भारतीय मानक

Indian Standard

IS 15884 : 2024

प्रत्यावर्ती दिष्ट धारा सक्रिय ऊर्जा के लिए डायरेक्ट कनेक्टेड स्टैटिक पूर्व भुगतान मीटर (श्रेणी 1 एवं 2) — विशिष्टि

(पहला पुनरीक्षण)

Alternating Current Direct Connected Static Prepayment Meters for Active Energy (Class 1 and Class 2) — Specification

(First Revision)

ICS 91.140.50

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Equipment for Electrical Energy Measurement and Load Control Sectional Committee, ETD 13

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Equipment for Electrical Energy Measurement and Load Control Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was first published in 2010 and is now being revised to update the requirements based on experience and feedback from field experts and to align its requirements with IS 13779: 2020 'a.c. static watthour meters, Class 1 and 2 — Specification (*second revision*)' and IS 14697: 2021 'a.c. static transformer operated watthour meters (Class 0.2 S and 0.5 S) and var-hour meters (Class 0.2 S, 0.5 S and 1 S) — Specification (*first revision*)'.

This revision includes the following major technical changes:

a) Exclusion of outdoor meters from the scope of the standard;
b) Exclusion of prepayment functionality processed outside the meter from the scope of the standard;
c) Definition of 'Load Control Switch' has been added;
d) Definition of 'Operation Reserve' has been added.
e) Standard reference voltages have been aligned with IS 12360 : 1988 and accordingly voltage marking requirements have been modified;
f) Standard basic current values for 1-phase modified;
g) Requirements w.r.t meter case have been modified;
h) Reference standard for IP protection modified;
j) Requirements for testing for insulation of insulating encased meter of protection Class II has been added;
k) Requirements w.r.t 'Retention time of the non-volatile memory' have been modified;
m) Display requirements w.r.t time and date, for prepayment meter operating in monetary units have been modified;
n) Requirement for dditional high resolution register for testing purposes added;
p) The pulse transition time (rise time) has been modified;
q) General requirements for token carrier interface modified;
r) Number of minimum operations of token carrier acceptor modified;
s) Number of minimum operations of each individual key of the keypad interface modified;
t) Separate requirement for limit range of operation deleted;
u) Electrical requirements w.r.t permitting temporary degradation of performance or loss of function during the tests deleted;
v) Following power consumption requirement in current circuit added- In case of single phase prepaid meters where both phase and neutral is switched, phase and neutral circuit to be considered as a separate circuit;
w) Terminology for Withstand voltage range changed to abnormal voltage range- separate clause of withstand range and abnormal voltage conditions deleted;
y) Verification of correct operation of payment meter to be carried out at both extreme values of extended operating range;
z) Test for Immunity to Earth/Phase Fault added;
aa) Requirements added for Time keeping of the meter during voltage dips and short interruptions;
bb) Tolerance added for short-time overcurrent;
cc) Maximum test duration for influence of self-heating added and break time added for repeating test at 0.5 (lagging) power factor;
dd) Values for Ambient temperature and cable length and its acceptable current density modified for testing for Influence of heating modified;
ee) Limits of error due to variation of the current modified for 0.2 $I_b \leq I \leq I_{Max}$ with power factor change to 0.5 capacitive (from 0.8 capacitive), percentage error limits added for 0.8 capacitive for value of current 0.2 $I_b \leq I \leq I_{max}$;
ff) Limits of variation due to abnormal a.c. magnetic induction of external origin (10 mT) modified;
gg) Value of current modified for testing Limits of variation due to dc and even harmonies in the ac current circuit;
hh) Temperature range values modified for calculation of mean temperature coefficient;

jj) Requirement of time keeping added;
kk) Requirements for load switching capability added;
mm) Performance requirements for Utilization category UC1, UC2 and UC3 added;
nn) Number of Samples for type tests now dependent upon the interfaces and functionality of the specific payment meter and requirement of equal no. of samples for re-testing in case of failure added;
pp) Acceptance criteria explicitly specified for tests of climatic influences;
qq) Damp heat cyclic test modified;
rr) Acceptance criteria modified for test of influence of voltage dips and interruptions;
ss) Acceptance criteria for test of influence of heating modified;
tt) Test conditions and acceptance criteria for test of insulation properties modified;
uu) Reference standard for impulse voltage test modified;
vv) Reference standard for vibration test and cold test modified;
ww) Test duration of a.c. voltage test modified.;
yy) Test duration of Insulation resistance test modified;
zz) General test conditions for Electromagnetic Compatibility (EMC) added;
aaa) Test condition for test of immunity to electrostatic discharges modified;
bbb) Test severity level deleted for Contact discharge test;
ccc) Acceptance criteria for test of immunity to electrostatic discharges modified;
ddd) Test severity level deleted, test conditions modified for Test of Immunity to Electromagnetic HF Fields;
eee) Test method and acceptance criteria for radio interference measurement modified;
fff) Reference standard for Surge Immunity Test modified; different test condition for surge immunity test for UCI, UC2, UC3 defined;
ggg) General test conditions for test of accuracy requirements added; additional test conditions added;
hhh) Reference conditions for test of influence quantities modified;
jjj) Values modified for minimum test period of no-load condition test;
kkk) Test of meter constant modified;
mmm) Type test repeatability removed; acceptance criteria of repeatability of error added;
nnn) Test of Consumption based charging functions and time-based charging functions added;
ppp) Requirement of Interruption and restoration of the load for emergency credit facility added;
qqq) Tests of the Load Switch operation at different voltages and temperature added;
rrr) Requirements to verify robustness of meter accounting process modified;
sss) General requirements of time-keeping modified;
ttt) Title of 'Crystal controlled clocks' changed to 'Real Time Clock' and accuracy requirements modified;
uuu) Requirements added for test of accuracy of real time clocks on main supplies for test duration greater than 48 h;
vvv) Battery requirement for providing reserve power for minimum operation life of the meter added; time period for test duration modified along with acceptable discrepancy in time indication;
www) Test conditions and time keeping accuracy modified for test of accuracy of real time clocks with temperature;
yyy) Effects of electromagnetic disturbances on time keeping deleted;
zzz) Method of test of the effects of short interruptions and voltage dips modified;
aaaa) Method of test and acceptance criteria for effect of short interruptions on real time clocks modified;
bbbb) Method of test and acceptance criteria for effect of voltage dips on real time clocks modified;
cccc) Recommended Test Sequences also list no. of samples now for clarity;
dddd) In Annex G 'Performance requirements for payment meters with load switching utilization categories UC2 and UC3' - Clarity provided for different test currents being prospective r.m.s currents for utilization categories;
eeee) Following methods of test for load switch (Annex G) modified;
ffff) Normal operation, electrical endurance, line to load voltage surge withstand, fault current making capacity and short-circuit current carrying capacity;
gggg) Process modified for ensuring minimum level of isolation between the supply input and load output terminals when load switch contacts are open;
hhhh) In line with IS 13779, additional resistor requirement for testing limits of error due to d.c. and even harmonies in the a.c. current circuit added and test method modified (in Annex K); and
jjjj) Circuit diagram for the test of immunity to earth phase fault added (Annex L).

Prepayment 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 prepayment meter in relation to a payment tariff agreed between the customer and the supplier. The prepayment meter is part of a system that uses tokens to pass payment information between a vending network and the prepayment meters that include the meter accounting process.

The functions of a prepayment meter are to measure electrical energy consumed and to decrement the available credit register in accordance with the metered consumption, and possibly fixed amount on daily basis for fixed charge calculation. This available credit register is incremented as the result of payments made to the electricity supplier, and the meter accounting process continuously calculates the balance of available credit to the customer. When the available credit register 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 intervals of day or night. Features to permit disconnection of supply on detection of tamper or fraud may be supported.

In return for the payment and depending on the particular type of system, the customer may be issued with a single-use token 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). One way and two-way data transfer systems may be used, and the tokens may be: physical device such as smartcards, or other electronic devices, or magnetic cards; virtual tokens transferred by remote communications system; or numeric tokens where sequences of digits are entered *via* keypad on the meter.

Annex B provides information of the core functions that are found in a payment meter.

While formulating this standard, assistance has been derived from IEC 62055-31 (2005) 'Electricity Metering — Payment systems — Part 31: Particular requirements — Static payment meters for active energy (Class 1 and Class 2)', issued by the International Electrotechnical Commission and IS 13779 : 2020 'a.c. Static Watthour Meters, Class 1 and Class 2 — Specification (*second revision*)'.

The composition of the Committee, responsible for the formulation of this standard is given in Annex N.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revison*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ALTERNATING CURRENT DIRECT CONNECTED STATIC PREPAYMENT METERS FOR ACTIVE ENERGY (CLASS 1 AND CLASS 2) — SPECIFICATION

(First Revision)

1 SCOPE

This standard applies to direct connected static watt hour prepayment meters of accuracy Class 1 and Class 2, for the measurement, registration and dispensation of alternating current electrical active energy of 50 Hz for single-phase and three-phase balanced and unbalanced loads in accordance with available credit. It applies to their type, acceptance and routine tests.

It applies to static watt-hour prepayment meters consisting of a measuring element and register(s) enclosed together in a meter case. It also applies to operation indicator(s) and test output(s). This standard also applies for additional prepayment functional element(s) which may include user/token interface credit transfer, credit accounting, load switch and time keeping in the same case.

The standard does not apply to the prepayment functionality processed outside the meter. In such case, prepayment functionality shall be part of HES validation.

NOTE — The standard covers utilization categories of switches in the meter as UC1 for I_{max} up to 100A and UC2 and UC3 categories of switches based on the installation conditions, short circuit current and other test requirements given in Annex G.

It applies to indoor applications only.

It does not apply to:

a) Watt-hour meters where the voltage across the connection terminals exceeds 600 V (line - to - line voltage for meters of poly phase systems);
b) Watt-hour meters for outdoor applications;
c) Meters with an external switch;
d) Meters for supply/load control switch applications;
e) Multi-part payment meter installation;
f) Outdoor meters (*see* IS 13779 for definition of outdoor meters); and
g) The standard does not apply to the prepayment functionality processed outside the meter. In such case, prepayment functionality shall be part vending system validation.

The long-term reliability aspect is not covered in this standard, as there are no short-term test procedures available yet, which would fit into type test documents to satisfactorily check this requirement.

This standard does not cover the software requirement for prepayment meters.

2 REFERENCES

The standards listed in Annex M contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards.

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 General Definitions

All definitions of IS 13779 shall apply.

3.2 Definitions Related to Functional Elements

All definitions of IS 13779 shall apply.

3.3 Definitions of Mechanical Elements

All definitions of IS 13779 shall apply.

3.4 Definitions Related to Insulations

All definitions of IS 13779 shall apply.

3.5 Definitions Related to Meter Quantities

All definitions of IS 13779 shall apply.

3.6 Definitions of Influence Quantities

All definitions of IS 13779 shall apply.

3.7 Definitions of Tests

All definitions of IS 13779 shall apply.

3.8 Definitions of General Payment Metering Terms

3.8.1 *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.

3.8.2 *Fault Current*

Current flowing at a given point of network resulting from a fault at another point of this network.

3.8.3 *Load Interface*

Terminal(s) where the customer's load circuit is connected to the payment meter where applicable.

3.8.4 *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.

3.8.5 *Payment Meter*

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

NOTES

1 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 min unit that also employs a single specified matching socket for the supply interface and load interface. In this 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.

2 *See* Fig. 1 in Annex B for the generalized block diagram of a payment meter instance.

3.8.6 *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.

3.8.7 *Prepayment Mode*

Payment mode in which automatic interruption occurs when available credit is exhausted.

3.8.8 *Supply Interface*

Terminal(s) where the supply network is connected to a payment meter or to a specified matching socket, where applicable.

3.8.9 *Emergency Credit*

Payment meter accounting function that deals with the dispensing of energy after available credit value becomes zero.

3.8.10 *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 base.

3.8.11 *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.

3.9 Definitions of Tokens

3.9.1 *Token*

3.9.1.1 *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

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.

3.9.1.2 *System related definition*

Subset of data elements, containing an instruction and information that is transferred to the payment meter by means of a token carrier.

3.9.2 *Credit Token*

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

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

3.9.4 *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.

3.9.5 *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.

3.9.6 *Replacement Token*

A token that replaces a previously issued token in value. Physical token carrier may require a blank token carrier to be configured for the customer's meters.

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.

3.9.7 *Single Use Token*

Token (such as a credit token) that can only be used for one successful session in a payment meter.

3.9.8 *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).

3.9.9 *Value Token*

See **3.9.2**.

3.10 Definition of Token Carriers

3.10.1 *Token Carrier*

3.10.1.1 *Equipment related definition*

Devices or media used to transport and present token information to payment meters, such as printed paper, magnetic care, 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.

3.10.1.2 *System related definition*

Medium that is used in the physical layer of the POS (Point of Sale) to token Carrier Interface, onto which the token is modulated or encoded, and which server to carry the token from the point where it is generated to the remote payment meter, where it is received.

3.10.2 *Bank Token Carrier*

Physical token carrier that has not been processed at the vending point or elsewhere and hence contains no specific data.

3.10.3 *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.

3.10.4 *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.

3.10.5 *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.

3.10.6 *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 program and associated data.

3.10.7 *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.

3.10.8 *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.

3.10.9 *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.

3.10.9.1 *Rechargeable token carrier* (*see* **3.10.11**)

3.10.10 *Reusable Token Carrier*

Rechargeable token carrier is physical token carrier that can be used for multiple sessions for transportation of tokens.

3.10.11 *Two-Way Token*

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 stamp.

3.10.12 *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, direct local communication etc.

3.11 Definitions Relating to Tokens and Token Carriers

3.11.1 *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 layer.

3.11.2 *Token Acceptance*

Recognition of the successful completion of the processing of any token that was presented to the payment meters.

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.

3.11.3 *Token Cancellation*

a) The process of erasing or invalidating information contained in a valid token upon its acceptance by a payment meter, to prevent its reuse; and
b) 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.

3.11.4 *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; and memory key acceptor.

3.11.5 *Token Carrier Charging*

Loading of a token and tariff or configuration data onto a token carrier at a vending point or a management system.

3.11.6 *Token Carrier Interface*

Token carrier interface permits the manual or automatic entry of tokens into a payment meter.

NOTES

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

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

3.11.7 *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.

3.11.8 *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.

3.11.9 *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.

3.11.10 *Virtual Token Carrier Interface*

Complete interface protocol stack that includes the physical layer protocol and application layer protocol, plus any intermediate protocol layers.

3.12 Definitions Related to Load Switching

3.12.1 *Minimum Switching Current*

Smallest current that the payment meter is able to make, carry and break at the rated breaking voltage and under prescribed conditions.

3.12.2 *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.

3.12.3 *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.

3.12.4 *Rated Breaking Voltage (V_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.

3.12.5 *Utilization 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 including short circuit current sourcing capacity. The main criteria being; minimum safety levels, lightning surge withstand, fault current withstand and switch endurance (*see* Annex G). This standard considers three utilization categories UC1, UC2 and UC3.

3.12.6 *Load Control Switch*

Load control switch considered in this standard is switch within the meter for connection and disconnection of supply to the consumer premises operated by meter internally or with external command.

3.13 Definitions Related to Time Keeping and Tariff Control

3.13.1 *Crystal-Controlled Time Keeping*

Process of maintaining a payment meter's time by means of an internal crystal-controlled clock.

3.13.2 *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).

3.13.3 *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 program.

3.13.4 *Internal Time Keeping*

Maintenance of a payment meter's time by its own internal clock facility.

3.13.5 *Operational 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.

3.13.6 *Reserve Restoration Time*

Period of time required for restoring the full operation reserve from the point where the operation reserve has been completely exhausted.

3.13.7 *Time Indication Discrepancy*

Difference between the time displayed by the payment meter and the actual time.

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

3.13.8 *Time Keeping Accuracy*

Increase or decrease in the time indication discrepancy within a specified time interval.

3.13.9 *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.

3.13.10 *Operation Reserve*

The internal power supply of the meter required to keep real time clock running while mains supply is not available.

4 GENERAL REQUIREMENTS

4.1 Standard Electrical Values

4.1.1 *Standard Reference Voltage*

Standard reference voltages shall be 240 (415) V. Exceptional value of standard reference voltage can be 220 (380) V and 230 (400) V.

NOTE — The values in bracket are phase to phase values.

4.1.2 *Standard Basic Current*

a) Standard basic currents shall be 2.5 A, 5 A, 10 A, 15 A and 20 A for 1-phase; and

b) Standard basic currents shall be 5 A, 10 A, 15 A, 20 A, 30 A, 40 A and 50 A for 3-phase.

4.1.3 *Maximum Current*

The maximum current shall preferably be an integral multiple of the basic current (for example, six times the basic current).

Typical Rated Maximum Current

Meter (1-phase and 3-phase)	Rated maximum current in percentage of basic current
Direct connected	200, 300, 400, 500, 600, 800, 1 000

4.1.4 *Standard Reference Frequency*

Standard value for reference frequency is 50 Hz.

4.2 Mechanical Requirements

Compliance to requirements covered in this clause is checked by tests if specified; or visual inspection.

4.2.1 *General Mechanical Requirements*

Meters shall be designed and constructed in such a way as to avoid introducing any danger in normal use and under normal conditions, so as to ensure especially:

a) Personal safety against electric shock;
b) Personal safety against effects of excessive temperature;
c) Protection against spread of fire; and
d) Protection against penetration of solid objects, dust and water.

All parts, which are subject to corrosion under normal working conditions, shall be protected effectively. Any protective coating shall not be liable to damage by ordinary handling nor damage due to exposure to air, under normal working conditions.

The electrical connections shall be such as to prevent any opening of the circuit under normal conditions of use, as specified in the standard, including any overload conditions specified in this standard.

The construction of the meter shall be such as to minimize the risks of short-circuiting of the insulation between live parts and accessible conducting parts due to accidental loosening or unscrewing of the wiring, screws, etc.

