भारतीय मानक
ए. सी. विद्युत ऊर्जा मीटरों के लिए
परीक्षण उपस्कर
(IS12346 – revised)

Indian Standard
TESTING EQUIPMENT FOR AC ELECTRICAL ENERGY METERS
(IS12346 – revised)

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

FOREWORD

Indian Standard IS12346 (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 Electro technical Division Council.

While preparing this standard assistance was derived from IEC 736-1982 'Testing equipment for electrical energy meters (first edition)' (now IEC60736) issued by the International Electro technical Commission.

As the New technology and higher accuracy meters has been put into use, the requirement of precision and standardization of Test system according to new technology is being raised. In this regard IEC has release the draft IEC 62057-1 which replaces IEC60736.

It is necessary that existing IS 12346 (first revision):1999 need to reaffirm. For this purpose ETD 13 has formed work group 3 under panel 2.

For the draft affirmation of IS12346 assistance was derived from CDV-IEC62057-1 (13/1816/CDV).

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1. Scope

This part of Standard applies to Meter test System, used for testing and calibration of electricity meters and electricity meter installations, Power meters, in particular for their type test, acceptance test and verification test in field (onsite) or laboratory as per IS13779, IS14697, IS15884, IS15959 (part 1, part 2 and part 3), IS15707 and IS16444 (Part1 and Part2). It covers the requirements for Meter test System for indoor laboratory application and outdoor meter testing and calibration units.

It applies to meter test systems to test electricity meters on 50 Hz networks with an AC voltage up to 300V (phase to neutral). Also the standard describes the test procedure for new meter installation as well as the one under operation. If meters are intended for system voltages not specified in this standard, special requirements should be agreed on between the manufacturer and the purchaser.

This standard also defines routine tests, acceptance tests, type tests and commissioning tests for meter test systems.

It does not apply to:

- Electricity meters;
- Personal computers supplied together with the meter test system.

2. Normative references

Table 1 Normative references

IEC 62057-1 (draft)	Test equipment, techniques and procedures for electrical energy meters - Part 1: Stationary Meter Test Units (MTU)
IEC 62057-2 (draft)	Portable Test Equipment and Test Procedure for Electricity Meter and Electricity Meter Installation Part-2
IEC 60050-300:2001	International electro-technical vocabulary (IEV)
IEC 60060-1:2010	High-voltage test techniques – Part 1: General definitions and test requirements
IEC 60085:2007	*Electrical insulation – Thermal evaluation and designation*
IEC 60269-1:2006	*Low-voltage fuses – Part 1: General requirements*
IEC 60417:2002	*Graphical symbols for use on equipment – 12-month subscription to regularly updated online database comprising all graphical symbols published in IEC 60417*
IEC 60359:2001	*Electrical and electronic measurement equipment - Expression of performance*
IEC 60375:2018	*Conventions concerning electric circuits*
IEC 60664-1:2007	*Insulation coordination for equipment within low-voltage systems – Part1: Principles, requirements and tests*
IEC 61140:2016	*Protection against electric shock – Common aspects for installation and equipment*
IEC 61326-1:2012	*Electrical equipment for measurement, control and laboratory use -EMC requirements*
IEC 62052-11 ED2	*Electricity metering equipment (a.c.) – General requirements, tests and test conditions – Part 11: Metering equipment*
IEC 62052-21: 2004	*Electricity metering equipment (a.c.) – General requirements, tests and test conditions – Part 21: Tariff and load control equipment*

IEC 62052-31:2015,	*Electricity metering equipment (a.c.) – General requirements, tests and test conditions – Part 31: Product safety requirements and tests*
IEC 62053-11:2003	*Electricity metering equipment (a.c.) – Particular requirements – Part 11: Electromechanical meters for active energy (classes 0.5, 1 and 2)*
IEC 62053-21 ED2:	*Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2)*
IEC 62053-22 ED2:	*Electricity metering equipment (a.c.) – Particular Requirements – Part 22: Static meters for active energy (classes 0.2 S and 0.5 S)*
IEC 62053-23 ED2:	*Electricity metering equipment (a.c.) – Particular requirements – Part 23: Static meters for reactive energy (classes 2 and 3)*
IEC 62053-24 ED2:	*Electricity metering equipment (a.c.) – Particular requirements – Part 24: Static meters for reactive energy (classes 0.5 S, 1S and 1)*
IEC 62058-11:2008,	Electricity metering equipment (AC) – Acceptance inspection – Part 11: General acceptance inspection methods
IEC 62058-21:2008,	*Electricity metering equipment (AC) – Acceptance inspection. Part 21: Particular requirements for electromechanical meters for active energy (classes 0,5, 1, and 2)*
IEC 62058-31:2008,	*Electricity meter equipment (AC) – Acceptance inspection. Part 31:Particular requirements for static meters for active energy (classes 0.2 S, 0.5 S, 1 and 2)*
IEC 61000-4-2:2008,	*Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques- Electrostatic discharge immunity test.*
IEC 61000-4-3:2006	*Electromagnetic compatibility (EMC)– Part 4-3: Testing and measurement techniques- Radiated, radio-frequency, electromagnetic field immunity test.*
IEC 61000-4-4:2012	*Electromagnetic compatibility (EMC) Part 4-4: Testing and measurement techniques- Electrical fast transient/burst immunity test.*
IEC 61000-4-5:2014	*Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques- Surge Immunity test.*
IEC 61000-4-6:2013	*Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques- Immunity to conducted disturbances, induced by radio frequency fields*
IEC 61000-4-8:2009 RLV,	*Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test*
IEC 61000-6-1:2016 RLV	*Electromagnetic compatibility (EMC) – Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments*
IEC 61000-6-2:2016 RLV	*Electromagnetic compatibility (*368 *EMC) – Part 6-2: Generic standards - Immunity for industrial environment*s
IEC 61000-6-3:2006	*Electromagnetic Compatibility (EMC) – Part 6-3: Generic Standards - Emission Standard for Residential, Commercial and Light-Industrial Environments*
IEC 61000-6-4:2006-	*Electromagnetic compatibility (EMC) – Part 6-4:Generic standards - Emission standard for industrial environments*

IEC 61010-1:2010,	*Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements*
IEC 61010-031:2015 RLV	*Safety requirements for electrical equipment for measurement, control and laboratory use – Part 031: Safety requirements for hand-held probe assemblies for electrical measurement and test*
IEC 60721-3-2:2001	*Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities - Section 2:Transportation*
IEC 60721-3-3:1994	*Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weather protected locations*
CISPR 11:2015,	*Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*
EN 50160:2011	*Voltage characteristics of electricity supplied by public distribution systems*
EN 50470-1:2006,	*Electricity metering equipment (a.c.) Part 1: General requirements, tests and test conditions - Metering equipment (class indexes A, B and C)*
EN 50470-2:2006,	*Electricity metering equipment (a.c.) Part 2: Particular requirements -Electromechanical meters for active energy (class indexes A and B)*
EN 50470-3:2006,	*Electricity metering equipment (a.c.) Part 3: Particular requirements -Static meters for active energy (class indexes A, B and C)*
JCGM 100:2008	*Evaluation of measurement data – Guide to the expression of uncertainty in measurement*
JCGM 200:2012	*International vocabulary of metrology – Basic and general concepts and associated terms (VIM)*
ISO 7000:2014	*Graphical symbols for use on equipment – Registered symbols*
ISO 3864-1:2011	*Graphical symbols – Safety colours and safety signs – Part1: Design principles for safety signs and safety markings.*
ISO 13732-1:2006	*Ergonomics of the thermal environment -- Methods for the assessment of human responses to contact with surfaces -- Part 1: Hot surfaces*
ISO/IEC 17025:2005	*General requirements for the competence of testing and calibration laboratories*

3. Terms and definitions

3.1 Definitions related to the elements of the meter test system

3.1.1 Meter under Test (MUT)

Electricity meter intended to measure active and/or reactive energy by integrating active and/or Reactive power with respect to time

Note: For the definition of various types of energy meters and their elements, see IS13010, IS13779: 2020, IS14697:2021, IEC 62052-11, IEC 62053-23, IS16444 (Part1 and part 2) and IEC 62053-24.

3.1.2 Meter Test System (MTS)

Assembly of sources, frequency generator, standard meter, and error calculation and indication system to supply the required test values to the MUT and to measure, calculate and display the error of the MUT

3.1.3 Automatic Meter Test System (AMTS)

MTS which conducts, controls and monitors the desired function(s) or activity (ies) of meter testing through software

3.1.4 Phantom loading

The method of loading the meter in which voltage source(s) and current source(s) are supplied from two separate circuits; the voltage source(s) is generally supplied at reduced current and rated frequency. The current source(s) is generally supplied at reduced voltage and rated frequency. The phase angle between the two circuits is adjustable through phase shifter. [Phantom loading can be obtained by static power source(s) or transformer based power source(s)].

Note 1: These test signals shall be independent from the mains input in the specified operating range.
Note 2: The test signals are based on the command(s) received from the test software or controller.

3.1.5 Primary standard (system)

A primary standard in metrology is a standard that is sufficiently accurate such that it is not calibrated directly by or subordinate to other standards. It will be calibrated by calibration of base parameters. Primary standards are used to calibrate other standards referred to as Working Standards/Reference Standard/Transfer Standard.

3.1.6 Transfer standard (meter)

Transfer standard is a measurement standard used as an intermediate device when comparing two other standards. Typical applications of transfer standards are to transfer a measurement parameter from one organization to another, from a primary standard to a secondary standard, or from a secondary standard to a working standard in order to create or maintain measurement traceability.

3.1.7 Reference standard (meter)

A standard whose measurement traceability has been verified at an accredited laboratory and is used for in-house verification of other standards in the meter test station (M. T.S.).

Note: A reference standard meter must be traceable to national or international primary standards.

3.1.8 Working Standard (meter)

A standard including a complete meter testing system, which has been verified by comparison to either a reference standard or a transfer standard, and is used for calibration and testing of metering equipment.

Note 1: It is calibrated against the reference standard (meter).
Note 2: A MTS can also be fitted with a reference standard used for day to day calibration of MUTs of high accuracy (reference standard used as the working standard).

3.1.9 Standard (meter)

Common term for the reference standard according to 3.1.7 or the working standard in accordance to 3.1.8

3.1.10 Error Calculation System

Device or a group of devices to count pulses, or read energy values and to compare, calculate and indicate the percentage error of the MUTs

Note: The default error calculation system receives pulses from the scanning heads or from the pulse outputs of the MUTs and compares these with pulses received from the standard meter.

3.1.11 Scanning head

For detecting optical impulse output of static meter or rotor disc of electro mechanical meter.

3.1.12 Output terminals of MTS

The terminals from which the power, corresponding to the separate application of voltages and currents, is supplied to the terminal block(s) of the meter(s) under test.

3.1.13 Maximum output power of the test source

Output power (in volt-amperes) corresponding to the highest load applied at the output terminals of a source. The output shall be defined separately for the voltage and current circuits.

3.1.14 Output stability of source

Number or percentage of the output quantity of the source indicating that the output quantity may likely vary within this number or percentage when all other parameters such as supply voltage etc. are in accordance to reference conditions (Annexure B).

Note 1: The output stability (S) for voltage, current, power and frequency test output shall be separately defined in % and is given in formula

$$S = \frac{max\{m1(T), m2(T) \dots \dots \dots mN\} - min\{m1(T), m2(T) \dots \dots \dots mN\}}{\frac{1}{N}\sum_{k=1}^{N} mk(T)} . 100\% \qquad \textit{Equation 1}$$

where:

S is the stability of the test output;

mN(T) is the Nth measured value with integration period T inside a successive sequence of measurements;

mk(T) is the kth value, k = 1…N inside this sequence;

N is the number of values inside this sequence;

T is the integration period.

max is the greatest of {m1(T), m2 (T), ... mN (T)};

min is the least of {m1(T), m2 (T), ... mN (T)}

The output stability (Sabs) of the phase angle between output values must be separately defined in ° (degree) and given in below formula

$$Sabs = max\{m1(T),m2(T),....mN(T)\} - min\{m1(T),m2(T),....mN(T)\} \quad \text{Equation 2}$$

Note 2: The purchaser and the supplier may mutually agree for the integration period T and the values N of the measuring sequence.

3.2 Definitions of active, reactive and apparent power

3.2.1 Active power

Active power at any single sinusoidal frequency component of a periodic signal in a single phase circuit is defined as the product of the RMS values of current and voltage and the cosine of the phase angle between them, where the phase angle is the angle of the voltage signal vector with respect to the current signal vector.

Note 1: Under sinusoidal conditions, the active power is the real part of the complex power.
Note 2: The active power of the periodic signal is the algebraic sum of the active power of the sinusoidal frequency components.
Note 3: The coherent SI unit for active power is the watt [W].
Note 4: Time domain calculation under general conditions.

$$P = \frac{1}{T}\int_{0}^{T} u(t).i(it).dt \quad \text{Equation 3}$$

Where:
P is the active power;
u(t) is the instantaneous value of the voltage;
i(t) is the instantaneous value of the current;
T is the integration time of the measurement cycle.

Fourier summation for frequency domain calculations with equal time periods for U and I up to nth harmonic

$$P = \sum_{k=1}^{N} Uk.Ik.cos(Øuk - Øik) = P1 + P2 + P3 ... + PN = P1 + PH \quad \text{Equation 4}$$

Where:
P1 is the fundamental active power;
PH is the harmonic active power;
Uk is the RMS value of the voltage component of order k;
Ik is the RMS value of the current component of order k;
Øuk is the phase shift between the voltage component of order k and the fundamental voltage component of order 1;
Øik is the phase shift between the current component of order k and the fundamental voltage component of order 1.
[SOURCE: 62052-11 Ed.2, modified – Note 4 to entry has been added.]

3.2.2 Apparent power

Product of the RMS voltage U between the terminals of a two-terminal element or circuit and the RMS electric current I in the element or circuit

Note 1: The SI unit for apparent power is the VA.
Note 2: There are no IS or IEC standards available for meters measuring apparent power / energy.
Note 3: Time domain calculation under general conditions

$$S = U.I \ = \frac{1}{T}\sqrt{\int_0^T i^2(t)dt.\int_0^T u^2(t)dt} \qquad \text{Equation 5}$$

Where:
S is the apparent power;
U is the RMS value of the voltage;
I is the RMS value of the current;
u(t) is the instant value of the voltage;
i(t) is the instant value of the current;
T is the integration time of the measurement cycle.

Note 4: Power triangle method to calculate the absolute value of apparent power under general conditions.

$$S = \sqrt{P^2 + Q^2} \qquad \text{Equation 6}$$

Where:
S is the apparent power;
P is the active power;
Q is the reactive power.

Note 5: Fourier summation for frequency domain calculations with equal time periods for U and I up to nth harmonic:

$$S = U.I = \sqrt{\sum_{k=1}^{n} U_k^2 . \sum_{k=1}^{n} I_k^2} \qquad \text{Equation 7}$$

Where:
S is the apparent power;
U is the RMS value of the voltage;
I is the RMS value of the current;
Uk is the RMS value of the voltage component of order k;
Ik is the RMS value of the current component of order k.
[Source IEC 131-11-41, modified – Note 3, 4 and 5 to entry has been added].

3.2.3 Reactive power (var)

Reactive power for sinusoidal waveforms of any single frequency in a single phase circuit is defined as the product of the r.m.s. values of current and voltage and the sine of the phase angle between them.
[Source: Clause no. 3.1.3 of IS14697:2021]

Note 1: For practical reason this standard applies to the reactive power for sinusoidal current and voltage containing the fundamental frequency only.
Note 2: The algorithm used for the calculation of reactive power is not specified, however the meter is expected to meet requirements of the relevant accuracy class standard.
Note 3: The coherent SI unit for reactive power is volt-ampere, VA. The special name var and its symbol var are also used.
Note 4: IEC 62053-24 specifies reactive power / energy for fundamental components explicitly. Harmonics are considered as influence quantities. The algorithm is not specified, but the change of accuracy in the presence of harmonics must be within the limits specified. To meet this requirement, meters need harmonic filtering. For testing it has to be verified, that also the standard meter measures the fundamental reactive power only in the presence of harmonics. This method is mandatory.

Note 5: Reactive power Q in a single phase system for steady-state and periodic signals is defined as:

$$Q = U_1 . I_1 . sin\, \emptyset$$

Equation 8

Where:
Q is the reactive power;
U1 is the RMS value of the fundamental frequency components of the voltage;
I1 is the RMS value of the fundamental frequency components of the current; and
Ø is the phase angle between U1 and I1.

Note 6: Power triangle method to calculate the absolute value of total non-active power under general conditions. This definition is widely known, used for the calculation of reactive power and called non active power according to IEV. Non-active power for a two-terminal element or circuit under periodic conditions, quantity equal to the square root of the difference of the squares of the apparent power and the active power.
[Source: IEV 131-11-43].

$$Q = \sqrt{S^2 - P^2}$$

Equation 9

Where:
Q is the non-active power;
S is the apparent power;
P is the active power.
This method is unambiguous if only fundamental components are present. With sinusoidal voltages and non- sinusoidal currents the result includes the fundamental and distortion power. Prefixes of Q shall conform to IEC 60375. Standard meters determining accuracy according to IEC 62053-24 do not use this method for sinusoidal conditions, the non-active power determined by Power Triangle Method is equal to the absolute value of the product of the apparent power and the sine of the displacement angle.

Note 7 to entry: Time domain calculation on pure sinusoidal conditions (time displacement method):

$$Q = \frac{1}{T} . \int_{0}^{T} u\left(t - \frac{T}{4}\right) . i(t) . dt \qquad \text{Equation 10}$$

Where:
Q is the reactive power;
u(t) is the instantaneous value of the voltage;
i(t) is the instantaneous value of the current;
T is the time period of the fundamental component.

