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Electricity metering – Payment systems –

Part 31: Particular requirements – Static payment meters for active energy (classes 1 and 2)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICITY METERING – PAYMENT SYSTEMS –

Part 31: Particular requirements – Static payment meters for active energy (classes 1 and 2)

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 62055-31 has been prepared by IEC technical committee 13: Equipment for electrical energy measurement and load control.

The text of this standard is based on the following documents:

FDIS	Report on voting
13/1344/FDIS	13/1355/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

IEC 62055 consists of the following parts, under the general title *Electricity metering – Payment systems*:

Part 21: Framework for standardization

Part 31: Static payment meters for active energy (Classes 1 and 2)

Part 41: Standard Transfer Specification – Application layer protocol for one-way token carrier systems[1]

Part 51: Standard Transfer Specification – Physical layer protocol for one-way numeric and magnetic card token carriers[1]

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

1 Under consideration.

INTRODUCTION

Payment meters are used in situations where the supply of electrical energy to the load may be interrupted or its restoration enabled under the control of the payment meter in relation to a payment tariff agreed between the customer and the supplier. The payment meter is part of a system that uses token carriers to pass payment information as tokens between a vending network and the payment meters that include the meter accounting process.

The functions of a payment meter are to measure electrical energy consumed and to decrement the available credit value in accordance with the metered consumption, and possibly in accordance with the passing of time. This available credit value is incremented as the result of payments made to the electricity supplier, and the meter accounting process continuously calculates the balance of available credit held by the customer. When the available credit value has been decremented to a predetermined value that is related to the payment mode in use, a switch is used to interrupt the supply to the customer's load. However, additional features may be present in the payment meter, which prevent or delay the opening of the switch, or limit further consumption to a low load level. Such "social" features may include the provision of an emergency credit facility, the possibility of operation in a fixed-payment mode, and the inhibiting of interruptions for certain periods of time.

In return for the payment (usually in cash) and depending on the particular type of system, the customer may be issued with a single-use token on a disposable token carrier for the equivalent value, or a reusable token carrier may be credited with that value, or the token may be transmitted directly to the meter via a communications network (a so-called virtual token carrier). "One-way" and "two-way" data transfer systems may be used, and the token carriers may be: physical devices such as smart cards, or other electronic devices, or magnetic cards; virtual token carriers where the token information is transferred by a remote communications system; or numeric token carriers where sequences of digits are issued on a paper receipt and entered via a keypad on the meter.

IEC 62051 provides some details of payment metering terminology in Clause 17.

ELECTRICITY METERING – PAYMENT SYSTEMS –

Part 31: Particular requirements – Static payment meters for active energy (classes 1 and 2)

1 Scope

This part of IEC 62055 applies to newly manufactured, static watt-hour payment meters of accuracy classes 1 and 2 for direct connection, for the measurement of alternating current electrical energy consumption of a frequency in the range 45 Hz to 65 Hz that include a load switch for the purpose of interruption or restoration of the electricity supply to the load in accordance with the current value of the available credit maintained in the payment meter. It does not apply to static watt-hour payment meters where the voltage across the connection terminals exceeds 600 V (line-to-line voltage for meters for polyphase systems).

It applies to payment meters for indoor application only, where the payment meter shall be mounted as for normal service (i.e. together with a specified matching socket where applicable).

Payment meters are implementations where all the main functional elements are incorporated in a single enclosure, together with any specified matching socket. There are also multi-part installations where the various main functional elements, such as the measuring element, the user interface unit, token carrier interface, and the load switch are implemented in more than one enclosure, involving additional interfaces. This part of IEC 62055 does not apply to multi-part payment metering installations.

Functional requirements that apply to payment meters are also defined in this part of IEC 62055, and include informative basic functional requirements and tests for the prepayment mode of operation in Annex A. Allowances are made for the relatively wide range of features, options, alternatives, and implementations that may be found in practice. The diverse nature and functionality of payment meters prevent the comprehensive specification of detailed test methods for all of these requirements. However, in this case, the requirements are stated in such a way that tests can then be formulated to respect and validate the specific functionality of the payment meter being tested.

This part of IEC 62055 does not cover specific functionality or performance requirements for safety, circuit protection, isolation or similar purposes that may be specified through reference to other specifications or standards.

This part of IEC 62055 does not cover software requirements. Software requirements for basic energy meter metrology are under consideration for the IEC 62059 series of standards, and in other organisations.

This part of IEC 62055 covers type-testing requirements only. For acceptance testing, the concepts given in IEC 61358 may be used as a basic guideline.

Dependability aspects are addressed in the IEC 62059 series of standards.

This part of IEC 62055 does not cover conformity tests and system compliance tests that may be required in connection with legal or other requirements of some markets.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62051:1999, *Electricity metering – Glossary of terms.*

IEC 61358:1996, *Acceptance inspection for direct-connected alternating current static watt-hour meters for active energy (classes 1 and 2)*

IEC 62052-11:2003, *Electricity metering equipment (AC) – General requirements, tests and test conditions – Part 11: Metering equipment*

IEC 62053-21:2003, *Electricity metering equipment (AC) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*

IEC 60050-300:2001, *International Electrotechnical Vocabulary – Electrical and electronic measurements and measuring instruments – Part 311: General terms relating to measurements – Part 312: General terms relating to electrical measurements – Part 313: Types of electrical measuring instruments – Part 314: Specific terms according to the type of instrument*

IEC 61000-4-5:1995, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61008-1:1996, *Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules*
Amendment 1 (2002)

IEC 62055-21:2005, *Electricity metering – Payment systems – Part 21: Framework for standardisation*

IEC 62054-21:2004, *Electricity metering (a.c.) – Tariff and load control – Part 21: Particular requirements for time switches*

3 Terms and definitions

For the purposes of this part of IEC 62055, the terms and definitions given in IEC 60050-300, IEC 62051, IEC 62052-11, and IEC 62055-21, as well as the following, apply.

Where there is a difference between definitions in IEC 62055-31 and those contained in other referenced IEC standards, then those defined in IEC 62055-31 shall take precedence.

NOTE Some of these definitions cancel and replace those for the same term in IEC 62051, including some terms in Clause 17 of that standard.

3.1 General payment metering definitions

3.1.1
a.c. withstand voltage
r.m.s. value of sinusoidal power frequency voltage that the equipment can withstand during tests made under specified conditions and for a specified time

[IEC 60050:1987 604-03-40, modified]

3.1.2
available credit value
value of available credit (in monetary or energy units) usable for further consumption that is either stored in the payment meter or calculated by it whenever required

3.1.3
fault current
current flowing at a given point of a network resulting from a fault at another point of this network

[IEC 60050:1986 603-02-25]

3.1.4
load interface
terminal(s) where the customer's load circuit is connected to the payment meter, or to a specified matching socket, where applicable

3.1.5
multi-part installation
payment metering installation where the functional elements comprising the measuring element(s); register(s), storage, and control; meter accounting process; user interface including any physical token carrier interface; any virtual token carrier interface; load switch(es); auxiliaries; plus supply interface and load interface are not arranged in the form of a payment meter, but instead are partitioned into two or more units that require appropriate mounting, connection, and commissioning

[IEC 62051, 17.45, modified]

3.1.6
payment meter
electricity meter with additional functionality that can be operated and controlled to allow the flow of energy according to agreed payment modes

NOTE It includes the following functional elements: measuring element(s); register(s), storage, and control; meter accounting process and any time-based functions; user interface including any physical token carrier interface; any virtual token carrier interface; load switch(es); auxiliaries; plus supply interface and load interface. A payment meter takes the form of a single unit, or a main unit that also employs a single specified matching socket for the supply interface and load interface. In either case. some payment meter implementations may allow for some or all of any time-based functions to be provided by an external unit connected to the payment meter, such as a time switch, a ripple control receiver, or a radio receiver.

[IEC 62051, 17.47, modified]

NOTE Refer to Figure B.1 for the generalised block diagram of a payment meter instance.

3.1.7
payment metering installation
set of payment metering equipment installed and ready for use at a customer's premises. This includes mounting the equipment as appropriate, and where a multi-part installation is involved, the connection of each unit of equipment as appropriate. It also includes the connection of the supply network to the supply interface, the connection of the customer's load circuit to the load interface, and the commissioning of the equipment into an operational state as a payment metering installation

3.1.8
prepayment mode
payment mode in which automatic interruption occurs when available credit is exhausted

3.1.9
specified matching socket
in relation to a payment meter arranged as a plug-in unit, a specified matching socket comprises a base with jaws to accept and connect to the plug-in unit, terminals for connection of the supply network and the consumer load circuit, and appropriate secure fixing and sealing arrangements. The payment meter is capable of meeting the relevant type-testing requirements when it is properly installed in any specified matching socket

3.1.10
supply interface
terminal(s) where the supply network is connected to a payment meter, or to a specified matching socket, where applicable

3.1.11
time-based credit
payment meter accounting functions that deal with the calculation and transacting of a (social) grant of credit that is released on a scheduled time basis

NOTE See IEC 62055-21:2005, 13.8.3.

3.1.12
user interface
that part of a payment meter or payment metering installation that allows the customer to monitor and operate the installation. It may also facilitate meter reading and inspection, and metering services activities. Where physical token carriers are employed, it includes a token carrier interface

3.2 Definitions of tokens

3.2.1
token
<Equipment-related definition> information content including an instruction issued on a token carrier by a vending or management system that is capable of subsequent transfer to and acceptance by a specific payment meter, or one of a group of meters, with appropriate security

[IEC 62051, 17.66, modified]

NOTE In a more general sense, the token refers to the instruction and information being transferred, while the token carrier refers to the physical device being used to carry the instruction and information, or to the communications medium in the case of a virtual token carrier.

<System-related definition> subset of data elements, containing an instruction and information, that is present in the APDU of the application layer of the *POS to Token Carrier Interface*, and which is also transferred to the payment meter by means of a token carrier

3.2.2
credit token
value token
token that represents an amount of credit in monetary or energy value for transfer from the vending point to the payment meter

3.2.3
duplicate token
token that contains the same information as a token that has already been issued, and hence may also be a valid token

NOTE 1 This is not the same as a replacement token (refer also to 3.4.9).

NOTE 2 A duplicate token is a reissue of the same token that was previously issued and is identical to it in all aspects; whereas a replacement token is a newly generated token in place of a previously generated token and may not be identical to it in all aspects.

3.2.4
multiple-use token
token (such as a test token) that can be used for more than one successful session in a payment meter or possibly with each in a group of meters. These are typically used for meter reading or service purposes on repeated occasions

3.2.5
no-value token
token that does not result in a financial advantage or disadvantage to the consumer, which may contain meter configuration data, or instructions to perform certain tests, or to display certain values on the user interface, or to retrieve certain data from the meter and return it on a token carrier

NOTE This is as opposed to value token.

3.2.6
replacement token
see 3.4.9

NOTE This is not the same as a duplicate token (see 3.2.3).

3.2.7
single-use token
token (such as a credit token) that can only be used for one successful session in a payment meter

3.2.8
valid token
in relation to a specific payment meter (or group of payment meters), a token that is capable of being processed successfully by the meter(s)

3.2.9
value token
see credit token (3.2.2)

3.3 Definitions of token carriers

3.3.1
token carrier
<Equipment-related definition> devices or media used to transport and present token information to payment meters, such as printed paper, magnetic card, electronic memory card/key, microprocessor card, or data communications networks. The token carrier may also carry ancillary control or monitoring information to or from the payment meter, depending upon system type and requirements

<System-related definition> medium that is used in the physical layer of the *POS to Token Carrier Interface*, onto which the token is modulated or encoded, and which serves to carry the token from the point where it is generated to the remote payment meter, where it is received

3.3.2
blank token carrier
physical token carrier that has not been processed at the vending point or elsewhere and hence contains no specific data

3.3.3
disposable token carrier
token carrier that is not capable of further use once it has been accepted or used, such as a paper-based magnetic card

3.3.4
machine-readable token carrier
physical or virtual token carrier carrying token information that is capable of being read and processed automatically on presentation to an appropriate payment meter, without further manual operation

EXAMPLE A token employing a magnetic card as the token carrier.

3.3.5
memory token carrier
physical token carrier containing a non-volatile memory device, in which the token is electronically encoded and stored while it is being transported

3.3.6
microprocessor token carrier
physical token carrier containing a microprocessor device with non-volatile memory, in which the token is electronically encoded and stored while it is being transported. In addition to the token information, the microprocessor token carrier may also contain an application programme and associated data

3.3.7
numeric token carrier
token transfer method where the token information can be represented in a secure manner by a visible and human readable sequence of numeric digits (typically 20 digits printed on a receipt)

NOTE They may be entered into a payment meter via a keypad interface for evaluation and action.

3.3.8
one-way token carrier
physical or virtual token carrier which is used for the transfer of credit and possibly tariff and configuration data in a single direction from the vending point or the management system to the payment meter

3.3.9
physical token carrier
token carrier that requires a human to transport it at least part of the way between the point where the token is loaded onto the token carrier and the point where it is retrieved from the token carrier by the payment meter

NOTE Examples of physical token carriers are: printed numbers; magnetic cards; printed bar codes; electronic storage in memory devices such as smart cards or memory keys; and audio messages dictated by interactive voice response equipment.

3.3.10
rechargeable token carrier
refer to 3.3.11 reusable token carrier

3.3.11
reusable token carrier
rechargeable token carrier
physical token carrier that can be used for multiple sessions for transportation of tokens

3.3.12
two-way token carrier
physical or virtual token carrier which is used for the transfer of credit and/or tariff and configuration data from the vending point or management system to the payment meter and response data from the payment meter back to the vending point or management system for further processing, where response data may possibly return on a subsequent vending transaction

NOTE Response data may contain consumption information, tamper information, accountancy information and token status with or without time and date stamps.

3.3.13
virtual token carrier
token carrier that does not require a human to transport it between the point where the token is loaded onto the token carrier and the point where it is retrieved from the token carrier by the payment meter

NOTE Examples of virtual token carriers are: modems on PLC, PSTN, GSM, GPRS and Radio; LAN; WAN and direct local connection.

3.4 Definitions relating to tokens and token carriers

3.4.1
physical token carrier interface
complete interface protocol stack that includes any token carrier acceptor or keypad for a physical token carrier, the physical layer protocol and application layer protocol, plus any intermediate protocol layers

3.4.2
token acceptance
recognition of the successful completion of the processing of any token that was presented to the payment meter

NOTE Typically, this might involve the addition of token credit to the meter's accounting register, cancellation of the token information from the token carrier so as to prevent subsequent acceptance by any meter, and a visible indication to the user on the user interface. Similarly, this may also be applicable to any tariff or configuration data included on the token carrier.

3.4.3
token cancellation
1) process of erasing or invalidating information contained in a valid token upon its acceptance by a payment meter, to prevent its reuse;
2) process of erasing or invalidating information contained in a token after it has been created, but before it is presented to a payment meter. This typically happens when the vending operator makes a mistake or if a technical problem occurs during the vending process

3.4.4
token carrier acceptor
physical part of a physical token carrier interface, which mechanically accepts and holds the token carrier in the correct position for the token transfer process to take place between the token carrier and the payment meter. Examples are: smart card acceptor; magnetic card acceptor; memory key acceptor

3.4.5
token carrier charging
loading of a token and tariff or configuration data onto a token carrier at a vending point or a management system

3.4.6
token carrier interface
token carrier interface permits the manual or automatic entry of tokens into a payment meter

NOTE 1 For example, it may be a keypad for numeric tokens, or a physical token carrier acceptor, or a communications connection to a local or remote machine for a virtual token carrier interface.