NOTES

1 Requirements mentioned above, in general, are covered by type tests prescribed in this standard.

2 For meters for special use in corrosive atmosphere, additional requirements shall be fixed in the purchase contract.

4.2.2 *Case*

The meter shall have a case which can be sealed in such a way that the internal parts of the meter are accessible only after breaking the seal(s). The meter shall have a reasonably dust/moisture-proof case, which shall be sealed by the manufacturer in such a way that the internal parts of the meter are accessible only after breaking such distinctive seal(s). The cover shall not be removable without the use of a tool. The case shall be so constructed and arranged that any non-permanent deformation cannot prevent the satisfactory operation of the meter. The components shall be reliably fastened and secured against loosening.

The holding on and sealing screws shall be held captive in the meter cover.

Unless otherwise specified, meters having a case wholly or partially made of metal, shall be provided with a protective earth terminal.

4.2.3 *Window*

If the cover is not transparent, one or more windows shall be provided for reading the display and observation of the operation indicator, if fitted. These windows shall be of transparent material, which cannot be removed, undamaged without breaking the seal(s).

4.2.4 *Terminals — Terminal Block(s) — Protective Earth Terminal*

Terminals may be grouped in a terminal block(s) having adequate insulating properties and mechanical strength. In order to satisfy such requirements when choosing insulating materials for the terminal block(s), adequate testing of materials shall be taken into account. The material of which the terminal block is made shall be capable of passing the tests given in IS 13360 (Part 6/Sec 17) for a temperature of 124 °C and a pressure of 1.8 MPa (Method A). The holes in the insulating material which form an extension of the terminal holes shall be of sufficient size to also accommodate the insulation of the conductors. The conductors where terminated to the terminals shall ensure adequate and durable contact such that there is no risk of loosening or undue heating. Screw connections transmitting contact force and screw fixings which may be loosened and tightened several times during the life of the meter shall screw into a metal nut. All parts of each terminal shall be such that the risk of corrosion resulting from contact with any other metal part is minimized.

Electrical connections shall be so designed that contact pressure is not transmitted through insulating material.

For current circuits, the voltage is considered to be the same as for the related voltage circuit.

Terminals with different potentials which are grouped close together shall be protected against accidental short-circuiting. Protection may be obtained by insulating barriers. Terminals of one current circuit are considered to be at the same potential.

Two screws shall be provided in each current terminal for effectively clamping the external leads or thimbles. Alternatively, if an elastic pressure plate or similar effective device is provided to keep the entire length of the conductor within the terminal well pressed, one screw may be used. Each clamping screw shall engage a minimum of three threads in the terminal. The ends of screws shall be such as not to pierce and cut the conductors used.

The internal diameter of terminal hole shall be as specified in Table 1.

Table 1 Terminal Holes

(*Clause* 4.2.4)

Sl No.	Rated Current (A)	Minimum Internal Diameter (mm)
(1)	(2)	(3)
i)	≤ 40	5.5
ii)	$40 < I \leq 60$	8.0
iii)	> 60	9.5

The terminals, the conductor fixing screws, or the external or internal conductors shall not be liable to come into contact with terminal covers (if made of metals).

The protective earth terminal, if any:

a) Shall be electrically bonded to the accessible metal parts;
b) Should, if possible, form part of the meter base;
c) Should preferably be located adjacent to its terminal block;
d) Shall accommodate a conductor having a cross-section at least equivalent to the main current conductors but with a lower limit of 6 mm^2 and an upper limit of 16 mm^2 (these dimensions apply only when copper conductors are used);
e) Shall be clearly identified by the graphical symbol: Protective earth (ground); and
f) After installation, it shall not be possible to loosen the protective earth terminal without the use of a tool.

4.2.5 *Terminal Cover(s)*

The terminal of a meter, if grouped in a terminal block and if not protected by any other means, shall have a separate cover which can be sealed independently of the meter cover. The terminal cover shall enclose the actual terminals, the conductor fixing screws and unless otherwise specified, a suitable length of external conductors and their insulation. When it covers a suitable length of external conductor, it is called an extended terminal cover and is used when the meter wiring is carried out from rear of the mounting board. Terminal covers without this provision and meant for meter wiring from front of mounting board are called as short terminal covers.

The fixing screws used on the terminal cover for fixing and sealing in either short terminal cover or extended terminal cover shall be held captive in the terminal cover.

When the meter is mounted on the meter board, no access to the terminals shall be possible without breaking seals(s) of the terminal cover.

Table 2 Clearances and Creepage Distances
(For Insulating Encased Meter of Protective Class I)

(*Clause* 4.2.6)

Sl No.	Voltage Phase to Earth Derived from System Voltage	Rated Impulse Voltage	Minimum Clearances	Minimum Creepage Distance
	(V)	(V)	(mm)	(mm)
(1)	(2)	(3)	(4)	(5)
i)	Not exceeding 300	4 000	3.0	3.2
ii)	Not exceeding 600	6 000	5.5	6.3

Table 3 Clearances and Creepage Distances
(For Insulating Encased Meter of Protective Class II)

(*Clause* 4.2.6)

Sl No.	Voltage Phase to Earth Derived from System Voltage	Rated Impulse Voltage	Minimum Clearances	Minimum Creepage Distance
	(V)	(V)	(mm)	(mm)
(1)	(2)	(3)	(4)	(5)
i)	Not exceeding 300	6 000	5.5	6.3
ii)	Not exceeding 600	8 000	8.0	12.5

4.2.6 *Clearance and Creepage Distances* — The clearance and creepage distances between:

a) Any terminal of a circuit with a reference voltage over 40 V; and
b) Earth, together with terminals of auxiliary circuits with reference voltages below or equal to 40 V shall not be less than stated in:
   1) Table 2 for meters of protective Class I; and
   2) Table 3 for meters of protective Class II.

The clearance and creepage distances between terminals of circuits with reference voltages over 40 V shall not be less than that stated in Table 2.

Clearance of minimum 3 mm shall be provided between incoming and outgoing terminals of the same phase.

The clearance between the terminal cover, if made of metal, and the upper surface of the screws when screwed down to the maximum applicable conductor fitted shall be not less than the relevant values indicated in Table 2 and Table 3.

4.2.7 *Insulating Encased Meter of Protective Class* II

A meter of protective Class II shall have a durable and substantially continuous enclosure made wholly of insulating material, including the terminal cover, which envelopes all metal parts, with the exception of small parts, for example, nameplate, screws, suspensions and rivets. If such small parts are accessible by the standard test finger (as specified in IS 1401) from outside the case, then they shall be additionally isolated from live parts by supplementary insulation against failure of basic insulation or loosening of live parts. The insulating properties of lacquer, enamel, ordinary paper, cotton, oxide film on metal parts, adhesive film and sealing compound, or similar unsure materials, shall not be regarded as sufficient for supplementary insulation. To comply therewith, they shall fulfil the tests as specified in **5.4.6** of this standard.

For the terminal block and terminal cover of such a meter, reinforced insulation is sufficient.

4.2.8 *Resistance to Heat and Fire*

The terminal block, the terminal cover, the insulating material retaining the main contacts in position and the meter case shall ensure reasonable safety against the spread of fire. They should not be ignited by thermic overload of live parts in contact with them. The material of the terminal block should not deflect under heating. To comply therewith, they must fulfil the tests as specified in **5.2.4** of this standard.

4.2.9 *Protection against Penetration of Dust and Water*

The meter shall conform to the degree of protection IP51 as per IS/IEC 60529, but without suction in the meter. 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. For testing, *see* **5.2.5**.

4.2.10 *Display of Measured Values*

4.2.10.1 *General*

The display shall be visible from the front of the meter. The display shall be electronic and when the meter is not energized, the electronic display need not be visible. The principal unit for the measured values shall be the kilowatt hour (kWh).

4.2.10.2 *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.

NOTE — Manufacturer shall provide declaration for compliance of above requirements.

The meter shall display current account information in terms of balance amount left for consumption in terms of energy units or monetary value.

Where multiple values are presented by a single display, all relevant values shall be available via appropriate selection (choice of selection shall be general, for example, keypad or push button). When displaying the values, each tariff register shall be identifiable and the active tariff rate shall be indicated (this can be done either by legends or by display headers before the actual parameter).

The register shall be able to record and display starting from zero, for a minimum of 1 500 h, the energy corresponding to maximum current at reference voltage and unity power factor. The register shall not roll over during this duration. Number of digits of display shall be sufficient to display cumulative energy as per this requirement. Further, this shall be supported by declaration of manufacturer (as the verification of rollover is not feasible in laboratory).

NOTES

1 Values higher than 1 500 h should be the subject of purchase contract.

2 It shall be impossible to reset the indication of the cumulative total of electrical energy during use. The regular rollover of the display is not considered as a reset. For verification of this requirement, manufacturer shall give a general description of implementation.

4.2.10.3 *Minimum character size*

The height of the display characters for the principal parameter values shall not be less than 5 mm.

4.2.10.4 *Minimum display capability*

The following information shall be capable of being displayed on the prepayment meter:

a) Cumulative kWh energy registers; and
b) Available credit value.

In addition, for virtual token systems, the prepayment meter shall be able to display details of the last purchase transaction token.

4.2.10.5 *Additional display requirements for prepayment meter operating in monetary units*

The prepayment meters, where the available credit register operates in monetary units, shall be capable of displaying the following information:

a) The price per kWh; and
b) Any time-based charge settings such as for standing charges or debt recovery.

In the case of a multi-rate prepayment meter, the meter shall be capable of displaying the following additional information also:

a) The price per kWh for each tariff rate; and
b) Cumulative kWh for each tariff rate.

For multi-rate tariff, the active tariff rate shall be indicated.

Prepayment meter, shall be capable of displaying the time in 24 hours' format (HH:MM:SS), including date (DD:MM:YY).

4.2.10.6 *Display indicators*

The following shall be indicated as a minimum and shall be visible from the front of the prepayment meter (in the form of parameter selection on display):

a) Indication of rate of kWh consumption (instantaneous loading); and
b) Indication of token acceptance (for all manually transported token types).

4.2.10.7 *Output device*

The meter shall have a test output device accessible from front and capable of being monitored with suitable testing equipment. The operation indicator, if fitted, shall be visible from the front.

Output devices generally may not produce homogeneous pulse sequences. Therefore, the manufacturer shall state the necessary number of pulses to ensure that measurement uncertainty factor due to repeatability of meter is less than 1/10 of the error limits specified at different test points and consistent with desired resolution.

The resolution of the test output in the form of pulses or high resolution register, whether accessible on the meter through external display, shall be sufficient to conduct satisfactorily accuracy test at the lowest load in less than 5 minutes and starting current test in less than 10 minutes. Additional high resolution register with minimum decimal of two digits shall also be available in the meter for testing purpose as mentioned in this standard.

4.2.10.8 *Mechanical and electrical characteristic*

An optical test output shall be accessible from the front.

The maximum pulse frequency shall not exceed 2.5 kHz. Modulated and unmodulated output pulses are permitted. The unmodulated output pulses shall have the shape shown in Fig. 5 in Annex F.

The pulse transition time (rise time or fall time) is the time of transition from one state to the other state, including transient effects. The transition time shall not exceed 20 µs (*see* Fig. 5 in Annex F).

The distance of the optical pulse output from further adjacent ones or from an optical status display shall be sufficiently long that the transmission is not affected. An optimum pulse transmission is achieved when, under test conditions, the receiving head is aligned with its optical axis on the optical pulse output.

The rise time (t_T) given in Fig. 5 in Annex F shall be verified by a reference receiver diode with rise time (t_T) ≤ 0.2 µs.

4.2.10.9 *Optical characteristics*

The wavelength of the radiated signals for emitting systems shall be between 550 nm and 1 000 nm.

The output device in the meter shall generate a signal with a radiation strength ET over a defined reference surface (optically active area) at a distance of *S*1 = 10 + 1 mm from the surface of the meter, with the following limiting values:

a) ON-condition: 50 $\mu W/cm^2 \leq E_T \leq 1\ 000\ \mu W/cm^2$; and

b) OFF-condition: $E_T \leq 2\ \mu W/cm^2$ (*see also* Fig. 5 in Annex F).

4.2.11 *Marking of Meter*

4.2.11.1 *Nameplates*

Every meter shall bear the following information as applicable:

a) Manufacturer's name and/or trade-mark and the place of manufacture;

b) Designation of type;

c) The number of phases and the number of wires for which the meter is suitable (for example, single-phase 2-wire, three-phase 4-wire); these markings may be replaced by the graphical symbols given in IS 12032 series;

d) The serial number and year of manufacture. If the serial number is marked on a plate fixed to the cover, the number shall also be marked on the meter base;

e) The reference voltage in one of the following forms:

   1) The number of elements if more than one, and the voltage at the meter terminals of the voltage circuit(s);

   2) The rated voltage of the system or secondary voltage of the instrument to which the meter is intended to be connected;

   Examples of voltage markings are shown in Table 4.

f) Principal unit in which the meter reads, for example kWh;

g) Basic current and the maximum current, for example, 10 A to 60 A or 10(60) A for a meter having a basic current of 10 A and a maximum current of 60 A;

h) Reference frequency in Hz;

j) Meter constant, for example in the form: Wh/ imp or imp/kWh;

k) Class index of the meter;

m) Reference temperature if different from 27 °C;

n) Sign of the double square for insulating encased meters of protective Class II;

p) Battery symbol, if the meter has an inbuilt battery and its chemical symbol (for example, Li, if lithium);

q) Ratings of any auxiliary switch shall be marked on the nameplate in case the system uses an auxiliary switch;

r) Meter can also be marked with the BIS Standard Mark (if certified by BIS);

s) Country of manufacture;

t) Utilisation category for example, UC1, UC2 or UC3; and

u) Information under (a), (b), (c) and (s) may be marked on an external plate permanently attached to the meter cover.

Table 4 Voltage Marking

(*Clause* 4.2.11.1)

Sl No.	Meter	Voltage at the Terminals of Voltage Circuits(s) (V)	Marking on Meter (V)
(1)	(2)	(3)	(4)
i)	Single- phase 2-wire 240 V	240	240
ii)	Three- phase 4-wire 3 element (240 V phase to neutral)	3 X 240 (415)	3 X 240 (415)

4.2.12 *Token Carrier Interface*

4.2.12.1 *General*

Where a physical token carrier interface is fitted, it shall comply with the following mechanical requirements. The prepayment electricity meter shall have a mechanism for transferring tokens. The token may be entered by keypad or smart cards. The credit transfer device shall be intrinsically safe and provide protection from damage by means of dust, water, sharp objects and electrostatic discharges.

4.2.12.2 *Token carrier acceptor*

Where a token carrier is fitted, an 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 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 2 000.

Valid Token shall be accepted.

4.2.12.3 *Keypad interface*

Where a keypad interface is fitted, it shall be designed to operate for a minimum of 10 000 operations of each individual key.

4.3 Climatic Requirements

4.3.1 *General*

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 acceptor during these tests.

4.3.2 *Operation within the Specified Operating Range*

This is the range of ambient temperature (that is from – 10 °C to + 55 °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 switches, 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.

For testing purpose, the meter shall be kept at – 10 °C and 55 °C (± 5 °C) and operation of the load switch shall be verified. The switch may be operated through communication port, if available or by normal operation of switch through payment function. For testing, *see* **5.10.**

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. For testing, *see* **5.10.**

4.3.3 *Limit Range for Storage and Transport*

Outside the specified operating range, but within the limit range for storage and transport (that is from – 25 °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. When the ambient temperature of the payment meter has returned to the specified operating range and stabilized and after the supply voltage has been connected and then commissioning (including the resetting of any time-keeping facility) has been completed, the meter shall operate normally. The test requirement is covered under **5.3**.

4.3.4 *Temperature Range*

The temperature range of the meter shall be shown in Table 5. For testing, *see* **5.3**.

Table 5 Temperature Range

(*Clause* 4.3.4)

Sl No.	**Indoor Meter**	**Range** (ºC)
(1)	(2)	(3)
i)	Specified operating range	- 10 to 55
ii)	Limit range of storage and transport	- 25 to 70

NOTE — For special application, other temperature values can be used according to purchase contract.

4.3.5 *Relative Humidity*

The meter shall be deemed to meet the relative humidity requirements of Table 6. For combined temperature and humidity testing (*see* **5.3.3**). The test for this requirement is covered under test of climatic influences (Damp Heat Cyclic Test).

Table 6 Relative Humidity

(*Clause* 4.3.5)

Sl No. (1)	(2)	(3)
i)	Annual mean	< 75 percent
ii)	For 30 days, these days being spread in a natural manner over one year	< 95 percent
iii)	Occasionally on other days	< 85 percent

The limits of relative humidity as a function of ambient air temperature are shown in Annex C

4.4 Electrical Requirements

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.

4.4.1 *Power Consumption*

The measurement of power consumption in the voltage and current circuits shall be determined as given in this clause.

4.4.1.1 *Voltage circuits*

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

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 acceptor and the token can be retained in the payment meter then these power consumption requirements shall also be met with a normal token retained in the meter in quiescent operation.

4.4.1.2 *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 percent of V_{ref} in volts multiplied by 100 percent of I_{max} in amperes (for example, 240 V and 60 A gives 11.5 VA; 240 V and 100 A gives 19.2 VA).

These values include consideration of the load switch.

In case of single-phase prepaid meters where both phase and neutral is switched, phase and neutral circuit to be considered as a separate circuit.

4.4.2 *Influence of Supply Voltage*

4.4.2.1 *Voltage range*

Payment meters shall comply with the requirements of Table 7.

Table 7 Voltage Ranges

(*Clause* 4.4.2.1)

Sl No. (1)	(2)	(3)
i)	Specified operating range	0.9 to 1.1 V_{ref}
ii)	Extended operating range	0.7 to 1.2 V_{ref}
iii)	Limit range of operation	0.0 to 1.2 V_{ref}
iv)	Abnormal voltage range	0.0 to 1.9 V_{ref}

For verification of voltage range, *see also* **4.6** and **5.6** (including any sub-clauses).

4.4.2.2 *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.

4.4.2.3 *Extended operating range*

This is the range of supply voltage over which the payment meter shall operate correctly.

Test requirements are as below:

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 switches, 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. This is to be verified at both the extreme values of the range.

4.4.2.4 *Limit range of operation*

Outside the extended operating range of supply voltage but within the limit range of operation and when the ambient temperature is within the specified operating range, the operational requirements given at **5.10.2.2** shall apply.

For testing, *see* **5.10.2**.