This method is only unambiguous under sinusoidal conditions with fundamental frequencies. In that case reactive power determined by the Time Displacement Method is the product of the apparent power and the sine of the displacement angle. To realize this method, meters have a provision for phase shifting adjusted for the fundamental only. This method is not recommended.

Note 8: For unambiguous determination of errors the algorithm used by the standard meter for measuring Q and S shall be indicated in the test report of a MUT. This is particularly important when testing poly phase meters. In addition, the calculation method of how poly phase power is determined shall be indicated in the test report.
[SOURCE: 62052-11 Ed.2, modified – Note 4, 5,6,7,8 to entry has been added.]

3.3 Definitions related to influence quantities

3.3.1 Laboratory or test and measurement area

Area that is specifically used for analysis, testing and servicing and places with equipment operated by trained personnel

3.3.2 Controlled Electromagnetic Environment

Environment usually characterized by recognition and control of EMC phenomena by users of the equipment

3.3.3 Influence quantity

Quantity which is not the subject of the measurement and whose change affects the relationship between the indication and the result of the measurement.

Note 1: This term is used in the "uncertainty" approach.
Note 2: Influence quantities can originate from the measured system, the measuring equipment or the environment.
Note 3: As the calibration diagram depends on the influence quantities, in order to assign the result of a measurement it is necessary to know whether the relevant influence quantities lie within the specified range.
[SOURCE: IEV 311-06-01]

3.3.4 Reference conditions

Appropriate set of influence quantities and performance characteristics, with reference values, their tolerances and ranges, with respect to which the intrinsic error is specified.

[SOURCE:3.6.2 of IS13779:2020]

3.3.5 Variation of error due to an influence quantity

Difference between the percentage errors of the meter when only one influence quantity assumes successively two specified values, one of them being the reference value.
[SOURCE: IEC 62052-11 3.6.6]

3.3.6 Total harmonic distortion, THD (abbreviation)

The ratio of the RMS value of the harmonic content of an alternating quantity to the RMS value of the fundamental component of the quantity.
[SOURCE: IEV 551-17-06]

3.3.7 Reference temperature

Ambient temperature specified for reference conditions. [SOURCE: IEC 62052-11 3.6.8]

3.3.8 Rated operating conditions

Set of specified measuring ranges for performance characteristics and specified operating ranges for influence quantities, within which the variations of operating errors of a MTS are specified and determined
[SOURCE: IEC 62052-11 3.6.10]

3.3.9 Enclosure port

Physical boundary of equipment through which electromagnetic fields may radiate or impinge.

3.4 Definitions related to accuracy

3.4.1 Maximum permissible measurement error

Extreme value of measurement error, with respect to a known reference quantity value, permitted by specifications or regulations for a given measurement, measuring instrument or measuring system

NOTE 1 usually, the term “maximum permissible errors” or “limits of error” is used where there are two extreme values.
NOTE 2 the term “tolerance” should not be used to designate ‘maximum permissible error’
[SOURCE: JCGM 200, 4.26]

3.4.2 Meter constant

The number of revolutions of the rotor of an electromechanical meter or the number of pulses of a static meter at the test output or electrical pulse output, per energy unit

3.4.3 Accuracy

Closeness of agreement between a measured quantity value and a true quantity value of a measurand
[SOURCE: JCGM 200, 2.13, modified]

3.4.4 Accuracy of a standard meter

Accuracy of a standard meter indicates the closeness of a measured quantity value in a given range of operation, at reference conditions and a true quantity value of a measurand
Note: The accuracy should be given for:

a) Accuracy of voltage measurements;
b) Accuracy of current measurements;
c) Accuracy of phase angle measurements;
d) Accuracy of frequency measurements;
e) Accuracy of active power / energy measurements;
f) Accuracy of reactive power / energy measurements;
g) Accuracy of apparent power / energy measurements.

3.4.5 Accuracy of a complete MTS

The accuracy of the MTS considering the accuracy of the standard meter, the accuracy of the calculation system (if any), and the accuracy of the test signals including the differences between the test positions

Note 1: Quantitative validations and qualifications should be done. The accuracy of the complete MTS may be close to the accuracy of the standard meter if:

- all differences between the accuracy of the standard meter are considered in the calculations;
- the MTS is designed for testing a small number of meters at a time;
- the manufacturer made efforts to reduce the voltage differences between the terminals of the standard meter and the terminals of the MUTs;
- The manufacturer made efforts to compensate or minimize variations caused by the error calculation system.

Note 2: The manufacturer has to specify both kinds of accuracies: that of the standard meter and that of the MTS.

3.5 Definitions related to testing

3.5.1 Type test

Series of tests carried out on one meter or a small number of meters of the same type having identical characteristics, selected by manufacturer to prove conformity with all the requirements of this standard for the relevant class of meter. These are intended to prove the general qualities and design of a given type of meter. [SOURCE: definition as per 3.7.1 of IS13779]

3.5.2 Routine test

Tests carried out on each meter to check conformity with the requirements of this standard in aspects which are likely to vary during production.
[SOURCE: definition as per 3.7.2 of IS13779]

3.5.3 Acceptance test

Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

NOTE — however specific qualities and design of the meters in a lot can be conclusively proved by performing relevant type test(s) on a number of samples if agreed by the user and the supplier. [SOURCE: definition as per 3.7.3 of IS13779]

3.5.4 Verification (or calibration)

Set of operations which is used to check whether the indications, under specified conditions, correspond with a given set of known measurands within the limits of a predetermined calibration diagram.
[SOURCE: IEV 311-01-13]

3.5.5 Commissioning test

Test on an item carried out on site, to prove that it is correctly installed and can operate correctly.
[SOURCE: IEV 151-16-24]

3.5.6 Maintenance test

Test carried out periodically on an item to verify that its performance remains within specified limits, after having made certain adjustments, if necessary
[SOURCE: IEV 151-16-25]

3.5.7 Power x Time Measurement Method (Wattmeter Method)

A method by which the energy supplied to the meter(s) under test is determined by the product of a known constant power and a known interval of time.

3.5.8 Energy Comparison Measurement Method (Standard Meter Method)

A method by which a known amount of energy is supplied to the meter(s) under test.

3.5.9 Basic Measurements

Minimum Measurements to be made before commencing service from a new MTS

3.5.10 Control Measurements

Measurements for periodical check on the accuracy of MTS while in service.

3.5.11 Skilled operator

A skilled operator is any operator who has special skill, training, knowledge which they can apply to their work of calibration and testing.

3.6 Definitions related to field (onsite) installations testing

3.6.1 Electro mechanical Meter

Meter in which currents in fixed coils react with the current included in the conducting moving element, generally (a) disc(s), which causes their movement proportional to the energy to be measured. [IEC 62052-11, 3.1.1]

3.6.2 Static Meter

Meter in which currents and voltage act on solid state (electronic) elements to produce an output proportional to energy to be measured. [IEC 62052-11, 3.1.1]

3.6.3 Current transformer (CT)

An instrument transformer in which the secondary current, in normal condition of use, is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections.
[Source: IEV 312-02-01]

3.6.4 Voltage transformer (PT)

An instrument transformer in which the secondary voltage, in normal condition of use, is substantially proportional to the primary voltage and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections.
[Source: IEV 312-03-01]

3.6.5 Nominal burden SN

The burden or burden range in VA at secondary rated voltage for PT or current for CT indicated on the type plate of the measuring transformer. The specification of the measuring transformer based on this burden resp. burden range. Therefore the measuring transformer must be loaded with an impedance inside this range.

3.6.6 Operating burden Sn

Under the operating condition of the measuring transformer with reference meter measured burden in VA related to the secondary rated voltage for PT or current for CT.

3.6.7 Current measuring clamps

Inductive or with other alternating procedure working current transformer for measuring of test current which cannot connected direct to the reference meter.
The current measuring clamps are looped around the current leading wire. The measuring value of the clamp to the reference meter is proportional to the wire current and can be an AC current, DC current, DC voltage or their digital information.

3.6.8 Voltage measuring transformer

Inductive or with other alternating procedure working voltage transformer for measuring of test voltage which cannot connected direct to the reference meter.
The voltage measuring clamps are connected direct to the voltage leading wire. The measuring value of the clamp to the reference meter is proportional.

4. Components of meter test system

4.1 Laboratory Meter Test System

Laboratory Meter test Systems (MTS) are assemblies of sources, standard meter, error calculators and indication systems to supply test parameters to and determine error of the MUT. This assembly of MTS may be integrated in one unit or separate units.

The measuring procedures shall preferably automated. These AMTS are MTS which conducts, controls and monitors the desired function(s) of meter testing through software/firmware. These activities generally include the following minimum tasks:

- Setting, generating, monitoring and controlling the test parameter(s), within defined limits and tolerances;
- Carrying out the test automatically, measuring, calculating and indicating the error of the MUT;
- Storing and reporting the results in a non-editable and reusable database.

The purchaser and the supplier may mutually agree for further automation such as connecting the meter and performing other activities automatically using agreed methods or techniques.

The AMTS generally includes the following components:

- Source;
- Standard meter;
- Scanning heads to detect the meter pulses or rotor marks;
- Error calculation system;
- Meter mounting fixtures;
- MSVT/ICTs (Refer note 1);
- Interface for data read outs of meter under test;
- Software.

Note 1: MSVT (Multi secondary voltage transformer) or ICTs (Isolating current transformer) have to be included in the AMTS if more than 1 meter under test with permanent closed link to be tested. Both transformer types are described and specified in Annex F and Annex G.
Note 2: To determine the error of the meters under test, scanning heads may be replaced by register readings via interfaces of the AMTS if sufficient synchronism of the readings and/or sufficient register resolution in the MUT can be achieved.
Note 3: Data read out ports have to be agreed between manufacturer and user.

4.2 Onsite (portable) Meter Test System

Onsite (Portable) Meter test systems are assemblies of portable Standard Meter, portable sources, and the basic design of onsite (portable) test system shall be consisting of inbuilt error calculator, display and connection panel. Onsite meter test system shall be suitable to carry to meter installations for testing of energy meter or complete installation at onsite. Testing of energy meter or the complete installation can be carried out on running load or on desired load point using portable power source (phantom loading set).
Generally include the following minimum tasks:

- Connection to onsite with meter or installation, measuring, calculating and indicating the error of the MUT;

Storing and reporting the results in a non-editable and reusable database. The purchaser and the supplier may mutually agree for further features performing other activities using agreed methods or techniques.

The Onsite Meter test system generally includes the following components:

- Portable Standard meter
- Portable Power Source (option)
- Software

Note 1: Instead of separate sources and standard meters also combined devices (Calibrators) can be applied. Accuracy and environmental tests of both -sources and standard meters- are applicable for calibrators.

5. Meter test methods

5.1 Introduction

The test methods described below can be used for all tests required for testing the MUTs. Modified or other test methods validated by National/International standards or publications, which fulfill the same requirements, may also be applied.
The test points and the required stability of the test signals shall be as specified in clause 6.2. The required accuracy of the standard meter and the complete MTS shall be as specified in Table 19 and Table 21.

5.2 Energy comparison method

A method by which a known amount of energy is supplied both to the MUT and the standard meter. This kind of test is also known as "register test" or "dial Test". The percentage error for energy comparisons is calculated as follows:

$$\delta W_{MUT} = \frac{W_{MUT} - W_{st}}{W_{st}} \, . \, 100\% \qquad \textit{Equation 11}$$

Where:

- δWMUT is the error of MUT in %;
- WMUT is the energy recorded by the MUT in kWh / kVArh / kVAh;
- Wst is the energy recorded by the standard meter in kWh / kVArh / kVAh.

Sufficient test duration shall be selected in order to minimize errors caused by switching on-off & filter effect in the standard meter.

5.3 Power – time measurement method (watt-meter method)

A method by which the energy supplied to the meter(s) under test is determined by the product of a known constant power and a known interval of time.

$$\delta W_{MUT} = \frac{W_{MUT} - P_{st} . t}{P_{st} . t} \, . \, 100\% \qquad \textit{Equation 12}$$

Where:
WMUT is the energy recorded by the MUT
Pst is the power recorded by the standard meter, used for control the Constance.
t is the measuring time interval

Note 1: This method requires highly stable sources and accurate time controls.
Note 2: The overall uncertainties due to the stability of power and time intervals have to be considered.
Note 3: Due to the increased accuracy of electronic DTUs this method is seldom used.
Note 4: The measuring time should guarantee in minimum a progress of 200 digits of the lowest register value, to reach a suitable measuring resolution accuracy.

5.4 Pulse comparison method

For this method pulses of an energy proportional pulse output of a standard meter are counted by a pulse counting device. The counter is started by a 1st pulse from MUT and is stopped after completion of a given number of pulses from the MUT.
Pulses from energy meters can be generated with help of a scanning head, based on sensing the rotor mark, or in case of static meters by a blinking LED or an electrical pulse output. A suitable pulse adapter is needed.
For counting the pulses delivered by the standard meter the following conditions shall be met: the test duration, at each test point, shall be selected so that the resolution error determined by the number of pulses from the standard meter shall be less than 1% of the accuracy class of the MUT. In case the manual or type approval of the MUT indicates a minimum test time e.g. to fulfil the legal metrology requirements this time shall be used.
The percentage error of MUT can be calculated from the nominal and actual number of pulses counted during the measurement period, as per the formula given below:

$$\delta W_{MUT} = \frac{N_{nom} - N_{act}}{N_{act}} \,.\, 100\% \qquad \textit{Equation 13}$$

Where:
δWMUT = is the error of MUT in %
Nact is the number of pulses actually received from the standard meter during the test
Nnom is the number of pulses from the standard meter expected for the given measuring period.

$$N_{nom} = \frac{3600\,.1000.\,N_{MUT}.\,f_{nom}}{m.\,U_r.\,I_r.\,c_m} \qquad \textit{Equation 14}$$

Where:
NMUT is the number of pulses (or revolutions) of MUT.
fnom is the power proportional frequency output of standard meter;
m is the number of phases;
Ur is the voltage range of standard meter;
Ir is the current range of standard meter;
cm is the meter constant of MUT in [1/kWh] or [1/kVArh] or [1/kVAh].

If the error of the standard meter (δWst) needs to be considered determining the total error of MUT the formula above has to be adapted by an additional term as follows:

$$\delta W_{MUT} = \left[\left(\frac{N_{nom} - N_{act}}{N_{act}}\right) + \left(\frac{N_{nom}}{N_{act}} . \frac{\delta W_{st}}{100\%}\right)\right] . 100\% \qquad \textit{Equation 15}$$

Where
δWMUT is the error of MUT in %
δWst is the error of the standard meter in % (taken from calibration certificate).

5.5 Method for onsite meter testing

Before the beginning of the test the skilled operator must familiarize himself with the connection diagram of the electricity meter installation by the available documentation and marking.

From the documentation must be identified clearly:
- Connection diagram of the electricity meter installation
- rating of instrument transformers
-

For electricity meter installations must be made sure that:
- Electricity meter is connected in the correct phase sequence
- Polarity of the phases is not changed
- Screws of the connecting terminals are tightened

5.5.1 Checking of Wiring for connection of reference meter

Checking of Wiring must be done to check for possibilities of wiring errors of the electricity meter installation according to type of installations:

- One or several voltage phases are not connected or interrupted
- One or several current phases are not connected or interrupted
- One or several current phases polarity is changed
- Voltage phases are changed
- Current phases are changed
- Voltage phases are changed cyclically
- Current phases are changed cyclically
- Voltage neutral is not connected

Note: in case of any abnormality in wiring of the installed meter is noticed, the same shall be recorded and reported. The decision on conducting the test under the incorrect wiring or after correcting the wiring shall be based on agreement between utility and test laboratory.

The connection of the reference meter (measuring point) is carried out near the MUT terminals or extended terminals. The connection of the test current to the reference meter can be done directly or using current measuring clamps.
Checking of Wiring can be done by reading the measuring values for current, voltage, power and phase angles as well as the vector diagram. The measuring values found out must be recorded.

5.5.2 The measuring error for electricity meter at installation:

The meter test system used for testing electricity meters at installation as per IS 15707 shall comply with this standard.

5.5.3 Total measuring error of the electricity meter (LT CT operated) installations.

The meter test system used for testing electricity meters along with LT CT as per IS 15707 shall comply with this standard.

5.6 Testing of smart meter / communicable meters

Test system may have capability to test smart meters complies with IS16444 (part 1 and Part 2) and IS15959 (part 1, 2 and 3). The test shall be performed to prove the functionality of smart meters as per IS16444 (part 1 and 2) and IS15959 (Part 1, 2 and 3), refer Informative Annex I

Following facility may be included as a part of smart meter testing:

5.6.1 Intensity test of optical data interface

Refer clause 4.3.5.2 of IS/IEC62056-21.

5.6.2 End to End testing

Refer Informative Annex I

5.6.3 Test for parameter verification as per IS15959 (part 2 and 3) of implemented commands

Refer Informative Annex I

5.6.4 Functional test

The Test system shall perform all the routine functional test as mentioned below simultaneously on all connected meters on the test bench over the communication port.

5.6.4.1 As per Table A30 of IS15959 Part2 and Table 29 of IS15959 Part3

Test shall be performed as per informative Annex I

5.6.4.2 Recommended test facility as per IS15959 part 2 and 3

Test shall be performed as per informative Annex I

5.6.5 Provision for Burden measurement of the smart meter:

Facility to measure burden (power consumption) as per clause no 6.10.1 of IS16444 (part 1and 2) using suitable methods:
The power consumption in voltage circuit has to be measured in following conditions:

- During idle mode of communication module
- If a separate module to service a IHD is present
- During data transmission per communication module.

Under each of above mentioned condition the burden measurement in the voltage circuit shall be performed

Also provision for Burden measurement in current circuit shall be provided with Test System.

