (Wh/imp).
<b>Metering device configuration</b>	The configuration of clocks, registers, and memory which can be configured in any way by the user so as to implement switching times, rate registers, display sequences, integrating periods etc. The action of changing the configuration of the device is called configuring. This definition is included to address the confusion of terms - reference is often made to "programming" the meters by the users, whereas what actually occurs is the configuration of meters. See "metering device program".
<b>Metering device program</b>	The code executing on the embedded controller or other form of processor or processors implemented in the metering device. This code is produced by the meter manufacturer and cannot be changed by the user in any way. This is usually referred to as the firmware of the meter.
<b>Metering element</b>	A device in a meter that carries out the required functions of multiplication of the voltage and current in order to obtain electrical power and integration to obtain energy.
<b>Metering information</b>	<p>The origin of metering information is the metering point or the point of supply. All information related to metering equipment will be referred to as metering information. The term "information" is used to include data (unprocessed information), processed and stored information. This includes the following:</p> <ul style="list-style-type: none"> <li>• Configuration data: This relates directly to the metering device itself. It uniquely describes the processing inherent in the device which converts secondary electrical quantities (voltage and current) into the required measurand. See "metering device configuration".</li> <li>• Status data: This data relates to the condition of the metering device and the validity of the metering information which originates from it. It could be contained in the information presented at the site interface, or elsewhere in the metering system.<sup>3</sup></li> <li>• Metering data: This refers to the measurands of energy values, (active, reactive and apparent), and the instantaneous values which may be available from the meter.</li> </ul>
<b>MV90</b>	The software package used as the DAS. This package is developed by Utility Translation Services of the USA.
<b>MVLT</b>	A subset of the MV90 software package specifically designed to be loaded onto laptop computers for the local reading of meters in the field.
<b>MVP</b>	A subset of the MV90 software package specifically designed to be loaded onto hand held units for the local reading of meters in the field. This software can also be loaded onto laptop computers.

Definition	Description
<b>Non-volatile memory</b>	A storage device, which can retain information in the absence of power. <b>Note:</b> The information is to be retained for a period of at least two years.
<b>Power loss</b>	The active power and apparent power loss in each voltage and current circuit at nominal voltage and basic current.
<b>Programmable metering device</b>	A device that is capable of calculating, storing and displaying active and/or reactive energy values according to a user defined configuration.
<b>Reactive energy</b>	The integral of reactive power with respect to time. For the purpose of this document, reactive energy is the energy measured in kvarh.
<b>Real time clock</b>	A device which maintains, to an acceptable level of accuracy, information describing the date and time of day. This information is maintained irrespective of whether power is supplied to the unit within which the clock is installed.
<b>Register</b>	This term was derived from the visible dial on the faceplate of the electro-mechanical meters, where the register provided an indication of the energy usage. In electronic meters, this term refers to the non-volatile memory locations within the metering device where similar energy usage information is stored.
<b>Software custodian:</b>	A person appointed by the Metering and Measurements Study committee to configure, test and maintain standard metering configuration schemes for a particular set of metering software.
<b>Time-of-use metering:</b>	Metering installations where the recorded energy or demand is derived over certain time periods of a day.

### 2.3.2 Disclosure classification

**Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

## 2.4 Abbreviations

Abbreviation	Description
<b>AMR</b>	Automated Meter Reading
<b>DAS</b>	Data Acquisition System (Also known as Master Station)
<b>DLMS</b>	Device Language Message Specification
<b>I</b>	Current.
<b>I<sub>b</sub></b>	The basic current of the meter.
<b>I<sub>max</sub></b>	The maximum current of the meter.
<b>kWh</b>	Kilowatt hour
<b>LPU</b>	Large power user
<b>MD</b>	Maximum demand
<b>pf</b>	Power factor
<b>QOS</b>	Quality of Supply
<b>SABS</b>	South African Bureau of Standards

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Abbreviation	Description
<b>SANAS</b>	South African National Accreditation System.
<b>SPU</b>	Small power user
<b>V</b>	Voltage
<b>Vnom</b>	Nominal voltage. For the purpose of this specification the voltage is 230V

## **2.5 Roles and responsibilities**

The requirements of this document shall be used during technical evaluations of programmable single phase meters. The Metering and Measurement Study Committee shall and PTM&C COE appoint technical evaluators to assist with tenders.