4.4.2.5 *Immunity to Earth/Phase Fault*

This test applies to three-phase four wire meters. During test under a simulated earth/phase fault condition in one/two of the three lines, all voltages are increased to 1.1 times the nominal voltages during 4 h. The neutral terminal of the meter under test is disconnected from the neutral terminal of the meter test equipment (MTE) and is connected to the MTE's line at which the earth/phase fault has to be simulated (*see* Annex L).

In this way, the two voltage elements of the meter under test which are not affected by the earth/phase fault are connected to 1.9 times the nominal phase voltages. During this test, the current circuits are set to 50 percent of the rated I_b, power factor 1 and symmetrical load. After the test, the meter shall show no damage and shall operate correctly.

The change of error measured when the meter is back at nominal working temperature shall not exceed the limits given in Table 8.

4.4.2.6 *Voltage dips and short interruptions*

Voltage dips and short interruptions shall not produce a change register of more than X units and the test output shall not produce a signal equivalent of more than X units. The value X is derived from the following formula:

$$X = 10^{-6} \times m \times V_{ref} \times I_{max}$$

where

m = number of measuring element;

V_{ref} = reference voltage, in volts; and

I_{max} = maximum current, in amperes.

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. Time keeping of the meter shall not drift by more than ± 2 s.

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.

For conduct of the test, refer **5.4.2**.

4.4.3 *Influence of Short-Time Overcurrents*

Short-time overcurrent shall not damage the meter and the switch shall remain operative. The meter shall perform correctly when back to its initial working conditions and the variation of error shall not exceed the values shown in Table 9. For testing, *see* **5.4.3**.

The meter shall be able to carry a short-time overcurrent of 30 I_{max} with a relative tolerance of +0 percent to -10 percent for one half-cycle at rated frequency. The load switch may open under the test conditions, but it should be possible to close it by simple manual operation on the meter by the user.

Table 8 Change of Error Due to Earth/Phase Fault

(*Clause* 4.4.2.5)

Sl No.	Value of Current	Power Factor	Limits of Variation in Percentage Error for Meters of Class	
			1.0	2.0
(1)	(2)	(3)	(4)	(5)
i)	I_b	1	0.7	1.0

Table 9 Variations Due to Short-Time Overcurrent

(*Clauses* 4.4.3)

Sl No.	Value of Current	Power Factor	Limit of Variation in Percentage Error for Meter of Class	
			1.0	2.0
(1)	(2)	(3)	(4)	(5)
i)	I_b	1	1.5	1.5

Short-time over currents shall not damage the load switch. After completion of short time over current, 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 functional and with the load switch closed.

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

4.4.4 *Influence of Self-Heating*

The variation of error due to self-heating shall not exceed the values given in Table 10.

The test shall be carried out as follows: after the voltage circuits have been energized at reference voltage for at least 2 h for Class 1 and 1 h for Class 2, without any current in the current circuits, the maximum current shall be applied to the current circuits. The meter error shall be measured at unity power factor immediately after the current is applied and then at intervals short enough to allow a correct drawing to be made of the curve of error variation as a function of time. The test shall be carried out for at least 1 h, and in any event until the variation of error during 20 min does not exceed 0.2 percent. Maximum test duration shall not be more than 2 hours.

The same test shall be carried out at 0.5 (lagging) power factor after a break of at least 2 hours. During this break, meter shall be in off condition The cable to be used for energizing the meter shall have a length of 1 m and a cross-section to ensure that the current density is between 3.2 A/mm^2 and 4 A/mm^2.

4.4.5 *Influence of Heating*

Under rated operating conditions, electrical circuits and insulation shall not reach a temperature, which might adversely affect the operation of the meter. The temperature rise at any point of the external surface of the meter shall not exceed 20 K with the ambient temperature at 25 °C to 45 °C.

The cable to be used for energizing the meter shall be insulated copper and shall have a length of 1 m ± 10 cm. It shall have a cross-section to ensure that the current density is between 3.2 A/mm^2 and 4 A/mm^2.

4.4.6 *Insulation*

The meter and its incorporated auxiliary devices including any tokens carrier 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 ac voltage test with a metallic token in the token acceptor or, if the token carrier cannot be retained, a suitable electrical connection to the token carrier interfaces. Such metallic tokens or electrical connections shall then be connected to the ground reference for the purposes of these tests. After these tests (*see* **5.4.6**), and when the payment meter has been restored to reference conditions, the payment meter shall operate correctly.

4.5 Electromagnetic Compatibility (EMC)

4.5.1 *General Test Conditions*

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.

4.5.2 *Immunity to Electromagnetic Disturbance*

Meters shall be designed in a way that prevents external electromagnetic phenomena from damaging the meter, corrupting the meter's registers or substantially influencing the result of measurements. For testing, *see* **5.5**.

NOTE — The disturbances to be considered are:

a) Electrostatic discharges,

b) Electromagnetic HF fields,

c) Fast transient burst, and

d) Surge immunity test.

4.5.3 *Radio Interference Suppression*

The meter shall not generate conducted or radiated noise, which could interfere with other equipment. For testing, *see* **5.5.5**.

4.6 Accuracy Requirements

4.6.1 *Limits of Error Due to Variation of the Current*

The requirements given in **5.6.1** shall apply, without a token inserted in any token acceptor fitted to the payment meter. If a token acceptor is fitted and a token can be retained in the payment meter then additional accuracy tests shall be carried out under reference conditions at V_{ref} and unity power factor, with balanced loads, and at both 0.05 I_b and I_{max}. The allowed limits of variation in percentage error compared to the same load point and no token present in the token 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.

Table 10 Variations Due to Self-Heating

(*Clauses* 4.4.4 *and* 5.4.4)

Sl No.	Value of Current	Power Factor	Limit of Variation in Percentage Error for Meter of Class	
			1.0	2.0
(1)	(2)	(3)	(4)	(5)
i)	I_{max}	1	0.7	1.0
ii)	I_{max}	0.5 inductive	1.0	1.5

When the meter is under the reference conditions given in **5.6.1**, the percentage errors shall not exceed the limits for the relevant accuracy class given in Tables 11 and 12.

Table 11 Percentage Error Limits
(Single-Phase Meters and Polyphase Meters with Balanced Loads)

(*Clauses* 4.6.1, 5.6.2, 5.6.5 *and* 5.6.6)

Sl No.	**Value of Current**	**Power Factor**	**Percentage Error Limits for Meters of Class (±)**	
			1.0	2.0
(1)	(2)	(3)	(4)	(5)
i)	$0.05\ I_b \leq I < 0.1\ I_b$	1	1.5	2.5
ii)	$0.1\ I_b \leq I \leq I_{max}$	1	1.0	2.0
iii)	$0.1\ I_b \leq I < 0.2\ I_b$	0.5 inductive	1.5	2.5
		0.8 capacitive	1.5	-
iv)	$0.2\ I_b \leq I \leq I_{max}$	0.5 inductive	1.0	2.0
		0.8 capacitive	1.0	-
v)	When specially requested by the user: from $0.2\ I_b \leq I \leq I_{max}$	0.25 inductive	3.5	-
		0.5 capacitive	2.5	-

Table 12 Percentage Error Limits (Polyphase Meters Carrying a Single-Phase Load, but with Balanced Polyphase Voltages Applied to Voltage Circuits)

(*Clauses* 4.6.1, 5.6.2, 5.6.6 *and* D-3.1)

Sl No.	**Value of Current**	**Power Factor**	**Percentage Error Limits for Meters of Class (±)**	
			1.0	2.0
(1)	(2)	(3)	(4)	(5)
i)	$0.1\ I_b \leq I \leq I_{max}$	1	2.0	3.0
ii)	$0.2\ I_b \leq I \leq I_{max}$	0.5 inductive	2.0	3.0

The difference between the percentage error when the meter is carrying a single-phase load and a balanced poly phase load at basic current and unity power factor shall not exceed 1.5 percent and 2.5 percent for meters of Classe 1 and Class 2 respectively.

NOTE — When testing for compliance with Table 11, the test current shall be applied to each element in sequence.

4.6.2 *Limits of Error Due to Other Influence Quantities*

The additional percentage error due to the change of influence quantities with respect to reference conditions, as given in **5.6.1** shall not exceed the limits for the relevant accuracy class given in Table 13.

Table 13 Influence Quantities

(*Clauses* 4.6.2, 5.5.3, 5.5.4 *and* 5.6.2, 5.6.2.4)

Sl No.	Influence Quantity	Value of Current (Balanced Unless otherwise Specified)	Power Factor	Limit of Variation in Percentage Error for Meter of Class	
				1.0	2.0
(1)	(2)	(3)	(4)	(5)	(6)
i)	Voltage variation ± 10 percent (*see* Note 1)	I_b	1	0.7	1.0
			0.5 inductive	1.0	1.5
ii)	Frequency variation ± 5 percent	I_b	1	0.5	0.8
			0.5 inductive	0.7	1.0
iii)	Wave form; 10 percent of 3rd harmonic in current (*see* Note 2)	I_b	1	0.6	0.8
iv)	Reverse phase sequence	$0.1I_b$	1	1.5	1.5
v)	Voltage unbalance (*see* Note 3)	I_b	1	1.5	1.5
vi)	Continuous magnetic induction of external origin 67 mT (*see* Note 4)	I_b	1	2.0	3.0
vii)	Continuous abnormal magnetic induction of external origin 0.2 T (*see* Note 4)	I_b	1	4.0	4.0
viii)	Magnetic induction of external origin 0.5 *mT* (*see* Note 4)	I_b	1	2.0	3.0
ix)	Abnormal a.c. Magnetic induction of external origin (10 mT) (*see* Note 4)	I_b	1	4.0	4.0
x)	Electromagnetic HF fields (*see* Note 5)	I_b	1	2.0	3.0
xi)	Fast-Transients burst test (*see* Note 5)	I_b	1	4.0	6.0
xii)	Operation of accessories (*see* Note 6)	$0.05\ I_b$	1	0.5	1.0
xiii)	d.c. and even harmonies in the a.c. current circuit (*see* Note 7)	$0.5I_b \leq I \leq I_{max}/\sqrt{2}$	1	3.0	6.0

NOTES

1 For the voltage ranges from –30 percent to –10 percent and + 10 percent to + 20 percent, the limits of variation in percentage errors are three times the values given in Table 13. Below 0.7 V_{ref}, the error of the meter may vary between +10 percent and –100 percent.

2 The distortion factor of the voltage shall be less than 1 percent. The variation in percentage error shall be measured under two conditions. The peak of third harmonic in first measurement in phase and in second measurement in anti-phase of the peaks of the fundamental current.

3 Polyphase meters with three measuring elements shall measure and register, within the limits of variation in percentage error shown in this table, if the following one or two phases of the 3-phase network are interrupted, provided the reference phase is available that is *Y*-phase for 3-phase 3-wire meters and neutral for 3-phase 4-wire meters. However, the operation of the meter shall not be affected by such removal of reference phase.

4 The test conditions are specified in **5.6.2.1** to **5.6.2.4**.

5 The test conditions are specified in **5.5.3** and **5.5.4**.

6 Such an accessory, when enclosed in the meter case, is energized intermittently, for example, the electromagnet of a multi rate register.

7 Test condition is specified in Annex K.

4.6.3 *Limits of Error due to Ambient Temperature Variation*

The mean temperature coefficient shall not exceed the limits given in Table 14.

The determination of the mean temperature coefficient for operating temperature range shall be made, but in no case, the temperature shall exceed the specified operating temperature range. The whole operating temperature range shall be divided into two subranges; - 10 ºC to reference temperature and reference temperature to 55 ºC.

The mean temperature coefficients of each subrange shall be measured individually by taking measurements at - 10 ºC, reference temperature and 55 ºC. Each of the mean temperature coefficient shall not exceed the limits given in Table 14.

4.6.4 *Starting and Running with No-Load*

For these tests, the conditions and the values of the influence quantities shall be as stated in **5.6.1** except for any changes specified below.

4.6.4.1 *Initial start-up of the meter*

The meter shall be functional within five seconds after the rated voltage is applied to meter terminals.

4.6.4.2 *Running with no-load*

When the voltage is applied with no current flowing in the current circuit, the test output of the meter shall not produce more than one pulse. For testing, *see* **5.6.3**.

4.6.4.3 *Starting*

The meter shall start and continue to register at the current shown in Table 15.

4.6.5 *Meter Constant*

The relation between the test output and the indication in the display shall comply with the marking on the nameplate.

Output devices generally may not produce homogeneous pulse sequences. Therefore, the manufacturer shall state the necessary number of pulses to ensure a measuring accuracy of at least 1/10th of the accuracy limits of the meter at different test points.

For testing, *see* **5.6.5.**

4.7 Requirement of Time Keeping

Refer Annex D for requirements and tests.

NOTE — For testing purpose, the resolution of time display shall be at least one second. Manufacturer may provide additional means (for example, software tool) to get better resolution.

Table 14 Temperature Coefficient

(*Clause* 4.6.3)

Sl No.	Value of Current	Power Factor	Mean Temperature Coefficient Percent/ºC for Meters of Class	
			1.0	2.0
(1)	(2)	(3)	(4)	(5)
i)	0.1 I_b to I_{max}	1	0.05	0.10
ii)	0.2 I_b to I_{max}	0.5 inductive	0.07	0.15

Table 15 Starting Current

(*Clause* 4.6.4.3)

Sl No.	Power Factor	Class of Meter	
		1.0	2.0
(1)	(2)	(3)	(4)
i)	1	0.004 I_b	0.005 I_b

4.8 Load Switching Capability

The payment meter load switching utilisation category (UC1 or UC2 or UC3) shall be subject to the purchase agreement between purchaser and supplier. However, category UC1 is applicable to payments meters rated at maximum currents up to 100 A.

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.

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 load switch 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 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 (V_c) shall be equal to the upper limit of the extended operating voltage range of the payment meter.

4.8.1 *Load Switching General Requirements*

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 **4.4.5**.

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, for example by pressing a pushbutton 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, for example, by pressing a pushbutton.

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. For testing, *see* **5.10**.

4.8.2 *Performance Requirements for Load Switching (Specific to Utilisation Category)*

4.8.2.1 *Utilisation category UC1*

The payment meter shall be capable of making and breaking currents for 3 000 contiguous make-and break operations at (V_c, I_c: tolerance 0 percent to - 5 percent) with a linear resistive load (power factor: 0.95 to 1), together with 3 000 contiguous make-and-break operations at V_c : tolerance 0 percent to - 5 percent, I_b ±5 percent, with power factor 0.5 (± 0.05) inductive. This test shall be done with actual load (not on phantom/virtual load).

Note that 1 operation is 1 make (for 10 sec) and 1 break (for 20 sec) and the total of 6 000 make-and-break operations must be met using a single specimen.

For the test, manufacturer shall provide special means (internal or external to the meter, for example, operation through communication port) by which the load switch can be operated (that is make and break) as per requirements of this test.

4.8.2.2 *Utilisation Category UC2 and UC3*

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

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.

5 TESTS AND TEST CONDITIONS

5.1 General Testing Procedures

5.1.1 *Test Conditions*

All tests are carried out under reference conditions unless otherwise stated in the relevant clause.

5.1.2 *Classification of Tests*

The schedule and recommended sequence shall be as given in Table 21 in Annex E. The accuracy of meter at reference conditions shall remain within accuracy class after completion of any type test, irrespective of the variation allowed during particular type test.

In case of modifications to the meter made after the type test and affecting only part of the meter, it will be sufficient to perform limited tests on the characteristics that may be affected by the modification.

5.1.3 *Type Tests, Number of Samples and Criteria for Conformity*

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 that 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,

5.1.3.1 *Number of samples*

All type tests shall be applied to samples as mentioned in Annex E. In case of one test sample failing to comply in any respect, further same nos. of samples (equivalent to 1st set) shall be taken, all of which shall comply with the requirements of standard.

5.1.4 *Schedule of Acceptance Test*

Required tests are marked with 'A' in Table 21 in Annex E. A recommended sampling plan and the criteria for acceptance of the lot are given in Annex G of IS 13779.

5.1.5 *Schedule of Routine Tests*

Required tests are marked with 'R' in Table 21 in Annex E.

5.2 Tests of Mechanical Requirements

5.2.1 *Spring Hammer Test*

The mechanical strength of the meter case shall be tested with a spring hammer (*refer* IS 9000 (Part 7/Sec 7).

The meter shall be mounted in its normal working position and the spring hammer shall act on the outer surfaces of the meter cover (including windows) and on the terminal cover with a kinetic energy of 0.22 Nm ± 0.05 Nm.

The result of this test is satisfactory if the meter case and terminal cover do not sustain damage which could affect the function of the meter and it is not possible to touch live parts. Slight damage which does not impair the protection against indirect contact or the penetration of solid objects, dust and water is acceptable.

5.2.2 *Shock Test*

The meter shall be subjected to shock test by method specified in IS 9000 (Part 7/Sec 1) to shocks as described below:

a) Meter in non-operating condition, without the packing
b) Peak acceleration : 400 m/s^2 (40 *g*)
c) Pulse shape : Half sine wave
d) Duration of the pulse : 18 ms
e) Number of shocks : Two in both directions of three mutual perpendiculars axes (total of 12 shocks).

After conclusion of test, the meter shall show no damage, no change of kWh reading, no change in credit balance and the variation of meter error shall not exceed 50 percent of accuracy class index at basic current, 5 percent basic current and maximum current at cos φ = 1 and shall satisfy the limits of error. Immediately after this test, a valid token shall be accepted.

5.2.3 *Vibration Test*

The meter shall be subjected by the method specified in IS/IEC 60068-2-6 to vibration as detailed below:

a) Meter in non-operative condition, without the packing;
b) Frequency range : 10 Hz to 150 Hz;
c) Transition frequency : 60 Hz ± 3Hz,
    1) Below transition frequency, constant amplitude of movement : 0.15 mm
    2) Above transition frequency, constant acceleration : 2 g (1g = 9.8m/s^2)
d) Single point control; and
e) Number of sweep cycles per axis : 10.

NOTE — 10 sweep cycles = 75 min.