5.6.6 Verification of electrical tamper conditions.

Test shall be performed as per informative Annex I

5.6.7 Influence of metrological stress on communication

Test shall be performed as per informative Annex I

5.6.8 Automatic testing of Communication:

Test shall be performed as per informative Annex I

6. Standard electrical values

6.1 Mains supply

The mains supply voltage shall be sufficiently stable to ensure a suitable accuracy of all components of the MTS necessary for testing meters of the given accuracy class. If necessary, mains supply voltage regulators shall be used with stationary equipment. The requirement are shown in Table 2.

Table 2 Mains power supply condition

Parameter	Value
Supply voltage Un	230 V
Variation in supply voltage	0.85 Un to 1.1 Un
Frequency fn	50Hz
Frequency range	fn ± 2%
Power consumption	Shall be specified by the manufacturer
Neutral to ground voltage	< 2V
Voltage quality of mains supply	As specified in IS12360

Note: The MTS manufacturer may specify equipment to operate correctly under the mains conditions beyond specified above; however under such conditions the performance of MTS shall be within the specified limits in this standard.

6.2 Output values and ranges of the test circuits

6.2.1 Test voltage circuit

The test voltage circuit shall provide output voltage range as required for testing of meter as per relevant MUT standard to ensure suitable load conditions and accuracy. The requirement are shown in Table 3

Table 3 Test voltage circuit each phase

Parameter	Standard Electricity meter			Smart and prepayment Electricity meter	
	Direct connected meter	LT-CT operated Meter	CT-PT operated meter	Direct connected meter	Transformer operated Meter
Test circuit voltage range, U (r.m.s. Phase to neutral voltage):	30V to 300V		30 to 85V	30V to 300V	30V to 85V
Setting resolution	0.1V		0.01V	0.1V	0.01V
Accuracy of the amplitude	± 0.1 % of the test value				

Stability (S) of the amplitude	<100 x 10-6 (with T = 60 s, N = 10) <500 x 10-6 (with T = 5 s, N = 24)	
Distortion factor at linear load	< 0.5%	
Maximum d.c. voltage permitted	<0.2%	
Minimum output power per meter test position	15 VA r.m.s at the high end of the voltage range and at resistive loads	25 VA r.m.s at the high end of the voltage range and at resistive loads
Protection	The output circuit shall be protected against short circuit and overload	
NOTE 1 The value in above table are indicative, covering the requirement of directed connected and transformer operated meters requirement as per relevant Indian Standard. The values beyond this can be agreed between purchaser and manufacturer. NOTE 2 The purchaser should specify if the MTS should be designed for single phase or three phase meter testing. The values given above shall be valid for each phase. NOTE3 The purchaser and the manufacturer may agree for any suitable value for output power considering the peak current drawn by the power supply of MUTs. NOTE4 A particular MTS may be suitable to cover more than one standard covering all ranges required by different metering standards		

6.2.2 Test current circuit

The test current circuit shall provide several current ranges to ensure suitable load conditions and accuracy. The requirement are given in Table 4

Table 4 Test current circuit each phase

Parameter	**Standard Electricity meter**			**Smart and prepayment Electricity meter**	
	Direct connected meter	LT-CT operated Meter	CT-PT operated meter	Direct connected meter	Transformer operated Meter
Test circuit current range I: r.m.s value	5mA to 100A	5mA to 10A	1mA to 10A	5mA to 100A	1mA to 10A
Setting resolution	0.1mA to 10 mA (depending on range)				
Accuracy of amplitude of I	±1.0 % (1 mA ≤ I <10 mA) ± 0.5% (10 mA ≤ I < 50 mA) ± 0.1% (50 mA ≤ I < 100 A)				
Stability (S) of amplitude	< 100 x 10-6 (with T = 60s, N = 10) < 500 x 10-6 (with T = 5s, N = 24) for I > 50 mA				
Distortion factor at linear load	< 0.5%				
Maximum permitted DC current	< 0.1 % of test current				

Minimum output power per meter test position.	Minimum 30 VA r.m.s at the end of range and at resistive loads
Protection	Output circuit shall be protected against open circuit and overload
NOTE 1 The value in above table are indicative, covering the requirement of directed connected and transformer operated meters requirement as per relevant Indian Standard. The values beyond this can be agreed between purchaser and manufacturer. NOTE 2 The purchaser should specify if the MTS shall be designed for single phase meter testing or three phase meter testing. The values given above shall be valid for each phase. NOTE 3 The values mentioned above are indicative and considering ideal conditions. The purchaser and the manufacturer may agree on any suitable value for maximum current and / or power ratings, considering distance, connectivity and the use of isolating current transformers. NOTE 4 A particular MTS may be suitable to cover more than one standard covering all ranges required by different metering standards. NOTE 5 The above specified VA rating shall be available at the terminals for connection of each MUT position.	

(Values are taken from IEC 62057-1 standard)

6.2.3 Phase angle

The requirement are given in Table 5.

Table 5 Setting of phase angle between each phase voltage and current circuit

Parameter	**Limits**
Range of phase angle	0 to 360 deg
Setting resolution	0.01°
Stability (S) of the angle setting	0.1° (with T = 60s, N = 10)
Accuracy of setting	± 0.1°
Angle between phase voltages	120 deg ± 1deg

(Values are taken from IEC 62057-1 standard)

6.2.4 Frequency

The requirement are given in Table 6.

Table 6 Setting of frequency

Parameter	**Value**
Range of frequency	As per requirement of relevant MUT standard
Setting resolution	0.01 Hz
Stability (S) of the frequency setting	0.1 Hz (for an integration time T = 60s, N = 10)
Accuracy of setting	± 0.01 Hz

The values are specified considering the overall uncertainty measurement requirement of metrology test.

6.2.5 Harmonics

The superimposition of harmonics may be possible in voltage and current circuit. The requirement are given in Table 7.

Table 7 Setting of harmonics

Parameter	Value
Harmonic range (frequency and amplitude)	As per requirement of relevant MUT standard
Setting resolution	Maximum 1% of fundamental frequency amplitude
Phase angle with respect to fundamental frequency	0° to 180°
Accuracy of setting	Amplitude: 1% Phase angle: 1° related to fundamental
NOTE The source may be capable to generate signal of Odd harmonics and Sub harmonics according to Annex C (informative). Generation of higher harmonic may be agreed between the purchaser and the manufacturer.	

(Values are taken from IEC 62057-1 standard

6.3 Standard meter

6.3.1 Accuracy class

The accuracy of the standard meter should be 10 times better than the accuracy class of the MUT. To meet the better uncertainty requirement for metrology, reference meter are also available. However in case of higher accuracy class of DUC then next higher available accuracy shall be selected. The recommended accuracy classes for the reference meter as per Table 18 are 0.01%, 0.02%, 0.05%, 0.1% and 0.2%. Other accuracy classes can be agreed between the purchaser and manufacturer.

6.3.2 Standard electrical values

The standard electrical values for standard meter are given in Table 8.

Table 8 Standard electrical values for the standard meter

Parameter	**Standard value**
Mains supply	Un (as defined in 6.1)
Voltage measuring range	30 V to 300 V (phase to neutral) [1)]
Current measuring range	1 mA to 120 A
Frequency measuring range	45 Hz to 55 Hz
Minimum frequency bandwidth	Up to 1050 Hz (21st harmonic of 50 Hz)
Measurement mode for single phase MTS	1 ph 2 wire active / reactive
Measurement mode for three phase MTS	1 ph 2 wire active / reactive 3 ph 4 wire active / reactive and apparent 3 ph 3 wire active / reactive and apparent
Frequency output	The standard meter shall provide a power proportional frequency output for calibration and measuring purposes.

Interface	The standard meter shall have interface(s) for communication & control
1)The maximum value of current and voltage can be mutually agreed between purchaser and manufacturer	

(Values are taken from IEC 62057-1 standard)

6.4 Magnetic field of the MTS

The magnetic induction produced by the MTS at the position of the meter(s) under test and given current and frequency ranges according to Table 8 shall not exceed the following values:

For $I \leq 120$ A $\quad$ B ≤ 0.05 mT

(As per limits specified in Reference condition table of IS13779:2020 and IS14697:2021)

Where:

- *I* is the output current of the MTS;
- B is the magnetic induction in air due to the magnetic field ($B = \mu_0 H$).
- The test shall be performed without MUT and current circuit shall be short circuited.

6.5 Electrical and mechanical values for the scanning head(s)

Table 9 Electrical and mechanical values for the scanning head(s)

Parameter	**Standard value**
Receiver diode	To sense the optical test output according to IEC 62052-11 clauses 5.11.1 & 5.11.2
Distance to the LED of the MUT	From 10 mm to minimum 60mm
Minimum impulse duration detection	100 µs for LED sensing of electronic MUT
Distance to rotor disk	Up to 45 mm
1) If the LED of the MUT radiates with the maximum strength specified in IEC 62052-11 & IS15884 (1000 µW / cm²) the distance rises to 60 mm. 2) In case of changes in the IEC62052-11 the relevant changes will be applicable.	

6.6 Error calculation system

6.6.1 Functional requirements

The error calculation system receives pulses from the scanning head(s) or from the pulse output of the MUT(s) and compares those with pulses received from the standard meter. The error calculation system shall be able to count pulses and to calculate and indicate the percentage error of one or more MUTs.

This system shall have the following standard functions:

- The system shall indicate, for each MUT, the error along with the sign (+ or -);
- A reset function shall be available allowing to reset the error indication in the case the error measurement is wrong for any reason;
- The system shall provide the parameters of the error calculation process for verification purposes.

Additional functionalities may be agreed between purchaser and manufacturer.

Error shall be displayed with suitable indicator at each meter test position for MUT. The error indication shall be clearly visible to the operator from viewing angle of 170 degree.

6.6.2 Electrical values for error calculation system

Table 10 Electrical values for the error calculation system

Parameter	Standard value
Pulse frequency range, which the system shall be able to count	0 to 1 kHz
Resolution of error indication	Minimum 0.01 %
Indication of the error	± indication, digits and unit in %
Accuracy	± 1digit of the lowest digit

7. Constructional requirements of the MTS

7.1 General requirements

The MTS shall be of protective class I according to IEC 61140 (clause no. 7.3) or protective class II according to IEC 61140 (clause no. 7.4). All parts which are subject to corrosion under normal working condition shall be protected effectively. Any protective coating shall not be liable for damage by ordinary handling nor damages due to exposure to air under normal working conditions.

IP class for Laboratory MTS shall be IP20 or higher. For Onsite equipment IP class shall be IP51 with carrying case and IP20 or higher without carrying case as to be used in operating condition.

As per IEC 60664-1 Over voltage category CATIII or higher shall be provided for onsite equipment. Over voltage category CAT-II or higher shall be provided for Laboratory Equipment.

7.2 Source and standard meter

The source and the standard meter may constitute a stand-alone unit or they may be located in the meter mounting system. If they are permanently connected to the MTS, then MTS shall have a protective connection terminal to Connect MUT with it. Operator shall be prevented to expose to live parts in normal operation.

Connection among reference meter, source and MUT shall not be exposed and shall not be hazardous to operator.

Protective earthing on MTS shall be provided according to Category of Protection.

The standard meter shall have frequency output proportional to measured power/energy for its calibration with higher accuracy standards.

7.3 Meter mounting system

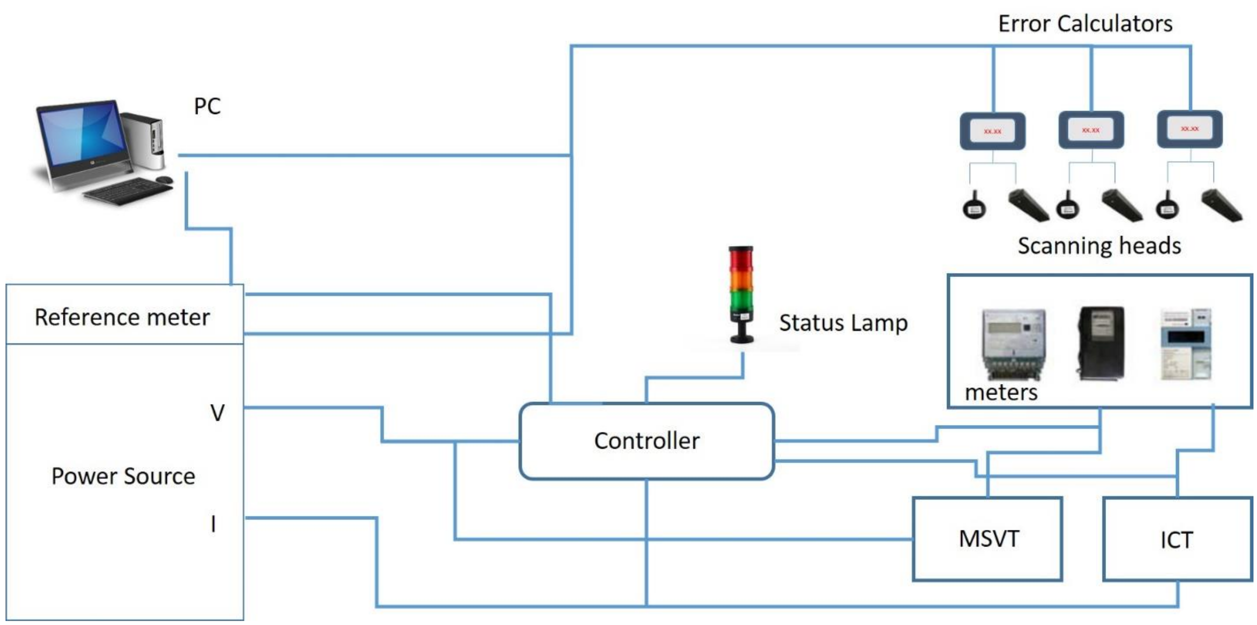
7.3.1 General

The meter mounting system is a rack including the necessary constructional requisites and the connections, designed to allow meters to be tested under the test conditions specified in the relevant standards. The wiring layout and cross sections should be suitably selected in order to minimize voltage drop, power losses, magnetic induction and capacitive interference.

It shall be designed to accommodate the number of MUTs specified, together with the scanning heads, error calculation and display units, and, when required, secondary voltage transformers (MSVT) and / or isolated current transformers (ICT) for each MUT position.

The design of the bench shall be agreed by the manufacturer and purchaser.

Figure 1- Block diagram of Lab MTS



7.3.2 Terminals

7.3.2.1 General

The purchaser and the manufacturer shall agree on the terminals where the output values of the MTS are specified. All the terminals shall be safety terminals i.e. no live parts shall be exposed.

NOTE: These terminals may be the terminals of the source or one of the MUT positions.

All parts of each terminal shall be such that the risk of corrosion/oxidation resulting from contact with any other metal part is minimized.

Electrical connections shall be designed to avoid contact pressure transmitted through too flexible insulating material.

7.3.2.2 Test voltage output terminals

Each meter test position shall have voltage output terminals, according to the number of phases. These terminals may be connected in parallel to the voltage source directly, or via MSVTs. Normally In case of single phase meter secondary terminals of the ICT cables do not match with the size of low rating single phase meters and/or sufficient VA rating are not available, to meet the VA burden and connection requirement, the MSVT shall be used.

The terminals shall be equipped with sockets of 1000V, CAT III according to IEC 61010-031, 6.5.2.1 that prevent an accidental touch of hazardous live parts.

The wiring shall ensure that the accuracy requirements and the reference test conditions are met at each meter test position.

In case of MSVT it should meet requirement of Annex E

NOTE: Voltage cables supplied with the MTS shall be rated for the maximum test voltages and shall meet the requirement of CATIII, 300V as per IEC61010-1.

7.3.2.3 Test current terminals

The meter mounting system shall have current in and output terminals according to the number of phases. These terminals may be connected in series to the current source directly, or via ICTs (refer to Annex F). In case of voltage and current terminals of meter under test are permanently connected or inseparable, ICT shall be used as isolation medium.
The current terminals shall be able to carry the maximum test currents continuously, without forced cooling condition under the operating conditions specified.

It shall be possible to open the current circuits without dangerous voltages arising.

NOTE: The manufacturer and the purchaser may agree on the connection method for example using free wiring or quick connectors. Quick connectors is a pre-assembly of prongs designed for the terminal block of MUT. By means of a mechanical lifter all prongs contact the terminal of the terminal block simultaneously.

7.3.2.4 Onsite Meter test system with carrying case

The case of the portable reference meter/power source must be adapted to the environmental conditions of the electricity meter installation for which they may be used.
For transportation the portable reference meter must be resistant against the listed vibration and shock conditions in without influence on function and accuracy. If required these conditions can be achieved by a suitable protection case. Protective class shall be as per clause 7.1.

Portable Reference meter/source with carrying case (if specified by manufacturer) shall confirm to following requirement.

7.3.2.4.1 Vibration:

The test shall be carried out as per IS 9000 (Part 8) under the following conditions:

a) MTS in non-operation condition with carrying case in position as preferred by manufacturer during transportation

b) Frequency range: 10 – 150 – 10 Hz.

c) Transition frequency (*f*): 60 ± 3 Hz.

d) Frequency below *f*: constant amplitude of movement 0.15 mm

e) Frequency above *f*: constant acceleration 2 g (1g = 9.8 m/s2)

f) Single point control

g) Number of sweep cycles per axis: 10

NOTE — 10 sweep cycles = 75 minutes

7.3.2.4.2 Shock

The test shall be carried out as per IS 9000 (Part 7/Sec 1) under the following conditions:

a) MTS in non-operation condition with carrying case;

b) Half-sine pulse;

c) Peak acceleration: 40 g (400 m/s2); and

d) Duration of the pulse: 18 ms

Number of shock: two in both direction of three mutual perpendicular axes (Total of 12 shocks).