## **2.6 Process for monitoring**

The Metering and Measurement Study Committee shall ensure that this standard be implemented.

## **2.7 Related/supporting documents**

This document supersedes 240-70427065 revision 1 – Specification for single phase programmable energy meters.

# **3. Requirements**

## **3.1 General**

- a) The devices defined in this standard are for single-phase applications.
- b) The meters shall be able to record import and export active energy as a minimum.

### **3.1.1 Accuracy class**

The accuracy class for single phase active energy meters will be at least class 1, in accordance with SANS 62053 part 21.

### **3.1.2 Master station (MV90) compatibility**

Certificates stating compliance with MV90 and MVLT shall be obtained from the distributors or local support agency of MV90 and provided to Eskom during the meter evaluation process, or with a formal tender process.

### **3.1.3 Communication protocols**

- a) Device Language Message Specification (DLMS)/Companion Specification for Energy Metering (COSEM) is the only protocol that has been standardized upon by the International Electrotechnical Commission (IEC). DLMS/COSEM is thus the preferred protocol for use with programmable meters, but this specification shall not limit itself only to DLMS/COSEM compliant meters.
- b) Communication protocols (including proprietary protocols) must be freely available to all third-party users.

## **3.2 Mechanical requirements**

### **3.2.1 General**

The mechanical and climatic requirements for the meter shall be in accordance with SANS 62052 part 11 and the following:

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### **3.2.2 Insulation**

Meters shall meet the insulation requirements of protective class II.

### **3.2.3 Meter cover**

- a) In cases where the meter cover is removable then it shall be sealed by at least two securing screws.
- b) The securing screws shall be of a shear-off type where the top part will break off if due force is applied to the screw to allow for a permanent fixture.

### **3.2.4 Terminals**

- a) The terminal blocks shall be positioned at the base of the meter and the terminal arrangement shall be in accordance with BS 5685-1.
- b) Fastening of the supply wiring shall either be by means of two securing screws on each terminal, or by means of a clamp terminal using at least one screw.
- c) Auxiliary inputs and outputs may either be spring-clamp terminals or screw-type terminals with one securing screw.
- d) The terminals shall have a bore diameter of at least 8 mm.
- e) The securing screws and terminals shall be of non-ferrous metal and of sufficient length so as to securely clamp/fasten the conductor/wire in the terminal block.
- f) Terminal blocks shall be mounted in a fashion that does not exert undue forces on internal circuitry.
- g) No circuits that carry current from instrumentation current transformers under normal operating conditions shall be routed by way of a printed circuit board.
- h) Terminal covers shall be in accordance with SANS 62052 part 11 and the following:
  - 1) The terminal cover shall enclose the actual terminals and the conductor fixing screws.
  - 2) When the meter is installed, no access to the terminals shall be possible without breaking a mechanical seal on the cover.

### **3.2.5 Ingress protection rating**

- a) The meter's electronic circuitry under the meter cover shall be suitably protected against the ingress of solid objects and liquids.
- b) The Ingress Protection (IP) rating of this part of the meter shall be IP52 or better.

### **3.2.6 Markings**

- a) All rating plates shall be in accordance with SANS 62052 part11.
- b) The meter's serial number shall comply with the requirements of SANS 474/ NRS057 and shall also be presented in barcode format.
- c) All markings shall be indelible, distinct and legible on the outside of the meter.
- d) Terminal markings shall be clearly indicated on the meter itself.
- e) Meter connection diagrams shall be in accordance with SANS 62052 part11 and shall be fixed inside the terminal block cover.

### **3.3 Electrical requirements**

#### **3.3.1 General electrical requirements**

Any batteries used shall have a minimum life of fifteen years under normal operating conditions and shall have a backup capacity of at least three years in the absence of auxiliary power.