After conclusion of test, the meter shall show no damage, no change of kWh reading, no change in credit balance and the variation of meter error shall not exceed 50 percent of accuracy class index at basic current, 5 percent basic current and maximum current at cos ø = 1 and shall satisfy the limits of error. Immediately after this test, a valid token shall be accepted.

5.2.4 *Test of Resistance to Heat and Fire*

The test shall be carried out according to IS 11000 (Part 2/Sec 1), with the following temperatures:

a) Terminal block and insulating material retaining the main contacts of the load switch: 960 °C ± 15 °C;
b) Terminal cover and meter case: 650 °C ± 10 °C; and
c) Duration of application: 30 s ± 1 s.

The contact with the glow wire may occur at any random location. If the terminal block is integral with the meter base, it is sufficient to carry out the test only on the terminal block.

5.2.5 *Tests of Protection against Penetration of Dust and Water*

The tests shall be carried out according to IS/IEC 60529 under the following conditions:

a) Protection against penetration of dust:
   1) Meter in non-operating condition and mounted on an artificial wall;
   2) The test should be conducted with sample lengths of cable (exposed ends sealed) of the types specified by the manufacturer in place;
   3) 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;
   4) First characteristic digit: 5 (IP5X). Any ingress of dust shall be only in a quantity not impairing the operation of the meter and its token acceptor and its dielectric strength (insulating strength).
   For testing, *see* **5.4.6.4**.
b) *Protection against penetration of water*
   1) Meter in non-operating condition; and
   2) Second characteristic digit: 1 (IPX1). Any ingress of dust shall be only in a quantity not impairing the operation of the meter and its token acceptor and its dielectric strength (insulating strength).

   For testing, *see* **5.4.6.4.**

Immediately after the IP51 tests without disturbing the meter, the prepayment meter shall operate correctly and a valid token shall be accepted on the first or subsequent presentations up to a maximum of four attempts.

5.3 Tests of Climatic Influences

After each of the climatic tests, the meter shall show no damage, no change in kWh reading, no change in credit balance and shall operate correctly. After each of these tests, valid token shall be accepted by the meter.

5.3.1 *Dry Heat Test*

The test shall be carried out according to IS 9000 (Part 3/ Sec 1 to 5), under the following conditions:

a) Meter in non-operating condition;
b) Temperature: + 70 °C ± 2 °C; and
c) Duration of the test: 72 h.

5.3.2 *Cold Test*

The test shall be carried out according to IS/IEC 60068-2-1, under the following conditions:

a) Meter in non-operating condition;
b) Temperature: – 25 °C ± 3 °C; and
c) Duration of the test: 72 h.

5.3.3 *Damp Heat Cyclic Test*

a) The test shall be carried out according to IS 9000 (Part 5/Sec 1 and 2), under the following conditions:
   1) Voltage and auxiliary circuits energized with reference voltage;
   2) Without any current in the current circuits;
   3) Variant 1
   4) Upper temperature: + 40 °C ± 2 °C for indoor meters;
   5) No special precautions to be taken regarding the removal of surface moisture; and
   6) Duration of the test: 6 cycles.
b) 24 h after the end of this test, the meter shall be submitted to the following tests:
   1) Insulation resistance test, *see* **5.4.6.4**; and
   2) A functional test. The meter shall show no damage or no change in kWh and shall operate correctly. Valid tokens should accept normally.

c) The damp heat test also serves as a corrosion test. The result is judged visually. No trace of corrosion likely to affect the functional properties of the meter shall be apparent.

5.4 Tests of Electrical Requirements

5.4.1 *Test of Power Consumption*

The power consumption in the voltage and current circuit shall be determined at reference values of the influence quantities given in **5.6.1** by any suitable method. The overall accuracy shall be better than 5 percent.

5.4.1.1 *Test of power consumption of voltage circuit*

For requirements, *see* **4.4.1.1**.

5.4.1.2 *Test of power consumption of current circuit*

For requirements, *see* **4.4.1.2**.

5.4.2 *Test of influence of voltage dips and interruptions*

For requirements, refer **4.4.2.6**

a) The test shall be carried out under the following conditions:
   1) Voltage and auxiliary circuits energized with reference voltage; and
   2) Without any current in the current circuits
b) Voltage interruptions of V_{ref} = 100 percent:
   1) Interruption time: 1 s;
   2) Number of interruptions: 3; and
   3) Restoring time between interruptions: 50 ms (*see also* Fig. 6 in Annex H).
c) Voltage interruptions of V_{ref} = 100 percent:
   1) Interruption time: 20 ms; and
   2) Number of interruptions: 1 (*see also* Fig. 7 in Annex H).
d) Voltage interruptions of V_{ref} = 50 percent:
   1) Dip time: 1 min; and
   2) Number of dips: 1 (*see also* Fig. 8 in Annex H).
e) Voltage dips and short interruptions shall not produce a change in register of more than x kWh and the test output shall not produce a signal equivalent of more than x kWh. The value x is derived from the following formula:

$$x = 10^{-6} \times m \times V_{ref} \times I_{max}$$

where

m = number of measuring element;

V_{ref} = reference voltage in volts; and

I_{max} = maximum current in amperes.

f) There shall be no change in the currency registers; and
g) Test shall not cause change in timekeeping discrepancy by more than ± 2 s.

5.4.3 *Test of Influence of Short-Time Overcurrent*

The test circuit shall be practically non-inductive.

After the application of the short-time overcurrent with the voltage maintained at the terminals, the meter shall be allowed to return to the initial temperature with the voltage circuit(s) energized (about 1 h).

For requirements, *see* **4.4.3**.

5.4.4 *Test of Influence of Self-Heating*

For test, refer **4.4.4**.

The variation of error, measured as specified, shall not exceed the value given in Table 10 (*see also* **4.4.4**).

5.4.5 *Test of Influence of Heating*

With each current of the meter carrying maximum current and with each voltage circuit (and with those auxiliary voltage circuits which are energized for periods of longer duration than their thermal time constants) carrying 1.15 times the reference voltage, the temperature rise of the external surface shall not exceed 20 °C, with an ambient temperature of 20 °C to 35 °C and RH 45 percent to 95 percent.

During the test, the duration of which shall be 2 h, the meter shall not be exposed to draught or direct solar radiation.

After the test, the meter shall show no damage and shall comply with the dielectric strength test of **5.4.6.4**.

5.4.6 *Tests of Insulation Properties*

5.4.6.1 *General test conditions*

The meter and its incorporated auxiliary devices including any tokens that may be inserted into the token acceptor shall be designed such that they retain adequate dielectric qualities under normal conditions of use. Where a token 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 acceptor or, if the token cannot be retained, a suitable electrical connection to the token 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.

The tests shall be carried out only on a complete meter, with its cover (except when indicated hereafter) and terminal cover, the terminal screws being screwed down to the maximum applicable conductor fitted in the terminals. Test procedure shall be in accordance with IS 2071 (Part 1).

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

During type tests, the dielectric strength tests are considered to be valid only for the terminal arrangement of the meter, which has undergone the tests. When the terminal arrangements differ, all the dielectric strength tests shall be carried out for each arrangement.

For the purpose of these tests, the term earth has the following meaning:

a) When the meter case is made of metal, the ‘earth’ is the case itself, placed on a flat conducting surface;
b) When the meter case or only a part of it is made of insulating material, the “earth” is a conductive foil wrapped around the meter and connected to the flat conducting surface on which the meter base is placed. Where the terminal cover makes it possible, the conductive foil shall approach the terminals and the holes for the conductors within a distance of not more than 2 cm; and
c) In case of meters with apertures for token acceptors, a metal token inserted into the token acceptor shall be construed as earth.

During the impulse and the a.c. voltage tests, the circuits, which are not under test, are connected to the earth as indicated hereafter.

No puncture or partial breakdown of solid insulation shall occur; however, a flashover (capacitance discharge) during impulse voltage test is not necessarily a criterion of failure if it occurs in a position that does not damage the meter.

After these tests, percentage errors of the meter shall be within class of accuracy.

In this clause, the expression ‘all the terminals’ means the whole set of terminals of the current circuits, voltage circuits and, if any, auxiliary circuits having a reference voltage over 40 V.

These tests shall be made in normal conditions of use. During the test, the quality of the insulation shall not be impaired by dust or abnormal humidity.

Unless otherwise specified, the normal conditions for insulation tests are:

a) Ambient temperature: 20 °C to 35 °C;
b) Relative humidity: 45 percent to 95 percent RH; and
c) Atmospheric pressure: 86 kPa to106 kPa.

The requirement of the impulse voltage test shall also be met (*see* **5.4.6.2**). For the purpose of these requirements, metallic objects of the same size and shape as the token carrier are inserted into the token carrier acceptor. This metallic token shall be considered to represent an auxiliary circuit with a reference voltage below or equal to 40 V.

5.4.6.2 *Impulse voltage test*

The impulse of 6 kV is applied ten times with one polarity and then repeated with the other polarity. The minimum time between the impulses shall be 3 s. The waveform and the generator characteristics shall be in accordance with IS 2071 (Part 1) with source impedance 500 ohm ± 50 ohm and source energy 0.5 J ± 0.05 J.

a) Impulse voltage tests for circuits and between the circuits — The test shall be made independently on each circuit (or assembly of circuits) which is insulated from the other circuits of the meter in normal use. The terminals of the circuits, which are not subjected to impulse voltage, shall be connected to earth.

Thus, when the voltage and the current circuits of a measuring element are connected together in normal use the test shall be made on the whole. The other end of the voltage circuit shall be connected to earth and the impulse voltage shall be applied between the terminal of the current circuit and earth. When several voltage circuits of a meter have a common point, this point shall be connected to earth and the impulse voltage successively applied between each of the free ends of the connections (or the current circuit connected to it) and earth.

The auxiliary circuits intended to be connected either directly to the mains or to the same voltage transformers as the meter circuits, and with a reference voltage over 40 V, shall be subjected to the impulse voltage test in the same conditions as those already given for voltage circuits. The other auxiliary circuits shall not be tested.

a) Impulse voltage test of electric circuits relative to earth — All the terminals of the electric circuits of the meter, including those of the auxiliary circuits with a reference voltage over 40V, shall be connected together.

The auxiliary circuits with a reference voltage below or equal to 40 V shall be connected to earth. In case of prepayment electricity meter with token acceptor a metallic part need to connect to earth shall be inserted into the aperture. The impulse voltage shall be applied between all the electric circuits and earth.

5.4.6.3 *a.c. voltage test*

The a.c. voltage test shall be carried out in accordance with Table 16.

The test voltage shall be substantially sinusoidal, having a frequency between 45 Hz and 55 Hz, and applied for one minute for type test and acceptance test. The test duration for routine test shall be minimum 5 s. The power source shall be capable of supplying at least 500 VA.

During the tests relative to earth, the auxiliary circuits with reference voltage equal to or below 40 V shall be connected to earth. In case of prepayment meter with token acceptor a metallic part need to connect to earth shall be inserted into the aperture.

5.4.6.4 *Insulation resistance test*

The insulation resistance test shall be carried out in accordance with Table 17. The voltage shall be applied for a minimum of one minute (for type test and acceptance test) or more for the pointer of the insulation tester to have come practically to rest. The insulation resistance test duration for routine test shall be minimum 5 s.

Table 16 a.c. Voltage Tests

(*Clause* 5.4.6.3)

SI No.	**Test Voltage (rms)**	**Points of Application of the Test Voltage**
(1)	(2)	(3)
i)		Test of meter with single insulation Test to be carried out with the case closed, cover and terminal cover in place
	2 kV	a) Between, on the one hand, all the current and voltage circuits as well as the auxiliary circuits whose reference voltage is over 40 V, connected together, and, on the other hand, earth b) Between circuits not intended to be connected together in service
ii)		Test of meter with double insulation (for insulating encased meters) Test to be carried out with the case closed, cover and terminal cover in place
	4 kV	a) Between, on the one hand, all the current and voltage circuits as well as the auxiliary circuits whose reference voltage is over 40 V, connected together, and, on the other hand, earth
	2 kV	b) Between circuits not intended to be connected together in service
	-	c) A visual inspection for compliance with the conditions of **4.2.7**.
	40 V (for test in item d), if applicable	d) Between on the one hand, all conductive parts inside the meter, connected together and, on the other hand, all conductive parts outside the meter case that are accessible with the test finger connected together

Table 17 Insulation Resistance test

(*Clause* 5.4.6.4)

Sl No.	Test Voltage	Point of Application of the Test Voltage	Insulation Resistance
(1)	(2)	(3)	(4)
i)	500 V dc ± 50 V dc	a) Between, on the one hand, all the current and voltage circuit as well as auxiliary circuits whose reference voltage is over 40 V, connected together, and, on the other hand, earth	5 MΩ
		b) between circuit not intended to be connected together in service	50 MΩ

NOTE — Where two or more voltage circuits are permanently joined together, the combination may be treated as one circuit for this test.

5.5 Tests for Electromagnetic Compatibility (EMC)

5.5.1 *General Test Conditions*

For all these tests, the meter shall be in its normal working position with the cover and terminal covers in place, unless otherwise specified. All parts intended to be earthed shall be earthed.

After the application of EMC testing, the payment meter shall recover any temporary degradation within a period of 1 min, without any external intervention. After these tests, the meter shall show no damage and operate correctly.

The payment meter shall be designed in such a way that the electromagnetic disturbances 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, without any temporary loss of function. Any test shall not cause change in timekeeping discrepancy by more than ± 2 s.

5.5.2 *Test of Immunity to Electrostatic Discharges*

The test shall be carried out according to IS 14700 (Part 4/Sec 2), under the following conditions:

Tested as table top equipment.

The meter shall be in operating condition:

a) Voltage circuits and auxiliary power supply circuits energized with reference voltages; and switch in close position; and
b) Without any current in the current circuits and the current terminals shall be open circuit.

5.5.2.1 *Contact discharge* (*for exposed conductive parts*)

a) Direct Discharge — The test voltage of 8 kV shall be applied to metallic parts accessible in normal operation.

   Number of discharges = 10 (in both the polarity)

b) Indirect Discharge — The test voltage of 8 kV shall be applied to both vertical and horizontal coupling planes in contact mode. In both vertical and horizontal plane, all faces of meter shall be exposed to the discharge.

   Number of discharges = 10 (in both the polarity)

5.5.2.2 *Air discharge*

a) Direct Discharge — The test voltage of 15 kV shall be applied to non-metallic parts accessible in normal operation.

   Number of discharges = 10 (in both the polarity)

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 acceptor where such a token can be retained in the meter.

Electrostatic discharge shall not produce a change register of more than x kWh and the test output shall not produce a signal equivalent of more than x kWh. Valid token shall be accepted. There shall be no change in credit balance.

The value x is derived from the following formula:

$$x = 10^{-6} \times m \times V_{ref} \times I_{max}$$

where

m = number of measuring element,

V_{ref} = reference voltage in volts, and

I_{max} = maximum current in amperes.

After application of the electrostatic discharge the meter shall show no damage, no change in kWh reading, no change in credit balance and shall stay within the accuracy requirements of this standard. Valid token shall be accepted.

5.5.3 *Test of Immunity to Electromagnetic HF Fields*

The test shall be carried out according to IS 14700 (Part 4/Sec 3) under the following conditions:

a) Voltage and auxiliary circuit energized with basic voltage,
b) Frequency band: 80 MHz to 2 000 MHz,
c) Sweep of frequency steps of 1 percent logarithm,
d) Test field strength: 10 V/m.
   1) Without any current in the current circuit and current terminal shall be open circuit. Switch in closed position.

   The application of the RF field shall not produce change in register of more than x kWh and the test output shall not produce a signal equivalent of more than x kWh. The value x is derived from the following formula:

$$x = 10^{-6} \times m \times V_{ref} \times I_{max}$$

   where

   m = number of measuring element,

   V_{ref} = reference voltage in volts, and

   I_{max} = maximum current in amperes.

   2) With basic current I_b and power factor equal to unity, the variation of error shall be within the limit given in Table 13 for all frequency steps.

5.5.4 *Fast Transient Burst Test*

The test shall be carried out according to IS 14700 (Part 4/Sec 4) under the following conditions:

a) Tested as Table top equipment;
b) Meter in operating condition:
   1) Voltage and auxiliary circuits energised with reference voltage; and
   2) With basic current in current power factor unity.
c) Cable length between coupling device and EUT: 1 m;
d) The test voltage shall be applied in common mode (line to earth) to:
   1) The voltage circuit;
   2) The current circuits, if separated from voltage circuit; and
   3) Auxiliary circuits if separated from voltage circuit in normal operation.
e) Test voltage on current and voltage circuit: 4 kV;
f) Test voltage on auxiliary circuits with a reference voltage above 40 V: 2 kV; and
g) Duration of test: 60 s at each polarity.

The test shall be carried out first with the load switch closed and limits of variation in percentage error as given in Table 13.

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.

5.5.5 *Radio Interference Measurement*

5.5.5.1 *For meters to be used without any wireless communication feature*

The test for radio interference shall be carried out as per IS 6873 (Part 2/Sec 1). The input to be applied to meter during test is reference voltage, load current between 0.1 I_b to I_b at UPF.

a) Test for conducted emission for the frequency range 0.15 MHz to 30 MHz — The test shall be carried out on mains port as per **4.3.3** of IS 6873 (Part 2/Sec 1). For mains ports, the limits specified in col (2) and col (3) of Table 5 of IS 6873 (Part 2/Sec 1) apply.
b) Test for radiated emission for frequency range 30 MHz to 300 MHz — The test shall be carried out as per **5.3.3** or **5.3.4** of IS 6873 (Part 2/Sec 1). The limits specified in col (2) and col (3) of Table 7 or of Table 9 respectively, of IS 6873 (Part 2/ Sec 1) apply.

5.5.5.2 *For meters having or to be used with wireless communication feature*

The test for radio interference shall be carried out for the frequencies as per IS/CISPR 32. The input to be applied to meter during test is reference voltage, load current between 0.1 I_b to I_b (any one value) at UPF. The meter shall be tested as table top equipment and shall meet class B equipment requirements of IS/CISPR 32.