For both test mentioned above, after the test the equipment shall functional properly and performance of the equipment shall not be degraded.

8. Information and Marking requirement

8.1 General

NOTE: This clause 8 is based on the following references:

- IEC 62052-11 sub-clause 5.12, IEC 62052-21 sub-clause 5.12, IEC 62055-31 sub-clause 5.13; IEC 62052-31
- IS 13779:2000 clause no. 7, IS 14697 :1999 clause no. 7, IS 15884,
- IEC 61010-1 clause 5; and
- IEC 62477-1 Clause 6

The purpose of this Clause is to define the information necessary for the safe selection, installation and commissioning, use, and maintenance of a MTS. The required information is presented in Table 11 showing where the information shall be provided, with reference to explanatory sub-clauses.

The requirements of this Clause 8 apply to all MTS, unless otherwise stated.

All information shall be in an appropriate language, and documents shall have identification references.

Table 11 Information requirements

Information For selection	**Sub-clause reference**	**Location a b**				**Technical sub-clause reference**
		C	**IM**	**UM**	**MM**	
General information						
Manufacturer's name or trade mark		X	X	X	X	
Designation of function, and type		X	X	X	X	
Space for approval mark (if any)		X	X	X	X	
Place of manufacture		X				
Serial number	8.3	X				
Protective class		(X)	X		X	8.4.4.1
Environmental conditions, storage			X		X	9.1
Environmental conditions, operation			X		X	9.1
Reference temperature if different from 23 °C			X		X	9.1

Information For selection	Sub-clause reference	Location a b				Technical sub-clause reference
		C	IM	UM	MM	
Owner specified information						
Reference to standards			X		X	
Reference to instructions			X	X	X	
Fuse ratings		X	X	X	X	
Supply voltage, frequency, max. apparent power, number of phases		X	X	X	X	6.1
For standard meters	8.3.2, 8.3.3					
Measuring voltage range		X	X	X	X	6.3.2
Measuring current range		X	X	X	X	6.3.2
Measuring frequency range		X	X	X	X	6.3.2
Number of phases, number of wires, service type(s)			X	X	X	6.3.2
Accuracy		X	X	X	X	6.3.1
For sources, generators	8.3.4					
Voltage, Current and Power		X	X	X	X	6.2.1, 6.2.2, 6.2.3
Product specific markings		X	X	X	X	
ICTs and MSVTs	8.3.5					
Measuring range		X	X	X	X	E.4.1
Frequency range		X	X	X	X	E.4.1
Accuracy		X		X		E.4.1
Output power		X	X	X	X	E.4.1
For Clamp on Transformers	8.3.6					
Accuracy		X	X	X	X	
Rating		X	X	X	X	
Insulation class (category)		X		X		
For the communication interfaces and error calculators	8.3.7					
Product specific markings		X	X	X	X	
Communication medium		X	X	X	X	
For meter installations	8.3.8					
For installation and commissioning	8.4					
Dimensions and mass	8.4.2		X		X	
Connection requirements	8.4.3		X			
Connecting cables identification	8.4.3.2	X	X		X	
Connection and wiring diagrams	8.4.3.3		X		X	
Auxiliary terminals	8.4.3.4	X	X		X	
Protection requirements	8.4.4	X				
Protective class and earthing	8.4.4.1		X		X	
Self-consumption	8.4.5		X		X	
For user						
General	8.5			X		

Information For selection	Sub-clause reference	Location a b				Technical sub-clause reference
		C	IM	UM	MM	
Display, push buttons and other controls	8.5.2			X		
Connection to other equipment	8.5.3			X		
External protection devices	8.5.4			X		
Cleaning	8.5.5			X		
For maintenance	8.5.6				X	

a Location:
C= Case. These markings may appear on nameplate(s) or may be carried by the unit cover(s) in a permanent manner;
IM = Installation manual;
UM = User's manual;
MM = Maintenance manual.
b The installation, user's and maintenance manuals may be combined as appropriate and, if acceptable to the customer, may be supplied in electronic format.
X – for all type of equipment
(X) – only for portable onsite equipment

8.2 Labels, signs and signals

Labelling shall be in accordance with good ergonomic principles so that notices, controls, indications, test facilities etc. are sensibly placed and logically grouped to facilitate correct and unambiguous identification.
All safety related equipment labels should be placed in such a way that they will be readily visible to the intended viewer and alert the viewer to any hazard in time to take appropriate action.
Graphic symbols shall conform to IEC 62053-52, IEC 60417, IEC 60617, ISO 7000, as appropriate. IEC 60417-2 and ISO 7000 symbols that may be used on metering equipment are shown in Annex A. Symbols not shown in these standards shall be explained where used. There are no color requirements for symbols.

The documentation of the MTS equipment shall include a statement that it must be consulted in all cases where symbol 14 of Table 29 is marked, in order to find out the nature of the potential hazards and any actions which have to be taken to avoid them.

Safety signs shall comply with ISO 3864-1.

The signal words indicated hereinafter shall be used and the following hierarchy

DANGER to call attention to a high risk, for example: "High voltage";
WARNING to call attention to a medium risk, for example: "This surface can be hot."
CAUTION to call attention to a low risk, for example; "Some of the tests specified in this standard involve the use of processes imposing risks on persons concerned."

Danger, warning and caution markings on the metering equipment shall be prefixed with the word "DANGER", "WARNING", or "CAUTION" as appropriate in letters not less than 3.2 mm high. The remaining letters of such markings shall be not less than 1.6 mm high.

8.3 Information for selection

8.3.1 General

MTS shall be provided with information relating to its function, electrical characteristics and intended environment, so that its fitness for purpose can be determined. This information includes, but is not limited to the following.

8.3.2 General Information

For MTS equipment following general information shall be provided:

- Manufacturer's name or trade mark;
- Designation of type;

NOTE 1 Designation of the function shall be preferably in English language.

- Approval mark or space for it, if required;
- Place of manufacture, if required;
- Serial number;
- Protective class;
- Environmental conditions for storage;
- Reference temperature if different from 27 °C;
- Owner-specified information, as agreed by the manufacturer and the purchaser;
- Reference to instructions for installation, operation and maintenance.

8.3.3 Information related to standard meters

For standard meters, the following information shall be provided in accordance to the relevant product standards for the MUT:

- Measuring voltage,
- Measuring current;
- Frequency range;
- Service type. This implies:
    - The number of phases;
    - The number of wires for which the meter is suitable.
- Quantities measured. This implies:
    - Active energy;
    - Reactive energy;
    - Apparent energy;
    - Voltage;
    - Current;
    - Frequency;
    - Phase angle.
- Measuring principle (according to clause 3.2);
- Accuracy (related to the measured quantity).

8.3.4 Information related to sources, error calculator and frequency generators

The equipment includes frequency generators, error calculators and voltage and current sources. For these, the following information shall be provided:

- The type & value of auxiliary supply voltage (a.c. or d.c.);
- The measuring range (if applicable);
- The maximum power consumption

For sources, following additional information shall be provided:

- Output specifications for voltage ranges in respect to frequency;
- Output specifications for current ranges in respect to frequency;

For sources, the following information shall be suitably displayed:

- The active operating range;
- On/Off status;
- Faults;
- The actual value of voltage;
- The actual value current.
- The actual value of frequency

8.3.5 Information related to the ICTs and MSVTs

For ICTs and MSVTs, the following information shall be provided

- Voltage range / max. load and accuracy for MSVTs;
- Current range / max. load and accuracy for ICTs;
- Frequency range.

8.3.6 Information related to clamp on transformers

Connections of different current and voltage measuring clamps as well as connections with the same plug connector types and design must mechanically be fixed against wrong connection and shall be suitably marked for

- Polarity of cable passing/connecting
- Polarity of connector to equipment
- Primary Current/voltage range
- Secondary current/voltage range
- Accuracy (if any)
- Protection class

8.3.7 For the communication interfaces and error calculators

For these devices, the following information shall be provided:

- Communication medium and the relevant standard(s), status information.

8.3.8 For the meter installations

Suitable connection diagram to meter installation shall be elaborated in the equipment manual.

8.4 Information for installation and commissioning

8.4.1 General

Safe and reliable installation is the responsibility of the installer. The manufacturer of MTS shall provide information to support this task. This information shall be unambiguous, and may be in diagrammatic form.

NOTE Since any electrical equipment can be installed or operated in such a manner that hazardous conditions can occur, compliance with the requirements of this standard does not by itself assure a safe installation. However, when equipment complying with those requirements is properly selected and correctly installed, commissioned and used, the hazards will be minimized.

8.4.2 Dimensions and weight

The following information shall be provided by the manufacturer:

- Dimensions and layout.
- Weight

8.4.3 Connection

8.4.3.1 General

Information shall be provided to enable the installer to make safe electrical connections to the MTS. This shall include information for protection against hazards.

8.4.3.2 Connecting cables

NOTE: generally, national regulations are in place concerning electrical installations. These regulations, among others specify the type and size of the connection cables to be used.

The installation manual shall include a statement that the installer shall consult the local regulations. The installation manual shall contain recommendations for the type of connecting cables to be used. Recommended cable terminations and requirements for tightening torque values shall be specified as well wherever applicable. The cables and connections shall be CATII/CATIII/CATIV compliance and marking on it.

8.4.3.3 Connection diagrams

Every MTS shall be provided with a diagram of connections. If the terminals are marked, this marking shall appear on the diagram.

8.4.3.4 Auxiliary terminals

Terminals and connectors of auxiliary circuits shall be readily identifiable by the equipment markings. The following information shall be provided in the documentation as far as relevant for safety and as applicable:

- The function(s): e.g. pulse input/output, control input/output;
- The kind of the circuit(s), e.g. opto-coupler, relay, solid state relay;
- Kind of voltage (a.c. or d.c.), nominal, minimum and maximum voltages.
- Nominal and maximum frequency as applicable.

8.4.4 Protection

8.4.4.1 Protective class and earthing

Laboratory MTS may be connected to the mains via a plug or permanently. As the equipment is of protective class I a protective conductor shall be provided.

The installation manual shall include a statement how the earth wire is or shall be connected.

8.4.5 Self-consumption

For the supply circuits of the portable MTS and for auxiliary circuits the following information shall be provided in the instruction and maintenance manuals.

The maximum power consumption in watts (active power) or volt-amperes (apparent power), or the maximum rated input current, with all accessories or plug-in modules connected but without MUT

8.5 Information for use

8.5.1 General

The user's manual shall include all information regarding the safe operation of the MUT. In particular, it shall identify any hazardous materials and risks of electric shock, overheating, explosion, excessive acoustic noise, etc.

All safety marking shall be clearly explained.

The user’s manual shall also indicate any hazards, which can result from reasonably foreseeable misuse of the metering equipment.

8.5.2 Display, push buttons and other controls

The user’s manual shall provide a description of the main items that can be displayed/ visualized at the MTS.

8.5.3 Connection to user’s equipment

If connection of user’s equipment is possible, the necessary connection diagrams, the identification, marking and description of the connectors, and the necessary operations shall be provided.

The user’s manual shall also indicate any hazards, which can result from connecting user’s equipment.

8.5.4 External protection devices

If external protection devices such as fuses and circuit breakers may be operated by the user, then any safety hazards related to their operation shall be explained in the user’s manual of the MTS.

8.5.5 Cleaning

The user’s manual shall provide information for cleaning if applicable.

8.5.6 Information for maintenance

Safety information shall be provided in the installation and maintenance manuals including, the following (as and if applicable):

- Preventive maintenance procedures and schedules;
- Safety precautions during maintenance;
- Location of live parts that can be accessible during maintenance (for example, when covers are removed);
- Adjustment procedures;

- Sub-assembly and component repair and replacement procedures;
- Information on safe disposal of the equipment and any replaceable parts;
- Verification of the safe state of the equipment after repair;
- Any other relevant information.

9. Climatic conditions for the MTS

9.1 Normal environmental conditions

The MTS shall be designed to operate under the following climatic conditions.

Table 12 Normal Environmental condition

Parameter	For lab use	For Onsite use
Nominal Temperature for operation [note1]	15°C to 35 °C	0°C to 45 °C
Humidity	Per Annexure B of IS13779:2020	Per Annexure B of IS13779:2020
Climatic condition for storage & transport	Low air temperature (-) 25°C, High air temperature + 70 °C, high relative humidity 75% Storage and transport of the MTS at the extremes of this temperature range should only be for a maximum period of 6 h.	Low air temperature (-)25°C, High air temperature + 70 °C, high relative humidity 75% Storage and transport of the MTS at the extremes of this temperature range should only be for a maximum period of 6 h.
Limit range of operation	0°C to 45 °C	-10°C to +50 °C
a See IEC 60721-3-3: (IS 13736 latest amendment) b See IEC 60721-3-2.		
Note1: Accuracy may be deviated as per defined temperature coefficient as defined in this standard.		

9.2 Temperature limits

The temperature of easily touched surfaces shall not exceed the values of Table 12 at the maximum temperature of the operating range.

Table 13 Surface temperature limits

Part	**Limit Deg. C**
1) Outer surface of enclosure parts likely to be touched (approx. 1 s) a) metal, uncoated or anodized b) metal, coated (paint, nonmetallic) c) glass and ceramics d) plastics	 65 75 80 85
2) User operated devices a) metal b) glass and ceramics c) plastics	 55 65 70
NOTE: ISO13732-1 gives information about the effect of the duration of contact.	

(Values taken from IEC62057-1)

10. Electrical requirements of the MTS

10.1 Influence of mains supply

The MTS and its components shall be designed to work under the mains supply conditions as described Annexure B without affecting the guaranteed accuracy class.

10.2 Insulation

10.2.1 General

The MTS and its incorporated components shall retain adequate dielectric qualities under normal conditions of use.

10.2.2 Clearances and Creepage distances

Clearances and Creepage distances shall comply with the requirements of IEC 61010-1 for minimum overvoltage category II and with the requirements of IEC 61010-031 for measurement minimum category II.
For onsite testing equipment the minimum overvoltage category III.

10.2.3 Verification of clearances and creepage distances

10.2.3.1 Verification by measurement

Verification of clearances and creepage distances shall be performed as specified in IS/IEC 60664-1 sub-clause 6.2.

10.2.3.2 Verification of clearances using impulse voltage tests

The clearances shall be verified by performing the impulse voltage tests as specified in IEC 60664-1. These are type tests and refer to the single components of a MTS.

10.2.4 A.C. voltage test

10.2.4.1 Test voltage

Test has to perform in accordance to IEC62052-31 sub clause 6.10.2.5. The test voltage shall be substantially sinusoidal, having a frequency between 45 Hz and 65 Hz, and applied for 60s. The power source shall be capable of supplying at least 500 VA.

The source voltage shall be verified with an accuracy of better than 3%.

The voltage shall be applied to the test object starting at a value sufficiently low to prevent any effect of over voltages due to switching transients. It shall be maintained for the specified time and then rapidly decreased, but not suddenly interrupted as this may generate switching transients which could cause damage or erratic test results.

10.2.4.2 Performing the tests

The test voltages and the points of application are specified in Table 14.
Each component of the lab MTS shall be treated and tested as a MUT:

- Voltage and current source;
- Standard meter
- Meter test rack

Note: for Onsite testing portable equipment it shall be perform on reference meter or source wherever applicable.

For Onsite testing equipment:
The tests are carried out during the manufacturing of a newly manufactured meter test unit.
The test voltages and the points of application are specified in Table 14 (on standard meter and source).
Each test equipment shall be treated and tested individually as a single MUT:

- Portable source;
- Portable standard meter (if applicable)
- Portable Meter Test Unit

The tests are carried out during the manufacturing.

Table 14 A.C. voltage tests (Laboraotry Equipment)

Applies on component	**Test voltage kV Protective class I**	**Point of application of test voltage**
Meter test rack Without Source and Standard meter	2	Between, on the one hand, all the current and voltage circuits as well as the auxiliary circuits whose reference voltage is above 40 V, connected together, and, on the other hand, earth
	2	Between, on the one hand, any circuit whose reference voltage is above 40 V and, on the other hand, all other independent circuits whose reference voltage is above 40 V connected together.

During these tests no flashover, disruptive discharge or puncture shall occur.

Table 15 A.C. voltage tests (Onsite Equipment)

Applies on component	**Test voltage kV**	**Point of application of test voltage**
For **Protective class I** Source Standard meter	2	Between, on the one hand, all the current and voltage circuits as well as the auxiliary circuits whose reference voltage is above 40 V, connected together, and, on the other hand, earth
For **Protective class II or higher** Source Standard meter	4	Between, on the one hand, all the current and voltage circuits as well as the auxiliary circuits whose reference voltage is above 40 V, connected together, and, on the other hand, earth

10.2.5 Insulation Resistance test

10.2.5.1 Test voltage shall be 500 ± 50 V dc

10.2.5.2 Performing the tests

The test voltages and the points of application are specified in Table 16 Table 14.
Each component of the lab MTS shall be treated and tested as a MUT:

- Voltage and current source
- Standard meter
- Meter test rack

For Onsite testing equipment:
The tests are carried out during the manufacturing of a newly manufactured meter test unit.
The test voltages and the points of application are specified in Table 16 (on standard meter and source).
If reference meter and source are separate units, each test equipment shall be treated and tested individually as a single MUT:

- Portable source;
- Portable standard meter (if applicable)
- Portable Meter Test Unit

The tests are carried out during the manufacturing.