NOTE 2 The token carrier interface may also be used to pass additional information to or from the payment meter, such as for the purposes of payment system management.

3.4.7
token credit
value of credit or energy to be transferred from the vending point to the payment meter in the form of a token on a token carrier

3.4.8
token rejection
this occurs when a token has been presented to but has not been accepted by a payment meter, and has not been erased or invalidated. In the case of a valid token not being accepted, the token may be presented and accepted at a later time when conditions allow

3.4.9
token replacement
token that replaces a previously issued token in value. Physical token carriers may require a blank token carrier to be configured for the customer's meter

NOTE A replacement token is a newly generated token in place of a previously generated token and may not be identical to it in all aspects; whereas a duplicate token is a reissue of the same token that was previously issued and is identical to it in all aspects.

3.4.10
virtual token carrier interface
complete interface protocol stack that includes the physical layer protocol and application layer protocol, plus any intermediate protocol layers

3.5 Definitions related to load switching

3.5.1
minimum switched current
smallest current that the payment meter is able to make, carry and break at the rated breaking voltage and under prescribed conditions

3.5.2
prospective current
specified root-mean-square or peak value of current that would flow in a circuit if the unit under test were to be replaced with a conductor having negligible impedance

3.5.3
rated breaking current
I_c
root-mean-square value of the current that the payment meter is able to make, carry continuously and break at the rated breaking voltage and under prescribed conditions

3.5.4
rated breaking voltage
U_c
root-mean-square value of the supply voltage, as measured on the output terminals of the payment meter connected to the load circuit, at which the payment meter is able to break the rated breaking current

3.5.5
trip-free design
design which ensures that the moving contacts of the load switch return to and remain in the open position when the automatic opening operation is initiated after the initiation of the closing operation, even if the closing command is maintained

NOTE To ensure proper breaking of the current, which may have been established, it may be necessary that the contacts momentarily reach the closed position.

3.5.6
utilisation category
performance criteria under which the load switching capability of a payment meter may be specified to suit the particular requirements of a payment metering installation. The main criteria being: minimum safety levels, lightning surge withstand, fault current withstand and switch endurance.

NOTE See also 7.9.3 and 7.9.4

3.6 Definitions related to timekeeping and tariff control

3.6.1
crystal-controlled timekeeping
process of maintaining a payment meter's time by means of an internal crystal-controlled clock

3.6.2
external tariff control
control of a payment meter's time-dependent or consumption-dependent tariff regime (time-based or consumption-based charges and/or registers) by external signal(s)

3.6.3
external time signal control
control of a payment meter's internal real-time clock by an external signal

3.6.4
external time synchronisation
synchronisation of a payment meter's internal real-time clock by an external signal

3.6.5
internal tariff control
control of a payment meter's time-dependent or consumption-dependent tariff regime (time-based or consumption-based charges and/or registers) by signals from an internal real-time clock and switching programme

3.6.6
internal timekeeping
maintenance of a payment meter's time by its own internal clock facility

3.6.7
operation reserve
maximum period of time after switching off the power supply voltage, during which the payment meter is capable of maintaining correct time with a specified, relaxed timekeeping accuracy

3.6.8
reserve restoration time
period of time required for restoring the full operation reserve from the point where the operation reserve has been completely exhausted

3.6.9
synchronous timekeeping
process of maintaining a payment meter's time by means of an internal clock synchronised to a signal derived from the power system frequency

NOTE Payment meters employing synchronous timekeeping may defer to crystal-controlled timekeeping in the absence of the synchronising signal.

3.6.10
time indication discrepancy
difference between the time displayed by the payment meter and the actual time or, in the case of synchronous timekeeping, the difference between the time displayed by the payment meter and the time determined by the network frequency

NOTE The actual time may be obtained by using a reference clock.

3.6.11
timekeeping accuracy
increase or decrease in the time indication discrepancy within a specified time interval

3.6.12
variation of timekeeping accuracy due to an influence quantity
difference in timekeeping accuracy of a payment meter when only one influence quantity assumes successively two specified values, one of them being the reference value

4 Standard electrical values

Payment meters shall comply with the values given for standard reference voltages, currents, and frequencies, and the maximum currents given for static meters for direct connection in Clause 4 of IEC 62052-11.

5 Mechanical requirements

5.1 General

The requirements of Clause 5 of IEC 62052-11 for indoor meters shall apply, where referenced and augmented herein. Where the payment meter is to be used with a specified matching socket then these requirements shall be met by the complete assembly, with the payment meter mounted as for normal service.

5.2 General mechanical requirements

The requirements of 5.1 of IEC 62052-11 shall apply, but without the note referring to corrosive atmospheres.

5.3 Case

The requirements given in 5.2 of IEC 62052-11 shall apply, including all subclauses. In addition: push button switch caps, if fitted, shall be positively retained and shall not be removable without the exterior of the case showing mechanical damage.

5.4 Window

The requirements given in 5.3 of IEC 62052-11 shall apply.

5.5 Terminals

The requirements given in 5.4 of IEC 62052-11 shall apply.

5.6 Terminal covers

The requirements given in 5.5 of IEC 62052-11 shall apply.

5.7 Creepage and clearance distances

The requirements given in 5.6 of IEC 62052-11 shall apply, to include where metallic objects of the same size and shape as the token carrier are inserted into the token carrier acceptor.

For the purpose of these requirements, this metallic token shall be considered to represent an auxiliary circuit with a reference voltage below or equal to 40 V.

5.8 Insulating-encased meter of protective class II

The requirements given in 5.7 of IEC 62052-11 shall apply.

5.9 Resistance to heat and fire

The requirements given in 5.8 of IEC 62052-11 shall apply, including to any specified matching socket. The requirements shall also extend to the insulating material retaining the main contacts of the load switch in position, where the test temperature of 960 °C shall apply.

5.10 Protection against penetration of dust and water

The requirements given in 5.9 of IEC 62052-11 shall apply, for indoor meters only.

If a token carrier acceptor is fitted to the meter, then the tests shall be carried out without any token carrier in place in the token carrier acceptor.

Immediately after the tests and without disturbing the meter, the payment meter shall operate correctly and a valid token shall be accepted on the first or subsequent presentation, up to a maximum of 4 attempts.

5.11 Display and indicators

5.11.1 General

The requirements for an electronic display given in 5.10 of IEC 62052-11 shall apply, subject to the following clarifications and augmentations.

5.11.2 Retention time of the non-volatile memory

For long outages, the payment meter shall be designed such that any data necessary for correct operation shall be retained for a minimum period of 10 years without an electrical supply being applied to the meter. In addition, refer to D.1.3 and D.1.4 for any operational reserve where a real-time clock is fitted.

5.11.3 Display of measured values

The principal unit for the measured values shall be the kilowatt-hour (kWh). The display shall be visible from the front of the meter. When the meter is not energised, the display need not be visible.

Where multiple values are presented by a single display, all relevant values shall be available via the display. When displaying the values, each tariff register shall be identifiable and the active tariff rate shall be indicated.

NOTE For testing purposes, a means of reading the energy register to within 0,01 kWh resolution shall be provided. This may be via the display or by other means, e.g. a local communication interface.

5.11.4 Minimum display capability

For payment meters operating in the prepayment mode, the following information shall be capable of being displayed:

- cumulative kWh energy register (energy consumption);
- available credit value.

In addition, for virtual token carrier systems, the payment meter shall be able to display details of the last purchase transaction (time, date and amount).

The height of the display characters for the numeric values shall be not less than 4,5 mm.

Where the available credit value is in monetary units, the following additional information shall be capable of being displayed:

- the price per kWh;
- any time-based charge settings, such as for standing charges or debt recovery.

In the case of a multi-rate payment meter, the following additional information shall also be capable of being displayed:

- cumulative kWh for each tariff rate;
- the price per kWh for each tariff rate.

Where a multi-rate payment meter is operated from an internal real-time clock, the time shall also be capable of being displayed.

Where any display of information considered to be private is required (e.g. debt amounts or transactions) it shall be possible to limit display access to the specific consumer (e.g. by presentation of a customer/meter-specific token or password).

5.11.5 Indicators

The following shall be indicated as a minimum and shall be visible from the front of the payment meter:

- indication of rate of kWh consumption (instantaneous loading);
- indication of token acceptance (for all manually-transported token types).

In addition, for virtual token carrier payment meters, when the load switch is open, an appropriate indication or message shall be capable of being shown (first indicating OFF, then ENABLED, and then ON, for example – see 7.9).

5.12 Output device

The requirements given in 5.11 of IEC 62052-11 shall apply, including all subclauses.

5.13 Marking of meter

The requirements given in 5.12 of IEC 62052-11 and its subclauses shall apply for the marking of name-plates, connection diagrams, and terminals on payment meters. In addition, the ratings of any auxiliary switches shall be marked on the nameplate. Where the meter contains an integral battery, the battery symbol and chemical symbol (e.g. Li = lithium) shall be marked on the meter. The utilisation category shall also be marked, as required in 7.9 and its subclauses.

NOTE Any marking of operating instructions should be agreed upon between purchaser and supplier of the payment meter.

Where a connection diagram is provided, it shall indicate all of the input and output connections. It shall also show where the internal power supply is connected, i.e. to which side of the measuring element(s) and load switch(es). Where auxiliary input(s) are fitted, the operating voltage and current shall be marked on the faceplate or on any connection diagram.

5.14 Token carrier interface

5.14.1 General

Where a physical token carrier interface is fitted, it shall comply with the following mechanical requirements.

5.14.2 Token carrier acceptor

Where a token carrier acceptor is fitted, the insertion force required to insert a token carrier into the token carrier acceptor shall not exceed 10 N. The force required to remove a token carrier from the token carrier acceptor shall not exceed 10 N. The meter shall be designed such that under normal circumstances, and with a properly maintained token carrier, the minimum number of insertions for which a token carrier acceptor shall operate is 10 000.

5.14.3 Keypad interface

Where a keypad interface is fitted, it shall be designed to operate for a minimum of 20 000 operations of each individual key.

6 Climatic requirements

6.1 General

Payment meters shall comply with the requirements for indoor meters in Clause 6 of IEC 62052-11 where referenced, and augmented as follows. The payment meter shall be mounted as for normal service, including in a specified matching socket where applicable.

Where relevant, and unless otherwise specified, the tests shall be carried out with the payment meter in the prepayment mode, and with the load switch closed, unless otherwise stated.

Where a token carrier acceptor is fitted, then the tests shall be carried out without any token carrier in place in the token carrier acceptor during these tests.

6.2 Temperature range

6.2.1 General

For temperature range refer to 6.1 of IEC 62052-11, for indoor meters.

Payment meters shall comply with the following requirements.

For detailed requirements and testing for accuracy and functional performance over a temperature range also refer to Clauses 8 and 9, (including any subclauses).

6.2.2 Operation within the specified operating range

This is the range of ambient temperature (i.e. from –10 °C to +45 °C) forming part of the payment meter's rated operating conditions for metrological and functional purposes, with limits of variation in meter error with ambient temperature specified in terms of maximum limits for the mean temperature coefficient. Within this temperature range, the operation of the power supply circuits, the display and any push buttons, the meter accounting process and any associated registers and parameters, the load switch(es), the token interface and/or any local or remote communications interface, plus any multi-rate facility and any auxiliary input and output circuits shall all be correct; a valid token shall be accepted, and an invalid token shall be rejected or ignored without damage or cancellation.

Where an internal real-time clock is fitted for internal tariff control or time-based credit release, then reference to Annex D shall be made.

Within this temperature range and when there is no supply voltage applied to the payment meter, the status of all registers, values, and parameters associated with the meter accounting process shall continue to be valid and free from corruption and there shall be no changes to the metrological and functional characteristics of the meter when the supply voltage is subsequently restored.

6.2.3 Operation within the limit range of operation

a) Outside the specified operating range but within the limit range of operation (i.e. from –25 °C to –10 °C and from +45 °C to +55 °C) and when the supply voltage applied to the payment meter is within the extended operating range (see 7.2.1 and 7.2.1.3), the following operational requirements shall apply:

The status of all registers, values, and parameters associated with the meter accounting process shall continue to be valid and free of corruption. Where an internal real-time clock is fitted for internal tariff control or time-based credit release, then reference to Annex D shall be made. No discrepancies between the cumulative kWh register(s) and available credit value shall become evident as a result of any such ambient temperature excursions outside the specified operating range.

A valid token need not be accepted when presented, but the information on the token carrier shall then not be altered or invalidated. However, when a valid token is accepted, the credit amount shall be transferred correctly to the meter and the credit information of the token itself shall have been invalidated. An invalid token shall not be accepted, altered or damaged by presentation to the meter.

The display need not operate, or is permitted to operate erratically. The state of the load switch shall not alter without appropriate conditions prevailing in the meter accounting process, and any otherwise permissible restoration to the "on" state shall not occur without additional manual intervention.

Correct operation of all aspects of the payment meter shall resume when the ambient temperature has returned to within the specified operating range.

b) Outside the specified operating range, but within the limit range of operation, and when there is no supply voltage applied to the payment meter the status of all registers, values, and parameters associated with the meter accounting process shall continue to be valid and free from corruption and there shall be no changes to the metrological and functional characteristics of the meter when the supply voltage is subsequently restored. Where an internal real-time clock is fitted for internal tariff control or time-based credit release then reference to Annex D shall be made. Correct operation of all aspects of the payment meter shall resume when the supply voltage has returned to within the extended operating range. However, where the meter is fitted with a real-time clock for tariff purposes and this no-supply-voltage condition persists for a time period longer than the operational reserve, then it is permissible that the time may need to be reset.

6.2.4 Storage and transport outside the limit range of operation

Outside the limit range of operation, but within the limit range for storage and transport (i.e. from +55 °C to +70 °C) and without any supply voltage applied to the payment meter, the following requirements shall apply:

The status of all registers, values, and parameters associated with the meter accounting process shall continue to be valid and free from corruption and there shall be no resulting damage or degradation to the metrological and functional characteristics of the meter. Under these conditions the operation and timekeeping accuracy of any timekeeping facility with an operation reserve that is incorporated in the payment meter are not specified. When the ambient temperature of the payment meter has returned to the specified operating range and stabilised and after the supply voltage has been connected and then commissioning (including the resetting of any timekeeping facility) has been completed, the meter shall operate normally.

7 Electrical requirements

7.1 General

Payment meters shall comply with the relevant electrical requirements of IEC 62052-11 and IEC 62053-21, where referenced and augmented herein. The payment meter shall be mounted as for normal service, including in a specified matching socket where applicable.

Where relevant, and unless otherwise specified, the tests shall be carried out with the payment meter in the prepayment mode.

The load switch shall be in the closed position for each of these tests, unless otherwise specified.