5.5.6 *Surge Immunity Test*

The test shall be carried out according to IS 14700 (Part 4/Sec 5), under the following conditions with meter in operating condition:

a) Voltage and auxiliary circuits energized with reference voltage;
b) Without any current in the current circuits and the current terminals shall be open circuit;
c) Cable length between surge generator and meter: 1 m;
d) Tested in differential mode (line to line);
e) Phase angle: Pulses to be applied at 60° and 240° relative to zero crossing of a.c. supply;
f) For meter of UC1 category - Test voltage on the current and voltage circuits (mains lines): 4 kV, Generator source impedance: 2 ohms;
For meter of UC2 and UC3 category- Test voltage on the current and voltage circuits (mains lines): 6 kV, Generator source impedance: 2 ohms;
g) Test voltage on auxiliary circuits with a reference voltage over 40 V: 1 kV;
h) Generator source impedance: 42 ohms;
j) Number of tests: 5 positive and 5 negative; and
k) Repetition rate: maximum 1/min.

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

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

The application of the surge shall not produce change in register of more than *x* kWh and the test output shall not produce a signal equivalent of more than *x* kWh. The value *x* is derived from the following:

Formula:

$$x = 10^{-6} \times m \times V_{ref} \times I_{max}$$

where

m = number of measuring element,
V_{ref} = reference voltage in volts, and
I_{max} = maximum current in amperes.

During the test, a temporary degradation or loss of function or performance is acceptable.

5.6 Tests of Accuracy Requirements

5.6.1 *General Test Conditions*

Determination of meter errors for the purpose of verification of accuracy requirement (*see* **4.6**) and variation of such errors for the purpose of other requirements shall be carried out in a meter testing station having Meter Testing Equipment of relevant accuracy class as laid down in IS 12346.

The following test conditions shall be maintained:

a) The meter shall be tested in its case with cover in position; all parts intended to be earthed shall be earthed;
b) Before any tests are made, the circuits shall have been energized for a time to reach thermal stability;
c) In addition, for polyphase meters:
   1) The phase sequence shall be as marked on the diagram of connections; and
   2) The voltages and currents shall be substantially balanced (*see* Table 18 and Table 19).
   d) The minimum test period at any test point shall contain sufficient number of power cycles (Not than 20 seconds) to take care instantaneous power variation within a cycle. The maximum test period is however determined by homogeneity and resolution of test output (*see* **4.2.10.7**); and
   e) The reference condition shall be as specified in Table 18 and Table 19.

Table 18 Voltage and Current Balance

(*Clause* 5.6.1)

Sl No.	Polyphase meters	Class 1	Class 2
(1)	(2)	(3)	(4)
i)	Each of the voltages between line and neutral or between any two lines shall not differ from the average corresponding voltage by more than	± 1 percent	± 1 percent
ii)	Each of the currents in the current circuits shall not differ from the average current by more than	± 2 percent	± 2 percent
iii)	The phase displacements of each of these currents from the corresponding line-to-neutral voltage, irrespective of the power factor, shall not differ from each other by more than	±2°	±2°

5.6.2 *Test of Influence Quantities*

It shall be verified that the influence quantity requirements as fixed under **4.6.1** and **4.6.2** are satisfied.

Tests for variation caused by influence quantities should be performed independently with all other influence quantities at their reference conditions (*see* Table 19).

Table 19 Reference Conditions

(*Clauses* 5.6.1 *and* 5.6.2)

Sl No.	Influence Quantity	Reference Value	Permissible Tolerance for Meters of Class	
			1.0	**2.0**
(1)	(2)	(3)	(4)	(5)
i)	Ambient temperature (*see* note 1)	Reference temperature or, in its absence, 27 °C	± 2 °C [for **4.6.1**, Table 11 and Table 12, for (i) to (ix) of Table 13] ± 5 °C (for all other tests)	± 2 °C [for **4.6.1**, Table 11 and Table 12, for (i) to (ix) of Table 13] ± 5 °C (for all other tests)
ii)	Voltage	Reference voltage	± 1.0 percent	± 1.0 percent
iii)	Frequency	Reference frequency	± 0.3 percent	± 0.5 percent
iv)	Wave-form	Sinusoidal voltages and currents	Distortion factor less than: 2 percent	Distortion factor less than: 3 percent
v)	Magnetic induction of external origin at the reference frequency	Magnetic Induction of external origin	Magnetic induction equal to zero ±	± 0.05 mT

NOTES

1 If the tests are made at a temperature other than the reference temperature, including permissible tolerances, the results shall be corrected by applying the appropriate temperature coefficient of the meter.
2 The reference conditions apply to both measuring and auxiliary supply.
3 This magnetic induction is that at the place of test without the presence of the meter and its connections.

5.6.2.1 *Continuous magnetic induction of external origin 67 mT*

The continuous magnetic induction of 67 mT ± 5 percent shall be obtained at a distance of 5 mm from the surface of the pole by using the electromagnet according to Annex J, energized with a dc current. This magnetic field shall be applied to all accessible surfaces of the meter. The value of the magnetomotive force applied shall be 1 000 AT (ampere-turns).

5.6.2.2 *Continuous magnetic induction of external origin* 0.2 T

D.C. magnetic field of 0.2 tesla ± 5 percent may be obtained at a distance of 0.5 cm from the surface of the pole, by using the electromagnet according to Annex J, energized with a dc current. The value of the magneto-motive force to be applied shall be generally 10 000 ampere-turns. However, considering the non-linearity of magnetization of the core, the ampere-turns might require slight adjustment to achieve the desired output. This magnetic field shall be applied to all surfaces of the meter when it is mounted as for normal use. The influence of abnormal magnetic fields shall not cause the meter to run slower than 4 percent in comparison to normal condition.

NOTE — In the event of logging of abnormal magnetic induction with date and time, the positive variation may be beyond the limit of 4 percent, but not exceeding a power value equivalent to product of rated voltage and maximum current.

5.6.2.3 *Magnetic induction of external origin* 0.5 mT

Magnetic induction of external origin of 0.5 mT produced by a current of the same frequency as that of the voltage applied to the meter and under the most unfavourable conditions of phase and direction shall not cause a variation in the percentage error of the meter exceeding the values shown in this table. The magnetic induction shall be obtained by placing the meter in the centre of a circular coil, 1 m in mean diameter, of square section and of small radial thickness relative to the diameter, and having 400 AT.

5.6.2.4 *Magnetic induction of external origin* 10 mT

A.C. magnetic induction of 10 mT produced by a current of the same frequency as that of the voltage applied to the meter and under most unfavourable conditions of phase and direction shall not cause a variation in the percentage error of the meter exceeding the values shown in the Table 13.

A.C. magnetic induction shall be obtained in a circular coil and the meter shall be placed in various orientation in the center of a circular coil (O.D.: 400 mm, I.D.: 320 mm, depth: 45 mm, Ampere-turns: 2 800, 10 SWG Copper wire) produce magnetic induction of 10 ± 10 percent milli-Tesla in the central region (covering an area of half the diameter of either of the coil surface. The influence of abnormal magnetic fields shall not cause the meter to run slower than 4 percent in comparison to normal condition.

NOTE — In the event of logging of abnormal magnetic induction with date and time, the positive variation may be beyond the limit of 4 percent, but not exceeding a power value equivalent to product of rated voltage and maximum current.

5.6.3 *Test of No-Load Condition*

For this test, the current circuit must be open circuit and a voltage of 115 percent of the marked voltage shall be applied to the voltage circuits.

The minimum test period Δt shall be

$$\Delta t = (600 \text{ x}10^{6})/ (k_m U_n I_{max}) \pm 2 \text{ min for meters of class 1}$$

$$\Delta t = (480 \text{ x}10^{6})/ (k_m U_n I_{max}) \pm 2 \text{ min for meters of class 2}$$

where

- k is the number of pulses emitted by the output device of the meter per kilowatt hour (imp/kWh);
- m is the number of measuring elements;
- U_n is the reference voltage in volts; and
- I_{max} is the maximum current in amperes.

During this test, the test output device of the meter shall not emit more than one pulse.

5.6.4 *Test of Starting Condition*

It shall be verified that the starting requirements as fixed under **4.6.4.3** are satisfied.

5.6.5 *Test of Meter Constant*

It shall be verified that the relation between the test output and the indication on the display complies with the marking on the nameplate.

Meter constant is relation between the test output and the energy recorded by the meter. This shall be verified by comparing actual energy register increment with number of pulses output by meter by suitable means. Meter shall have correct meter constant as declared by the manufacturer. The allowed error in meter constant shall not be more than 0.10 percent for class 1 meter and 0.20 percent for class 2 meter.

Registration error shall also be verified by comparing the energy recorded by the meter against the energy recorded by reference standard. This is to verify the accuracy of registration of energy by the meter. Registration error shall not be more than the class of accuracy.

The test shall preferably be carried out at Imax, reference voltage and UPF.

Although this verification is not required for meters having test output in the form of high resolution register, a long period registration test shall be performed at this test point to verify conformity of registration error, as indicated by the display of the meter and as distinct from any other external display used for testing purpose within the limits specified in Table 11.

5.6.6 *Interpretation of Test Results*

During type tests, certain test results may fall outside the limits indicated in Table 11 and Table 12, owing to uncertainties of measurements and other parameters capable of influencing the measurements. However, if by one displacement of the zero line parallel to itself by no more than the limits indicated in Table 20, all the test results are brought within the limits indicated in Table 11 and Table 12, the meter type shall be considered acceptable.

Table 20 Interpretation of Test Results

(*Clause* 5.6.6)

Sl No.	Condition of Acceptability	Class of Meter	
		1	2
(1)	(2)	(3)	(4)
i)	Permissible displacement of the zero (percent)	0.5	1.0

5.6.7 *Repeatability of Error Test*

Test shall be carried out at 0.05 I_b, I_b at UPF load under reference test conditions. Six error samples shall be taken by keeping a gap of time-intervals of 5 minutes between each sample. Identical test condition shall be maintained throughout the test. For error test duration, refer **4.2.10.7**.

Repeatability of error (difference between maximum error and minimum error) shall not exceed 0.5 percent for class 1.0, 1 percent for class 2 meters.

5.7 Test of the Load Switch operation for payment function

The meter accounting process may be 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 register. Time-based charges such as standing charges also decrement the available credit register 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

5.8 Test of Charging Functions

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.

5.8.1 *Test of Consumption Based Charging Functions*

Where application-specific non-interruption periods or emergency credit facilities are incorporated in a payment meter they shall be disabled before carrying out the following test. The consumption-based charge function shall 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 shall be set. Where the payment meter includes time-based charging functions they shall be disabled for this test. Sufficient available credit shall be provided and noted, and then maximum load shall be applied to the payment meter for the necessary period of time. The advance of the cumulative kWh register shall correspond to the deduction of available credit that has then taken place. Where the payment meter operates in monetary units the test shall 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 shall be repeated for each rate of the kWh registers.

NOTE — For the purpose of this test, the chosen values of tariff rate and credit values shall be capable of a result with resolution less than one percent.

5.8.2 *Test of Time Based Charging Functions*

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.

5.9 Interruption and Restoration of the Load for Emergency Credit Facility (if applicable)

With a suitable tariff rate per kilowatt, the payment meter shall be credited with one currency units or energy credit unit and shall be run on a suitable load until the switch opens. The difference in the energy display before and after the test shall be recorded.

NOTE — For the purpose of this test, the chosen values of tariff rate and credit value shall be capable of resolving the result to at least one percent.

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, for example by pressing a push-button or by manually presenting a further credit token.

5.10 Tests of the Load Switch operation at Different Voltages and Temperature

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. 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.

5.10.1 *Test within Specified and Extended Operating Voltage Range*

Following test is repeated at each of the test conditions as specified in Table 21:

a) Readings of the cumulative kWh register and available credit value are then recorded. The supply voltage is then removed;

b) The meter is brought to the temperature and the temperature is allowed to stabilize. The 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;

c) 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;

d) 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; and

e) A load of I_{max} and unity power factor is then applied so that the available credit reduces and eventually the load switch shall open 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.

Table 21 Test Conditions

(*Clause* 5.10.1)

Sl No.	Test Conditions number	Temperature (ºC)	Voltage (V)	Current (A)
(1)	(2)	(3)	(4)	(5)
i)	1	- 10	1.2 V_{ref}	I_{max}
ii)	2	- 10	0.7 V_{ref}	I_{max}
iii)	3	55	1.2 V_{ref}	I_{max}
iv)	4	55	0.7 V_{ref}	I_{max}

5.10.2 *Test within Limit Range of Operation*

5.10.2.1 *Effect of voltage variation*

The requirements for payment meter operation outside the extended operating range of supply voltage but within the limit range of operation (that is from 0.0 to 0.8 V_{ref}) are given in this clause. The following tests should be carried out under reference conditions, with the supply voltage to the payment meter varying between zero and 0.8 V_{ref}. 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 no 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;

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 percent of V_{ref} per second with no load current, dwelling at each of the following levels for 60 s: 20 percent V_{ref} 40 percent $V_{ref,}$ 60 percent $V_{ref,}$ 80 percent V_{ref}. While at 80 percent V_{ref} it should be verified that the load switch is in the correct position;

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

e) After 10 s at zero voltage, a supply voltage of 0.8 V_{ref} 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 switch shall remain in closed position and shall not change due to change in voltage. 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 10s at zero voltage, a supply voltage of 0.8 V_{ref} 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.

5.10.2.2 *Effect of temperature*

Meter shall be powered at 50 percent of reference voltage for 30 minutes at both extremes of specified operating temperature range. Immediately after completion of 30 min with applied voltage kept at 50 percent reference voltage, 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–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.

Correct operation of all aspects of the payment meter shall resume when the supply voltage has returned to within the extended operating range. The status of all registers, values, and parameters associated with the meter accounting process and timekeeping shall continue to be valid and free of corruption.

However, where the meter is fitted with a real-time clock for tariff purposes and the supply voltage is below 0.8 V_{ref} for a time period longer than the operational reserve, then it is permissible that the time may need to be reset. There is no test specified for this requirement.

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.

6 FUNCTIONAL REQUIREMENTS

6.1 General

The general requirements for operation of payment meter functionality over the temperature ranges and voltage ranges are given in **4.3.2** and **4.4.2.1** and their sub-clauses.

When testing payment meters under **4** and **5** (including any sub-clauses) 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. **6.2** 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 sub-clauses) 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 **A-2** and **A-3** (including any sub-clauses). 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.

6.2 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 **4** and **5** (including any sub-clauses):

a) 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 and the modes that are active. 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:

b) There are no changes in any energy-based rate setting;

c) There are no changes in any time-based charge or credit setting;

d) Any changes in credit and debt values are exactly accounted for by energy measured by the meter during the test × the value of the active energy-based rate setting and: duration of time recorded by the meter × 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;

e) There are no changes to any active modes in the meter;

f) The meter’s display is functioning correctly;

g) 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; and

h) 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.

NOTES

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

2 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.

ANNEX A

(*Clause* 6.1)

FUNCTIONAL PERFORMANCE

(*Informative*)

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 standard. 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 sub-clauses).

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 V_{ref}, I_{max}, and unity power factor.

Where 'minimum meter load' is stated, this should be taken as balanced at V_{ref}, 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).

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 (*see* **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 **4** and **5** (including any sub-clauses).

NOTES

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.

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 that is 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.

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 (*see* **A-2** and its sub-clauses).

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 (for example 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 is 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, for example 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.

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. *See* **A-1.3** for testing.

NOTE — *See* **5.4.2** 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 for lower and upper limits of the specified operating temperature range and lower and upper limits of the extended operating voltage range.

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

a) Lower temperature limit + lower voltage limit;
b) Lower temperature limit + upper voltage limit;
c) Upper temperature limit + lower voltage limit; and
d) 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 cooled to the lower temperature limit and the temperature is allowed to stabilise. The lower supply 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; and

j) 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 (that is from 0.0 to 0.8 V_{ref}) are given in **4.4.2.4**. The following tests should be carried out under reference conditions, with the supply voltage to the payment meter varying between zero and 0.8 V_{ref}. 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 no 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 **5.10.2.2** 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 percent of V_{ref} per second with no load current, dwelling at each of the following levels for 60 s: 20 percent V_{ref} 40 percent V_{ref}, 60 percent V_{ref}, 80 percent V_{ref}. While at 80 percent V_{ref} it should be verified that the load switch is in the correct position;

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

e) After 10 s at zero voltage, a supply voltage of 0.8 V_{ref} 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 V_{ref} 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 for lower and upper limits of the limit range of operation with temperature and with the supply voltage at the reference voltage V_{ref} in each case.

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

a) Lower temperature limit + reference voltage; and

b) Upper temperature limit + reference voltage.

The test sequence in **A-1.3** (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 auctioned more than once, including where token acceptance has been interrupted.

A-1.6.2.1 *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.

A-1.6.3.1 *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 *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, for example with a valid token or message.

A-1.6.5 *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, for example with a valid token or message.

A-1.6.6 *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, for example 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 organizations 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 organization 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:

a) Credit limit mode;
b) Fixed payment mode;
c) Budget mode and reserved credit;
d) Emergency credit;
e) Token credit partially allocated for repayment of emergency credit debt;
f) Non-interruption periods;
g) Load-limiting mode;
h) Reverse-running interruption;
j) Multiple-block tariffs; and
k) 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 (that is 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 program 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 program and tariff register displays should be checked by setting appropriate test program 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 29 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 be 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 29 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 program for adoption from a defined future date, then this action should be checked, including with unpowered operation over change of year and 29 February and summertime changes during the pending period, and with power outages applied at the time the new tariff/charging program 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 organizations 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 organization may be appropriate.

The details of these system-dependent requirements and related system compliance tests are not covered in this standard.

ANNEX B

[*Foreword and clause* 3.8.5 (*Note* 2)]

REFERENCE MODEL FOR A PAYMENT METER

(*Informative*)

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 standard. Particular attention should be given to their proper functioning under abnormal influence conditions such as fault currents, voltage variation, temperature variation and EMC.

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 sub-classified functions or with multiple instances of the same sub-class. 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 unit based accounting function together with a current 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 realize 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 GENERALIZED PAYMENT METER INSTANCE

In this instance, the single-part payment meter is arranged as a plug-in unit for use in a matching socket (*see* Fig. 1). 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 unauthorized 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 realized 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.