Table 16 Insulation resistance test

Test voltage	**Point of application of test voltage**	**Insulation resistance**
500 ± 50 V dc	Between, on the one hand, all the current and voltage circuits as well as the auxiliary circuits whose reference voltage is above 40 V, connected together, and, on the other hand, earth.	5 MΩ
	Between circuits not intended to be connected together in service.	50 MΩ

11. Electromagnetic compatibility

11.1 General requirements

The MTS shall be designed in such a way that conducted or radiated electromagnetic phenomena and electrostatic discharge neither damage nor subsequently influence the function and the accuracy. The MTS shall meet the requirements for light industrial EMC environments. However, RF transmitters such as mobile telephones shall not be used in close proximity of the MTS.
The phenomena and test levels shall be as specified in IEC 61326-1 Table 1, unless otherwise specified in the following sub-clauses.
Short duration electromagnetic phenomena are considered as disturbance and the performance criteria specified in IEC 61326-1 Table 1 apply.
Continuous and long duration electromagnetic phenomena are considered as influence quantities and the accuracy requirements for the standard meter are specified in Table 17 for these tests, the test points shall be as follows:

- I_n - nominal current of selected current range;

- *Un - nominal voltage of selected voltage range;*

The test points shall be for Onsite testing/ Lab testing equipment:

- In = 5 A;
- Un = 240/110 V (user shall define as applicable);
- Frequency =50 Hz
- Auxiliary circuits energized with reference voltage (where applicable);
- Balanced voltage and current;
- Power factor cos ϕ = 1 and sin ϕ = 1.

NOTE Standard meters may have several current ranges and voltage ranges, laboratory may select minimum and maximum ranges.

Table 17 Limits of variation of error of standard meters during immunity test

Phenomenon	Accuracy class of the standard meter used in the MTS				
	0.01	**0.02**	**0.05**	**0.1**	**0.2**
Electromagnetic RF fields	0.10	0.10	0.25	0.50	1.00
Conducted RF	0.10	0.10	0.25	0.50	1.00
Power frequency magnetic field test	0.10	0.10	0.25	0.50	1.00

Note: Appropriate methodology to be used to protect the cable carrying frequency/pulse output of EUT to Reference meter from getting influenced.

The definition of acceptance criteria is in line with the definition in IS13779/IS14697 and Table 17, the primary functions are the energy registration and the error calculation.

11.2 General test conditions

The EMC tests may not be possible to perform on the complete MTS. Therefore, each component may be treated and tested separately as a EUT.

Unless otherwise specified, the MTS shall be tested as floor mounted. In case of separate component wise testing, it may be tested as table-top equipment, in their normal working position and operating condition. All parts intended to be earthed shall be earthed.
Wherever the performance post EMC-EMI test is not possible to check individually, it shall be integrated with MTS to check its performance.

Note: If it is not feasible to integrate with MTS, simulator can be used for checking performance of individual component.

11.2.1 Test of immunity to electrostatic discharges

The discharges shall be applied to the enclosure port, Switches, keypad of the voltage- and current sources, the standard meter and the error calculator.
The test level shall correspond to IS 14700-section 2 2018 Level 2.
Functional performance shall not be permanently degraded.

11.2.2 Test of immunity of electromagnetic RF Fields

This test applies to the enclosure port of the voltage- and current sources, the standard meter and the error calculator. The cable length exposed to the field shall be 1m. The test level shall be

1V/m (80 MHz to 1 GHz) for Lab testing equipment and 3V/m (80 MHz to 1 GHz) for onsite testing equipment. The test shall be carried out according to IS 14700 (Part 4/Sec 2).

Test of standard meter

- Test points as specified in 11.1;
- Limits of variation of error during application of RF field as specified in Table 17

a) Test of voltage- and current sources:
- Device in operating condition;
- Test points as specified in 11.1;
- Limits of variation equal to as specified in Table 3 and Table 4

b) Test of MSVT and ICTs:
- Device in operating condition;
- Test points as specified in 11.1;
- Limits as specified in Table 32 and Table 34 . The accuracy test shall be performed Pre and Post application of RF field and the accuracy variation shall not be more than accuracy specified in Table 32 and Table 34.

11.2.3 Immunity to power frequency magnetic fields of external origins

This test applies to onsite meter test system. The test level shall correspond to IEC 61326-1 Table 2, industrial locations, but with 400 A/m, using immersion method.

a) Test of standard meter
- test points as specified in 11.1;
- Limits of variation of error as specified in Table 17

b) Test of voltage- and current sources:
- Device in operating condition;
- Test points as specified in 11.1;
- Limits as specified in Table 3 and Table 4

c) Test of MSVT and ICTs:
- Device in operating condition;
- Test points as specified in 11.1;
- Limits as specified in Table 32 and Table 34 . The accuracy test shall be performed Pre and Post application of Magnetic field and the accuracy variation shall not be more than accuracy specified in Table 32 and Table 34.

11.2.4 Test of immunity to fast transient bursts

The test voltage shall be applied to the AC power ports of the voltage- and current sources and the standard meter:

a) Between the terminals of each circuit normally connected to the mains;
b) Between any two independent circuits having reference voltages over 40V;
c) Between each independent circuit having reference voltage over 40 V and earth.

Pre and Post accuracy test shall be perform. The test level shall correspond to IEC 61326-1 Table 2, industrial locations.

Duration of the test: 60 s at each polarity.

Test shall be perform on supply –mains, for voltage circuit transits are not required in stationary but required on Onsite test equipment.

11.2.5 Test of immunity to surges

The surges shall be applied line-to-line to the AC power ports of the voltage- and current sources and the standard meter.

The test level shall correspond to IEC 61326-1 Table 2, industrial locations.

Test shall be perform on supply –mains, for voltage circuit. Surge test are only applicable on Onsite test equipment.

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

The surges shall be applied line-to-line to the AC power ports of the voltage- and current sources and the standard meter.
The test level shall correspond to IEC 61326-1 Table 2, industrial locations.

a) Test of standard meter
- test points as specified in 11.1;
- Limits of variation of error as specified in Table 17

b) Test of voltage and current sources:
- Device in operating condition;
- Test points as specified in 11.1;
- Limits as specified in Table 3 and Table 4

c) Test of MSVT and ICTs:
- Device in operating condition;
- Test points as specified in 11.1;
- Limits as specified in Table 32 Technical requirements of MSVTs and Table 34 . The accuracy test shall be performed Pre and Post application of RF field and the accuracy variation shall not be more than accuracy specified in Table 32 and Table 34.

11.2.7 Radio interference suppression

The test shall be carried out for the standard meter and the voltage and current sources of the MTS according to CISPR 11.
The standard meter shall be in normal operating condition:
- device in operating condition;

The voltage- and current source shall be in normal operating condition:
- Auxiliary/ power circuits energized with reference voltage;
- Loaded with 50% of the maximum output power, with resistive load.

The test result shall comply with the requirements given in IEC 61326-1 for Class A Group 1 equipment.
(Taken from IEC62057-1)

12. Standard meter

12.1 General

The tests in sub-clause 12.3 and 12.4 are applicable for type testing.

Table 18 Standard Accuracy Classes

Accuracy class of MTS	0.01	0.02	0.05	0.1	0.2
	Standard Meter				
Recommended accuracy class of MTS standard meter	0.01	0.02	0.05	0.1	0.2

Note: Better accuracy class standard meter may be used in order to achieve required overall uncertainty of MTS as defined in Table 26.

12.2 Accuracy requirements under reference conditions

When the standard meter is under the reference conditions given in Annex B, the percentage errors shall not exceed the limits for the relevant accuracy class given in Table 19. If the standard meter is designed for the measurement of energy in both directions, the values shall apply for both directions.

Note 1 The values given in Table 19 apply to standard meters with voltage range 30 – 300 V, current range 1 mA – 120 A and frequency range 45 Hz to 65 Hz. Other ranges may be agreed between the manufacturer and the purchaser.

Table 19 Percentage error limits for the laboraotry standard meter

Quantity measured	**Range**	**Percentage error limits for accuracy class (in percentage of the true value)**				
		0.01	**0.02**	**0.05**	**0.1**	**0.2**
Voltage	30 V to 300 V	± 0.005	± 0.01	± 0.025	± 0.05	± 0.1
Current	1 mA ≤ *I* <10 mA	± 0.02	± 0.05	± 0.10	± 0.2	-
	10 mA ≤ *I* < 50 mA	± 0.01	± 0.03	± 0.08	± 0.2	± 0.3
	50 mA ≤ *I* < 120 A	± 0.005	± 0.01	± 0.025	± 0.05	± 0.1
		Percentage error limits for accuracy class (in percentage of the true value of apparent energy / power)1)				
Active, reactive and apparent power / energy in the complete voltage range	1 mA ≤ *I* <10 mA	± 0.04	± 0.08	± 0.2	± 0.4	± 0.8
	10 mA ≤ *I* < 50 mA	± 0.02	± 0.04	± 0.1	± 0.2	± 0.4
	50 mA ≤ *I* < 120 A	± 0.01	± 0.02	± 0.05	± 0.1	± 0.2
		Limits of drift per year for accuracy class (in percentage of the true value) 2)				
Drift Voltage Measurement	30 V to 300 V	± 0.003	± 0.005	±0.01	± 0.025	± 0.05
Drift Current measurement	50 mA to 120 A	± 0.003	± 0.005	±0.01	± 0.025	± 0.05
Drift Active, reactive and apparent power / energy	30 V to 300 V 50 mA to 120 A	±0.005	±0.01	± 0.025	± 0.05	± 0.1

1) The percentage error limits for active and reactive power or energy is related to Unity power factor. The percentage error limits for power factors different arise from Unity Power Factor, the percentage error limits at Unity Power factor divided by the corresponding power factor according to the example below.
2) For uncertainty calculations it is feasible to take the drift of voltage, current and power measurement accuracy from the manufacturer's type specification.
3) Reference shall have lower current ranges as specified above.

Example:
Calculation of error limits for active and reactive power measurement at power factors cos ϕ=0.5 or sin ϕ=0.866 and percentage error limit for apparent energy measurement of + 0.05%.
The percentage error limit of active power measurement is equal to + 0.05% / 0.5 = + 0.1%.
The percentage error limit of reactive power measurement is equal to + 0.05% / 0.866 = + 0.0577%

The error limits shall remain the same in the case when a three phase standard meter measures single phase current but with balanced poly-phase voltage applied to the voltage circuits. The difference between the percentage error when the standard meter is carrying a single-phase load and a balanced poly-phase load at unity power factor shall not exceed 0.01%, 0.02%, 0.05%. 0.1% and 0.2% for standard meter of classes 0.01, 0.02, 0.05, 0.1 and 0.2 respectively.

Table 20 Percentage error limits for the Onsite standard meter

Quantity measured	**Range**	**Percentage error limits for accuracy class (in percentage of the true value)**				
		0.01	**0.02**	**0.05**	**0.1**	**0.2**
Voltage	30 V to 300 V	± 0.005	± 0.01	± 0.025	± 0.05	± 0.10
Current (direct measurement)2	1 mA ≤ *I* < 10 mA	± 0.02	± 0.05	± 0.20	± 0.10	-
	10 mA ≤ *I* < 50mA	± 0.01	± 0.04	± 0.10	± 0.20	± 0.30
	50 mA ≤ *I* < 120 A	± 0.005	± 0.01	± 0.025	± 0.05	± 0.10
Current measurement (Clamp on CT)2	500 mA ≤ *I* < 120 A/300A 50mA ≤ *I* < 500mA	± 0.15 ± 0.30				
		Percentage error limits for accuracy class (in percentage of the true value of apparent energy / power) 1)				
Active, reactive and apparent power / energy in the complete voltage range(direct measurement)	1 mA ≤ *I* < 10 mA	± 0.04	± 0.08	± 0.2	± 0.4	-
	10 mA ≤ *I* < 50 mA	± 0.02	± 0.04	± 0.1	± 0.2	± 0.4
	50 mA ≤ *I* < 120 A	± 0.01	± 0.02	± 0.05	± 0.1	± 0.2
Active, reactive and apparent power / energy in the complete voltage range(Clamp on CT measurement)	500 mA ≤ *I* < 120 A/300A 50mA ≤ *I* < 500mA	± 0.2 ± 0.4				
		Limits of drift per year for accuracy class (in percentage of the true value) 2)				
Drift Voltage	40 V to 300 V	± 0.003	± 0.005	±0.01	± 0.025	± 0.05

Drift Current-direct measurement	50 mA to 120 A	± 0.003	± 0.005	±0.01	± 0.025	± 0.05
Drift Current-clamp on CT measurement	500 mA ≤ *I* < 120 A/300A	±0.05				
Drift Active, reactive and apparent power / energy(direct measurement)	40 V to 300 V 50 mA to 120 A	±0.005	±0.01	± 0.025	± 0.05	± 0.1
Drift Active, reactive and apparent power / energy(Clamp on CT measurement)	40 V to 300 V 500 mA ≤ *I* < 120 A/300A	± 0.1				
	40 V to 300 V 50 mA ≤ *I* < 500mA	± 0.2				

1) The percentage error limits for active and reactive power or energy is related to power factor 1. The percentage error limits for power factors different 1 arise from the percentage error limits at 1 divided by the corresponding power factor according to the example below.

2) The other ranges and their accuracies for clamp on/flexible CTs shall be decided by buyer and seller.

2) For uncertainty calculations it is feasible to take the drift of voltage, current and power measurement accuracy from the manufacturer's type specification.

Example:
Calculation of error limits for active and reactive power measurement at power factors cos ϕ=0.5 or sin ϕ=0.866 and percentage error limit for apparent energy measurement of + 0.05%.
The percentage error limit of active power measurement is equal to + 0.05% / 0.5 = + 0.1%.
The percentage error limit of reactive power measurement is equal to + 0.05% / 0.866 = + 0.0577%

12.3 Limits of error due to influence quantities

The additional percentage error due to the change of influence quantities with respect to reference conditions, as given in Annex B shall not exceed the limits for the relevant accuracy class given in Table 21.

Note 1 The values given in Table 21 apply to standard meters with voltage range 30 – 300 V and current range 1 mA – 120 A and frequency range 45 Hz to 65 Hz. Other ranges and their accuracies may be agreed between the manufacturer and the purchaser.

Table 21 Influence quantities for standard meter used in laboratory (controlled environment)

Influence quantity	**Range 1)**	**cos ϕ / sin ϕ**	**Mean temperature coefficient in /K for accuracy class**				
			0.01	**0.02**	**0.05**	**0.1**	**0.2**
Ambient temperature variation (+ 15°C to 35°C)							
Voltage measurement	30 V to 300 V	NA	1 PPM	5 PPM	10 PPM	20 PPM	50 PPM
Current measurement	50 mA to 120 A	NA	1 PPM	5 PPM	10 PPM	20 PPM	50 PPM

Active, reactive and apparent power / energy Measurement	30 V to 300 V 50 mA to 120 A	1	2 PPM	10 PPM	20 PPM	40 PPM	100 PPM	
NOTE The effect of the following influence quantities applies to the measurement of active, reactive apparent Power / Energy only.			**Limits of variation in percentage error for standard meter of accuracy class**					
Influence quantity	**Range 1)**	**cos ϕ / sin ϕ**	**0.01**	**0.02**	**0.05**	**0.1**	**0.2**	
Reversed phase sequence	30 V to 300 V 50 mA to 120 A	1	± 0.005	± 0.01	± 0.02	± 0.05	± 0.1	
Harmonic components (5th harmonics) in voltage and current circuit 2)	U1 =30 V to 300 V I1= 50mA to 120A	1	± 0.02	± 0.04	± 0.1	± 0.2	± 0.4	
3rd harmonics in current circuit	U1 = 30V to 300 V I1 = 50mA to 120A	1	± 0.02	± 0.04	± 0.1	± 0.2	± 0.4	
Odd harmonics in the a.c. current circuit 3)	I1 = 50mA to 120A	1	± 0.02	± 0.04	± 0.1	± 0.2	± 0.4	
Sub-harmonics in the a.c. current circuit	I1 = 50mA to 120A	1	± 0.02	± 0.04	± 0.1	± 0.2	± 0.4	
Magnetic induction of external origin 0.5mT 4)	30 V to 300 V 50 mA to 120 A	1	± 0.02	± 0.04	± 0.1	± 0.2	± 0.4	

1) The manufacturer can choose the test point which represents the entire range/spectrum.
2) The test condition shall be according to clause 12.4.2.
3) The test condition shall be according to clause 12.4.3
4) A magnetic induction of external origin of 0.5mT produced by a current of the same frequency as that of the voltage applied to the meter and under the most unfavorable 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 standard meter in the center of a circular coil, 1m in mean diameter, of square section and of small radial thickness relative to the diameter, and having 400 AT.
5) Reference meter shall be back to its original condition i.e. within its accuracy class when operated in reference condition after influence.

Note :In addition the influence quantities and limits of variation of Table 17 are applicable
There shall be no change in accuracy of Reference meter when change in its auxiliary supply for +/- 10% and Auxiliary supply frequency +/- 5%

Table 22 Influence quantities for standard meter used at Onsite (uncontrolled enviorinment)

Influence quantities	Limits of variation in percentage error for standard meter of accuracy class during the test				
	0.01%	**0.02%**	**0.05%**	**0.1%**	**0.2%**
Supply voltage variation of ± 10%	≤± 0.005%	≤± 0.01%	≤± 0.025%	≤± 0.05%	≤± 0.1%
Frequency range 45 to 55 Hz	According to Table 8				
Magnetic induction of external origin 0.5mT	≤± 0.07%				
Drift of the voltage measurement per year	≤± 0.003%	≤± 0.005%	≤± 0.01%	≤± 0.025%	≤± 0.05%
Drift of the current measurement per year	≤± 0.003%	≤± 0.005%	≤± 0.01%	≤± 0.025%	≤± 0.05%
Additional error at 5th harmonics in voltage and current circuit	≤± 0.02%	≤± 0.04%	≤± 0.1%	≤± 0.2%	≤± 0.4%
Additional error at 10% 3rd harmonics in current circuit of 50mA to 120A	≤± 0.02%	≤± 0.04%	≤± 0.1%	≤± 0.2%	≤± 0.4%
Additional error at reverse phase sequence in the range 50 mA to Imax (direct measurement) 500mA to Imax (clamp on measurement)	≤± 0.005%	≤± 0.01%	≤± 0.02%	≤± 0.05%	≤± 0.1%
Temperature coefficient (Direct measurement)/Clamp +0°C to +45°C	≤± 5 PPM/K	≤± 10 PPM/K	≤± 20 PPM/K	≤± 50 PPM/K	≤± 100 PPM/K

1) The manufacturer can choose the test point which represents the entire range/spectrum.
2) The test condition shall be according to clause 12.4.2.
3) The test condition shall be according to clause 12.4.3
4) A magnetic induction of external origin of 0.5mT produced by a current of the same frequency as that of the voltage applied to the meter and under the most unfavorable 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 standard meter in the center of a circular coil, 1m in mean diameter, of square section and of small radial thickness relative to the diameter, and having 400 AT.