Where a token carrier acceptor is fitted to the payment meter, then the tests shall be carried out without a token carrier in place in the token carrier acceptor, unless otherwise specified.

Where these requirements permit a temporary degradation of performance or loss of function during the tests then within a maximum period of 15 s after the end of the tests the payment meter shall operate correctly in accordance with the relevant requirements without any external intervention. No change of actual operating state or stored data is allowed. Refer to 9.2 for checks at beginning and end of tests. Where an internal real-time clock is fitted for internal tariff control or time-based credit release then reference to Annex D is also to be made.

7.2 Influence of supply voltage

7.2.1 Voltage range

7.2.1.1 General

Payment meters shall comply with the following requirements.

Table 1 – Voltage ranges

Specified operating range (See 7.2.1.2)	From 0,9 to 1,1 U_n
Extended operating range (See 7.2.1.3)	From 0,8 to 1,15 U_n
Limit range of operation (See 7.2.1.4)	From 0,0 to 1,15 U_n
Withstand range (See 7.2.1.5)	From 0,0 to 1,9 U_n

For verification of voltage range, refer also to Clauses 8 and 9, (including any subclauses).

7.2.1.2 Specified operating range

This is the range of supply voltage forming part of the payment meter's rated operating conditions for metrological purposes, with specified limits of variation in percentage error with supply voltage.

7.2.1.3 Extended operating range

This is the range of supply voltage over which the payment meter shall operate correctly. Within this range, the operation of the power supply circuits, the display and any push buttons, the meter accounting process and any associated registers, values, parameters, and timekeeping, the load switch(es), the token carrier interface and/or any local or remote communications interface, plus any multi-rate facility and any auxiliary input and output circuits shall all be correct; a valid token shall be accepted, and an invalid token shall be rejected without damage or cancellation. Outside the specified operating range of supply voltage, but within the extended operating range, the limits of variation in percentage error of the meter are three times the values applicable within the specified operating range.

7.2.1.4 Limit range of operation

Outside the extended operating range of supply voltage but within the limit range of operation (i.e. from 0,0 to 0,8 U_n) and when the ambient temperature is within the specified operating range the following operational requirements shall apply:

The status of all registers, values, and parameters associated with the meter accounting process shall continue to be valid and free of corruption. Any internal timekeeping facility shall continue to maintain timekeeping until the support period applicable to any operational reserve has elapsed. The error of the meter may vary between +10 % and –100 % and no discrepancies between the cumulative kWh register(s) and available credit value shall become evident as a result of any such supply voltage excursions outside the extended operating range.

A valid token need not be accepted when presented, but the information on the token carrier shall then not be altered or invalidated. However, when a valid token is accepted the credit amount shall be transferred correctly to the meter and the credit information of the token itself shall have been invalidated. An invalid token shall not be accepted, altered or damaged by presentation to the meter.

The display need not operate, or is permitted to operate erratically. The state of the load switch shall not alter without appropriate conditions prevailing in the meter accounting process, and any otherwise permissible restoration to the "on" state shall not occur without additional manual intervention.

Correct operation of all aspects of the payment meter shall resume when the supply voltage has returned to within the extended operating range. However, where the meter is fitted with a real-time clock for tariff purposes and the supply voltage is below 0,8 U_n for a time period longer than the operational reserve, then it is permissible that the time may need to be reset.

NOTE Where requirements for a meter function that specifically opens the load switch during low or high supply voltage conditions are agreed between purchaser and supplier of the payment meter, it shall be possible for this function to be inhibited when assessing compliance with this clause, without changing any relevant firmware.

7.2.1.5 Withstand range

Outside the limit range of operation, but within the supply voltage withstand range (i.e. from 1,15 to 1,9 U_n), the payment meter may sustain permanent damage and degradation to its metrological and functional characteristics, but this shall not give rise to a safety hazard (e.g. exposure of live conductors, fire, explosion, or undesirable restoration of the supply).

7.2.2 Voltage dips and short interruptions

The requirements given in 7.1.2 of IEC 62052-11 shall apply. Where the payment meter is fitted with a token carrier acceptor and the token carrier can be retained in the meter then these tests shall be carried out with and without a customer token carrier inserted in the meter during the tests. Where the token carrier cannot be so retained these tests shall be performed without any token carrier in place in the token carrier acceptor during the test. No tokens shall be presented to the meter for action during these tests.

Voltage dips and short interruptions shall not produce any loss or corruption of data in the payment meter, whether a token carrier is inserted in the meter or not. Data on the token carrier shall not be corrupted when the latter is inserted and retained in the meter for the duration of these tests.

After the tests, a valid credit token shall be presented. The token and payment meter shall then operate correctly, including operation of the load switch off and on.

The test shall be carried out first with the load switch closed and it shall be in or resume the closed position at the end of the test. The test shall be repeated with the switch open and it shall remain open throughout the test.

NOTE Refer also to A.1.2.7 for the effects of power failure, and to Annex D for further influences on the timekeeping of any internal timekeeping facility.

7.2.3 Abnormal voltage conditions

For single-phase types, the payment meter shall withstand, without a safety hazard arising, the maximum withstand voltage (1,9 U_n) applied between the line voltage and neutral terminals. The maximum withstand voltage shall be applied for a period of 4 h together with a current of 50 % of I_{max} and unity power factor (in the case of two-element single-phase two-wire meters 50 % of I_{max} in each measuring element simultaneously). This requirement shall also apply to single-phase three-wire payment meters, where the maximum withstand voltage shall first be applied to test the first line voltage and current, and then repeated to test the second line voltage and current – in each case without any supply voltage applied to the unused line terminal. No load current flows through to the neutral terminal in any of these testing arrangements.

For three-phase four-wire polyphase types, the payment meter shall withstand, without a safety hazard arising, the maximum withstand voltage (1,9 U_n) applied to any two phases and neutral with a phase angle of 60° between the two phase voltages. The maximum withstand voltage shall be applied for a period of 4 h together with a current of 50 % of I_{max} and unity power factor in each of the two phases under test. A total of three test runs is required to cover the pairs of phases, with a cooling period of 1 h between each run. This supply voltage withstand requirement does not apply to three-phase three-wire direct-connected payment meters.

For all polyphase types, the payment meter shall continue to operate with any combination of one or more phases remaining connected and supplying power when the supply voltage is within the extended operating range. In the case of a three-phase, three-wire network (where the meter is designed for this service), this requirement shall be met when any two of the three phases remain connected. Any internal timekeeping facility shall continue to maintain timekeeping under these conditions, without having to run on any operational reserve fitted.

7.3 Power consumption

The measurement of power consumption in the voltage and current circuits shall be determined as given in 7.1 of IEC 62053-21.

7.3.1 Voltage circuits

The active and apparent power consumptions in each phase of a direct-connected payment meter at reference voltage, reference temperature, and reference frequency shall not exceed 3 W and 10 VA, including the auxiliary power supply consumption.

When a polyphase meter is operated on only one or two phases, the total consumption of the meter in each of those phases shall not exceed these same amounts.

Short-term increases in consumption due to the reading/writing of a token or the operation of a switch are permitted. Where the meter is fitted with a token carrier acceptor and the token carrier can be retained in the payment meter, then these power consumption requirements shall also be met with a normal token carrier retained in the meter in quiescent operation.

7.3.2 Current circuits

The apparent power taken by each current circuit of a direct-connected payment meter at maximum current, reference frequency, and reference temperature shall not exceed a value in VA equivalent to 0,08 % of U_n in volts multiplied by 100 % of I_{max} in amperes (e.g. 230 V and 60 A gives 11,0 VA; 230 V and 100 A gives 18,4 VA).

The internal heating test in 7.5 shall also be met.

These values include consideration of the load switch.

7.4 Influence of short-time overcurrents

The requirements given in 7.2 of IEC 62053-21 shall apply, for meters for direct connection.

In relation to the note on meters having contacts in the current circuits, the following shall also apply:

Short-time overcurrents shall not damage the load switch. The switch shall still operate under specified conditions, the surroundings of the payment meter shall not be endangered and protection against indirect contact shall be assured in all cases.

Testing shall be carried out with the meter energised and with the load switch closed and the switch contacts shall remain closed after the test overcurrent has been applied.

The open-circuit source voltage of the generator used to provide the current waveform for this test shall be U_n ± 5 %. The period of time for which the generator voltage is maintained at the terminals after the overcurrent has occurred shall be one minute. For polyphase payment meters and load switches, the test may be performed on a phase-by-phase basis.

The test is passed if the criteria given in 7.2 of IEC 62053-21 are met, if protection against indirect contact remains assured and if the load switch can still be operated correctly after the test overcurrent has been applied.

7.5 Influence of heating

The requirements given in 7.2 of IEC 62052-11 shall apply. The cable used for energising the payment meter shall be insulated copper and have a minimum length of 1 m and a cross-section to ensure that the current density is less than 4 A/mm^2.

7.6 Influence of self-heating

The requirements given in 7.3 of IEC 62053-21 shall apply.

7.7 Insulation

The requirements given in 7.3 of IEC 62052-11 and its subclauses shall apply for the general test conditions (7.3.1 in IEC 62052-11) and impulse voltage test (7.3.2 in IEC 62052-11) and its subclauses. The requirements given in 7.4 of IEC 62053-21 shall apply for the a.c. voltage test. The load switch contacts shall be in the closed position for these tests.

The meter and its incorporated auxiliary devices including any token carriers that may be inserted into the token carrier acceptor shall be designed such that they retain adequate dielectric qualities under normal conditions of use.

Where a token carrier acceptor is fitted, the meter shall withstand both the impulse voltage test and the a.c. voltage test with a metallic token in the token carrier acceptor or, if the metallic token cannot be retained, a suitable electrical connection to the token carrier interface. Such metallic tokens or electrical connections shall then be connected to the ground reference for the purposes of these tests.

After these tests, and when the payment meter has been restored to reference conditions, the payment meter shall operate correctly.

7.8 Electromagnetic compatibility (EMC)

The requirements given in 7.5 of IEC 62052-11 and its subclauses shall apply subject to the following clarifications and augmentations:

7.8.1 General test conditions

The requirements given in 7.5.1 of IEC 62052-11 shall apply together with the following:

Any time-based charging shall be set to zero for the duration of these tests. The initial available credit and any settings in the payment meter shall be such that the load switch is not expected to operate during these tests. The load switch shall not operate during these tests, but for other functions a temporary degradation or loss of function or performance is acceptable unless stated otherwise.

No tokens shall be presented to the meter during these tests. Where the payment meter is fitted with a token carrier acceptor and the token carrier can be retained in the meter these tests shall be carried out with a customer token carrier in place in the meter during the tests.

Immediately after the end of each of the immunity tests, a valid credit token shall be presented. The token and payment meter shall then operate correctly, including operation of the load switch off and on. Any internal timekeeping facility shall continue to operate during and after these tests, and D.5.1 may also be applicable.

7.8.2 Test of immunity to electrostatic discharges

The requirements given in 7.5.2 of IEC 62052-11 shall apply together with the following: The test shall be carried out first with the load switch closed and repeated with the load switch open, and the load switch shall not operate during the tests. Where the payment meter is fitted with a token interface, the tests shall include air discharges to the keypad or to a customer token inserted into the token carrier acceptor where such a token carrier can be retained in the meter.

After the application of ESD testing, the payment meter shall revert to normal function and performance within a period of 1 min, without any external intervention.

7.8.3 Test of immunity to radiated RF electromagnetic fields

The requirements given in 7.5.3 of IEC 62052-11 shall apply together with the following:

For test (a) at 10 V/m, the test shall be carried out for the test load and limits of variation in percentage error as given in 8.2 and Table 8 of IEC 62053-21. During the test, the correct behaviour of the payment meter shall not be disturbed.

For test (b) at 30 V/m, the test shall be carried out with the load switch open and therefore no test current flowing. A temporary degradation of performance or loss of function during the test is permitted.

After the application of EMC testing, the payment meter shall revert to normal function and performance within a period of 1 min, without any external intervention.

7.8.4 Test of immunity to electrical fast transients/bursts

The requirements given in 7.5.4 of IEC 62052-11 shall apply together with the following:

The test shall be carried out first with the test load and limits of variation in percentage error as given in 8.2 and Table 8 of IEC 62053-21.

The test shall be repeated with the load switch open and therefore no test current flowing and with the load cables still connected. No change of the actual operating state or stored data is allowed. The meter shall continue to operate correctly after the test without any external intervention.

7.8.5 Test of immunity to conducted disturbances, induced by RF fields

The requirements given in 7.5.5 of IEC 62052-11 shall apply together with the following:

The test shall be carried out first for the test load and limits of variation in percentage error as given in 8.2 and Table 8 of IEC 62053-21. The test shall be carried out with the load switch closed and test current flowing. During the test, the normal behaviour of the payment meter shall not be disturbed.

The test shall be repeated with the load switch open and therefore no test current flowing and with the load cables still connected. No change of the actual operating state or stored data is allowed. The meter shall continue to operate correctly after the test without any external intervention.

7.8.6 Surge immunity test

The requirements given in 7.5.6 of IEC 62052-11 shall apply together with the following:

This test shall first be performed with the load switch closed.

The test shall then be repeated with the load switch open.

After the application of EMC testing the payment meter shall revert to normal function and performance within a period of 1 min, without any external intervention

7.8.7 Damped oscillatory wave test

The requirements in 7.5.7 of IEC 62052-11 are not applicable to direct-connected payment meters.

7.8.8 Radio interference suppression

The requirements given in 7.5.8 of IEC 62052-11 shall apply.

7.9 Load switching

7.9.1 General

For the purposes of the requirements and tests given in this clause, the load switch shall be considered as an integral part of the payment meter and each test shall be performed on the payment meter as a complete unit.

Unless otherwise specified, the supply input terminals and the load output terminals of the payment meter shall be taken to be the effective terminals of the load switch.

In the case of a polyphase payment meter, the tests and test values given shall apply to each phase.

The temperature rise for the load switch under high current values is not specifically tested, but the complete meter shall pass the heating test given in 7.5.

There is no specific test for this requirement, but precautionary measures shall be taken to protect the load switch from adverse effects resulting from the ingress of vermin into the payment meter.

There is no specific test for this requirement, but the reading process of a valid token shall not be adversely affected by coincident switching of the load switch while making or breaking currents under rated operating values of voltage and current. If the token is not accepted due to the disturbance caused by the load switch, then it shall not be invalidated and shall be accepted when presented to the payment meter subsequent to the disappearance of the disturbance.

The payment meter load switching utilisation category shall be subject to the purchase agreement between the payment meter supplier and the purchaser and shall be marked on the label of the payment meter as UC1, UC2, UC3, or UC4 in accordance with the relevance of 7.9.3 or 7.9.4.

Once the load is interrupted by low credit in the meter accounting process, the load switch shall only be operable to restore the load after a further appropriate manual intervention, e.g. by pressing a push button or by manually presenting a further credit token. In the case of virtual-token-carrier-operated meters, the acceptance of sufficient credit token value while in the interrupted state shall result in a change of load switch state to “enabled”. The load switch shall then be operable to restore the load after appropriate manual intervention, e.g. by pressing a push button (see 5.11.5).