#### **3.3.2 Current and voltage inputs**

- a) The standard reference frequency is 50Hz  $\pm 2$  %.
- b) The standard reference voltage is 230V.
- c) The basic current  $I_b$ , shall be 10A or lower with a maximum current,  $I_{max}$ , of 80A or higher.
- d) The meter shall operate correctly with a maximum current input of at least 120% of the maximum current.
- e) The meter shall operate correctly with a maximum voltage input of at least 115% of the standard reference voltage of the meter.

#### **3.3.3 Auxiliary power circuits**

The meter shall operate from the phase voltage – no external auxiliary supply.

#### **3.3.4 Pulse outputs (optional)**

- a) One configurable potential free auxiliary contact for indicating active rate switching is required.
- b) These auxiliary contacts shall comply with the following rating:
  - 1) A power rating of at least 50VA.
  - 2) Switching voltage of at least  $U_{DC} = 110$  V and/or  $U_{AC} = 230$  V.
  - 3) A life expectancy of at least  $10^8$  operations.
- c) All contacts shall be bounce free.
- d) All relays used for external signalling shall have a minimum isolation of 2kV between the relay coil and the contacts.

### **3.4 Functional requirements**

#### **3.4.1 Power flow measurables required**

The meters shall be able to measure import and export active energy.

#### **3.4.2 Real time clock**

- a) Each meter, and, if applicable, each concentrator shall have a real time clock that is accurate to better than  $\pm 2.0$  s/day under normal operating conditions.
- b) Synchronisation of the clock shall not be based on power system frequency.
- c) The clock of each meter shall be automatically synchronized through the master station or locally through the optical interface.
- d) During any loss of supply, the time of the clock shall be maintained for at least 3 months.

#### **3.4.3 Calibration facilities**

The meters shall have an optical test output device as specified in SANS 62052-11.

#### **3.4.4 Local display**

- a) The meters shall be equipped with a display to facilitate manual meter reading when required.
- b) The displayed registers shall be in accordance with the requirements of 240-69387766.
- c) The display shall be fully configurable to display the register contents in any sequence as required by the user.
- d) The registers of the meters shall have at least 6 (six) digits. The last digit shall not represent a decimal point, but a unit (kWh) in the normal operating mode.
- e) A test mode shall be provided for where the resolution of the registers shall be at least 1/10 kWh for testing and calibration purposes.
- f) It must be possible to assign a unique register number for each value to be displayed locally on the meter.
- g) The digits of the values must be at least 4mm in height.

#### **3.4.5 Communication interface**

- a) The meter shall have an optical port for meter reading and configuration that will conform to SANS 62056 part21.
- b) The meter shall have a serial port (such as RS 232 or RS 485 (preferably an RJ12 or RJ45 connection for RS485)) that will be used for communication to a remote system.

#### **3.4.6 Load profile (Mass memory)**

- a) The meter shall cater for at least two channels of load profile memory (import and export active energy) for a period of at least 100 days over a 30 minute integration period.
- b) The integration period shall be user configurable to cater for typical intervals (e.g. 60, 30 and 15 minutes)
- c) The following non-interval data shall also be stored on the meter and it shall be able to retrieve this data through remote communication:
  - 1) Total energy
  - 2) Status alarms to verify the integrity of the data
- d) All data shall be date and time stamped at the meter

### **3.5 Software**

#### **3.5.1 General software requirements**

- a) The metering systems shall be supplied with configuration software.
- b) All software supplied with the system shall be documented comprehensively, with all the features and functions discussed, including a set of examples as to how the meters can be configured for different tariff structures and applications. Included in the documentation shall be a list of possible problems and how to solve them.
- c) Eskom shall be given an Eskom wide licence agreement for all software offered.
- d) Future revisions of software shall be supplied in terms of a contract but shall be submitted in accordance with Eskom standard 240-76624509.