Note :In addition the influence quantities and limits of variation of Table 17 are applicable

12.4 Accuracy tests in the presence of harmonics

12.4.1 Test with 3rd harmonic in the current

Test conditions:

- Fundamental frequency current: *I1* = 5 A;
- Fundamental frequency voltage: *U1* = 240 V;
- Fundamental frequency power factor: cos ϕ_1 = 1 and sin ϕ_1 = 1
- Content of 3rd harmonic current: I3 = 10 % of I1;
- Harmonic power factor: cos ϕ_3 = 1 and sin ϕ_3 = 1

Fundamental and harmonic currents are in one case in-phase, at positive zero crossing and other case out-phase, at positive Zero crossing. The variation in percentage error in both of above cases, when the meter is subjected to the test condition shall not exceed the limits of variation given in Table 21.

12.4.2 Test with 5th harmonic in the current and voltage

Test conditions:

- Fundamental frequency current: *I1* = 5 A;
- Fundamental frequency voltage: *U1* = 240 V;
- Fundamental frequency power factor: cos ϕ_1 = 1 and sin ϕ_1 = 1
- Content of 5th harmonic voltage: U5 = 10 % of U1;
- Content of 5th harmonic current: I5 = 40 % of I1;
- Harmonic power factor: cos ϕ_5 = 1 and sin ϕ_5 = 1

Fundamental and harmonic voltages are in phase, at positive zero crossing. The variation in percentage error when the meter is subjected to the test condition shall not exceed the limits of variation given in Table 21.

12.4.3 Tests of the influence of odd and sub-harmonics (Annex C)

The tests of the influence of odd and sub-harmonics shall be made with the circuit shown in Figure C. 1 or with other equipment able to generate the required wave-forms, and the current waveforms as shown in Figure C. 2 and Figure C. 4 respectively. The variation in percentage error when the meter is subjected to the test wave-form given in Figure C. 2 and Figure C. 4 respectively and when it is subjected to the reference waveform shall not exceed the limits of variation given in Table 21.

Note 1 : the values given in the figures are for 50 Hz only. For other frequencies the values have to be adapted accordingly.

13. Software requirements

13.1 Application

These requirements apply to the software supplied with the MTS.

The manufacturer and the purchaser may agree on different requirements for the software if needed.

Software:

1. Embedded software
2. Software required for testing of meter
3. Software required for automation of testing
4. Software require for data retrieval and report generation.

13.2 Identification

The software shall be clearly identifiable by the program name, version number and target operating system (if applicable).

13.3 Protection

The software and the test programs written by the operator(s) shall be protected against unauthorized modification and / or use i.e. integrity of software shall be protected. The administrator of the software may assign specific rights to each operator. Each entry of a program module shall only be possible with an identification of the operator at least by a password before use. Measurement data shall be protected against unauthorized access.

13.4 Functional requirements

The software shall support following minimum functionalities

- Programming facilities for setting parameters,
- Acquiring the data,
- Monitor and control the source and measuring system,
- Computation of error,
- Display of error and measurement,
- Evaluation and presentation of test results.
- Provision for limiting the generation of current and voltage for protection of unit under test.
- Display of software version.

Any other requirement shall be as agreed between the manufacturer and the purchaser Annex J may be referred for details.

Note 1: the requirements are met should be verifiable by the local certification bodies and depend on the code of practice.

13.5 Protection of integrity and storage of test results and test protocols (reports)

Measured values, test results and related parameters shall be printed or stored as needed in suitable formats. It shall be always possible to correlate the test results to the test program generating those results and its parameters such as test sequence, test points, operator inputs, meter constants, error limits, fail/pass criteria etc. The test protocols shall be stored for each batch tested. They shall be easily identifiable, they shall be protected against any changes and it shall be not possible to erase them without prior approval by the responsible authority.

13.6 Documentation of the software

The software of the MTS shall be properly documented and accompanied with operating instructions delivered on a suitable storage media (paper or digital data storage devices). It shall be written in clear and unequivocal terms and in consistent form.

The software documentation shall at least include:

- the program name;
- the software version, release and operating system
- the author of the program;
- contact details of the organization / person providing support;
- explanation of all functions and operator commands;

- description of test sequences;
- description of parameter tables;
- description of all calculation formulae used for calculating the results;
- list of error messages, diagnostic information and hints for troubleshooting;
- Description of all display screens, printout and storage formats.
- Software validation certificate with version no. (from Manufacturer)

14. Accuracy requirements and tests

14.1 General

This clause specifies the overall accuracy requirements for the MTS, describes the various tests to be performed, the test points, test methods and the evaluation of the results.

Note 1: Error definitions and error determination are given in Annex D.

14.2 Test methods for determination of MTS accuracy

The determination of the overall error of an MTS shall be made according to either of the following methods

Method 1 Comparison is done by comparing the energy delivered and indicated by the MTS standard meter with the energy indicated by the precision standard meter.

Method 2 The energy comparison can be done by comparing the number of pulses from a test output of the MTS standard against the number of pulses from the test output of the precision standard meter using suitable error calculator according to the method clause 5.4

To measure the overall error of the MTS, the following conditions shall be fulfilled.

a) The MTS shall operate under reference conditions performing accuracy test on a MUT. The standard meter shall be connected at the preferred output terminals of the meter test rack as the MUT. The determined errors are errors of the MTS at that particular position;

b) The MTS and the standard meter shall reach thermal stability;

c) The recommended accuracy class of the standard meter used for testing of overall accuracy of the MTS is given in Table 23. If the calibration error of the standard meter is known a required error correction can be applied;

d) The tests are performed under reference conditions given in Table B. 1;

e) The MTS should have suitable hardware and software provisions to determine the overall error of the MTS. Error results should be stored for corrections of the error of the standard meter.

Table 23 Recommended accuracy class of standard meter to Test MTS

	Accuracy class of the standard meter used in the MTS				
Accuracy Class of under test MTS	**0.01**	**0.02**	**0.05**	**0.1**	**0.2**
Recommended accuracy class of standard meters	0.005	0.01	0.01	0.02	0.05

NOTE

1 In order to obtain best possible uncertainty of measurement it is highly recommended that correction of errors of standard meter is used in all cases. However it is mandatory to use correction of errors of standard meter in cases of class 0.02 and class 0.01 MTS.
(Example: Obtained error of 0.02 class reference meter on particular load point is -0.015%, whereas During calibration error of reference standard on particular load point (from calibration certificate) is -0.005%, hence after correction the error shall be reported as follows:
-0.015%-0.005% =+0.020%

2 The above accuracy class of standard meter are only recommended. Actual accuracy class may be decided in order to achieve required overall uncertainty of measurement for respective MUT class as defined in Table 26.

14.3 Test points for MTS

14.3.1 Selection of voltage and current ranges

From all value combinations related to voltage, current, power factor and measuring mode the most significant ones for practice should be tested. The values given in Table 24 are recommended test points and can be separately agreed upon by the supplier and the purchaser.

Table 24 Basic measurement table (recommended test points for lab equipment)

Measurement mode	**Voltage**	**Current**	**cos ϕ / sin ϕ**	**Load of the MTS**			
		A		Phase 1	Phase2	Phase 3	All Phases
All available measurement mode	Vmin	Imax 0.8Imax 0.5 Imax 0.2 Imax 0.1 Imax 0.05 Imax I min	1 0.5 Lag 0.5 lead	x	x	x	X (note 6)
	Vmax	Imax 0.8 Imax 0.5 Imax 0.2 Imax 0.1 Imax 0.05 Imax	1 0.5 Lag 0.5 lead	x	x	x	X (note 6)

		I min					
3 phase 4 wire active	240V	120 or Imax	1 0.5 inductive 0.5 capacitive	X	X	X	X
		50		X	X	X	X
		20		X	X	X	X
		10		X	X	X	X
		5		X	X	X	X
		2		X	X	X	X
		1		X	X	X	X
		0.5		X	X	X	X
		0.1		X	X	X	X
		0.05		X	X	X	X
		0.01		X	X	X	X
3 phase 4 wire reactive	240V	5	1 0.5 inductive 0.5 capacitive	X X X	X X X	X X X	X X X
3 phase 3 wire active	110Vp-p	1	1	x	x	x	X
3 phase 3 wire reactive	110Vp-p	1	1	x	x	x	X
NOTE 1 Tests can be carried out at frequency 50 Hz. if it is ensured that influence due to frequency is not significant. These are the minimum requirement, other load points can be decided as per purchaser and manufacturer according to test bench design/specification of MTS. NOTE 2 For single phase MTS only the test points of one phase are valid. NOTE 3 For Imax > 120A an additional test point at Imax has to be added. Note 4 Vmin <= 0.3 Vref of meter under test. Vmax >= 1.2 Vref of meter under test Imin <= 0.01 Ib/In of meter under test Imax >= 1.2 Imax of meter under test Note 5 the periodicity of performing control measurement shall be one year, user is free to split the table on quarterly or half yearly basis as per convenience and cover all the points once in a year. Note 6: these measurement shall be perform for control measurement.							
Laboratory/purchaser may decide additional load points applicable for the test bench depending on use.							

Table 25 Recommended test points for Onsite equipment for functional check before taking to Onsite and and bring back from Onsite

Measurement mode	**Voltage**	**Current**	**cos ϕ / sin ϕ**	**Load of the MTS**			
		A		Phase 1	Phase2	Phase 3	All Phases
3 phase 4 wire active	30 V or Vmin	0.05 or Imin	1	X	X	X	X
	300 V or Vmax	120 or Imax	1	X	X	X	X

14.4 Accuracy requirements

14.4.1 Limits of maximum permissible error

The overall error of MTS (δW_{MTS} - as per Table 33 and Table 35) and maximum permissible error of MTS at given at different current range is denoted as δWmax in Table 27.

Overall uncertainty of measurement shall be better than as specified in Table 26

It is recommended that Transformer operated meters shall not be tested using ICTs or MSVTs.

Table 26 Overall uncertainty of Meter Test System

	MUT (Electricity meter)				
MUT accuracy class	0.1	0.2 / 0.2S	0.5 / 0.5S	1	2
Overall uncertainty of MTS (for testing at Laboratory condition)	Better than 1/5 of limit of error defined in product standard for particular load point.				
Overall uncertainty of MTS (for testing at site)	IS15707 clause no. 12.3.2				

Note: 1. for site testing of meters particularly Low tension meters, the general practice is to use the MTS with clamp on CTs. Hence for such testing of all types of meters, one class better accuracy MTS then the meter under test may be used. Such MTS can be tested as per the relevant standard of accuracy. For eg. For 0.5 class of meter installation Clamp on CT of class 0.2 can be used.

2. The expanded uncertainty calculation shall be perform as per NABL guideline NABL-141. The examples of uncertainty budgets are given under informative Annex K

Example is illustrated for calculation of uncertainty of MTS as per Annex K)

Table 27 Limits of maximum permissible error (δWmax) of the complete MTS in laboraotry condition (without MSVT and ICT)

	Standard Meter									
Accuracy class of MTS standard meter	0.01		0.02		0.05		0.1		0.2	
	Maximum permissible error of MTS									
Power factor	1	0.5 Ind/ 0.5 cap	1	0.5 ind/ 0.5 cap	1	0.5 ind/ 0.5 cap	1	0.5 ind/ 0.5 cap	1	0.5 ind/ 0.5 cap
δWmax in % (1 mA ≤ I <10 mA)	± 0.04	± 0.08	± 0.08	± 0.16	± 0.20	± 0.40	± 0.40	± 0.80	± 0.80	± 1.6
δWmax in % (10 mA ≤ I < 50 mA)	± 0.02	± 0.04	± 0.04	± 0.08	± 0.10	± 0.20	± 0.20	± 0.40	± 0.40	± 0.80
δWmax in % (50 mA ≤ I < 120 A)	± 0.01	± 0.02	± 0.02	± 0.04	± 0.05	± 0.10	± 0.1	± 0.2	± 0.02	± 0.40

1) Accuracy class of MUT according to the Metering Standards. IS13779/IS14697/IS13010 and reference meter accuracy class according to this standard. For MUT accuracy class better then 0.02, the limits shall be considered half of the limits mentioned for 0.02 class. NOTE 1 The standard voltage range for δW_{max} shall be 30 V to 300 V.		
NOTE 2 For active energy measurements δW_{max} is determined for cos ϕ = 1 and 0.5. For Reactive Energy measurements δW_{max} is determined for sin ϕ = 1 and 0.5		

14.4.2 Correction of the error δW of the meter test system

If any measurement exceeds the maximum permissible limits, two additional measurements at this particular test point shall be taken. The results of the additional measurements should be within the permissible limits of δWmax.

The MTS can be used for meters of the relevant class according to Table 27. If the results of any test points are not within the limits, the use of this MTS shall be restricted excluding such range (s) . Such restriction shall be indicated at the MTS and in the test report.

If the error δWmax of the MTS in service is out of the limits of the maximum permissible error but less than twice the relevant values of Table 27 a correction for the error of the MTS shall be applied to the results of the tests on the MUT. In these cases, an effort should be made to reduce the error of the MTS in order to bring it within the permissible limits. How this is done must be documented.

14.4.3 Mean value and repeatability of the measurements

Maximum acceptable repeatability of measurement () are specified in Table 28 as standard deviation of errors.

The number of measurements shall support a reasonable statistical basis. As a proof the estimation s of the standard deviation shall be in accordance to Table 28

A sequence of repeated measurements at test points and power factors given in Table 28 is recommended. Not less than 10 measurements for each test point shall be made to calculate the estimation s of the standard deviation.

$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}\left(\delta Wi - \overline{\delta W}\right)^2} \qquad \textit{Equation 16}$$

where:

s is the estimation for standard deviation;

δWi is the measurement results of the MTS determined by one individual measurement of a sequence of repeated measurements at a certain test point;

$\overline{\delta W}$ is the mean value of measurement results *δWi;*

n is the total number of individual measurements.

The value s of a newly manufactured MTS shall be within the limits of *Smax* given Table 28.

These measurements shall be repeated in case of any overloading, mishandling, gives questionable results or has been shown to be defective or outside specified requirements.

Table 28 Limits of permissible values of standard deviation of MTS

	Standard Meter									
Accuracy class of MTS standard meter	0.01		0.02		0.05		0.1		0.2	
	Maximum permissible standard deviation of MTS reference meter									
Power factor	1	0.5 ind/ 0.5 cap	1	0.5 ind/ 0.5 cap	1	0.5 ind/ 0.5 cap	1	0.5 ind/ 0.5 cap	1	0.5 ind/ 0.5 cap
Smax	0.0015	0.0025	0.002	0.004	0.005	0.01	0.01	0.02	0.02	0.04
1) Accuracy class of MUT according to the Metering Standards. IS13779/IS14697/IS13010 and reference meter accuracy class require according to this standard. For MUT accuracy class better then 0.02, the limits shall be considered half of the limits mentioned above for 0.02 class.										

14.5 Evaluation of test results

14.5.1 Basic measurements

The basic measurements according to Table 24 shall be performed on newly manufactured MTS before putting into service. Repeated measurements also shall be made in case of any overloading, mishandling, gives questionable results or has been shown to be defective or outside specified requirements.

14.5.2 Recalibration of meter test system

The time interval of recalibration shall be adapted to the use of the equipment and has to be determined by the detected drift of the measurement results. e.g. the measurements according to **Error! Reference source not found.**

Note 1:. National regulations have to be considered.

14.6 Test for output values and ranges of test circuits

Requirements as specified in clause 6.2 shall be complied.

15. Tests and testing procedures

15.1.1 Type tests

In case it is difficult to conduct any type test on complete MTS it may be conducted on individual major components.

These major components shall include:

- Source and its parts such as voltage, current amplifier, controller and generators
- Standard meter;
- MSVT and ICTs;
- Error calculation system;
- scanning head.

The requirements are given in clause 10.2.3.2, 10.2.410, 10.2.5, 11, 12.3, 13, 14 and 16.

15.1.2 Routine tests

15.1.2.1 General

A routine test is made on each individual component of the MTS during or after manufacturing to check if it complies with the requirements of the standard concerned or the criteria specified.

The following routine tests shall be performed on each meter test unit or on the integrated components respectively (such as source, standard meter, generator, etc.)

15.1.2.2 Visual inspection

Visual inspection shall be performed on the MTS to ensure the:

- Mechanical aspect as per its design;
- Wiring and connection as per its design;
- Terminals and marking as defined in this standard.

15.1.2.3 AC voltage test and IR test

The A.C. voltage tests and IR test shall be performed on each MTS as defined in clause 10.2.4.

15.1.2.4 Operation and Inspection of safety devices

The operation of devices for indication of hazards or protective switches - such as visible warnings and alarms, emergency switches - shall be inspected. The operation of alarms shall be tested by invoking various failures like:

- Short circuits;
- Overloads;
- Input power overvoltage and under voltage
- Other test as agreed between supplier and customer

15.1.2.5 Accuracy of standard meter

The standard meter used in the MTS shall be calibrated against a traceable standard of higher accuracy. The error of the standard meter shall be within the limits specified in clause 12.2.