7.9.2 Specified ratings

These ratings do not apply to the load switch as a component, but shall apply to the payment meter as a complete unit, thus as applied between the supply input and load output terminals of the payment meter.

The load switch shall remain correctly operable by the payment meter for all values of supply voltage present at the input terminals within the extended operating voltage range of the payment meter.

The payment meter shall be able to make, carry and break all values of currents between the minimum switched current rating to the rated breaking current for all values of the rated operating voltage range and the specified operating temperature range of the payment meter.

The **rated breaking current (I_c)** shall be equal to I_{max} of the payment meter.

The **minimum switched current** shall be equal to the nominal starting current of the payment meter.

The **rated breaking voltage (U_c)** shall be equal to the upper limit of the extended operating voltage range of the payment meter.

7.9.3 Performance requirements for load switching utilisation category UC1

The payment meter shall be capable of making and breaking currents for 3 000 contiguous make-and-break operations at (U_c, I_c) with a linear resistive load, together with 3 000 contiguous make-and-break operations at (U_c, 10 A), with power factor 0,4 inductive. Note that 1 operation is 1 make and 1 break, and the total of 6 000 make-and-break operations must be met using a single specimen. Category UC1 is applicable to payment meters rated at maximum currents up to 100 A. There are no other particular performance requirements for load switching under utilisation category UC1 apart from the short-time overcurrent withstand requirements in 7.4. There is no requirement for the load switch to also switch the neutral circuit.

NOTE Where the payment meter load switching capability is also used as part of the main circuit protection or isolation at the customer’s premises then such additional requirements may be specified through reference to other specifications or standards.

7.9.4 Performance requirements for load switching utilisation categories UC2, UC3, and UC4

Where a payment meter has additional load switching performance capabilities that meet the requirements for load switching utilisation category UC2, UC3, or UC4, such a payment meter shall comply with the relevant requirements of Annex C.

7.10 Auxiliary output switches

Where fitted auxiliary output switches providing control signals to external equipment shall conform to the following requirements:

Rated voltage: U_n

Rated current: 2 A

Number of operations: The output switches shall be rated at U_n, 2 A, unity power factor for 10 000 contiguous make-and-break operations, together with U_n, 1 A, power factor 0,4 inductive for 10 000 contiguous make-and-break operations, so that a total of 20 000 make-and-break operations is required for a single switch specimen. This is a design requirement only, and no testing is required as part of the type testing plan for a payment meter.

7.11 Token carrier acceptor interface test

Where the payment meter is fitted with a token carrier acceptor, the meter and token carrier acceptor shall not suffer electrical damage and all the payment metering functions shall continue to operate normally when a metallic token carrier is inserted into the token aperture such that it short circuits all contacts to the token carrier. For testing purposes, the meter shall be operating at U_n, zero current, and with the load switch closed, when the metallic token carrier is inserted.

8 Metering accuracy requirements

The requirements given in Clause 8 of IEC 62053-21 shall apply (including all subclauses), without a token carrier inserted in any token carrier acceptor fitted to the payment meter. Refer to 9.2 for checks at beginning and end of the tests.

If a token carrier acceptor is fitted and a token carrier can be retained in the payment meter then additional accuracy tests shall be carried out under reference conditions at U_n and unity power factor, with balanced loads, and at both 0,05 I_b and I_{max}.

The limits of variation in percentage error compared to the same load point and no token carrier present in the token carrier acceptor shall then be 0,3 for meters of Class 1, and 0,5 for meters of Class 2.

The payment meter shall be mounted as for normal service, including in a specified matching socket where applicable.

The response of the payment meter to energy flowing in the reverse direction shall be agreed between manufacturer and purchaser.

9 Functional requirements

9.1 General

The general requirements for operation of payment meter functionality over the temperature ranges and voltage ranges are given in 6.2 and 7.2.1 and their subclauses.

When testing payment meters under Clauses 6, 7 and 8 (including any subclauses) a record of all relevant readings and status shall be made before and after each test or sequence of tests. The beginning and end readings shall then be reconciled with the testing procedure and duration to confirm the integrity of the meter accounting process. Clause 9.2 gives further details of these requirements.

NOTE Refer to informative Annex A for some general functional requirements, tests, and testing guidelines for payment meters, which may for example be considered and applied when agreeing overall evaluation and system testing requirements between manufacturer and purchaser. Clause A.1 (including all subclauses) gives basic functional requirements and tests for the prepayment mode of operation. For additional features and options and other payment modes, the specifying of requirements and testing is more diverse and so an outline of the approaches that may be adopted is given in Clauses A.2 and A.3 (including any subclauses). Further evolution of the functional requirements and testing arrangements in Annex A is anticipated and so they do not have to be assessed during payment meter type tests.

9.2 Robustness of meter accounting process

Although acceptable error limits are defined for accuracy of energy measurement under nominal and influence conditions for electricity meters, there is not an equivalent acceptable error in the calculation of available credit on payment meters. In addition, the settings and current operating modes of the meter shall not change spontaneously as a result of testing.

Therefore when testing a payment meter under Clauses 6, 7, and 8 (including any subclauses), a record shall be made prior to each test or sequence of tests of all relevant registers, settings, status, and active modes, including:

- readings of all energy registers;
- readings of all energy-based rate settings (where monetary-based credit is used);
- readings of all credit and debt values;
- the modes that are active.

and where the meter includes a timekeeping function:

- readings of all time-based charge or credit settings (where used);
- meter time/date;
- offset of meter time from the time on the reference clock.

During each test, the amount of any token credit loaded into the meter shall be recorded.

At the end of each test or sequence of tests, these readings shall be recorded again. Further recordings may also be made when any settings are changed as part of the tests.

Unless specifically stated otherwise, a test or sequence of tests is passed only if the following conditions are also met:

- energy measurement is within the error limits specified for that test;
- the meter's timekeeping accuracy is within acceptable limits for the timekeeping mode and the nature of the test;
- there are no changes in any energy-based rate setting;
- there are no changes in any time-based charge or credit setting;
- any changes in credit and debt values are exactly accounted for by:
  energy measured by the meter during the test x the value of the active energy-based rate setting
  and:
  duration of time recorded by the meter x the value of the active time-based charge or credit setting
  and:
  the value of any token credit accepted by the meter during the test;

  NOTE 1 Verification of this value requires the ability to verify the value of valid credit on a token carrier before and after it has been presented to the meter.
- there are no changes to any active modes in the meter;
- the meter's display is functioning correctly;

- any push buttons on the meter operate correctly;
- token acceptance of a valid token occurs on the first or second presentation. This shall not be tested until satisfaction of the criteria listed above has been confirmed;
- the load switch operates correctly.

Unless specifically stated otherwise, a maximum of 1 energy-based rate setting and a maximum of 1 time-based charge or credit setting shall be active for the duration of any test.

NOTE 2 It is acceptable for 2 or more time-based charge settings (e.g. standing charge and debt collection) to be active during a test, provided that their combined value remains constant throughout the test.

NOTE 3 If for some tests, it is required that the rate per kWh for the active rate is to be set to zero, then the rate per kWh for non-active rates shall be set to non-zero values.

NOTE 4 Where the meter is operating within its limit range of operation, but outside its extended operating range, a valid credit token that is presented to the meter shall either be accepted correctly, or be rejected or ignored without modifying its information.

10 Type test

See both Clause 8 and Annex F of IEC 62052-11.

Where additional or modified test requirements are specified in this part of IEC 62055 they may be carried out during the relevant sections of the recommended test sequence. The additional tests and checks in 9.1 and 9.2 may be carried out as part of the tests in the second group of the test schedule. A separate series of tests and specimens is required if Annex C applies.

A detailed testing plan will need to be drawn up for the specific type of payment meter to be tested. The testing plan should take into consideration the following guidelines:

- Several identical specimens of the meter are likely to be required, the actual number being dependent upon the interfaces and functionality of the specific payment meter, the testing facilities and time constraints available, and the extent of any further specific type-testing that may also be applicable under Annexes C or D of this part of IEC 62055.
- The scope of the type testing carried out (including or excluding any of Annexes C or D) should be made clear at the front of the test report. This should include the nature of any specific agreements between manufacturer and purchaser, for example on timekeeping requirements.

NOTE 1 For some tests, it may be appropriate to test two specimens in parallel, with one to check accounting consistency and the other to check the operation of the load switch (such as for testing of climatic requirements).

NOTE 2 Where a specimen is subjected to any of the tests in 7.8 and its subclauses, then the matching requirements of D.5.1 may also be applicable.

Annex A
(informative)

Functional performance

A.1 Basic functionalities – prepayment mode

A.1.1 General

This Annex covers some functionalities, tests, and testing guidelines for payment meters, which may for example be considered and applied when agreeing any overall evaluation and system testing requirements between manufacturer and purchaser. The basic functionalities are given here for the prepayment mode of operation, and are separate to the normative requirements given in the main section of this part of IEC 62055. For additional features and options and other payment modes, the specification of requirements and testing is more diverse and therefore an outline of the approaches that may be adopted is given in A.2 and A.3 (including any subclauses).

The core functionalities are covered in A.1.2 and their testing includes the sequence of operations and checks in A.1.3 that covers the basic functionality of the payment meter. The meter's behaviour will be dependent upon both hardware and software, as well as on influence factors. The sequence of tests is therefore repeated for combinations of the main influence factors, which are supply voltage and ambient temperature. Further basic functionalities are tested under reference conditions, unless otherwise stated, or are design considerations.

The payment meter should be mounted as for normal service, including in a specified matching socket where applicable. Verification should be carried out under reference conditions unless otherwise stated.

Where "maximum meter load" is stated, this should be taken as balanced at U_n, I_{max}, and unity power factor. Where "minimum meter load" is stated, this should be taken as balanced at U_n, 0,05 I_b and unity power factor.

A.1.2 Prepayment mode – core functionalities

A.1.2.1 Token acceptance

The payment meter should handle valid and invalid tokens in accordance with the following requirements:

The acceptance of a valid token should always result in the exact amount of credit on the token carrier being transferred to the appropriate register(s) in the payment meter, and the available credit value in the meter should be incremented by exactly this amount (see Note 1 of this subclause).

Acceptance of the token should be indicated on the payment meter and should also always result in token cancellation so that this token is then invalid and cannot be accepted again. However, reusable token carriers may then be loaded with a new purchase of token credit and become valid again.

Where prevailing conditions prevent the acceptance of a valid token, it should be rejected as an invalid token, or ignored and left unchanged. A valid token that has previously been rejected or ignored should be capable of being accepted when prevailing conditions subsequently allow.

Verification of token acceptance should be carried out at both zero current and at I_{max} and unity power factor. Token acceptance should be verified at the limits of the extended operating range of supply voltage, and the limits of the specified operating range of temperature. Refer also to A.1.3, A.1.4, and A.1.5.

This should apply without the invocation of certain additional facilities that may be present in the meter, such as emergency credit, reserve credit, or token credit partially allocated for repayment of emergency credit debt.

Token acceptance should also be verified as part of some of the other requirements and tests given in Clauses 5, 6, 7 and 8 (including any subclauses).

NOTE 1 For some payment meter implementations using magnetic card token carriers, the token carrier acceptor applies a mark to the token carrier to indicate that token acceptance has been completed.

NOTE 2 For some payment meter implementations an audible signal is given to indicate that token acceptance has been completed.

A.1.2.2 Token rejection

The payment meter should handle valid and invalid tokens in accordance with the following requirements:

Under normal conditions, any invalid token should be rejected or ignored by the payment meter, and should not result in any change to information in the accounting registers in the meter. Rejection or ignoring should not lead to any token cancellation or to any change of information on the token carrier, i.e. the token should remain valid for use in its intended application or with the correct meter.

The payment meter should always reject or ignore an invalid token under any prevailing conditions; there should be no prevailing conditions within the limit range of operation under which an invalid token can be accepted.

Where prevailing conditions prevent the acceptance or rejection of a token, it should be ignored and both the token and the meter's accounting register(s) should be left unchanged.

Verification of token rejection or ignoring should be carried out at both zero current and at I_{max} and unity power factor. Token rejection or ignoring should be verified at the limits of the extended operating range of supply voltage, and the limits of the specified operating range of temperature. Refer also to 6.2, 7.2.1, A.1.3 and their subclauses.

A.1.2.3 Meter accounting process

The meter accounting process is handled in the payment meter itself. In general, in the prepayment mode, the metered kWh consumption leads to a proportionate decrementing of the available credit value. Time-based charges such as standing charges also decrement the available credit value where applicable. All such decrementing can reduce the available credit through zero to negative values unless further token credit is bought and loaded. When the available credit falls to zero, the load switch is opened automatically. Switching on of the load switch is only enabled when token credit is again loaded and the available credit becomes positive. Testing these other functions validates the meter accounting process.

The load switch interrupt/restore conditions may be different where there is additional functionality such as emergency credit, or token credit partially allocated for repayment of emergency credit debt; they will also be different for alternative payment modes (refer to A.2 and its subclauses).

A.1.2.4 Collection of consumption-based charges

Where application-specific non-interruption periods or emergency credit facilities are incorporated in a payment meter, they should be disabled before carrying out the following test.

The consumption-based charge function should be tested for a sufficient amount of energy consumption to ensure correct deductions from the available credit. Where the payment meter operates in monetary units, an appropriate price per kWh should be set. Where the payment meter includes time-based charging functions, they should be disabled for this test. Sufficient available credit should be provided and noted, and then maximum load should be applied to the payment meter for the necessary period of time. The advance of the cumulative kWh register should correspond to the deduction of available credit that has then taken place.

Where the payment meter operates in monetary units, the test should be repeated with a representative range of settings of price per kWh, including the maximum setting. Where the payment meter includes multi-rate kWh registers, these tests should be repeated for each rate of the kWh registers.

A.1.2.5 Collection of standing charges

Where the payment meter incorporates a standing charge collection facility the following should apply:

The available credit value should be decremented at the correct rate set for the time-based charges. The implementations of such charge deductions from available credit will vary between different payment meter types (e.g. deductions being made per hour or per day); appropriate choices of testing periods should be made.

Where the payment meter includes any other time-based charging functions, then they should be disabled for this test, and the meter load should be zero. An appropriate standing charge should then be set to permit verification of accurate deduction from available credit over a suitable test period. The choice of settings will be dependent upon the specific implementation of the standing charge facility in the payment meter.

The above test should then be repeated at maximum meter load and, where the payment meter operates in monetary units, an appropriate price per kWh should be set. The total deduction from available credit over the test period should then be correct in respect of both standing charge and kWh register advance. Where the payment meter includes multi-rate kWh registers these tests should be repeated for each rate of the kWh registers.

A.1.2.6 Interruption and restoration of the load

The meter should normally interrupt the load when the available credit has been consumed. The meter should be able to decrement the available credit value past zero, into negative values, including where for application-specific reasons the load is not interrupted when the available credit has been consumed.

Once the load is interrupted by such meter accounting process action, the load switch should only be operable to restore the load after a further appropriate manual intervention, e.g. by pressing a push button or by manually presenting a further credit token. This should be true for any conditions of the meter accounting process and available credit, and for any supply voltage or temperature within the limit ranges of operation.

Refer also to 5.11.5, 6.2, 7.2.1, 7.9, A.1.3, A.1.4, A.1.5 and any subclauses.