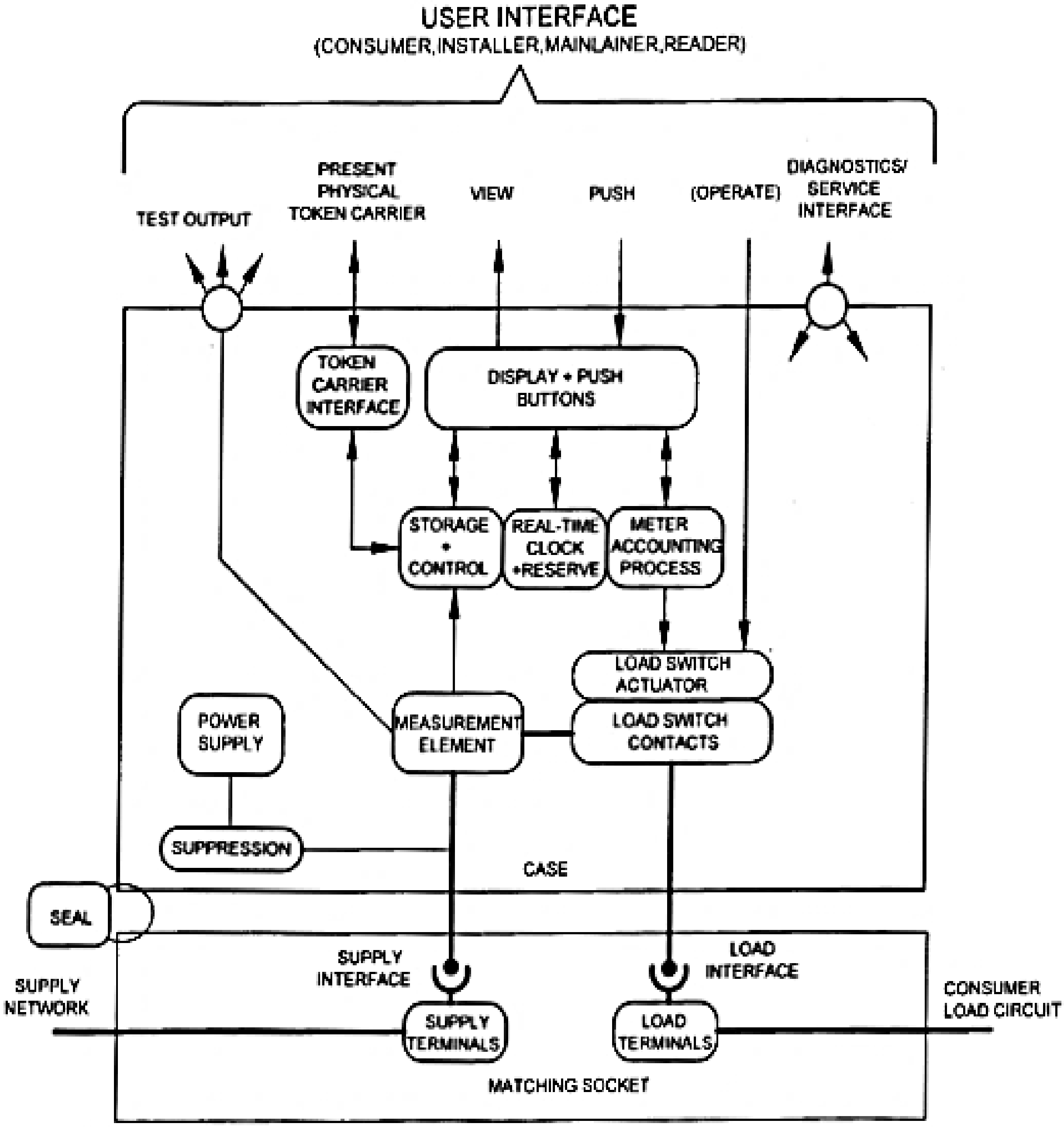


FIG. 1 GENERALIZED BLOCK DIAGRAM OF A PAYMENT METER INSTANCE

Certain reusable 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 infrared 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 generalized 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

Clauses **B-3.2** to **B.3.11** should be read along with Fig. 2 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.

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.

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.

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.

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.

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 time keeping during power outage of the supply network.

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.

Tests on a payment meter are typically initiated manually by the action of a user (consumer, service technician, installer, and 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. 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; and 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. 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; and 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; and 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.

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; and tariff expiry.

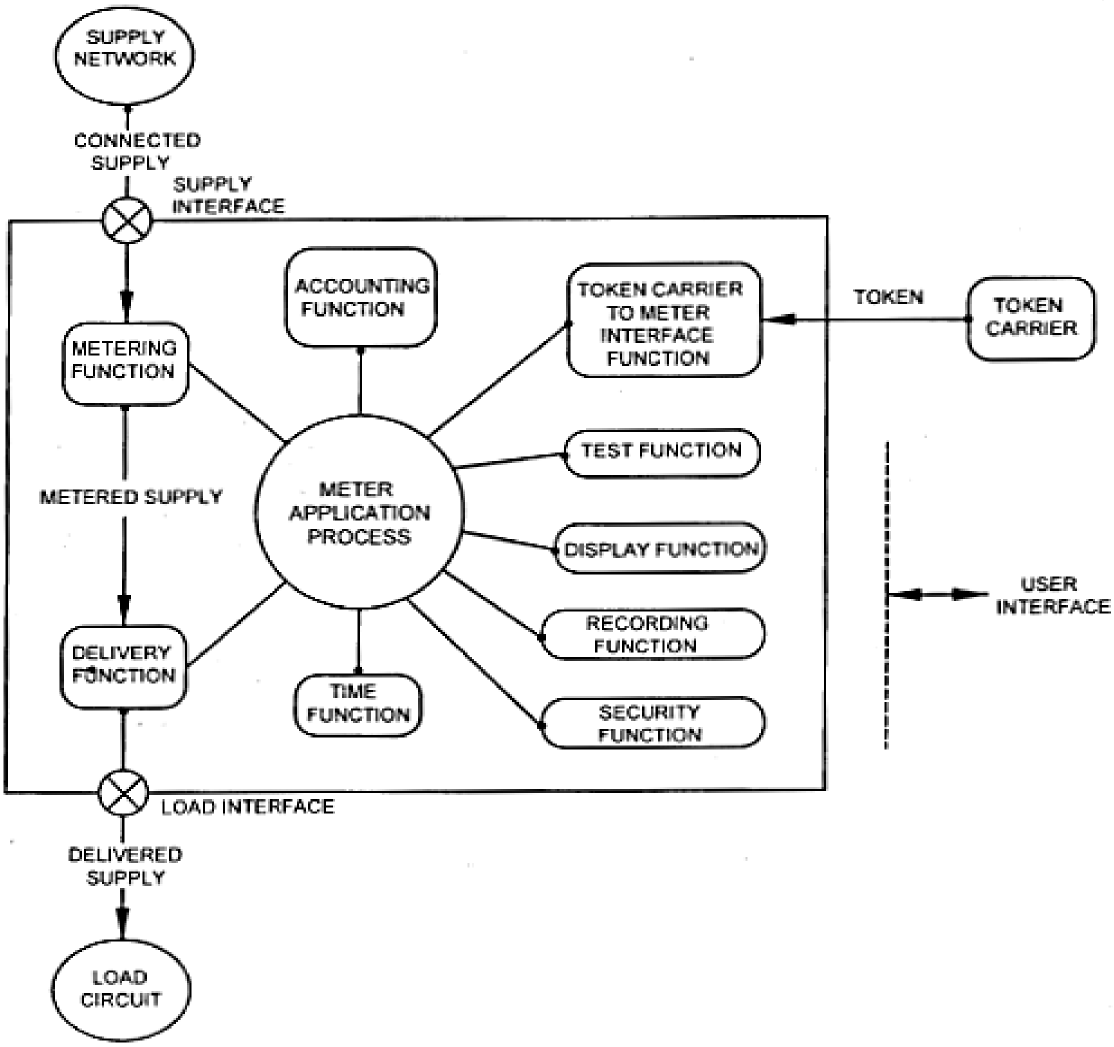


FIG. 2 FUNCTIONAL BLOCK DIAGRAM OF A SINGLE-PART PAYMENT METER INSTALLATION

ANNEX C

(*Clause* 4.3.5)

RELATIONSHIP BETWEEN AMBIENT AIR TEMPERATURE AND RELATIVE HUMIDITY

(*Normative*)

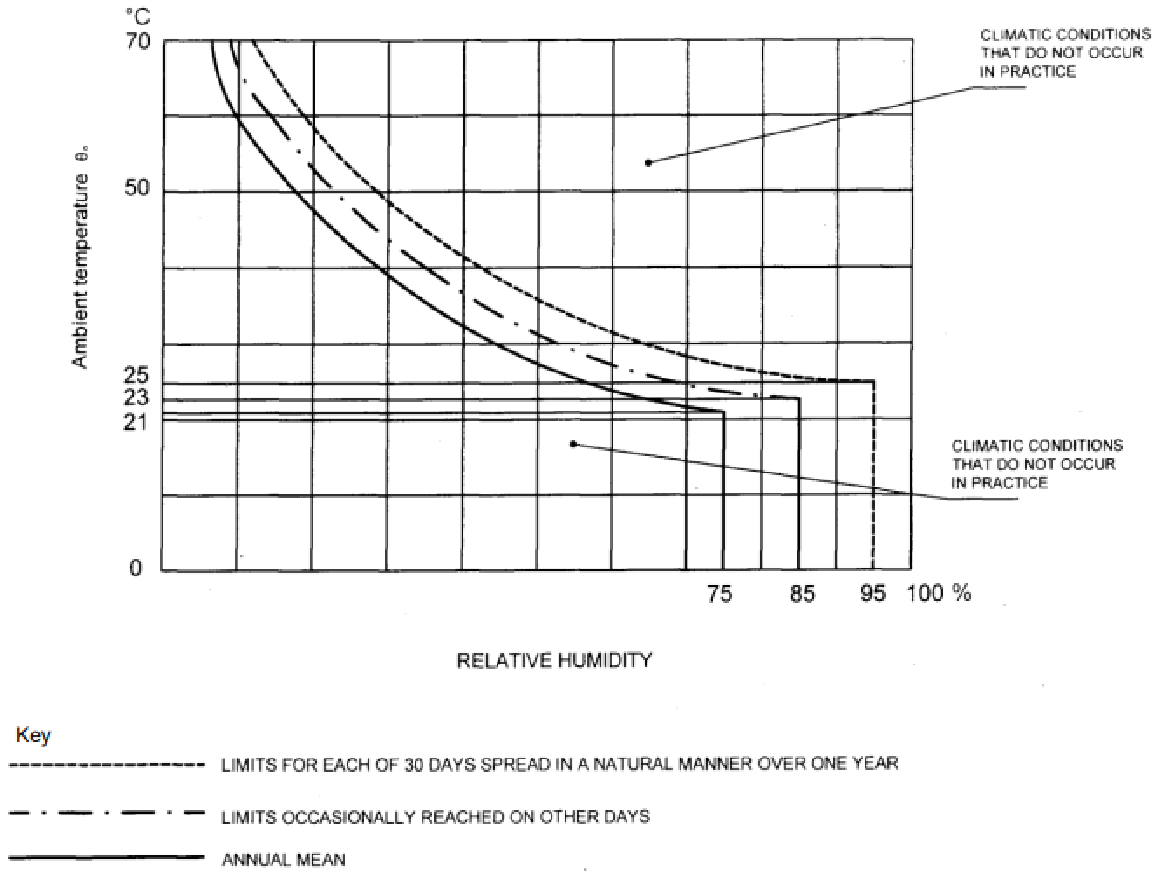


FIG. 3 RELATIONSHIP BETWEEN AMBIENT AIR TEMPERATURE AND RELATIVE HUMIDITY

ANNEX D

REQUIREMENTS OF TIME-KEEPING

(*Clause* 4.7)

(*Normative*)

D-1 GENERAL

D-1.1 General

Where a payment meter is of a type that provides for energy-based tariffs TOD metering, time-based credit controlled from an internal real time clock, then the time-keeping requirements of this Annex shall apply.

NOTES

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

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 standard.

Real time clock shall be of one of the following types:

a) *Crystal controlled real time clock* — In these types of clocks, the real time is set at the time of manufacturing. Later on, for any adjustment or resetting of real time, a manual intervention is required.
b) *Auto synching real time clock* — In these types of clocks, the real time is set at the time of manufacturing. In addition to this, these real time clocks have feature to automatically and periodically adjust its real time with respect to external predefined source of real time; for example, GPRS, GSM, GPS.

Manufacturer shall declare the type of implementation of real time clock along with synching technology if applicable.

D-1.2 Real-Time Clock - Operation Reserve

In order to ensure that meter keeps the time within prescribed accuracy during non-availability of supply voltage (not exceeding the operation reserve duration), the real time clock shall be fitted with a battery or other support device.

D-1.3 Real-Time Clock Setting 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 may reset the seconds to zero.

D-2 REAL TIME CLOCK – ACCURACY

a) Real time clock shall have time-keeping accuracy better than 0.5 s/24 h at reference temperature when supply voltage is connected. The variation of time-keeping accuracy with temperature shall be less than 0.15 s/°C/24 h.
b) On operation reserve, at reference temperature, the accuracy shall be better than 1 s/24 h, and the variation of time-keeping accuracy with temperature shall be less than 1 s/°C/24 h (for tests, refer **5.3.1** and **5.3.2** that is dry heat and cold tests respectively).
c) The clock shall operate correctly for all values of frequency between 0.95 and 1.05 times the rated supply frequency.

NOTE — For testing of Auto synching real time clock, the manufacturer shall facilitate external source of synchronisation, if not available with laboratory.

D-3 TESTS OF TIME-KEEPING ACCURACY

D-3.1 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 12 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 synchronization 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 time-keeping accuracy. This could be, for example, an electrical or optical output, or, in the case of capacitor calibrated real time clocks, an electromagnetic coupling picking up the signal from the crystal or syncing to external source. Where such test facilities provide for the time-keeping 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-3.2 Test of Real Time Clocks in Payment Meters

D-3.2.1 *Test of accuracy of Real time Clocks on mains Supplies*

The payment meter under test is supplied with power and compared with a reference clock at reference temperature. 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. For test duration of greater than 48 h the allowed time indication discrepancy is recalculated based on 0.5 s/24 h.

D-3.2.2 *Test of Accuracy of Real time Clocks on Operation Reserve*

The battery for real time clock shall be capable of providing reserve power for the minimum operation life of the meter, on the basis of an initial 2 years of continuous reserve use. Thereafter, the RTC battery shall be capable of providing reserve power for one week per year for a minimum of 8 further years.

NOTE — Manufacturer shall provide declaration for compliance of above requirements.

The payment meter to be tested is supplied with power and compared with a reference clock at reference temperature. 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 48 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 ± 2 s. The minimum time for this test is 48 h. The restoration of the voltage shall be made with a switching device free from bounce. For test duration of greater than 48 h the allowed time indication discrepancy is recalculated based on 0.5 s/24 h.

For auto synching real time clock, this test shall be done with auto synching facility disabled.

D-3.2.3 *Test of Accuracy of Real time Clocks with Temperature*

The test is to be carried out with reference voltage applied to meter with current circuit open.

The payment meter is placed in a climatic chamber and its time base is measured at + 27 °C. The temperature is then set at + 55 °C. After thermal equilibrium is obtained, the time-keeping accuracy shall be better than ± 4.2 s/24 h plus the time-keeping accuracy measured at reference temperature.

The temperature is then set at – 10 °C. After thermal equilibrium is obtained the time-keeping accuracy shall be better than ± 5.55 s/24 h plus the time keeping accuracy measured at reference temperature.

No minimum period of time is stated for this test.

NOTE — For auto synching real time clock, this test shall be done with auto synching facility disabled.

D-4 EFFECTS OF DISTURBANCES ON TIMEKEEPING

D-4.1 This Clause has been Left Blank

D-4.2 Voltage Dips and Short Interruptions

D-4.2.1 *General*

The payment meter shall be designed in such a way that voltage dips and short interruptions, including those specified in **5.4.2** and in **D-4.2.3** to **D-4.2.4**, 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-4.2.2 *Test of the Effects of Short Interruptions and Voltage Dips*

For these tests, the payment meter is supplied in parallel with and synchronized to a suitable type of reference clock before each test (alternately, difference of time of meter under test from a reference clock may be noted). 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-4.2.3 *Effect of Short Interruptions on Real time Clocks*

The payment meter under test is submitted to sequences of supply interruptions as below:

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 change in time-indication discrepancy between payment meter under test and the reference clock shall not be more than ± 2 s.

D-4.2.4 *Effect of Voltage Dips on real time Clocks*

The supply voltage to the payment meter under test is reduced to 50 percent of V_{ref} for a period of 2 min, and then restored directly to V_{ref}. After the test, the change in time indication discrepancy between the payment meter under test and the reference clock shall not be more than ± 2 s.