15.1.2.6 Electrical and Functional test

The following tests shall be performed on each MTS:

- Functionality of emergency switch, mains power switch, other control circuit, of each hardware and software control elements;
- Testing of the protection system and fault indication by short and open circuits;
- Matching of respecting phases i.e. L1, L2 and L3 as per labelling.
- Symmetry of the output voltage and current at full load and no load, at preferred MUT locations as per clause 6.2.3.
- Waveform distortion measurement: Measurements shall be made in each current and voltage circuit at no load and full load; refer to Table 3 and Table 4
- Generation of test signals: It shall be verified that the test signals necessary for testing the MUTs with harmonics can be generated as specified by the manufacturer and according to Table 7.

Note 1 No load for the MTS means that the voltage terminals are open and the current terminals are short circuited and the MTS is switched on for its minimum and/or maximum test value.

Note 2 Full Load for the MTS means that both the voltage and the current circuits are loaded with the highest load specified for the voltage- and current sources.

15.1.2.7 Basic measurement of complete meter test system

Basic measurements as defined in **Error! Reference source not found.** shall be carried out on newly manufactured MTS. The maximum permissible error should not exceed the percentage error limits defined in Table 27 for the given class accuracy of MUT and for which MTS is going to be used.

The test points for newly manufactured MTS can be reduced to exemplary tests. The standard meter shall be supplied with a calibration certificate which covers all points.

15.1.2.8 Software function test

All general tests to ensure the proper functioning of software as described in clause no. 13.4 shall be carried out once for the given version number.

Specific tests requested by the purchaser shall be carried out according to specification of the purchaser.

15.1.2.9 Test for smart meters/communicable meter

The software shall be capable to conduct all smart meters/ communication tests as specified in clause no. 5.6

15.1.3 Acceptance test

Acceptance tests are contractual tests proving that the MTS meets the specification. This shall be mutually agreed between the customer and the manufacturer.

15.1.4 Commissioning test

Commissioning tests are contractual tests proving that the MTS meets the specification. This shall be mutually agreed between the customer and the manufacturer.

16. Test of climatic condition

These test are applicable for MTS to be used for onsite.

16.1 Dry heat test

The test shall be carried out according to relevant section of IS 9000 (Part 3/Sec 3). Under the following conditions:

a) Meter test system in non-operating condition with carrying case
b) Temperature: + 70 ± 2 °C
c) Duration of the test: 72 h

After the test meter test system shall show no damage and function as per this standard. Accuracy test shall be carried out on test points for control measurement as per Table 24

16.2 Cold test

The test shall be carried out according to relevant section of IS 9000 (Part 2/Sec 3) under the following conditions:

a) Meter test system in non-operating condition with carrying case
b) Temperature: – 25 ± 3 °C
c) Duration of the test: 72 h

After the test meter test system shall show no damage and function as per this standard. Accuracy test shall be carried out on test points for control measurement as per Table 24

16.3 Damp heat cyclic test

The test shall be carried out according to relevant section of IS 9000 (Part 5/Sec 2) under the following condition:

a) Meter test system in operating condition without carrying case.
b) Voltage and auxiliary circuits energised with reference voltage
c) Without any current in the current circuits
d) Upper temperature +45 °C ± 2 °C
e) No special precautions shall be taken regarding the removal of surface moisture
f) Duration of test: 3 cycles

24 h after the end of this test the meter test system shall be submitted to the following tests:

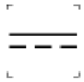
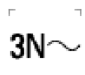
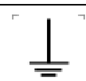
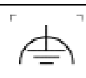
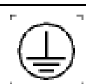
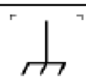
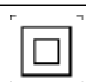
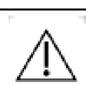
g) An insulation resistance test according to clause 10.2.5
h) A functional check.

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 test system shall be apparent.

After the test meter test system shall show no damage and function as per this standard. Accuracy test shall be carried out on test points for control measurement as per Table 24

Annex A
(Informative)
Symbols according to IEC 60417:2002 DB

Table 29 Symbols, may be used on metering equipment

Number	Symbol	Reference	Description
1		IEC 60417-5031	Direct current
2		IEC 60417-5032	Alternating current
3		IEC 60417-5033	Both direct and alternating current
4a		IEC 60417-5032-1	Three-phase alternating current
4b		IEC 60417-5032-2	Three-phase alternating current with neutral conductor
5a		IEC 60417-5017	Earth; ground
5b		IEC 60417-5018	Functional earthing; functional grounding (US) [b]
6		IEC 60417-5019	Protective earth; protective ground
7		IEC 60417-5020	Frame or chassis
8			Not used
9			Not used
10			Not used
11		IEC 60417-5172	Protective class II equipment
12		IEC 60417-5036	Dangerous voltage
13			Not used
14		ISO 7000-0434B	Caution [a]

[a] The use of symbol number 14 requires manufacturers to state that documentation must be consulted in all cases where this symbol is marked.

[b] There may be national differences concerning the use of this symbol

Annex B
(Normative)
Reference conditions

Table 30 Reference conditions

Influence Quantity	Reference	Permissible tolerance
Ambient temperature	Reference temperature or in its absence, 27°C	± 2°C
Voltage unbalance	All phase connected	-
Input mains Voltage	240V	± 10%
Input mains frequency	50Hz	± 2%
Waveform	Mains Voltage U	in accordance to IS17036
Continuous magnetic induction of external origin	Equal to Zero	-
Magnetic induction of external origin at the reference frequency	Magnetic induction equal to zero	< 0.05 mT
Electromagnetic RF fields, 30kHz to 2 GHz	Equal to Zero	< 1V/ m
Conducted disturbances, induced by radio frequency fields, 2 kHz to 80 MHz	Equal to Zero	< 1V
NOTE: If the tests are made at ambient temperatures other than the reference temperature, including permissible tolerances, the results shall be corrected by applying the appropriate temperature coefficient of the reference meter.		

Annex C
(Informative)
Test circuits and test signals for testing in the presence of harmonics

The test setup is for informative use and belongs to the connection of MUTs and standard meters generally. The verification of the working standard/electricity meter (MUT) has to be done with the standard meter.

Note 1: The values given in Figure 4 and Figure 6 are for 50 Hz only. For different frequencies the values shall be adapted accordingly.

C.1 Phase fired control (odd harmonics)

The test layout of the harmonics test circuit is shown in Figure 2

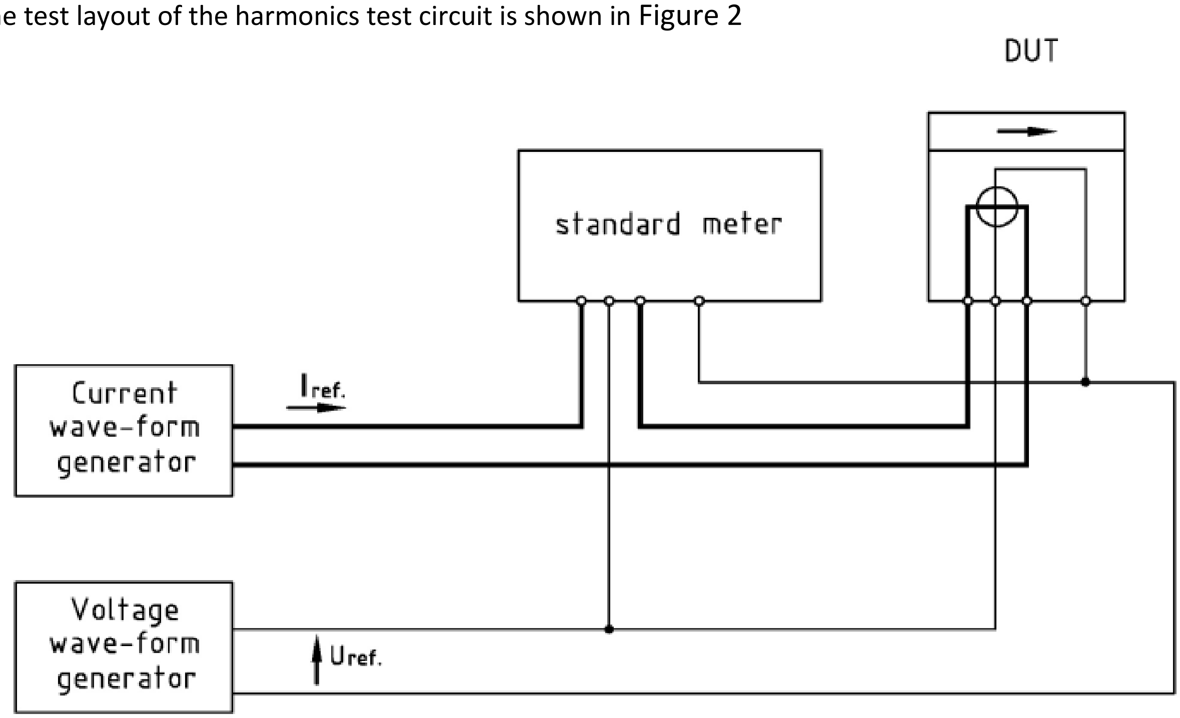


Figure 2- Test circuit diagram (informative)

NOTE
1. In the presence of harmonics the standard meter shall measure the total active energy (fundamental and harmonics). For reactive energy the standard meter shall measure the fundamental only.
2. DUT is standard meter under test.

The wave form of the phase-fired test values is shown in Figure 3

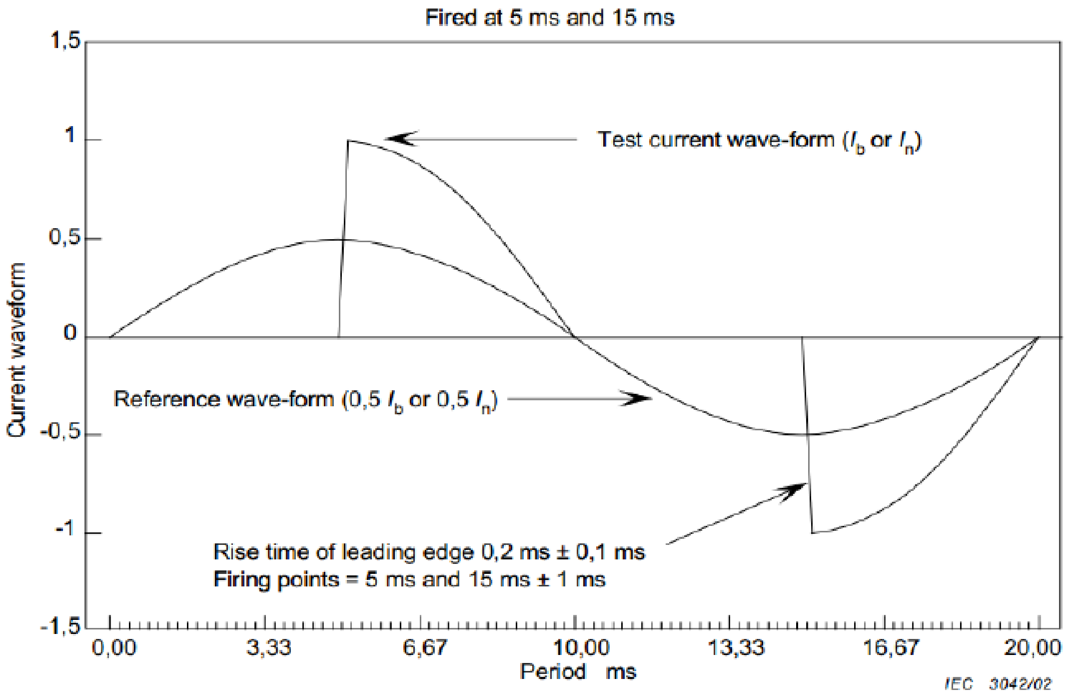


Figure 3 – Phase fired waveform

The harmonic content of the phase-fired test values is shown in Figure 4

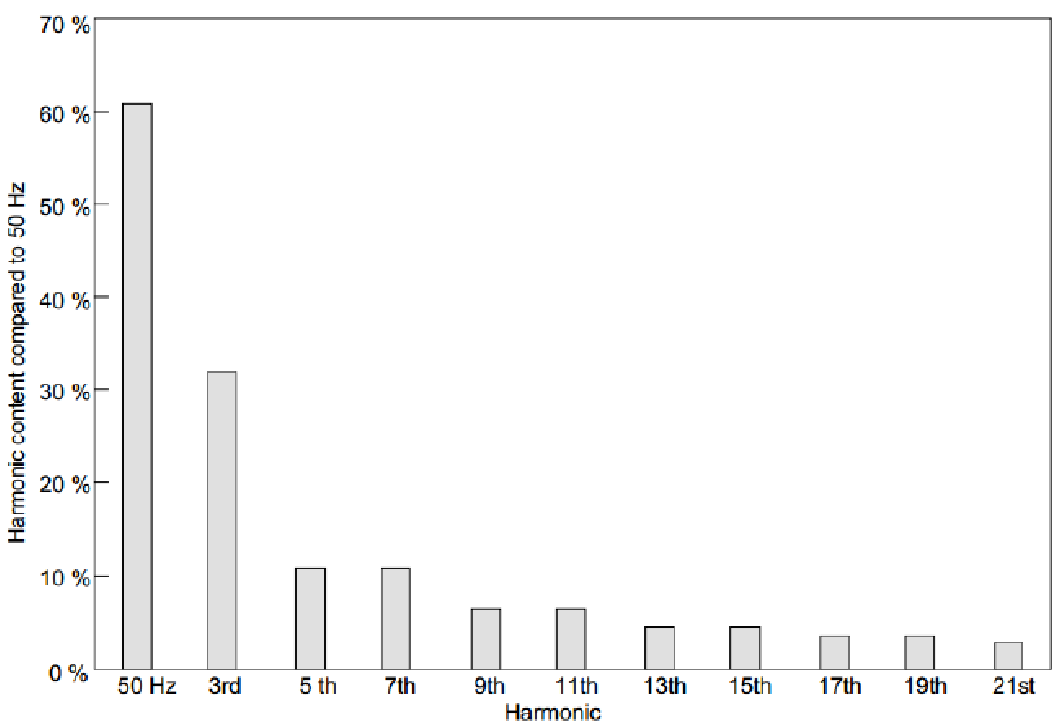


Figure 4– Informative distribution of harmonic content of phase fired waveform

C.2 Burst control (sub-harmonics)

Test circuit diagram, see Figure 2

The wave form of the burst-fired test values is shown in Figure 5

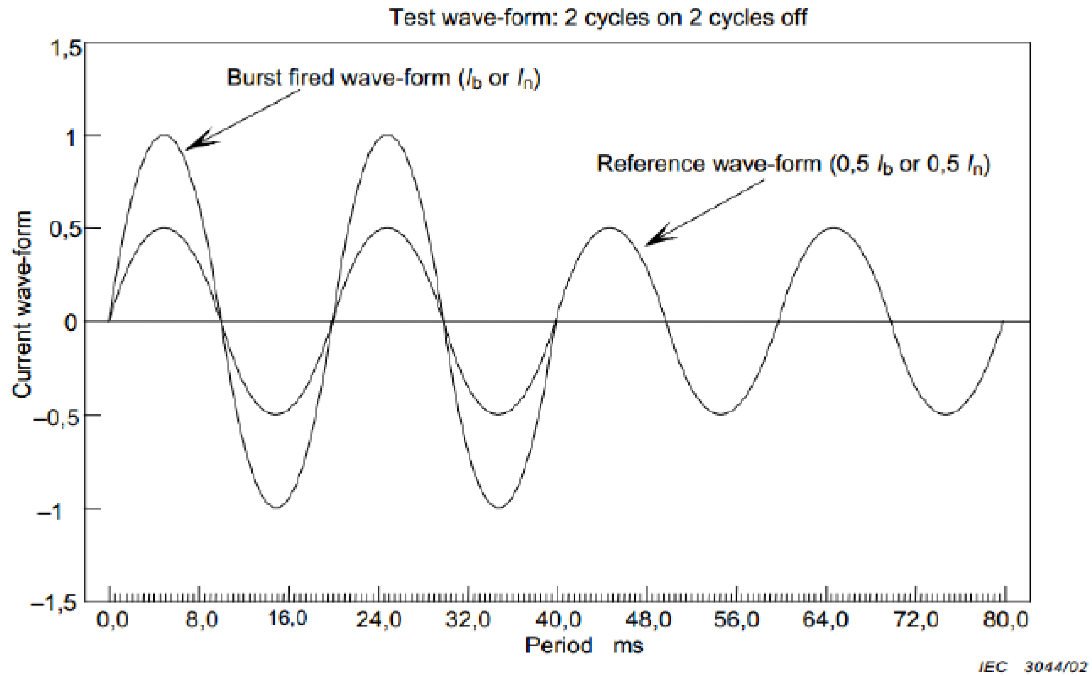


Figure 5– Burst fired waveform

The harmonic content of the burst-fired test values is shown in Figure 6

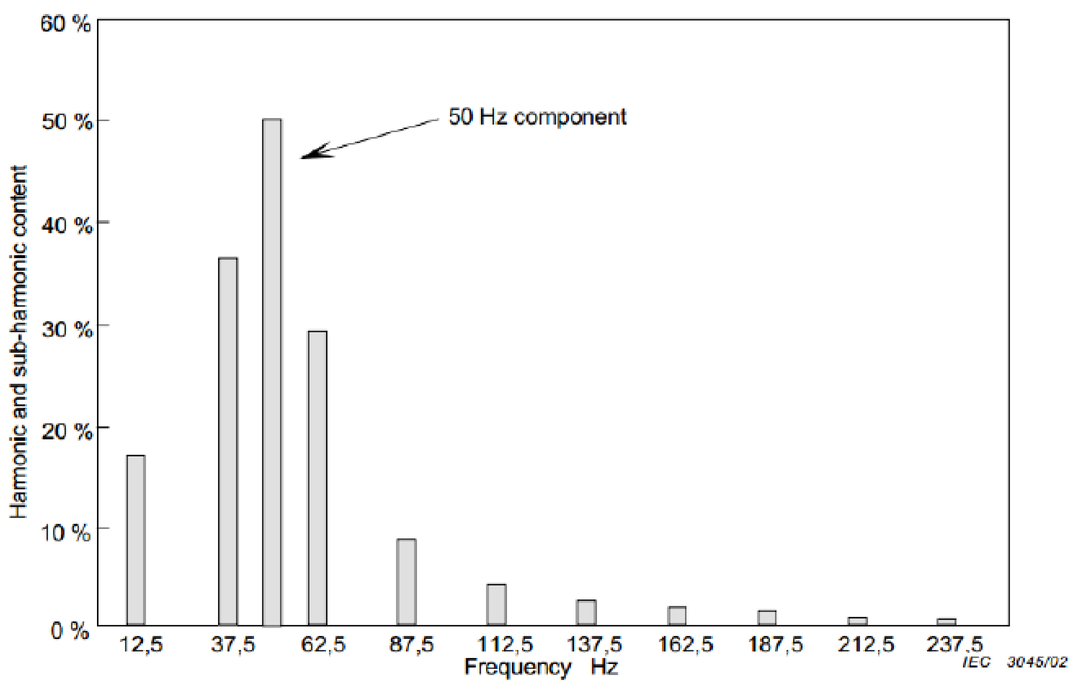


Figure 6 – Informative distribution of harmonics

Annex D
(Informative)
Guidelines for overall laboratory setup

D.1 Introduction

If legally relevant measurement results are stored on electronic data storage devices, the data shall be readable for at least 10 years. Explanations, how, has to be given to the notified body

For every meter test equipment, a software log must be kept. Every first application of a new test software must be documented with date, program name and version number in the logbook. Old versions of the software have to be kept also. Changes in the software must be documented: which change at what time has been done, how the change influences the measuring results and the name of the author of change. The changes must be released by the person responsible. The MTS may be only used again for calibration or tests or batch tests after a new acceptance by the person responsible. The logging of new release can be done electronically if a complete and understandable recording is guaranteed.