A.1.2.7 Effect of power outages

In the event of a power system outage interrupting the power supply to the payment meter, there should be no malfunction in the operation of the meter accounting process. All registers should retain their values prior to the power outage. For test purposes, any time-based charging functions should be inhibited. Refer to A.1.3 for testing.

NOTE Refer to 7.2.2 for the influence of short voltage dips and interruptions.

A.1.3 Core functional tests within voltage and temperature range limits

The core functions of the payment meter should also be tested and requirements should be met under each of the following conditions:

- lower and upper limits of the specified operating temperature range;
- lower and upper limits of the extended operating voltage range;

The test sequence is therefore carried out four times under these conditions:

- lower temperature limit + lower voltage limit;
- lower temperature limit + upper voltage limit;
- upper temperature limit + lower voltage limit;
- upper temperature limit + upper voltage limit.

The following test sequence should be used:

a) The payment meter should be in the prepayment mode and mounted for normal service, including in a specified matching socket where applicable. Where the meter includes collection of time-based charging functions, they should be disabled until the appropriate part of these tests. Where application-specific non-interruption periods or emergency credit facilities are incorporated, they should be disabled throughout these tests.

b) Where the payment meter operates in monetary units, an appropriate price per kWh should be set. The meter should be prepared by applying a load until the available credit is exhausted and the load switch opens automatically. Readings of the cumulative kWh register and available credit value are then recorded. The supply voltage is then removed.

c) The meter is subjected to the desired temperature limit and the temperature is allowed to stabilise. The supplied voltage is then applied with zero load current and after one minute, the register and value readings are again recorded, and checked for correct retention. An invalid token is then presented and checked for correct rejection.

d) A valid token carrying a suitable amount of credit should then be presented to the meter to check token acceptance. The readings are then recorded and checked for the correct advance of available credit. The load switch should now be closed, or can be closed manually, depending on the design.

e) The supply voltage is now removed for 5 min and then restored with zero load current. The readings are then recorded and checked for correct retention.

f) A load of I_{max} and unity power factor is then applied so that the available credit reduces and eventually the load switch opens automatically. The readings are then recorded and their changes checked for correct reconciliation. In the case of a multi-rate meter, this test may be carried out for a single rate only.

g) Where the payment meter includes a facility for collection of standing charges, the following test should apply. Where any other time-based charging functions are included, they should be disabled for this test. An appropriate standing charge should be set to permit verification of accurate deduction from available credit over a suitable test period. The choice of settings will be dependent upon the specific implementation of the standing charge facility in the payment meter.

A suitable token amount should then be loaded into the meter and the readings recorded. The meter should then remain under voltage with zero current for a suitable period of time, which should be measured with a reference clock. Upon the completion of this period, the readings should be recorded, and their changes checked for correct reconciliation.

h) Test steps a) to g) should then be repeated for the lower temperature limit, but at the upper voltage limit.

i) Test steps a) to h) should then be repeated at the upper temperature limit.

A.1.4 Functional tests within the limit range of operation with voltage

The requirements for payment meter operation outside the extended operating range of supply voltage but within the limit range of operation (i.e. from 0,0 to 0,8 U_n) are given in 7.2.1.4.

The following tests should be carried out under reference conditions, with the supply voltage to the payment meter varying between zero and 0,8 U_n. The following test sequence should be used:

a) The payment meter should be in the prepayment mode and mounted for normal service, including in a specified matching socket where applicable. Where the meter includes collection of time-based charging functions, they should be disabled throughout these tests. Where application-specific non-interruption periods or emergency credit facilities are incorporated they should be disabled throughout these tests. Where the payment meter operates in monetary units, the maximum price per kWh should be set. In respect of any function covered by the note in 7.2.1.4 being included in the payment meter, this function may be inhibited where relevant.

b) The meter should be arranged to have a negative value of available credit, such as to ensure that the load switch is open. Readings of the cumulative kWh register and available credit value are then recorded. The supply voltage is then removed.

c) The supply voltage should be increased from zero at a steady and progressive rate of approximately 1 % of U_n per second with no load current, dwelling at each of the following levels for 60 s: 20 % U_n, 40 % U_n, 60 % U_n, 80 % U_n. While at 80 % U_n it should be verified that the load switch is in the correct position.

d) After 60 s at 80 % U_n the supply voltage should be decreased at a steady and progressive rate of approximately 1 % of U_n per second with no load current, dwelling at each of the following levels for 60 s: 70 % U_n, 50 % U_n, 30 % U_n, 10 % U_n, before reaching zero.

e) After 10 s at zero voltage, a supply voltage of 0,8 U_n should be applied to the meter and the readings of the cumulative kWh register and available credit value then recorded. Sufficient token credit should then be loaded to ensure that the load switch is closed. The readings of the cumulative kWh register and available credit value are then recorded again, and the supply voltage is then removed.

The test sequence in (c), and (d) is then repeated, with the load switch closed but no load current applied. After (d) and 10 s at zero voltage, a supply voltage of 0,8 U_n should be applied to the meter and the readings of the cumulative kWh register and available credit value then recorded.

After these tests, the status of all registers, values, and parameters associated with the meter accounting process should be seen to have continued to be valid and free of corruption. Any internal timekeeping facility should be seen to have continued to maintain timekeeping. Any unexpected or uncontrolled behaviour occurring during these tests should be noted and attached to the test report for future reference.

A.1.5 Functional tests within the limit range of operation with temperature

The core functions of the payment meter should also be tested and requirements should be met under each of the following conditions:

- lower and upper limits of the limit range of operation with temperature;
- with the supply voltage at the reference voltage U_n in each case.

The test sequence is therefore carried out two times under these conditions:

- lower temperature limit + reference voltage;
- upper temperature limit + reference voltage.

The test sequence in A.1.3 items (a) to (f) should be used, first for the lower temperature limit, then repeated for the upper temperature limit. The test at A.1.3 (g) is not required; however any real-time clock should continue to maintain timekeeping during the test sequences.

A.1.6 Prepayment mode – token handling and data integrity requirements

A.1.6.1 Interruption to token acceptance

Where a token carrier acceptor is fitted to a payment meter, a token carrier will be inserted into the token carrier acceptor and normally the data transfer process will be completed before token carrier withdrawal takes place. Where the token carrier can be withdrawn from the acceptor before the data transfer process is completed, then the meter should be designed such that data on the token carrier should not be corrupted or lost and any data transferred to the payment meter should not be actioned until the token transaction is subsequently completed. Data corruption on the token carrier is permitted if the payment meter is able, from the information available, to reconstruct the appropriate data on the next insertion of the token carrier into the token carrier acceptor.

A.1.6.2 Rejection of duplicate tokens

Where payment system operation is based on meter-specific tokens for single use, the payment meter should ensure that no customer token intended for single use may be actioned more than once, including where token acceptance has been interrupted.

Test for rejection of duplicated tokens

Connect the meter as for normal use, with zero load. Generate a customer token, and a duplicate of the token.

Present the first token, and verify that the meter has accepted the token.

Then present the duplicated token. Verify that the meter rejects this token, and where a virtual token is used, that the meter issues an appropriate message.

A.1.6.3 Rejection of valid tokens when available credit is saturated

Where a valid token presented to the payment meter would result in the amount of available credit exceeding the maximum amount possible in the meter, then the token should be rejected. The token should not be erased or invalidated; presentation of a virtual token should result in an appropriate message being returned from the meter. It should be possible for the token to be presented and accepted at a later time when conditions then allow.

Test for saturation of available credit in the meter

Connect the payment meter as for normal use, with almost the maximum amount of available credit already present, and with zero load.

Generate a token that, when added to the current available credit, would give a total amount of available credit greater than the maximum amount that the meter is declared as being capable of handling.

Present this token to the payment meter. Verify that the meter rejects the token, and where appropriate that it has not been physically marked. For virtual tokens, verify that an appropriate message is returned from the meter.

Apply a load to reduce the available credit sufficiently to allow for acceptance of the token. Present the token again and verify that the meter now accepts it correctly.

A.1.6.4 Energy register roll-over

The cumulative kWh register should be set near to its maximum reading and sufficient available credit should be provided to allow for register roll-over. Where the payment meter operates in monetary units, the maximum price per kWh should be set. Where the payment meter includes time-based charging functions, they should be disabled for this test. Where emergency credit facilities are incorporated in a payment meter, they should not be used during this test. After noting the meter readings, the maximum meter load should then be applied sufficient to cause rollover of the cumulative kWh register. The rollover must proceed correctly with the deduction from the available credit value corresponding to the advance of the kWh register.

Where the payment meter includes multi-rate kWh registers, this test should be repeated for each of the kWh registers.

A.1.6.5 Secure storage of credit

The payment meter should be designed such that the amount of credit stored in the meter cannot be changed other than by legitimate means, e.g. with a valid token or message.

A.1.6.6 Tariff security

Where the payment meter requires changes to tariff information held within it at any time, it should be designed such that the tariff information stored in the meter cannot be changed other than by legitimate means, e.g. with a valid token or message.

A.1.6.7 Reading and setting facilities

The payment meter may incorporate a service interface for extracting meter reading status and diagnostics information, and for making changes to payment mode, settings, security keys, or test modes to meet overall system requirements. These actions may be implemented via the token interface or via a separate service interface, possibly in conjunction with the push button(s) and display or indicators. In such cases, it should be designed such that it should not be possible to make any changes or resetting to the meter other than by legitimate means, e.g. with a valid token or message.

A.2 Additional functionalities

A.2.1 General

A payment meter may provide for additional features and options, and alternative modes of operation. The detailed specification of such additional functionality may be manufacturer-specific or of a proprietary nature, or be agreed between purchaser and supplier, or be defined by user organisations or standards.

Functional performance and testing guidelines and schedules will then need to be based on the relevant specifications, and may need to take account of the specific implementation and system requirements. In these circumstances, confirmation of compliance by the manufacturer or relevant organisation may be appropriate, or inspection and testing may be carried out jointly where so agreed between purchaser and supplier.

Details of additional functionalities and tests are under consideration and include the following aspects. Some aspects of payment system functionality may be dependent upon the associated infrastructure and management system. Such cases are not covered in this annex.

A.2.2 Requirements for other modes of operation

Since the main aspects of hardware-dependent functionality and performance are checked in the prepayment mode, the software-dependent functionality of any alternative modes of operation may be checked under reference conditions. This may apply to any of the following:

- credit limit mode;
- fixed payment mode;
- budget mode and reserved credit;
- emergency credit;
- token credit partially allocated for repayment of emergency credit debt;
- non-interruption periods;
- load-limiting mode;
- reverse-running interruption;
- multiple-block tariffs;
- collection of agreed debt.

In general, the testing of functionality for these modes and options are somewhat dependent upon the specific details of implementation and specific functional test sequences are likely to be needed. A general test sequence for the last point is given in A.2.3.

A.2.3 Collection of agreed debt

Where the payment meter incorporates a specific debt collection facility, the following should apply:

Where the payment meter includes any other time-based charging functions, they should initially be disabled for this test, and the meter load should be zero. An appropriate debt collection rate (and where applicable, an amount of agreed debt) should then be set to permit verification of accurate deduction from available credit over a suitable test period. The choice of settings will be dependent upon the specific implementation of the debt collection facility in the payment meter. Where applicable, the debt collection should cease when the agreed debt amount has been deducted from the available credit.

The above test should then be repeated at maximum meter load and maximum debt collection rate and, where the payment meter operates in monetary units, an appropriate price per kWh should be set. Where applicable, an appropriate amount of agreed debt should be set such that debt collection is to terminate before the end of the test period. The total deduction from available credit over the test period should then be correct in respect of both debt collection and kWh register advance. Where the payment meter includes multi-rate kWh registers, these tests should be repeated for each rate of the kWh registers.

Where the payment meter also includes collection of standing charges, the test at maximum load should be repeated with the standing charge also set at maximum.

A.2.4 Time-of-use tariff facilities

A.2.4.1 External tariff control

Where the meter includes arrangements for setting up the tariff register operation and displays, this should only be possible by legitimate means.

Checks of correct tariff register operation and displays should be made for each permissible combination of tariff control input signals (i.e. for each tariff rate). Checks of consumption-based charging should be made as in A.1.2.4.

A.2.4.2 Internal tariff control

Where an internal real-time clock is fitted for time-of-use tariff control, it should be possible to set the time, but only by legitimate means. It should also be possible to set the tariff time programme and tariff register displays, but only by legitimate means.

Checks of correct tariff register operation and displays should be made for each tariff rate, including checks of consumption-based charging as in A.1.2.4.

The correct operation of the tariff time programme and tariff register displays should be checked by setting appropriate test programmes that exercise each rate, weekday type, holiday type, and monthly or seasonal segment, where included. The checks should include correct roll-over for the beginning of each new type of tariff day, including at end of year and for 29th February where appropriate, as well as any summertime begins/ends dates. The manufacturer should state any restrictions that may apply when setting times or dates to make these checks, The date range over which the calendar function is tested should consistent with the reasonable expectation of the life of the meter. The required calendar date/weekday functionality of the internal real-time clock should also be included as part of these checks.

The checks should also include unpowered operation of the meter over any relevant critical periods including change of season, change of year, over 29th February where appropriate, and over summertime begins/ends dates, with correct date/time and tariff status evident after the outage period. Where the meter includes facilities for storing a new tariff/charging programme for adoption from a defined future date, then this action should be checked, including with unpowered operation over change of year and 29th February and summertime changes during the pending period, and with power outages applied at the time the new tariff/charging programme is due to be adopted.

Where auxiliary output switches are fitted for time-of-use tariff purposes, their correct operation in response to these test programmes and rate changes should be included in these checks.

A.3 System compliance requirements

The payment meter is operated as part of an overall payment system, and the token interface, service port, or any remote communications port may be involved in data exchanges for both payment and system management purposes. The detailed specification of these data exchanges may be manufacturer-specific or of a proprietary nature, or be agreed between purchaser and supplier, or be defined by user organisations or standards.

The overall system requirements and payment meter compliance tests will then need to be based on the relevant system specification and system testing procedures. In these circumstances, confirmation of system compliance by the manufacturer or a relevant organisation may be appropriate.

The details of these system-dependent requirements and related system compliance tests are not covered in this part of IEC 62055: they may be specified through reference to other specifications or standards.

Annex B
(informative)

Reference model for a payment meter

B.1 General

This informative annex serves to draw attention to the core functions that are found in a payment meter, which should be taken into consideration while performing the type tests in the normative part of this part of IEC 62055. Particular attention should be given to their proper functioning under abnormal influence conditions such as fault currents, voltage variation, temperature variation and EMC.

This annex should be read in conjunction with IEC 62055-21 for more in depth definitions of functions and processes in payment metering systems. From this perspective, the payment meter is one of the system entities that embodies certain functions and certain processes, which together create the payment meter application process. A function definition is an abstract representation of functionality and becomes concrete only once it is deployed in a specific instance of a payment meter. It essentially serves to model and define the workings of the payment meter.