ANNEX E

Table 21 RECOMMENDED TEST SEQUENCES

(*Clauses* 5.1.2, 5.1.3.1, 5.1.4 *and* 5.1.5)

Sl No.	Test	Clause Reference	Acceptance Test (A)	Routine Test (R)	No. of Samples
(1)	(2)	(3)	(4)	(5)	(6)
i)	**Tests of Insulation Properties**	**5.4.6**	—	—	
	1. Impulse voltage test	**5.4.6.2**	—	—	On sample(s) 1^{st} (or 1^{st} set) Refer Note 1
	2. a.c. voltage test	**5.4.6.3**	A	R	
	3. Insulation resistance test	**5.4.6.4**	A	R	
ii)	**Tests of Accuracy Requirements**	**5.6**	—	—	
	1. Test on limits of error due to variation of the current	**4.6.1**	A	R	On sample(s) 1^{st}
	2. Test of meter constant	**5.6.5**	A	R	
	3. Test of starting condition	**5.6.4**	A	R	
	4. Test of no-load condition	**5.6.3**	A	—	
	5. Test of repeatability of error	**5.6.7**	A	—	
	6. Limits of error due to other influence quantities	**4.6.2**	—	—	
	7. Limits of error due to ambient temperature variation	**4.6.3**	—	—	
	8. Interpretation of test results	**5.6.6**	—	—	
iii)	**Tests of Electrical Requirements**	**5.4**	—	—	On sample(s) 1^{st}
	1. Test of power consumption	**5.4.1**	A	—	
	2. Test of influence of supply voltage	**4.4.2** and **5.4.2**	—	—	
	3. Test of influence of short-time over current	**5.4.3**	—	—	
	4. Test of influence of self-heating	**5.4.4**	—	—	
	5. Test of influence of heating	**5.4.5**	—	—	
	6. Effect of Earth/phase fault	**4.4.2.5**	—	—	
	7. Time keeping accuracy	**4.7**	—	—	On sample 2^{nd} Refer Note 2
	8. Load switching capability	**4.8**	—	—	On sample 3^{rd}
iv)	**Tests of Electromagnetic Compatibilities (EMC)**	**5.5**	—	—	On sample(s) 1^{st}
	1. Radio interference measurement	**5.5.5**	—	—	
	2. Fast transient burst test	**5.5.4**			
	3. Test of immunity to electromagnetic HF fields	**5.5.3**	— —	— —	
	4. Test of immunity to electrostatic discharges	**5.5.2**	—	—	
	5. Surge immunity test	**5.5.6**			
v)	**Tests of Climatic Influences**	**5.3**	—	—	
	1. Dry heat test	**5.3.1**	—	—	On sample(s) 1^{st}
	2. Cold test	**5.3.2**	—	—	
	3. Damp heat cyclic test	**5.3.3**	—	—	

Sl No.	Test	Clause Reference	Acceptance Test (A)	Routine Test (R)	No. of Samples
(1)	(2)	(3)	(4)	(5)	(6)
vi)	**Tests of Mechanical Requirements**	**5.2**	—	—	
	1. Vibration test	**5.2.3**	—	—	On sample(s) 1st
	2. Shock test	**5.2.2**	—	—	
	3. Sprint hammer test	**5.2.1**	—	—	
	4. Tests of protection against penetration of dust and water	**5.2.5**	—	—	
	5. Test of resistance to heat and fire	**5.2.4**	—	—	
	6. Token carrier interface (if fitted)	**4.2.12**	—	—	On sample 4th
vii)	**Pre-Payment functional tests**				
	1. Test of consumption-based charging function	**5.8.1**	—	—	On sample 3rd
	2. Interruption and restoration of the load	**5.9**	—	—	
	3. Functional requirements	**6**	—	—	
viii)	**Tests of the load switch operation at different voltages and temperature**	**5.10**	—	—	
ix)	**Keypad interface**	**4.2.12.3**	—	—	On sample 4th Refer Note 2
x)	**Performance requirement for payment meter with load switching utilization categories UC2 and UC3**	Annex G	—	—	As per Annex G

NOTES

1 1st set could comprise of minimum one sample. It could have more than one sample based on agreement between manufacturer and purchaser.

2 2nd and 4th sample can be a common sample.

ANNEX F

(*Clauses* 4.2.10.8 *and* 4.2.10.9)

OPTICAL TEST OUTPUT

(*Normative*)

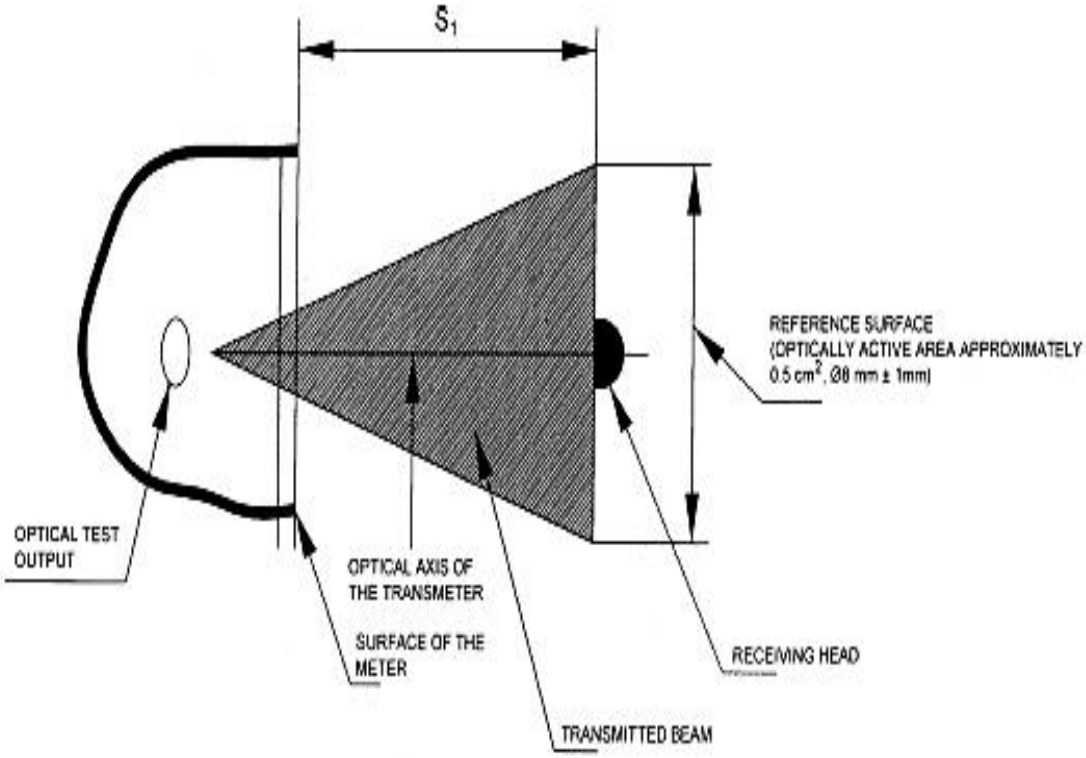
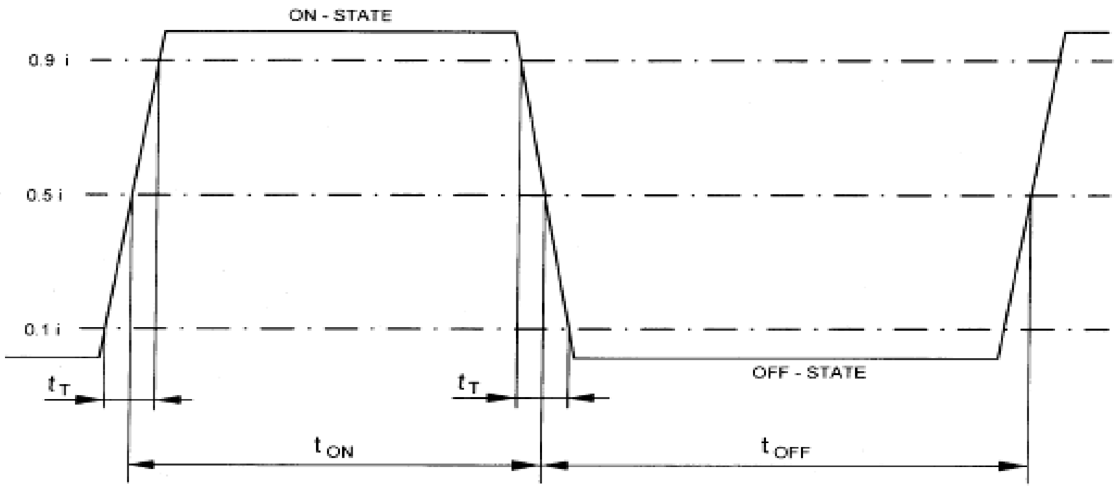


FIG. 4 TEST ARRANGEMENT FOR THE TEST OUTPUT



Requirements:
t_{ON} > 0.2 ms
t_{OFF} > 0.2 ms
t_T < 20 µs

FIG. 5 WAVE FORM OF THE OPTICAL TEST OUTPUT

ANNEX G

(*Clauses* 1, 3.12.5, 4.8.2.2 *and* Annex E)

PERFORMANCE REQUIREMENTS FOR PAYMENT METERS WITH LOAD SWITCHING UTILIZATION CATEGORIES UC2 AND UC3

(*Normative*)

G-1 LOAD SWITCHING CAPABILITIES

Payment meters with load switching category UC2 and UC3 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; and
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 utilization categories UC2 and UC3 is given in Table 22.

G-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; that is, 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:

a) Payment meter in normal operating condition;
b) Load a small amount of available credit, so that the load switch restores the supply to the load circuit;
c) Supply voltage ± 5 percent at, or just above, the lowest value of the rated operating voltage range; and
d) Current in the load circuit at I_c (Tolerance: 0 percent to - 5 percent) and PF = between 0.95 to 1.0 inductive.

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

a) The load switch shall interrupt the supply to the load circuit;
b) The load switch shall operate on the first attempt;
c) There shall be no evidence of sticking of the contacts;
d) There shall be no change in any of the memory registers in the payment meter, except for those that are expected to change; and
e) Repeat the test 3 times.

G-3 ELECTRICAL ENDURANCE

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

a) Payment meter in normal operating condition;
b) Temperature range: 10 ºC to 40 ºC;
c) 1 m length cable with current carrying capacity of I_c;
d) Supply voltage at V_c (tolerance: 0 percent to - 5 percent);
e) Load current at I_c (tolerance: 0 percent to - 5 percent) and PF = between 0.95 to 1.0 inductive; and
f) Number of operating cycles equal to 4 000, with 10 seconds make time and break time between 20 s to 60 s.

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

Load current at I_c (tolerance: 0 to -5 percent), and PF = 0.5 ± 0.05 inductive.

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

a) The load switch shall show no signs of malfunction, sticking of contacts or reluctance to latch;
b) The contacts shall open on the first attempt;
c) After the test, it shall meet the requirements of **G-7**: test for minimum switched current;
d) After the test, it shall meet the requirements of **4.4.1** and its sub-clauses: test for power consumption for current circuit;
e) After the test, it shall meet the requirements of **G-8**: test for dielectric strength; and
f) 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.

NOTES

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

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.

3 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.

4 It is recommended to operate switch in the meter with a command to meter from communication port if available or a software residing in the meter. Manufacturer shall make such provision to operate meter switch for testing purpose.

G-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 IS 14700 (Part 4/Sec 5) under the following conditions:

a) With load switch contacts in open position;
b) Payment meter in the non-operating mode;
c) Between the group of input terminals and the group of output terminals;
d) Ambient temperature at reference conditions;
e) Relative humidity at 40 percent to 95 percent;
f) Atmospheric pressure at 80 kPa to 106 kPa;
g) Cable length between surge generator and payment meter as 1 m;
h) Open circuit voltage of generator at 4 kV (1.2/50 µs); Meter shall not be tested to other lower levels.
j) 5 positive and 5 negative impulses; and
k) Repetition rate not faster than 1 impulse per minute.

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

a) It is permitted for flashover and disruptive discharge to occur during the test;
b) There shall be no permanent damage to any part of the payment meter; and
c) 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.

NOTES

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 through 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.

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.

Table 22 Summary of Test Currents for Utilization Categories

(*Clause* G-1)

Sl No.	Test Case	UC2	UC3
(1)	(2)	(3)	(4)
i)	Fault current making capacity (*see* **G-5**)	2.5 kA	3 kA
ii)	Short-circuit current carrying capacity test 1 (*see* **G-6**)	4.5 kA	6 kA
iii)	Short-circuit current carrying capacity test 2 (*see* **G-6**)	2.5 kA	3 kA

NOTES

1 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.

2 The above values are prospective rms currents. The peak value of actual current during test will depend on angle of point on wave at which switch is closed. May refer, IS 13234.

G-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:

a) Temperature range: 10 ºC to 40 ºC;
b) Payment meter in the normal operating condition;
c) Voltage source at V_c;
d) 3 pre-fusing operating cycles at I_c and PF = 0.9 to 1.0 at 10 s intervals;
e) Prospective test current at 2.5 kA rms for utilization category UC2;
f) Prospective test current at 3 kA rms for utilization category UC3;
g) Power factor of test current shall be between 0.80 and 0.90 inductive;
h) Frequency at reference value;
j) Current tolerance ± 5 percent; and
k) Voltage tolerance 0 percent to - 5 percent.

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 is carried out as specified above.

Temperature range: 10 ºC to 40 ºC;

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

a) Contacts shall open on the first attempt after each make cycle;
b) The load switch shall show no signs of malfunction, sticking or welding of contacts or reluctance to latch;
c) After the test it shall meet the requirements of **G-7**: test for minimum switched current;
d) After the test it shall meet the requirements of **4.4.1** and its sub-clauses: test for power consumption for current circuit;
e) After the test it shall meet the requirements of **G-8**: test for dielectric strength; and
f) When the payment meter is returned to normal operating conditions, it shall operate and there shall be no change in any of the memory registers, except for those that are expected to change.

NOTES

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.

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

3 Standard rms current breaking capacity values for residual current devices are 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 value is chosen for utilisation categories UC3 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.

4 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 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.

5 The values of overload currents under consideration are multiples of 3, 5, 10, 20 and 30 of 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.

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

7 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.

8 It is recommended to operate switch in the meter with a command to meter from communication port if available OR a software residing in the meter. Manufacturer shall make such provision to operate meter switch for testing purpose.

G-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:

a) Temperature range: 10 ºC to 40 ºC;
b) Series connection of a voltage source, the payment meter under test, load to produce the required test current and a test switch;
c) Payment meter in the normal operating condition;
d) 3 pre-fusing operating cycles at I_c and PF = 0.9 to 1.0 at 10 s intervals;
e) Load switch contacts in the closed position;
f) Voltage source at V_c;
g) Prospective test current at 4.5 kA rms for utilization category UC2;
h) Prospective test current at 6 kA rms for utilization category UC3;
j) Power factor of test current 4.5 kA shall be between 0.7 to 0.80 inductive and test current 6 kA shall be between 0.6 to 0.70 inductive;
k) Test switch closing at zero voltage crossover;
m) Test switch opening at the first subsequent zero voltage crossover, thus remaining in the closed position for one half cycle of the supply voltage;
n) Frequency at reference value;
p) Current tolerance: ± 5 percent; and
q) Voltage tolerance: 0 percent to - 5 percent.

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 is carried out as specified above.

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

a) It is permissible that the contacts may weld or burn away;
b) The surroundings of the payment meter shall not be endangered; and
c) 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 (with power factor between 0.8 to 0.90 inductive) shall be 2.5 kA rms for utilization category UC2, 3 kA rms for utilization category UC3. During and after the test the following requirements shall be met:

a) The load switch shall show no signs of malfunction, sticking or welding of contacts or reluctance to latch;
b) Contacts shall open on the first attempt;
c) After the test it shall meet the requirements of **G-7**: Test for minimum switched current;
d) After the test it shall meet the requirements of **4.4.1** and its sub-clauses: Test for power consumption for current circuit;
e) After the test it shall meet the requirements of **G-8**: Test for dielectric strength; and
f) 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.

NOTES

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.

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

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

4 Standard rms current breaking capacity values for residual current devices are 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 utilization categories UC3 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 utilization categories UC3 as representing the short-circuit current sourcing capacities at the load connection socket outlet points of wired premises where payment meters are commonly installed.

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.

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 I2t 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.

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

G-7 MINIMUM SWITCHED CURRENT

The test is carried out under the following conditions:

a) Payment meter in normal operating condition;
b) Test voltage at V_c;
c) Test current at minimum switched current value and PF = 1.0; and
d) 10 operating cycles at approximately 10 s closed and 20 s open.

The following requirements shall be met:

1) Test current shall successfully conduct each time the contacts are in the closed position; and
2) Test current shall successfully break each time the contacts are in the open position.

NOTES

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

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.

G-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:

a) With the load switch contacts in the open position;
b) The payment meter in the non-operating condition;
c) Between input circuits grouped and output circuits grouped;
d) Impulse test voltage at 2 kV peak; and
e) a.c. test voltage at 1 kV rms.

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

Apply the impulse voltage test as given in **5.4.6.2** of this standard, but with the test voltage level and between circuits as given above.

Apply the ac voltage test as given in **5.4.6.2** of this standard, but with the test voltage level, and between circuits as given above.

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

a) There shall be no flash-over, disruptive discharge or puncture; and
b) 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.

G-9 SEQUENCE OF TESTS

The test sequence and sample plan given in Table 23 is recommended.

Table 23 Test Sequence and Sample Plan

(*Clause* G-9)

Sl No.	**Test**	**Clause**	**Sample S1**	**Sample S2**	**Sample S3**	**Sample S4**	**Sample S5**	**Sample S6**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Normal operation	**G-2**	S1	-	-	-		
ii)	Electrical endurance	**G-3**	-	S2	-	-		
iii)	Line to load voltage Surge withstand	**G-4**	-	-	S3	-		
iv)	Fault current making capacity	**G-5**	-	-	-	S4		
v)	Short circuit current carrying capacity	**G-6** Test 1	-	-	-	-	S5	
		G-6 Test 2						S6
vi)	Minimum switched current	**G-7**	-	S2	-	S4	S5	S6
vii)	Dielectric strength	**G-8**	-	S2	-	S4	S5	S6
viii)	Power consumption	**4.4.1**	-	S2	-	S4	S5	S6

NOTES

1 Sequence of the tests shall always follow the same as given in the Table.

2 Test in **G-4** (sample S3) is applicable to payment meter in which the neutral line is also switched.

3 Sample 6 might not be required, depending on the result of Test 1 of **G-6** (if Test 1 is passed and the requirements for Test 2 are also met).