### **3.5.2 Security within the software**

- a) Security measures, such as a hierarchical password system shall prevent the configuration information, in the meter and the configuration software, from being changed by unauthorised personnel.
- b) Three levels of security will be provided within the software to enable the following functions:
  - 1) Read only mode whereby all the registers within the meter may be read.
  - 2) Reading and programming access to the meter.
  - 3) Reading, programming and configuration access.
- c) Within the access to programming of the meter it must be further possible to only configure the following parameters without changing any of the other parameters within the meter:
  - 1) Time and date

### **3.5.3 Tariff implementation through the software**

- a) The configuration software must cater as a minimum for all the different tariff structures applied within Eskom.
- b) The following shall be catered for:
  - 1) The meter shall be capable of measuring and recording active energy.
  - 2) The time definitions shall be configurable in the meter in the following way:
    - At least two different time periods will be provided for within each day (Peak and off-peak) and it will be possible to switch them in any possible combination.
    - Two different weekend day switching schedules will be provided for.
- c) All these values shall be displayed through the meter's display in a user defined sequence. This display sequence must be flexible enough to enable shifting displayed values in any sequence.

## **3.6 Firmware**

- a) For the purposes of this document, the firmware of the meter is considered to form an integral part of the meter.
- b) The firmware will determine the correct functioning of the metering device in accordance with the requirements of this specification, and any related enquiry specification.
- c) Future versions of firmware shall be supplied in terms of any contract by shall be submitted in accordance with Eskom standard 240-76624509.

## **3.7 Facilities for sealing the meter**

Provision shall be made for sealing the meter in accordance with 240-76628631. It must be able to seal the terminal cover and meter cover separately (if the cover is removable).

## **3.8 Documentation**

### **3.8.1 Drawings**

- a) All metering equipment shall be accompanied by drawings as listed below:
  - 1) Outline and mounting details of each item.
  - 2) Electrical termination and cabling details. These diagrams shall also be mounted on the metering device, under the terminal cover.

- 3) An exploded view or similar diagram to indicate each physical part with its part number and description.

### **3.8.2 Manuals**

All metering equipment shall be supplied with instruction manuals that shall be detailed enough to enable Eskom staff to install, maintain, test, configure and use each item of equipment.

## **3.9 Training**

- a) Training shall be provided on request for Eskom staff.
- b) This training shall cover the installation, maintenance, and operation of the system and the configuration software.

## **3.10 Packaging**

- a) The meter serial number and barcode shall be printed onto the packaging of the meter.
- b) Where multiple meters are supplied within one package, all the serial numbers and barcodes of the individual meters shall be printed onto the packaging.

## **3.11 Support**

- a) Dedicated local expertise to support all meters or parts thereof offered by the supplier shall be available.
- b) If any of the meters or parts thereof are sourced from overseas, Eskom requires the maximum transfer of technology from the supplier's principals, to enhance local expertise capacity. The supplier shall make the necessary arrangements in this regard.

# **4. Test and calibration requirements**

## **4.1 Type testing**

- a) The meters shall be type tested according to the requirements specified in SANS 62052 part11, and SANS/IEC 62053 part 21. The type tests shall be done at an approved test facility (test facility accredited by a full member facility that is listed at International Laboratory Accreditation Cooperation (ILAC)).
- b) The supplier of the meters shall obtain a Regulatory Compliance Certificate (RCC) certification to indicate that the type tests are suitable for South African conditions in cases where the type testing was done at an international facility.
- c) A copy of all test certificates, details of tests performed and the RCC approval certificates shall be submitted with a tender.
- d) Full details of accelerated life-cycle testing (type of tests performed) shall also be submitted with a tender.
- e) Eskom may require that accelerated life-cycle testing be done according to its own requirements if the tests done by the manufacturer are considered to be insufficient.

## **4.2 Testing procedures**

Eskom reserves the right to appoint a representative to inspect the equipment at any stage in the manufacturing process and to witness any tests.

### 4.3 Evaluation procedure

- a) All meter types shall be subjected to Eskom's internal evaluation procedure.
- b) The supplier shall state compliance with requirements of this specification.
- c) Two sample units shall be submitted to Eskom for functional evaluation, together with the configuration software.
- d) The supplier shall indicate the version of the meter hardware, the firmware in the meter and the software version; and these versions shall be the versions as evaluated. Version changes shall be made in accordance with 240-76624509.