A particular function may be implemented with any combination of its subclassified functions or with multiple instances of the same subclass. For example: a demand tariff may combine 3 time-based tariff rates with 2 consumption-based tariff rates with 1 monthly standing charge and a tax. Multiple instances of the same function class are also possible. For example: a payment meter may hypothetically implement a units-based accounting function together with a currency-based accounting function, the one being for consumption charges and the other for debt recovery charges. (See also B.3.4).

A clear distinction has to be made between the concept of a function and that of an object and also in understanding their mutual relationship. A function is an abstract definition of a capability that may be embodied in an object, where it then manifests as an instance of the function. An object is an entity (physical component, device or object-orientated model) that embodies one or more functions, giving it the capability to do things according to those functions.

It may also require several components in order to realise a specific function in a payment meter. For example: the load-side terminals, plus the load switch, plus the electronic driver circuitry, plus the firmware in the microprocessor, plus the memory storage space, all of which in combination embody the Delivery function.

B.2 Generalised payment meter instance

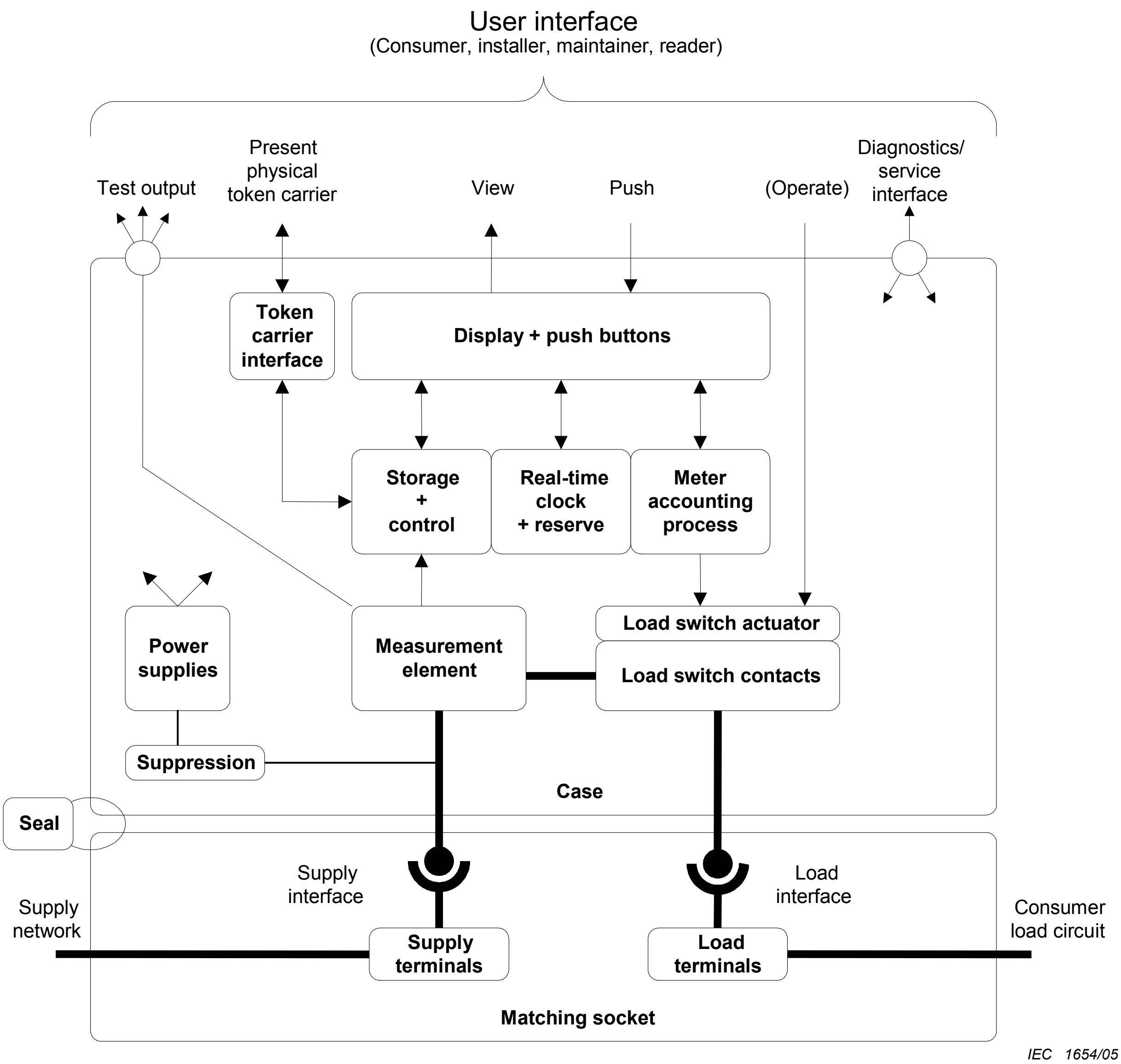

Figure B.1 – Generalised block diagram of a payment meter instance

In this instance, the single-part payment meter is arranged as a plug-in unit for use in a matching socket. The electrical connections between the two parts are made by means of suitable plugs and matching sockets. Once the two parts are properly installed and mechanically locked together, a suitable seal is installed to prevent unauthorised access to the supply terminals and load terminals in the socket.

During installation, the supply network is connected onto the supply terminals and the consumer's load circuit is connected to the load terminals in the socket. It can be seen that the load current passes through the measurement element and also through the load switch contacts in the active part of the payment meter, such that the electrical energy being consumed in the consumer load circuit can be measured and that the supply can be interrupted when the available credit runs out.

The power supplies for the internal workings of the payment meter are derived from the mains supply in this instance and are protected against the influence of electro-magnetic disturbances by means of suitable suppression circuits.

Measurements from the measurement element are passed on to the storage and control functions, typically realised by means of a microprocessor with supporting memory devices. The measurements are cumulatively stored and are also passed on to the meter accounting process for decrementing the available credit.

When the available credit reaches zero, the meter accounting process automatically causes the load switch actuator to operate such as to interrupt the supply to the consumer load circuit. The consumer then has to purchase more credit in order to replenish the available credit before he is able to consume more energy.

Credit is purchased by the consumer at a vending point, which is loaded onto a suitable token carrier for him to enter into the payment meter by means of the token carrier interface. Examples of typical token carriers are magnetic cards, barcodes, numeric strings printed on paper slips and solid-state memory devices such as smart cards and memory key devices. Correspondingly, typical token carrier interfaces are magnetic card readers, barcode readers, keypads, memory key readers and smart card readers.

Certain re-usable token carriers also have the capability to be loaded with information by the payment meter and to transfer the information to the vending point on the next occasion that the consumer goes to purchase more credit. This information typically comprises consumption quantities, various accumulated charges performed by the meter accounting process and the technical status of the payment meter. This allows the management system to perform an accounting audit on, for example, credits purchased versus actual consumption and auxiliary charges transacted at the payment meter. All information loaded onto a token carrier is usually encrypted to prevent tampering and fraudulent activities.

Once the available credit is replenished, the meter accounting process will either automatically cause the load switch actuator to operate or to optionally enable it to be manually operated by the consumer in order to restore power to the consumer load circuit. Manual operation is usually performed by operating a mechanical lever that is accessible on the user interface of the payment meter.

The meter accounting process reduces the available credit according to tariff charges for actual consumption and optionally according to auxiliary charges, such as standing charges, debt recovery and taxes. Conversely, the meter accounting process increments the available credit in accordance with purchased credit or in accordance with other credit sources, such as emergency credit, that may be conditionally released by the meter accounting process.

A real-time clock with an operational reserve (backup battery) typically provides date and time information to the meter accounting process for the scheduling of time-based charges and release of time-based credit.

The user interface facilitates operating the meter by various users that interact with the meter from time to time. Examples of typical users are: the meter manufacturer, the installation technician, the maintenance technician, the meter inspector, the meter reader and the consumer. Besides the already described token carrier interface and the optional manually operable load switch actuator, various push buttons and a display are also typically provided on the front panel of the payment meter in order to input information to the various processes in the payment meter and to view the results from some of these processes. Examples of typical display values are: available credit, cumulative total consumption, date and time, tariff rates and register values.

An optional diagnostics/service interface may be provided by the payment meter, which may be located on the front or the back of the meter. An example of such an interface is an infra-red port on the front panel or an electrical connector for direct local connection to a diagnostic tool like a hand-held-unit.

A test output is usually provided on the front panel of the payment meter and takes the form of a lamp, which gives out visible light pulses in proportion to the energy being measured by the metering function. This enables external reference equipment to verify the metrological accuracy of the payment meter.

Many configuration variations of the generalised instance of a payment meter are possible. One example is a single part payment meter, where the terminals are integrated into the same case as the active part. Another example is a two-part payment meter where the user interface is separated from the active part and remotely located from each other.

B.3 Functions in a single-part payment meter

B.3.1 General

With reference to Figure 6 of IEC 62055-21, the supply interface connects to the supply network and the load interface to the consumer's load circuit while the user interacts with the payment meter by means of the user interface.

Subclauses B.3.2 to B.3.11 should be read in conjunction with 13.8 of IEC 62055-21 and its subclauses in order to gain a more detailed understanding of the functions and processes found in payment systems in general and in payment meters in particular.

B.3.2 Meter application process

The meter application process coherently joins together the functions deployed in the payment meter and controls the behaviour of the payment meter in response to the various inputs and outputs that are presented at its interfaces.

See also 13.8.2 of IEC 62055-21 for a more detailed definition of the various processes that constitute the meter application process.

B.3.3 Token_Carrier_to_Meter_Interface function

The Token_Carrier_to_Meter_Interface function deals with all activities related to the reading of information from and also the writing of information to the Token_Carrier.

It defines an application layer and physical layer in terms of the OSI reference model with possible intermediate layers, while the token carrier is defined as the carrier medium in the physical layer.

See 13.7.2 of IEC 62055-21 for more details on the definition and sub-classification of the Token_Carrier_to_Meter_Interface functions.

B.3.4 Accounting function

The Accounting function maintains a current balance of all credit and charge transactions performed in the payment meter. These activities together constitute the meter accounting process.

See 13.8.3 of IEC 62055-21 for more details on the definition and sub-classification of the Accounting functions.

B.3.5 Metering function

The Metering function primarily deals with the measurement of the quantity of delivered electrical energy to the consumer. These measurements are made available for use by other functions in the payment meter.

See 13.8.4 of IEC 62055-21 for more details on the definition and sub-classification of the Metering functions.

B.3.6 Delivery function

The Delivery function primarily deals with the functions related to the delivery of electrical energy to the consumer’s load circuit. It also monitors the status of the attributes of other functions, in response to which it interrupts or restores the supply of power.

See 13.8.5 of IEC 62055-21 for more details on the definition and sub-classification of the Delivery functions.

B.3.7 Time functions

The Time function maintains date and time information and time reference information for use by other functions. It also maintains status of any backup supply used for timekeeping during power outage of the supply network.

See 13.8.6 of IEC 62055-21 for more details on the definition and sub-classification of the Time functions.

B.3.8 Test functions

The generic Test function is a support function to all other functions embodied in the payment meter and specific instances of tests thus vary according to the particular implementations. See also IEC 62055-21 Clause 6, 11.14, A.8.5.2, A.9.2.6, A.9.3.6, A.9.4.6 and any subclauses for more discussion on the Test function and instances thereof.

Tests on a payment meter are typically initiated manually by the action of a user (consumer, service technician, installer, inspector). For example: the press of a button; entering a code; or inserting a special action token;

Examples of test functions are: testing for the correct functioning of indicators and display devices; of the load switch; of the token reading interface; of the integrity of the memory recording registers; of the meter accounting function; of the data transport functions; of the security functions; of the recording functions; of the metering function (optical test output for calibration) and of the system interfaces.

B.3.9 Display functions

The generic Display function is a support function to all other functions embodied in the payment meter and specific instances of display activities thus vary according to the particular implementations. See also IEC 62055-21 Clause 6, 11.15, A.8.5.2, A.8.6, A.9.2.3, A.9.3.3, A.9.4.3 and any subclauses for more discussion on the Display function and instances thereof.

Examples of display devices are: alpha/numeric/graphic LCD; LED indicator; neon indicator; visible position of mechanical actuator lever; label on meter panel and terminal cover; barcode under meter serial number; printed numeric codes on paper token carriers.

Events to initiate or terminate the display process may be manually generated by a user, such as: the press of a button; entering a code; inserting a special action token. Events may also be automatically generated, such as a process state generating an indication of an alarm condition. Examples of process indicators are: the acceptance of a token; the rejection of a token; when a token is old (or expired); when a token has already been used; after a successful completion of a key change operation;

Examples of typical displayed information are: available credit; low level warning; accumulated consumption; accumulated charges; tariff rate; measured power; consumption rate; status of incoming supply; state of the load switch; tamper status; meter serial number; terminal cover markings; printed numeric token carrier; alarm indication.

B.3.10 Recording functions

The generic Recording function is a support function to all other functions embodied in the payment meter and specific instances of recording activities thus vary according to the particular implementations. See also IEC 62055-21 Clause 6, 11.16, A.8.5 (Set and Clear tokens), A.9.2.5, A.9.3.5, A.9.4.5 and any subclauses, for more discussion on the Recording function and instances thereof.

In general, the Recording functions deal with recording of data into memory registers in the payment meter and are initiated by the entering of tokens and the occurrence of events within the meter application process (such as metering pulses due to consumption). It would also deal with the recording of data onto the token carrier where this is implemented and as such it would be a support function to the Token_Carrier_to_Meter_Interface function.

Examples of recording devices are: mechanical rotary registers; electronic memory in the payment meter or on the token carrier; printing on labels on the payment meter user interface.

Examples of recording registers are: cumulative token credit register; cumulative social credit register; cumulative credit advance register; cumulative emergency credit register; cumulative lifeline credit register; cumulative total consumption register; tariff rate registers, auxiliary charge rate registers; token identifier register; date and time register; load switch activation count register.

Examples of recorded parameters are: daylight savings; events calendar; power limit; under voltage limit; over voltage limit; phase unbalance limit; low credit warning level; accounting mode; emergency credit level; credit advance level; credit cycle; billing cycle; activation date; expiry date; schedules of tariff rates; schedules of auxiliary charge rates; token identifier; cryptographic key; meter serial number; software version; date of manufacture; manufacturer identifier.

Examples of recorded events are: credit expired; power limit exceeded; load switch opened/closed; over/under voltage detected; phase unbalance detected; tamper detected; internal reset occurred; memory failure detected; token entered.

B.3.11 Security functions

The generic Security function is a support function to all other functions embodied in the payment meter and specific instances of security activities thus vary according to the particular implementations. See also IEC 62055-21 Clause 6, 11.18, 13.7.2, A.8.4, A.8.7, A.9.2.4, A.9.3.4, A.9.4.4 and any subclauses, for more discussion on the Security function and instances thereof.

In general, the Security functions deal with prevention and detection of physical access to sealed parts of the payment meter, assuring the integrity of recorded data elements and prevention of fraud in the form of tampering with data elements. The latter functions are present mainly in the application layer protocol of the Token_Carrier_to_Meter_Interface function.

Examples of physical protection and access control devices are: metal seals crimped around steel sealing wires; one-way screws; breakout plastic sealing caps for screw heads; tamper detection switch under cover plate of meter and terminal block; conformal coating of electronic components; shielding against magnetic fields; preventing entry of foreign objects; fail-safe techniques in the design of components (like the load switch).