ANNEX H

(*Clause* 5.4.2)

VOLTAGE WAVEFORM FOR THE TESTS OF THE EFFECT OF VOLTAGE DIPS AND SHORT INTERRUPTIONS

(*Normative*)

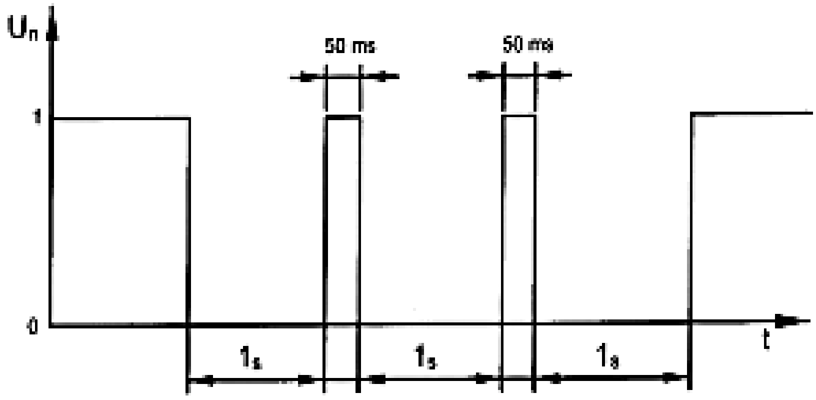


FIG. 6 VOLTAGE INTERRUPTIONS OF ΔU = 100 PERCENT, 1S

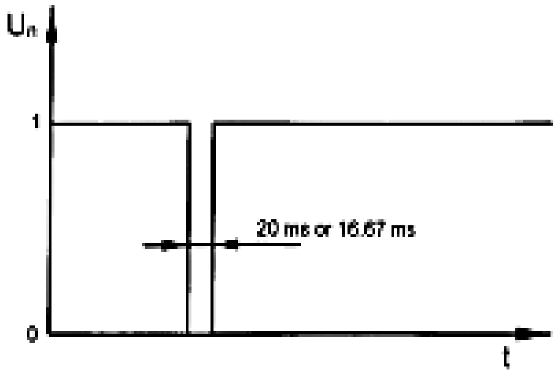


FIG. 7 VOLTAGE INTERRUPTIONS OF ΔU = 100 PERCENT, ONE CYCLE AT RATED FREQUENCY

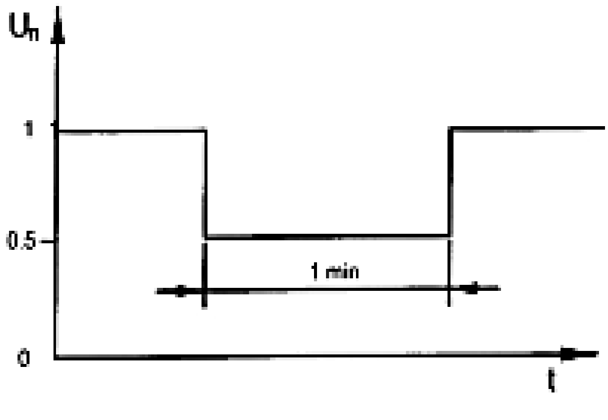


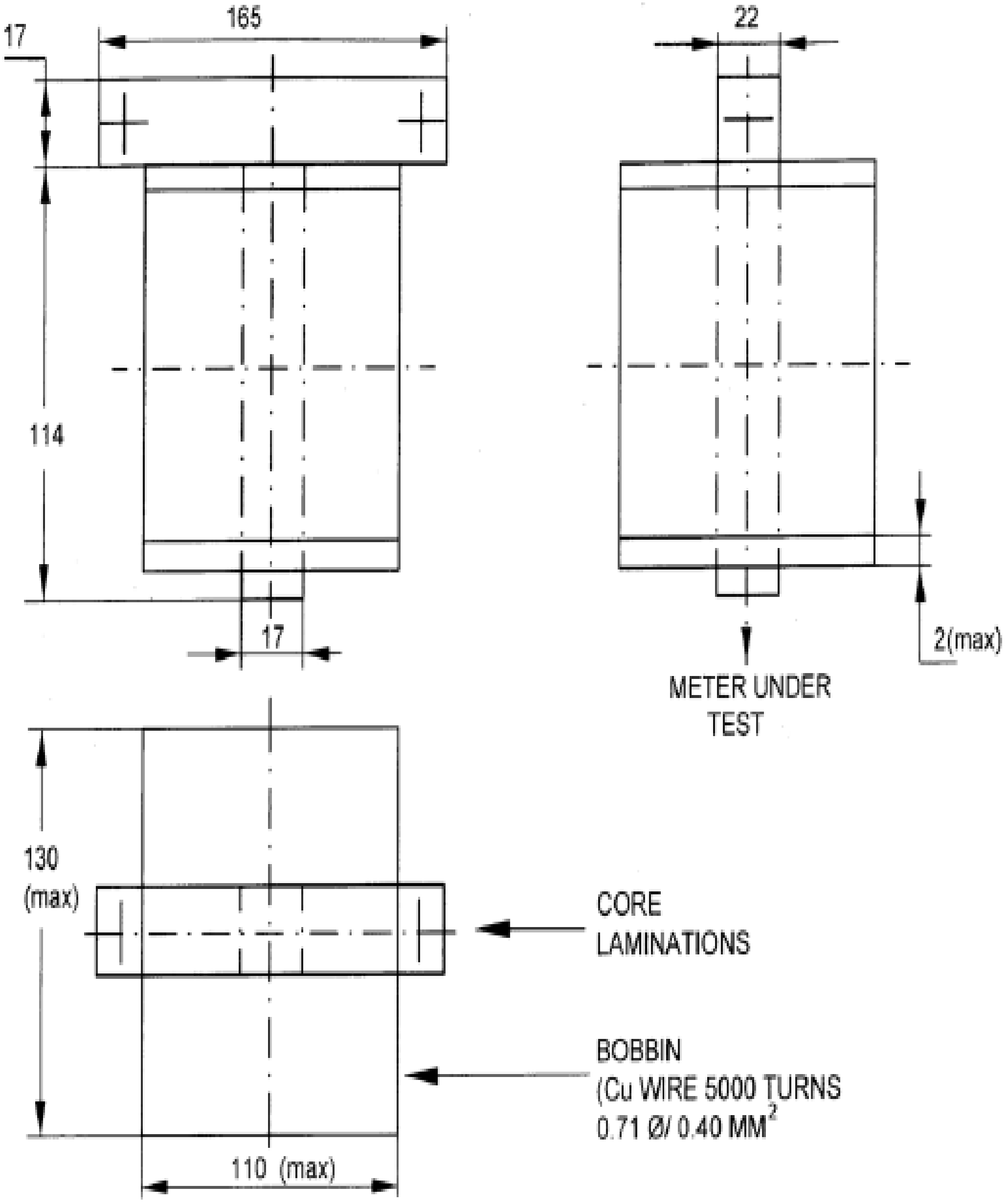
FIG. 8 VOLTAGE DIPS OF ΔU = 50 PERCENT

ANNEX J

(*Clauses* 5.6.2.1 *and* 5.6.2.2)

ELECTROMAGNET FOR TESTING THE INFLUENCE OF EXTERNALLY PRODUCED dc MAGNETIC FIELDS

(*Normative*)



All dimensions in millimetres.

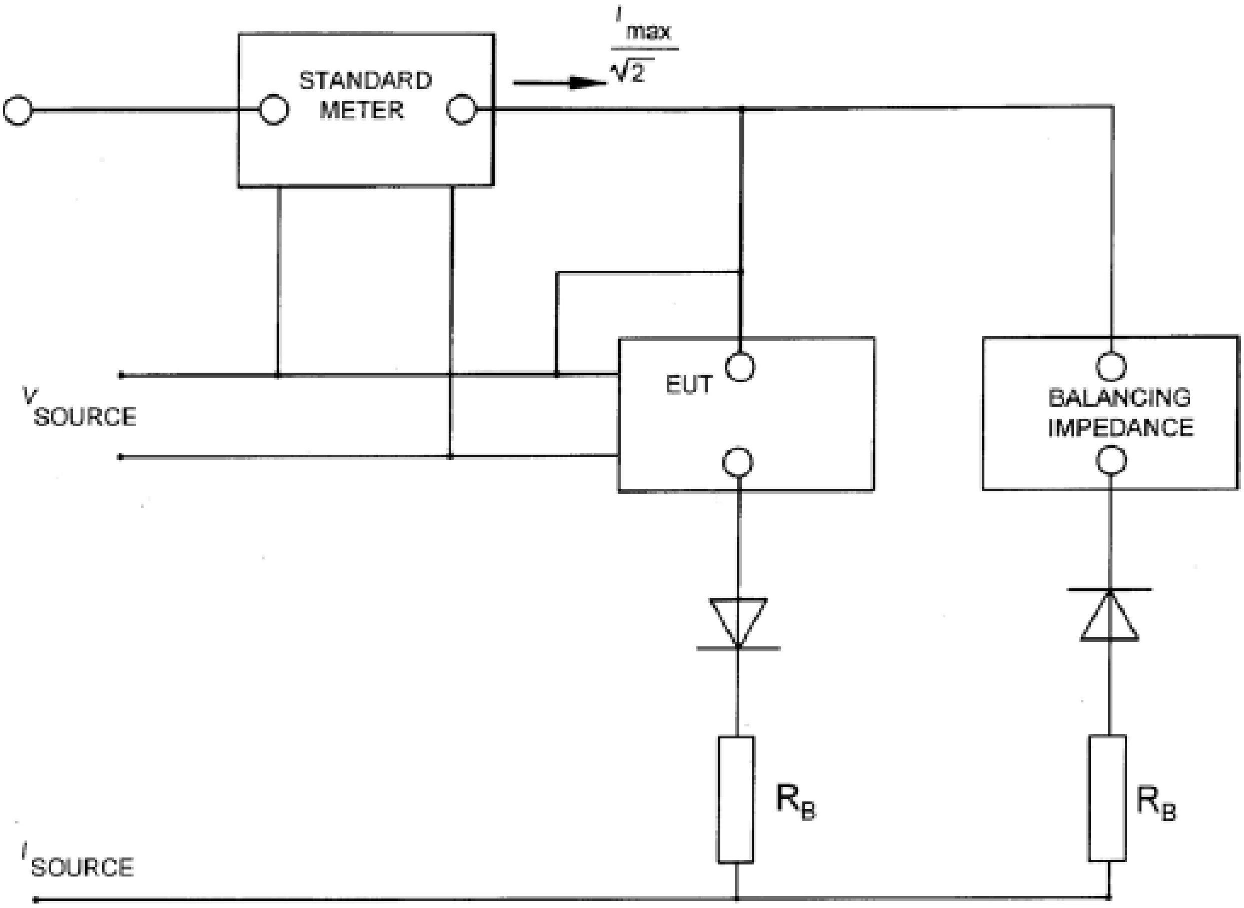
FIG. 9 ELECTROMAGNET FOR TESTING THE INFLUENCE OF EXTERNALLY PRODUCED d.C. MAGNETIC FIELDS

ANNEX K

[*Clause* 4.6.2 *and Table* 13]

TEST CIRCUIT DIAGRAM FOR d.c. AND EVEN HARMONICS

(*Normative*)



NOTES

1 The balancing impedance shall be equal to impedance of the equipment under test to ensure the measurement accuracy.

2 It is recommended to use a meter of same type as the EUT in place of balancing impedance.

3 The rectifier diodes shall be of same type.

4 To improve the balancing condition an additional resistor (RB) can be introduced in both paths. Its value should be approximately 10 times the value of EUT.

5 The influence of the dc components and even harmonics in the ac current circuit shall be checked at 0.5 I_b, $I_{max}/\sqrt{2}$ and any one value in the range of these two values of the currents through the standard meter.

6 With above connections, the EUT will measure half of the energy measured by standard meter.

FIG. 10 HALF WAVE VERIFICATION (d.c. AND EVEN HARMONICS)

ANNEX L

(*Clause* 4.4.2.5)

TEST CIRCUIT DIAGRAM FOR THE TEST OF IMMUNITY TO EARTH FAULT

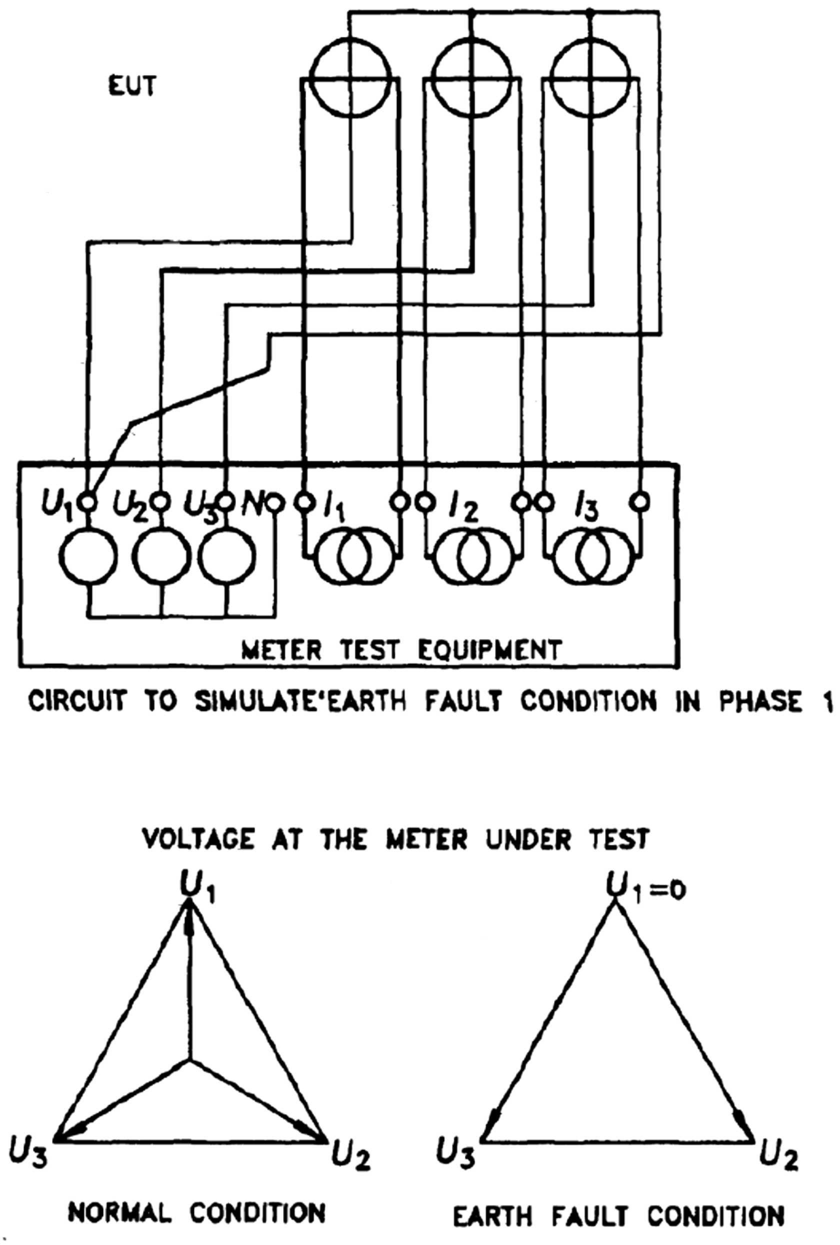


FIG. 11 TEST CIRCUIT DIAGRAM FOR THE TEST OF IMMUNITY TO EARTH FAULT

ANNEX M

(*Clause* 2)

LIST OF REFERRED STANDARDS

IS No.	*Title*
IS 1401 : 2008	Protection of person and equipment by enclosure-probes for verification (*second revision*)
IS 2071 (Part 1) : 2016	High voltage test techniques: Part 1 General definitions and test requirements (*third revision)*
IS 6873 (Part 2/Sec 1) : 2019	Limits and methods of measurement of radio disturbance characteristics: Part 2 Electromagnetic Compatibility (EMC) — Requirements for household appliances, electric tools and similar apparatus, Section 1 Emission (*third revision*)
IS 9000 (Part 3/Sec 1 to 5) : 1977	Basic environmental testing procedures for electronic and electrical items: Part 3 Dry heat test
IS 9000 (Part 5/Sec 1 and 2) : 1981	Basic environmental testing procedures for electronic and electrical items: Part 5 Damp heat (cyclic) test
IS 9000 (Part 7/Sec 1) : 2018	Basic environmental testing procedures for electronic and electrical items: Part 7 Impact test, Section 1 Shock (test Ea) (*second revision*)
IS 9000 (Part 7/Sec 7) : 2020	Environmental testing: Part 7 Tests, Section 7 Test Eh: Hammer tests (*first revision*)
IS 11000 (Part 2/Sec 1) : 2018	Fire hazard testing: Part 2 Test methods, Section 1 Glow-wire apparatus and common test procedure (*second revision*)
IS 12032	Graphical symbols for diagrams in the field of electrotechnology:
(Part 1) : 1987	General information
(Part 2) : 1987	Symbols elements, qualifying symbols and other symbols having general application
(Part 3) : 1987	Conductors and connecting devices
(Part 4) : 1987	Passive components
(Part 6) : 1987	Production and conversion of electrical energy
(Part 7) : 1987	Switchgear, control gear and protective devices
(Part 8) : 1987	Measuring instruments, lamps and signalling devices
(Part 9) : 1993	Telecommunications, switching and peripheral equipment
(Part 10) : 1991	Telecommunications: Transmission
(Part 11) : 1987	Architectural and topographical installation plans and diagrams
IS 12346 : 1999	Testing equipment for a.c. electrical energy meters (*first revision*)
IS 13234 (Parts 0 to 4) : 2017	Short-circuit currents in three-phase a.c. systems (*first revision*)
IS 13360 (Part 6/Sec 17) : 2017	Plastics — Methods of testing: Part 6 Thermal properties, Section 17 Determination of temperature of deflection under load — Plastics and ebonite (*second revision*)
IS 13779 : 2020	a.c. static watt-hour meters, Class 1 and 2 — Specification (*second revision*)
IS 14700	Electromagnetic compatibility (EMS):
(Part 4)	Testing and measurement techniques

IS No.	*Title*
(Sec 2) : 2018	Section 2 Electrostatic discharge immunity test (*second revision*)
(Sec 3) : 2018	Test methods for protective devices for HEMP conducted disturbance (*first revision*)
(Sec 4) : 2018	Electrical fast transient/burst immunity test (*second revision*)
(Sec 5) : 2019	Surge immunity test (*first revision*)
IS/IEC 60068-2-1 : 2007	Environmental testing: Part 2 Tests, Section 1 Test A: cold
IS/IEC 60068-2-6 : 2007	Environmental testing: Part 2 Tests, Section 6 Test Fc: vibration (sinusoidal)
IS/IEC 60529 : 2001	Degrees of protection provided by enclosures (IP CODE)
IS/CISPR 32 : 2015	Electromagnetic compatibility of multimedia equipment — Emission requirements

ANNEX N

(*Foreword*)

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