### 4.4 Calibration requirements

- a) All meters shall be tested at a South African National Accreditation System (SANAS) accredited test facility (refer to SANS 474/ NRS057) before delivery.

**Note:** The meters shall be tested at the various load points as specified in Table 1 and the final error results shall be within these limits.

**Table 1: Calibration limits for active energy meters**

Load Point	Current	Pf	Max error Limit (%)
1	5 % $I_b$	1	+/- 1.5
2	100 % $I_b$	1	+/- 1
3	100 % $I_b$	0,5 lag	+/- 1
4	100 % $I_{max}$	1	+/- 1

**Note:** Tests shall be done for both import and export active energy.

- b) The reference conditions under which testing is to be performed shall be as stated in IEC 62058 part 31.
- c) A 'TESTED' sticker shall be applied to each meter after calibration. The sticker shall indicate the date of accuracy testing and the facility that has tested the meter.
- d) The following tests shall also be performed on each meter:
  - 1) Running with No Load – not more than one pulse shall be produced by the test output of the meter over a period of 10 min.
  - 2) Starting Current Test – The meter shall start and continue to register at a maximum of 0.4%  $I_b$  at unity power factor.
  - 3) Dial/register Constant Test – the meter shall register a known amount of energy to verify that the dial/register constant is correct.
- e) The measuring process shall be such that the overall uncertainty of measurement does not exceed the values as stated in IEC 62058 part 31.
- f) The calibration results shall be available to Eskom in an electronic format as an import file compatible with Microsoft Windows software.

## 5. Authorization

This document has been seen and accepted by:

Name and surname	Designation
S Mkhabela	Senior Manager: Distribution

## 6. Revisions

Date	Rev	Compiler	Remarks
Feb 2017	2	HPD Groenewald	Reference documents numbering changed to new 240 numbers. 3.3.2.a) Frequency amended from 50Hz $\pm 5\%$ to 50Hz $\pm 2\%$ . 3.3.2.e) Voltage amended from 120% to 115% 4.1.b) Reference to SABS for RCC certificates removed – done via NRCS
March 2014	1	HPD Groenewald	New number allocated to document 240-70427065 Development team expanded. 3.1 The meter shall record both import and export kWh to cater for co-generation applications 3.2.3 Specified shear-off screws for the terminal cover 3.3.2.c) Lowered the basic current to 10A 3.4.4.e) Test mode resolution specified 3.4.6.a) Two channels of load profile specified 4.4 Calibration tests shall be done for both import and export

## 7. Development team

The following people were involved in the development of this document:

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## 8. Acknowledgements

Not applicable.

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## **Annex A – Requirements for the "Tested" sticker**

- It shall be a polyurethane, permanent sticker.
- Printing shall be black on a yellow or white background.
- The sticker surface shall accept writing with a permanent marker.
- The size of the sticker shall be 40mm long and 8mm wide.
- The test facility's name shall be pre-printed on the sticker by using a bold Arial font, size 8 and all in capital letters - see samples.
- The "TESTED /20" shall be pre-printed on the sticker by using a bold Arial font, size 12 and all in capital letters - see samples.
- The letter spacing shall be as shown in the samples.



SCHLUMBERGER TESTING  
**TESTED /20**



ESKOM BRACKENFELL  
**TESTED /20**

**Figure A.1: Sample sticker**

### **Instructions for the use of the sticker**

- A permanent, black marker shall be used for writing. The month of calibration shall be written in the space between "TESTED" and "/20" on the sticker. Numbers shall be used, for example 01 for January and 12 for December. The year of calibration shall be written in the space after "/20" on the sticker. Two digits shall be used, for example 01 for 2001 and 05 for 2005.
- The sticker shall be applied to the nameplate of the meter. It shall be clearly visible from outside the meter with the meter cover in place. It shall not obscure information on the nameplate of the meter.