Examples of data and function integrity methods are: use of CRC and parity checks with blocks of data elements; traceability of metrological certification.

Examples of data tampering prevention are: encryption/decryption techniques; message sequencing; unique token identifiers; use of MAC with data element blocks; use of public/private key signatures on data blocks and messages; token validation; token cancellation; token authentication; token erasure; key expiry; tariff expiry.

NOTE: MAC is an acronym for Message Authentication Code, which is the result of a mathematical computation, performed on a set of data and may later be used to test the integrity of the set of data.

Annex C
(normative)

Performance requirements for payment meters with load switching utilisation categories UC2, UC3 and UC4

C.1 Load switching capabilities

Payment meters with load switching category UC2, UC3 or UC4 shall have the following properties:

a) capable of making and breaking negligible currents of specified values;
b) capable of making, breaking and carrying rated currents of specified values;
c) capable of making into fault currents with specified value and under specified conditions;
d) capable of carrying short-circuit currents of specified value for a specified time period and under specified conditions;
e) not required to provide safety isolation properties in the open contact position. These are requirements for the installation mains isolation switch;
f) not required to break overload currents or short-circuit currents. These are requirements for fuses and circuit breakers that are normally used to protect the installation.

A summary of test currents for utilisation categories UC2, UC3 and UC4 is given in Table C.1.

Table C.1 – Summary of test currents for UC2, UC3 and UC4

Test clause		UC2	UC3	UC4
C.5	Fault current making capacity	2,5 kA	3 kA	4,5 kA
C.6	Short-circuit current carrying capacity test 1	4,5 kA	6 kA	10 kA
C.6	Short-circuit current carrying capacity test 2	2,5 kA	3 kA	4,5 kA

NOTE 1 The capability of making and carrying overload currents is under consideration as a future requirement.

NOTE 2 Where the payment meter load switching capability is also used as part of the main circuit protection or isolation at the customer's premises, then such additional requirements may be specified through reference to other specifications or standards.

C.2 Normal operation

The load switch shall be operable by the payment meter to interrupt the supply to the load circuit when available credit expires.

The load switch shall be operable by the payment meter to restore the supply to the load circuit when available credit is replenished, but only under manual control; i.e. by pushing a button or by manually entering a token.

If the payment meter is programmed with other functions that also operate the load switch, then these other functions shall be disabled for the purpose of this test.

The test is carried out under the following conditions:

- payment meter in normal operating condition;
- load a small amount of available credit, so that the load switch restores the supply to the load circuit;
- supply voltage at, or just above, the lowest value of the rated operating voltage range;
- current in the load circuit at I_c and PF = 1,0;

Wait until the available credit expires and check for compliance with the following requirements:

- the load switch shall interrupt the supply to the load circuit;
- the load switch shall operate on the first attempt;
- there shall be no evidence of sticking of the contacts;
- there shall be no change in any of the memory registers in the payment meter, except for those that are expected to change.

Repeat the test 3 times.

Where a load switch has a mechanical actuating lever for manually closing or opening the contacts, then perform each test when the lever is held in the following positions:

- when pushing the lever in the direction for closing of the contacts, then hold the lever at the nearest point where the load switch contacts have just made contact;
- by inspection, select the nearest point to where the contacts are placed under the greatest pressure during the closing operation;
- where the lever is in its normal resting position after the contacts have closed.

C.3 Electrical endurance

The test shall be carried out on a new sample under the following conditions:

- payment meter in normal operating condition;
- room temperature at reference conditions;
- 1 m length cable with current carrying capacity of I_c;
- supply voltage at U_c;
- load current at I_c and PF = 1,0;
- number of operating cycles equal to 5 000, with 10 s make time and 20 s break time.

Repeat the test using the same sample, but with the following changes:

- load current at I_c and PF = 0,5 inductive.

During and after the test the following requirements shall be met:

- the load switch shall show no signs of malfunction, sticking of contacts or reluctance to latch;
- the contacts shall open on the first attempt;
- after the test it shall meet the requirements of C.7: test for minimum switched current;
- after the test it shall meet the requirements of 7.3 and its subclauses: test for power consumption;

- after the test it shall meet the requirements of C.8: test for dielectric strength;
- when the payment meter is returned to normal operating conditions, it shall operate correctly and there shall be no change in any of the memory registers, except for those that are expected to change.

NOTE 1 One operating cycle of the load switch is one make followed by one break action.

NOTE 2 For the purpose of this test, the payment meter manufacturer may provide an external means, which allows for the opening and closing of the load switch to be under the control of the test equipment.

C.4 Line to load voltage surge withstand

The payment meter shall be able to withstand simulated lightning induced common mode voltage surges as might be expected in a typical domestic installation, while the load switch contacts are in the open position.

The test is only applicable to a payment meter in which the neutral line is also switched.

All current carrying phase and neutral input terminals are grouped and connected together; and all current carrying phase and neutral output terminals are grouped and connected together. All other terminals are connected to a safety ground reference.

Perform the test in accordance with IEC 61000-4-5 under the following conditions:

- with load switch contacts in open position;
- payment meter in the non-operating mode;
- between the group of input terminals and the group of output terminals;
- ambient temperature at reference conditions;
- relative humidity at 40 % to 60 %;
- atmospheric pressure at 80 kPa to 106 kPa;
- cable length between surge generator and payment meter at 1 m;
- open circuit voltage of generator at 20 kV (1,2/50 μs);
- prospective short circuit current of 250 A peak;
- generator source impedance of 80 Ω;
- 5 positive and 5 negative impulses;
- repetition rate not faster than 1 impulse per minute;

During and after the test the following requirements shall be met:

- it is permitted for flashover and disruptive discharge to occur during the test;
- there shall be no permanent damage to any part of the payment meter;
- when the payment meter is returned to normal operating conditions, it shall operate correctly and there shall be no change in any of the memory registers.

NOTE 1 In certain networks lightning arrestors are only fitted differentially between the live and neutral lines. Lightning conditions are thus able to induce common mode voltage impulses in such a network on the live and neutral lines relative to earth. If the load switch contacts are in the open position under such conditions, then the impulse voltage will attempt to find a discharge path though any circuit that is connected across the open contacts to the load-side circuit, thus possibly causing damage to internal circuitry of the payment meter.

NOTE 2 This test is specifically designed for the case where there is internal electrical coupling of circuits between the input and output terminals of the payment meter when the load switch contacts are in the open condition.

C.5 Fault current making capacity

The payment meter shall be capable of making into simulated fault currents as given in this Clause.

Perform the test on a new payment meter sample under the following conditions:

- climatic conditions at reference values;
- payment meter in the normal operating condition;
- voltage source at U_c;
- 3 pre-fusing operating cycles at I_c and PF = 1,0 at 10 s intervals;
- prospective test current at 2,5 kA r.m.s. for utilisation category UC2;
- prospective test current at 3 kA r.m.s. for utilisation category UC3;
- prospective test current at 4,5 kA r.m.s. for utilisation category UC4;
- power factor of test current shall be inductive in accordance with Table 16 of IEC 61008-1;
- frequency at reference value;
- current tolerance +5 % –0 %;
- voltage tolerance +5 % –5 %;
- power factor tolerance +0,00 –0,05.

NOTE 1 One pre-fusing operating cycle is to maintain the switch contacts in the closed condition for 5 s, then to maintain the switch contacts in the open condition for 5 s.

Cause the payment meter to close the load switch contacts into the above prospective test current and to remain in the closed position.

The test current shall be maintained to flow up to the first zero point crossing of the current, at which point, the test equipment shall disconnect the voltage source.

Repeat the test 3 times on the same sample with a minimum delay of 1 min between each test.

Plot a graph of the voltage and the test current waveform during each test and verify that the test was executed as is required.

During and after the test the following requirements shall be met:

- contacts shall open on the first attempt after each make cycle;
- the load switch shall show no signs of malfunction, sticking or welding of contacts or reluctance to latch;
- after the test it shall meet the requirements of Clause C.7: test for minimum switched current;
- after the test it shall meet the requirements of 7.3 and its subclauses: test for power consumption;
- after the test it shall meet the requirements of Clause C.8: test for dielectric strength;
- when the payment meter is returned to normal operating conditions, it shall operate correctly and there shall be no change in any of the memory registers, except for those that are expected to change.

NOTE 2 One operating cycle of the load switch is one make followed by one break action.

NOTE 3 It is recognised that there is significant statistical variance in the result of this test, but a more exact method is under consideration for a future revision of the standard.

NOTE 4 Standard r.m.s. current breaking capacity values for residual current devices are given in 5.3.10 of IEC 61008-1 as 3 kA, 4,5 kA, 6 kA, 10 kA and 20 kA, which represent the fault current levels that the load switch of a payment meter is expected to make. The first two values are chosen for utilisation categories UC3 and UC4 respectively as representing the short-circuit current sourcing capacities at the load connection socket outlet points of wired premises where payment meters are commonly installed. Further categories may be created in future for higher current values. The values given for UC2 correspond to a special category, applicable only to certain countries where large quantities of prepayment meters are installed, which are rated to these levels of fault current withstand.

NOTE 5 The aim of the test is to check for welding of contacts caused by contact bounce at the point of closure into the test current. The I^2t let-through energy is not an essential part of this evaluation at present and is thus constrained to a value that amounts to less than would be expected from protection devices of either a fuse type or circuit breaker type normally used in the distribution board of the wired premises under short-circuit conditions.

NOTE 6 Further test requirements for withstand of I^2t let-through energy at various values of overload current are under consideration for a future revision of this part of IEC 62055. The values of overload currents under consideration are: 3x, 5x, 10x, 20x and 30x I_c at PF = 0,8 and shall be co-ordinated with the maximum time delays expected from network protection devices at these current values.

NOTE 7 It is recommended that the plotted graph of the voltage and test current waveform be attached to the test report for future reference.

NOTE 8 It is not permitted to allow the load switch to be activated under the control of the external test equipment, because it could possibly negate special techniques that the payment meter application process may employ, such as zero point switching. The load switch contacts thus have to be caused to close under the direct control of the payment meter itself.

C.6 Short-circuit current carrying capacity

The payment meter shall withstand simulated short-circuit currents as may be experienced under short-circuit conditions in a payment meter installation.

Test 1 shall be carried out on a new payment meter sample under the following conditions:

- climatic conditions at reference values;
- series connection of a voltage source, the payment meter under test, load to produce the required test current and a test switch;
- payment meter in the normal operating condition;
- 3 pre-fusing operating cycles at I_c and PF =1,0 at 10 s intervals;
- load switch contacts in the closed position;
- voltage source at U_c;
- prospective test current at 4,5 kA r.m.s. for utilization category UC2;
- prospective test current at 6 kA r.m.s. for utilization category UC3;
- prospective test current at 10 kA r.m.s. for utilization category UC4;
- power factor of test current shall be inductive in accordance with Table 16 of IEC 61008-1;
- test switch closing at zero voltage crossover;
- test switch opening at the first subsequent zero voltage crossover, thus remaining in the closed position for one half cycle of the supply voltage;
- frequency at reference value;
- current tolerance +5 % –0 %;
- voltage tolerance +5 % –5 %;
- power factor tolerance +0,00 –0,05.

NOTE 1 One pre-fusing operating cycle is to maintain the switch contacts in the closed condition for 5 s, then to maintain the switch contacts in the open condition for 5 s.

Repeat the test 3 times on the same sample with an interval of at least 1 min between each test.

Plot a graph of the voltage and the test current waveform during each test and verify that the test was executed as is required.

During and after the test the following requirements shall be met:

- it is permissible that the contacts may weld or burn away;
- the surroundings of the payment meter shall not be endangered;
- protection against indirect contact shall remain assured;

Test 2 shall be carried out on a new sample under the following conditions:

- the same conditions as for Test 1 shall apply, except that the prospective test current shall be 2,5 kA r.m.s. for utilisation category UC2, 3 kA r.m.s. for utilisation category UC3 and 4,5 kA r.m.s. for utilisation category UC4.

During and after the test the following requirements shall be met:

- the load switch shall show no signs of malfunction, sticking or welding of contacts or reluctance to latch;
- contacts shall open on the first attempt;
- after the test it shall meet the requirements of Clause C.7: test for minimum switched current;
- after the test it shall meet the requirements of 7.3 and its subclauses: test for power consumption;
- after the test it shall meet the requirements of Clause C.8: test for dielectric strength;
- when the payment meter is returned to normal operating conditions, it shall operate correctly and there shall be no change in any of the memory registers, except for those that are expected to change.

NOTE 2 One operating cycle of the load switch is one make followed by one break action.

NOTE 3 If Test 1 is passed and the requirements for Test 2 are also met, then Test 2 need not be performed.

NOTE 4 Standard r.m.s. current breaking capacity values for residual current devices are given in 5.3.10 of IEC 61008-1 as 3 kA, 4,5 kA, 6 kA, 10 kA and 20 kA, which represent the short-circuit current levels that the load switch of a payment meter is expected to carry. For Test 1, the third and fourth values are chosen for utilisation categories UC3 and UC4 respectively as representing the short-circuit current sourcing capacities at the network supply point to customer installations where payment meters are commonly installed. Further categories may be created in future for higher current values. For Test 2, the first two values are chosen for utilisation categories UC3 and UC4 as representing the short-circuit current sourcing capacities at the load connection socket outlet points of wired premises where payment meters are commonly installed. The values given for UC2 correspond to a special category, applicable only to certain countries where large quantities of prepayment meters are installed, which are rated to these levels of fault current withstand.

NOTE 5 The aim of Test 1 is to check that the safety of the installation to the user remains intact after experiencing a short-circuit condition directly on the payment meter output terminals. It is permissible for the payment meter to be non-functional after the test, but consideration shall be given to the risk of exposure to electric shock and the possibility of causing a fire.

NOTE 6 The aim of Test 2 is to check for welding of contacts caused by the contacts being forced open by magnetic forces due to the high value of fault current. The I^2t let-through energy is not an essential part of this evaluation at present and is thus constrained to a value that amounts to less than would be expected from protection devices of either a fuse type or circuit breaker type normally used in the distribution board of wired premises under short-circuit conditions.

NOTE 7 It is recommended that the plotted graph of the voltage and test current waveform be attached to the test report for future reference.

C.7 Minimum switched current

The test is carried out under the following conditions:

- payment meter in normal operating condition;
- test voltage at U_c;
- test current at minimum switched current value and PF = 1,0;
- 10 operating cycles at approximately 10 s closed and 20 s open.

The following requirements shall be met:

- test current shall successfully conduct each time the contacts are in the closed position;
- test current shall successfully break each time the contacts are in the open position.

NOTE 1 One operating cycle of the load switch is one make followed by one break action.

NOTE 2 For the purpose of this test, the payment meter manufacturer may provide an external means, which allows for the opening and closing of the load switch to be under the control of the test equipment.

C.8 Dielectric strength

It is not intended that the payment meter should meet the requirements for a mains isolator switch of an installation, but when the load switch contacts are in the open condition, it shall present a minimum level of isolation between the supply input and load output terminals.

In the case where the neutral line is not switched, only the current carrying input phase terminals are grouped and connected together, and similarly the current carrying output phase terminals are grouped and connected together. All other terminals are connected to a safety ground reference.

In all other cases, the current carrying phase and neutral input terminals are grouped and connected together, and the current carrying phase and neutral output terminals are grouped and connected together. All other terminals are connected to a safety ground reference.

Perform the test under the following conditions:

- with the load switch contacts in the open position;
- the payment meter in the non-operating condition;
- between input circuits grouped and output circuits grouped;
- impulse test voltage at 1 kV peak;
- a.c. test voltage at 2 kV r.m.s.

The impulse voltage test shall be carried out first and the a.c. voltage test afterwards.

Apply the impulse voltage test as given in 7.3.2 of IEC 62052-11, but with the test voltage level and between circuits as given above.

Apply the a.c. voltage test as given in 7.4 of IEC 62053-21, but with the test voltage level, and between circuits as given above.

During and after the test the following requirements shall be met:

- there shall be no flash-over, disruptive discharge or puncture;
- when the payment meter is returned to normal operating conditions, it shall operate correctly and there shall be no change in any of the memory registers.

NOTE Where the payment meter load switching capability is also used as part of the main circuit protection or isolation at the customer's premises, then such additional requirements may be specified through reference to other specifications or standards.

C.9 Sequence of tests

The test sequence and sample plan given in Table C.2 is recommended.

Table C.2 – Test sequence and sample plan

Test number	Test clause		Sample A	Sample B	Sample C	Sample D
1	C.2	Normal operation	*			
2	C.3	Electrical endurance				*
3	C.4	Line to load voltage surge withstand	*			
4	C.5	Fault current making capacity	*			
5	C.6	Short-circuit current carrying capacity Test 1		*		
6	C.6	Short-circuit current carrying capacity Test 2			*	
7	C.7	Minimum switched current	*	*	*	*
8	7.3 and 7.3.2	Power consumption in current circuits	*	*	*	*
9	C.8	Dielectric strength	*	*	*	*

NOTE 1 The * in the table indicates that the particular test should be performed on the particular sample, but the sequence of the tests shall always follow the same order as the test number sequence. For example: sample A shall be subjected to test numbers 1, 3, 4, 7, 8 and 9, in that specific order.

NOTE 2 Tests 1 and 3 may alternatively be performed on any one of the Samples B, C or D, prior to performing the tests indicated in the table.

NOTE 3 Sample C might not be required, depending on the result of test 5 on Sample B (see NOTE 3 of Clause C.6)

Annex D
(normative)

Requirements of timekeeping

D.1 General

D.1.1 General

Where a payment meter is of a type that provides for energy-based tariffs controlled from an internal real-time clock, then the timekeeping requirements of this Annex shall apply, at least as design requirements. The type-testing requirements in this Annex shall not be mandatory where testing the timekeeping of any internal real-time clock is not required for the legal metrology approval testing of payment meters.

NOTE 1 The calendar functions of any internal real-time clock are covered in A.2.4.2.

Where a payment meter is of a type that includes maximum demand tariffs and/or demand recording controlled from an internal real-time clock that is not subject to frequent synchronisation or setting via a virtual token carrier system or other external system, then the timekeeping provisions in 7.5 and 7.6 of IEC 62054-21 and their subclauses shall apply when agreed between manufacturer and purchaser.

NOTE 2 Some tariff or security applications that are not related to real time may employ an elapsed-time clock, but such applications are not covered in this part of IEC 62055.

D.1.2 Real-time clock support facilities

Where a real-time clock is fitted and a battery or other support device is used to provide an operation reserve while no supply is available, then the following requirements shall be met. During an interruption of the supply voltage not exceeding the operation reserve, the payment meter shall keep the time within the prescribed accuracy.

An operation reserve shall be provided where the clock is used for internal tariff control or control of time-dependent credit.

In cases where a real-time clock is fitted but an operation reserve is either not fitted, or is not available when the supply voltage is restored, the manufacturer shall state what default status and indications are then adopted.

D.1.3 Operation reserve

For primary batteries and alternative support systems (e.g. a rechargeable battery or a super-capacitor), the timekeeping accuracy shall be better than a change in error of 1,5 s after running on the operation reserve for 36 h at reference temperature.

Unless otherwise stated, operational reserve use is defined as no supply voltage being applied at the payment meter terminals. For polyphase payment meters, the operation reserve shall not run while at least one of the phase-to-neutral voltages is present within the extended operating range.

NOTE If the supply voltage is below 0,8 U_n for a time period longer than the operation reserve, then the time may need to be readjusted.

Where the operation reserve is provided by a supercapacitor or a rechargeable battery, the maximum reserve restoration time shall not exceed 100 h.

D.1.4 Primary batteries

Where a primary battery is fitted, it shall be capable of providing reserve power for the minimum operational life of the meter, on the basis of an initial 2 years of continuous reserve use. Thereafter, the battery shall be capable of providing reserve power for 1 week per year for a minimum of 8 further years.

D.1.5 Back up battery replacement

Where the payment meter is designed to enable replacement of the back-up battery in use, it shall be designed in such a way that it does not lose the time during the replacement of the backup battery, even if a power outage occurs during this process. The time necessary for the replacement (with back-up battery disconnected) shall be less than 5 min.

D.1.6 Real-time clock setting and synchronisation facilities

It shall be possible to set the date and time (day, month, year, hours and minutes) with an accuracy of 5 s. The setting of the time shall reset the seconds to zero. If setting of the seconds is also available, then the setting of the time shall not reset the seconds to zero, but to the intended value.

If a daylight saving time function is available, the payment meter shall be capable of displaying the official time according to the regulations.

D.2 Synchronous clocks

Where fitted, a synchronous clock shall be capable of maintaining an accuracy of better than 0,15 s/24 h at reference conditions assuming that the supply frequency keeps its nominal value on average and without any power outages.

The synchronous clock shall operate normally for all values of frequency between 0,98 and 1,02 times the rated supply frequency, and for all values of voltage within the extended operating range.

Where an operation reserve based on a crystal-controlled clock is also fitted to handle timekeeping during power outage periods, the accuracy shall be better than 0,5 s/24 h, and the variation of timekeeping accuracy with temperature shall then be less than 0,15 s/°C/24 h. Testing to verify this requirement may be based on the method in D.4.3.3 below, or by measuring the change in time-indication discrepancy at each relevant temperature over suitable time periods.

D.3 Crystal-controlled clocks

Where fitted, a crystal-controlled time clock shall have timekeeping accuracy better than 0,5 s/24 h at reference temperature. The variation of timekeeping accuracy with temperature shall be less than 0,15 s/°C/24 h.

The crystal-controlled clock shall operate correctly for all values of frequency between 0,98 and 1,02 times the rated supply frequency.

On operation reserve, at reference temperature, the accuracy shall be better than 0,5 s/24 h, and the variation of timekeeping accuracy with temperature shall be less than 0,15 s/°C/24 h.

NOTE In applications where the payment meter is used as part of a system providing overall time synchronisation, the manufacturer and the purchaser may agree on relaxed timekeeping accuracy specifications for the payment meter when it is operating in stand-alone mode. In this case, the payment meter maintains the system time and synchronisation is performed by the system at the necessary intervals.

D.4 Tests of timekeeping accuracy

NOTE Where a payment meter includes provision for alternative timekeeping facilities (i.e. either synchronous or crystal-controlled modes may be selected for use) then the payment meter shall be tested in each of these modes.

D.4.1 General test conditions

Where the payment meter under test includes a clock it shall be placed in its normal operating position and in a climatic chamber where required, and supplied from a power source free of voltage dips and short interruptions. Unless otherwise indicated, the reference conditions shown in Table 11 of IEC 62053-21 shall be maintained.

NOTE For accuracy testing, the payment meter shall be able to display the real time including the seconds, and shall allow for a means of time synchronisation where the seconds are either reset to zero, or to the intended value. The manufacturer should also provide a suitable means on the payment meter for rapid testing of the timekeeping accuracy. This could be, for example, an electrical or optical output, or, in the case of capacitor-calibrated crystal-controlled clocks, an electromagnetic coupling picking up the signal from the crystal. Where such test facilities provide for the timekeeping accuracy to be assessed over a shorter period of time, then the minimum period of time required for each test is that stated below.

D.4.2 Test of synchronous clocks in payment meters

D.4.2.1 Test of synchronous clock on a.c. supply

The payment meter under test is supplied in parallel with and synchronised to a synchronous reference clock. After a testing period of 6 days, the time indication discrepancy between the reference clock and the payment meter under test shall not be more than ±1 s. The minimum period of time for this test is 144 h.

D.4.2.2 Test of synchronous clock on operation reserve

The payment meter to be tested is supplied with power in parallel with and synchronised with a crystal-controlled reference clock. Before the test, the payment meter shall be powered for a suitable length of time, so that the operation reserve is fully available.

NOTE The manufacturer should specify the time necessary for keeping the payment meter powered up before the test of operation reserve may commence.

The power supply to the payment meter under test is then switched off for 36 h. When the power supply is restored, the time-indication discrepancy between the reference clock and the payment meter under test shall not be more than ±1,5 s. The minimum period of time for this test is 36 h.

The restoration of the voltage shall be made with a switching device free from bounce.

D.4.3 Test of crystal-controlled clocks in payment meters

D.4.3.1 Test of crystal-controlled clocks on a.c. supplies

The payment meter under test is supplied with power and synchronised with a crystal-controlled reference clock. After a testing period of 2 days, the time-indication discrepancy between the reference clock and the payment meter under test shall not be more than 1 s. The minimum period of time for this test is 48 h.

D.4.3.2 Test of crystal-controlled clocks on operation reserve

The payment meter to be tested is supplied with power and synchronised with a crystal-controlled reference clock. Before the test, the payment meter shall be powered for a suitable length of time, so that the operation reserve is fully available.

NOTE The manufacturer should specify the time necessary for keeping the payment meter powered up before the test of operation reserve may commence.

The power supply to the payment meter under test is switched off for 36 h. When the power supply is restored, the time-indication discrepancy between the reference clock and payment meter under test shall not be more than ±1,5 s. The minimum time for this test is 36 h.

The restoration of the voltage shall be made with a switching device free from bounce.

D.4.3.3 Test of accuracy of crystal-controlled clocks with temperature

The payment meter is placed in a climatic chamber and its time base is measured at +23 °C. The temperature is then set at +45 °C. After thermal equilibrium is obtained, the timekeeping accuracy shall be better than ±3,3 s/24 h plus the timekeeping accuracy measured at reference temperature (maximum ±0,5 s/24 h).

The accuracy of the time base shall not differ from the 23 °C measurement by more than $\pm 38 \times 10^{-6}$.

The temperature is then set at –10 °C. After thermal equilibrium is obtained the timekeeping accuracy shall be better than ±4,95 s/24 h plus the timekeeping accuracy measured at reference temperature (max. ±0,5 s/24 h).

The accuracy of the time base shall not differ from the 23 °C measurement by more than $\pm 57 \times 10^{-6}$.

No minimum period of time is stated for this test.

D.5 Effects of disturbances on timekeeping

NOTE Where a payment meter includes provision for alternative timekeeping facilities (i.e. either synchronous or crystal-controlled modes may be selected for use), then the payment meter shall be tested in each of these modes.

D.5.1 Electromagnetic disturbances

The payment meter shall be designed in such a way that the electromagnetic disturbances specified in 7.8 and its subclauses do not have an adverse permanent effect on the timekeeping of any incorporated time function, including where the meter remains in powered operation after the disturbances have been removed.

Any internal timekeeping facility shall continue to operate during each of the EMC tests in 7.8.2 to 7.8.6, without any temporary loss of function.

For 7.8.2 Test of immunity to electrostatic discharges, during and after the test the disturbances shall not produce any change in time indication discrepancy.

For 7.8.3(a) Test of immunity to radiated RF electromagnetic fields at 10 V/m, during the test the disturbances shall not produce any change in the time displayed, and after the test there must be no change in time indication discrepancy.

For 7.8.3(b) Test of immunity to radiated RF electromagnetic fields at 30 V/m, during the test the disturbances may result in unavailability of the setting facilities and a temporary change in timekeeping accuracy. However, after the test the time must be preserved.

For 7.8.4 Test of immunity to electrical fast transients/bursts, during the test the disturbances may result in unavailability of the setting facilities and a temporary change in timekeeping accuracy. However, after the test the time indication discrepancy must be preserved.

For 7.8.5 Test of immunity to conducted disturbances, induced by RF fields, during the test the disturbances shall not produce any change in the time displayed, and after the test there shall be no change in time indication discrepancy.

For 7.8.6 Surge immunity test, during the test the disturbances shall not produce any change in the time displayed, however the disturbances may result in a blinking display, unavailability of the setting facilities, and a temporary change in timekeeping accuracy. After the test the time indication discrepancy shall be preserved.

D.5.2 Voltage dips and short interruptions

D.5.2.1 General

The payment meter shall be designed in such a way that voltage dips and short interruptions, including those specified in 7.2.2 and in D.5.2.2 to D.5.2.6, do not adversely affect the timekeeping of any incorporated time function. Any internal timekeeping facility shall not be affected adversely during these tests and shall not exhibit any resulting time-indication discrepancies of more than the amounts given below.

D.5.2.2 Test of the effects of short interruptions and voltage dips

For these tests, the payment meter is supplied in parallel with and synchronised to a suitable type of reference clock before each test. Suitable equipment is inserted in the power supply line to the payment meter in order to submit the payment meter under test to programmable short interruptions and voltage dips without any switching bounce.

D.5.2.3 Effect of short interruptions on synchronous clocks

The payment meter under test is submitted to sequences of 20 successive supply interruptions with at least 5 s intervals between each interruption. The period of the interruptions to be applied shall be 100 ms in the first sequence and 1 s in the second sequence. After each test sequence, the time-indication discrepancy between the payment meter under test and the synchronous reference clock shall not be more than 2 s and 10 s respectively.

D.5.2.4 Effect of voltage dips on synchronous clocks

The supply voltage to the payment meter under test is reduced to 50 % of U_n for a period of 2 min, then restored directly to U_n. After the test, the time-indication discrepancy between the payment meter under test and the synchronous reference clock shall not be more than 1 s.

D.5.2.5 Effect of short interruptions on crystal-controlled clocks

The payment meter under test is submitted to the same sequences of supply interruptions as described in D.5.2.3 above. After each test, the time-indication discrepancy between the payment meter under test and the crystal-controlled reference clock shall not be more than 1 s in each case.

D.5.2.6 Effect of voltage dips on crystal-controlled clocks

The payment meter under test is powered as in D.5.2.4 above. After the test the time-indication discrepancy between the payment meter under test and the crystal-controlled reference clock shall not be more than 1 s.

D.5.3 Harmonics in the voltage waveform

The payment meter is supplied together with, and synchronised to, a suitable reference clock. A third harmonic content equivalent to 10 % of U_n is added to the supply voltage of the payment meter under test, symmetrically to each phase in the case of a polyphase meter.

The test is carried out for a period of 48 h under reference conditions. At the end of the test, the time-indication discrepancy between the payment meter under test and the reference clock shall not be more than ±1 s for synchronous clocks and not more than ±1 s for crystal-controlled clocks.

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