The storage duration of software releases and documents are the task of accreditation of the lab.

All laboratories for the testing of electrical energy meters should have appropriate facilities for carrying out the required tests in accordance with the relevant standards and the corresponding requirements for test laboratories such as specified in e.g. ISO/IEC 17025.

D.2 General Conditions

The rooms for the laboratory should be:

- Sufficiently large, clean dry, dust free;
- Free from vibration. The calibration area should be adequately free from vibrations generated by central air conditioning plants, vehicular traffic and other sources to ensure consistent and uniform operating conditions. Continuous vibration in the lab may lead to malfunctioning of the sensors. Acoustic noise level in the laboratory should be maintained to facilitate proper performance of calibration work. A threshold noise level of 60 dBA is recommended;
- Sufficiently illuminated. The calibration & testing area should have adequate level of illumination. The recommended level of illumination is 450-700 lux on the working table;
- Protected against solar radiation.

D.3 Quality of mains supply

The test laboratory should have necessary arrangements to maintain power supply conditions as specified in Table 31.

Table 31 Mains supply quality

Quantity	Value
Voltage supply	1 phase 2 wire, 240 or 3 phase 4 wire, 3 x 240/415V, with a relative tolerance of ± 5%
Frequency	50 Hz +/- 1%
Voltage distortion	< 2%
Earth resistance	< 2 Ohm
Protection	Protection against, lightning, spikes, voltage surges. Individual equipment shall be protected against short circuit, earth fault and over current.

D.4 Standard meter

The laboratory shall be equipped with an appropriate standard meter for determining the overall accuracy of the MTS, for control measurement and other purposes.

Annex E
(Normative)
Multi-secondary voltage transformer
(Reference taken from IEC62057-1)

E.1 Introduction

Multi Secondary Voltage Transformers (MSVT) are necessary for testing single-phase meters the current and voltage circuits of which are permanently connected together (meters with no jumper to open the link between voltage and current circuits).

E.2 Definitions

E.2.1 Meter With Permanently Closed Link

Meter, in which the link between the voltage circuit and current circuit cannot be opened for testing

Note 1: In some cases the link may exist but it is either inaccessible or cannot be opened in order to prevent tampering. In some electronic meter designs, the voltage and current circuits cannot be separated due to technical limitations imposed by the integrated circuits used.

E.2.2 Multi Secondary Voltage Transformer, MSVT

Isolating transformer, used to provide isolation between the primary and secondary windings while maintaining the same voltage.

Note 1: An MSVT has one primary winding and N or N+1 secondary windings. N is the number of meter test positions at the MTS.

E.3 Application

Meters are usually tested with the link between the voltage and current circuits opened, with the voltage circuits of the MUTs connected in parallel and with the current circuits connected in series. This method allows testing multiple meters at the same time.

If the link between the voltage and current circuits cannot be opened, and the meters were connected the same way, a voltage drop would occur on the current circuit of each meter and therefore the voltage would be different on each test position.

Hence, an MSVT is required to test meters with permanently closed link. The principle of the test is illustrated in Figure 7 and Figure 8.

The difference of both test layouts is in the connection method of the voltage circuit of the standard meter. Also, the uncertainty calculation for the whole measuring circuit will be different. Both layouts are suitable.

Note 1: The MVST is an optional component of each MTS. The purchaser should specifically request that the MTS be equipped or not with an MSVT depending on the kind of meters to be tested.

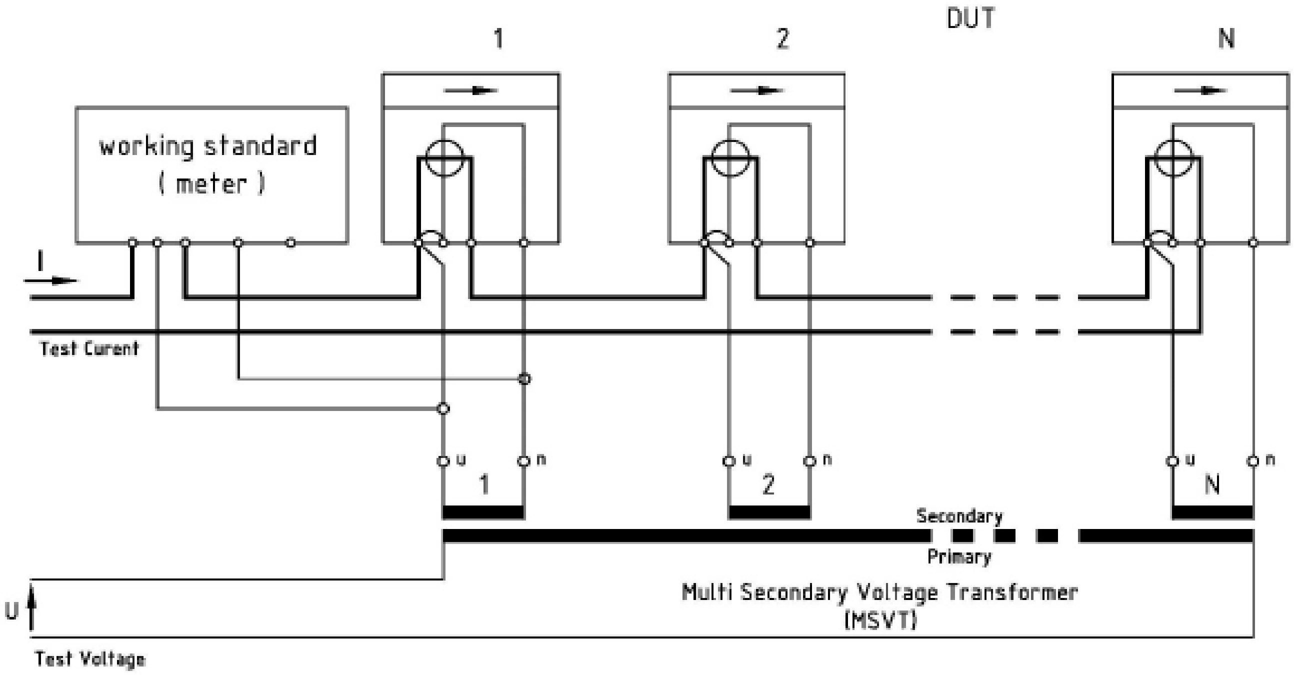


Figure 7– Testing of single phase meters with closed link between the voltage and current circuits (variant 1)

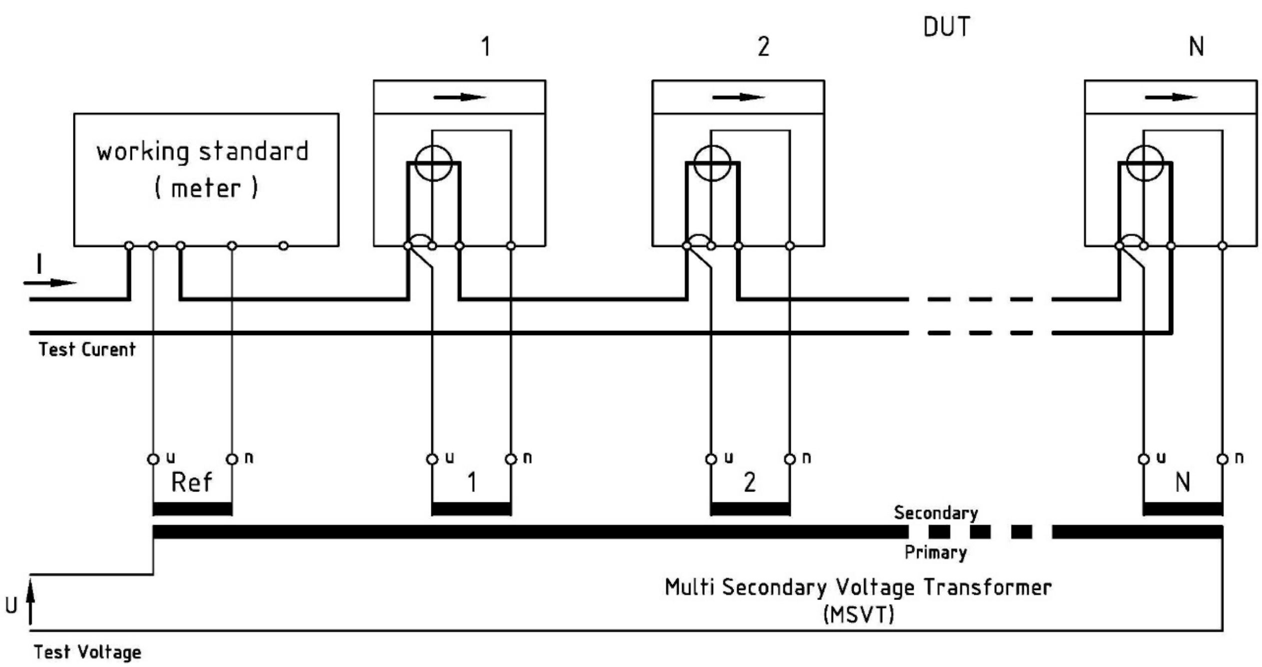


Figure 8– Testing of single phase meters with closed link between the voltage and current circuits (variant 2)

E.4 Technical requirements

E.4.1 Number of windings and ratio

The MSVT shall meet the requirements specified in Table 32

Table 32 Technical requirements of MSVTs

Parameter	Requirement
Number of secondary windings	N (N = Meter test positions) Additional windings may be available for the standard meter to improve the accuracy (see Figure 8)
Nominal value of primary voltage	220 V...240 V(other voltages may be specified)
Nominal value of secondary voltage	220 V...240 V(other voltages may be specified)
Operating voltage range	-10 …+ 15%
Nominal frequency	50 Hz
Operating frequency range	fn ± 2%
Secondary burden at each winding	0 VA - 15 VA
Error between primary to secondary winding in the whole operation range. (only required if the standard meter is connected to the primary side of the MSVT)	≤ ± 0.1%, ≤ ± 2 min
Error between each secondary winding in the whole operating range. (if the standard meter is connected to the secondary side of the MSVT)	≤ ± 0.05%, ≤ ± 1 min

E.5 Total accuracy of MTS with MSVT

The manufacturer shall provide the accuracy test results of each MSVT over the operating range. The maximum permissible limits of error are shown in Table F. 2

Table 33 Maximum permissible limits of error of MTS with MSVT

Operating range		**Maximum permissible limits of error of MTS in % while using MSVT**	
Voltage	**Current range**	**PF = 1**	**PF = 0.5**
240 V ± 10%	50 mA ≤ *I* ≤ 120 A	δWmax + 0.07	δWmax + 0.15
NOTE: δWmax is taken according to Table 27			

Annex F
(Normative)
Isolating Current Transformer (ICT)

F.1 Introduction

Isolating Current Transformers (ICTs) are used for testing direct connected polyphaser meters with current and voltage circuits permanently closed in each phase (no means to open the link between voltage and current circuits).

F.2 Definitions

F.2.1 Three phase closed-link meters

Three phase meters in which the link between voltage and current circuit in all three phases are closed permanently or it is not possible to open them for testing

F.2.2 Isolating Current Transformer (ICT)

Three phase current transformer which has a ratio 1:1 and provides isolation in the current circuits of the MTS, between the current source and the MUT.

F.3 Application

Testing of multiple numbers of three phase closed link meters requires isolation in the current circuits. Each phase and each meter test position will require an ICT to provide the isolation.

Note 1: ICTs are optional components of MTS. This mainly depends on the design of meters to be tested. The purchaser should specifically mention in his technical requirements along with meter test positions.

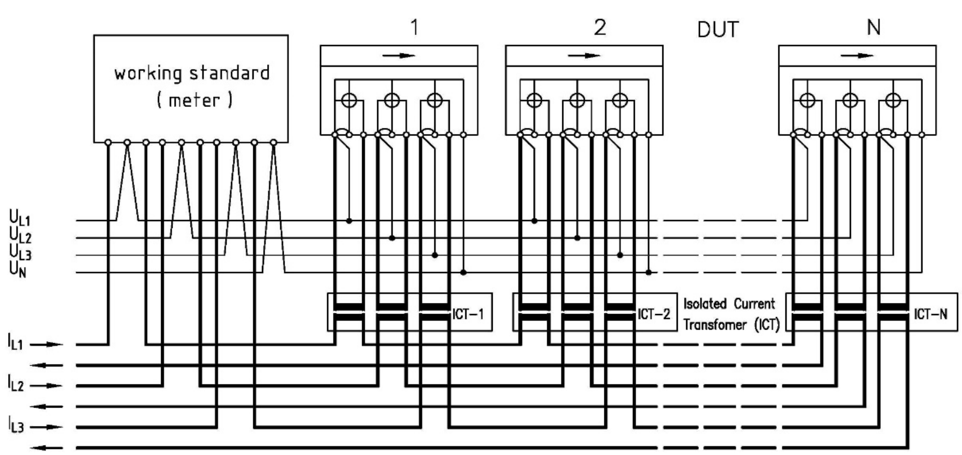


Figure 9– Testing of 3-phase meters with closed link between the voltage and current circuits

F.4 Technical requirements

ICTs shall fulfil the following technical characteristics of Table 34

Table 34 Technical requirements of ICT

Technical Parameters	Requirements		
Maximum current (*I*max)	120 A per phase (other secondary current according to ratio may be obtained)		
Minimum current	10mA per phase (optionally 1mA)		
Ratio	1:1 (other Ratios may be opted)		
Power rating	Minimum 40 VA per phase at 120 A max.		
	Current Range	**Ratio error %**	**Phase angle error, min**
Accuracy	25 mA < *I* < 150 mA	0.2	10
	150 mA < *I* < 1 A	0.05	3
	1A < *I* < 120 A	0.01	1
Power supply of ICT	Shall be decided by the manufacturer		
Attention shall be paid on the sufficiency of maximum VA power rating of amplifier, maximum number of ICTs in each current circuit and required test current.			

The manufacturer and the purchaser may agree on the suitable requirements.

F.5 Wiring and terminals

The ICT wiring and terminals shall meet the following requirements unless otherwise agreed by the purchaser and the manufacturer

- The ICT secondary cable should have appropriate length and size to keep the burden low;
- The ICT terminals in the MTU shall be marked in each phase, identifying the inputs and the outputs.

F.6 Total accuracy of MTS with ICT

The overall error of the MTU while using ICT should not exceed the values specified in Table 35

Table 35 Maximum permissible limits of error of MTS with ICT

Test point		**Maximum permissible limits of error of MTS in % while using ICT**	
Voltage	**Current Range**	**PF =1**	**PF=0.5**
240 V	25 mA < *I* < 150 mA	δW_{max} + 0.2	δW_{max}+ 0.7
240 V	150 mA < *I* ≤ 1 A	δW_{max} + 0.05	δW_{max}+ 0.3
240 V	1A < *I* ≤ 120A	δW_{max} + 0.01	δW_{max}+ 0.07
NOTE 1 δW_{max} is taken according to Table 27 NOTE 2 During the error evaluation, the secondary of the ICT shall be connected to the nominal voltage potential of the MTU (closed link between voltage and current terminals at meters with links to be opened). NOTE 3 For active power measurements δW_{max} is determined for cos ϕ= 1 and 0.5. For reactive power measurements the maximum permissible limits belong to δW_{max} at sin ϕ = 1 and 0.5			

The manufacturer and the purchaser may agree on the suitable requirements.

Annex G
(informative)
Wiring samples of test sets and MUTs

G.1 Connection of the reference meter for wiring check / error measurement for testing of Single Phase energy meter

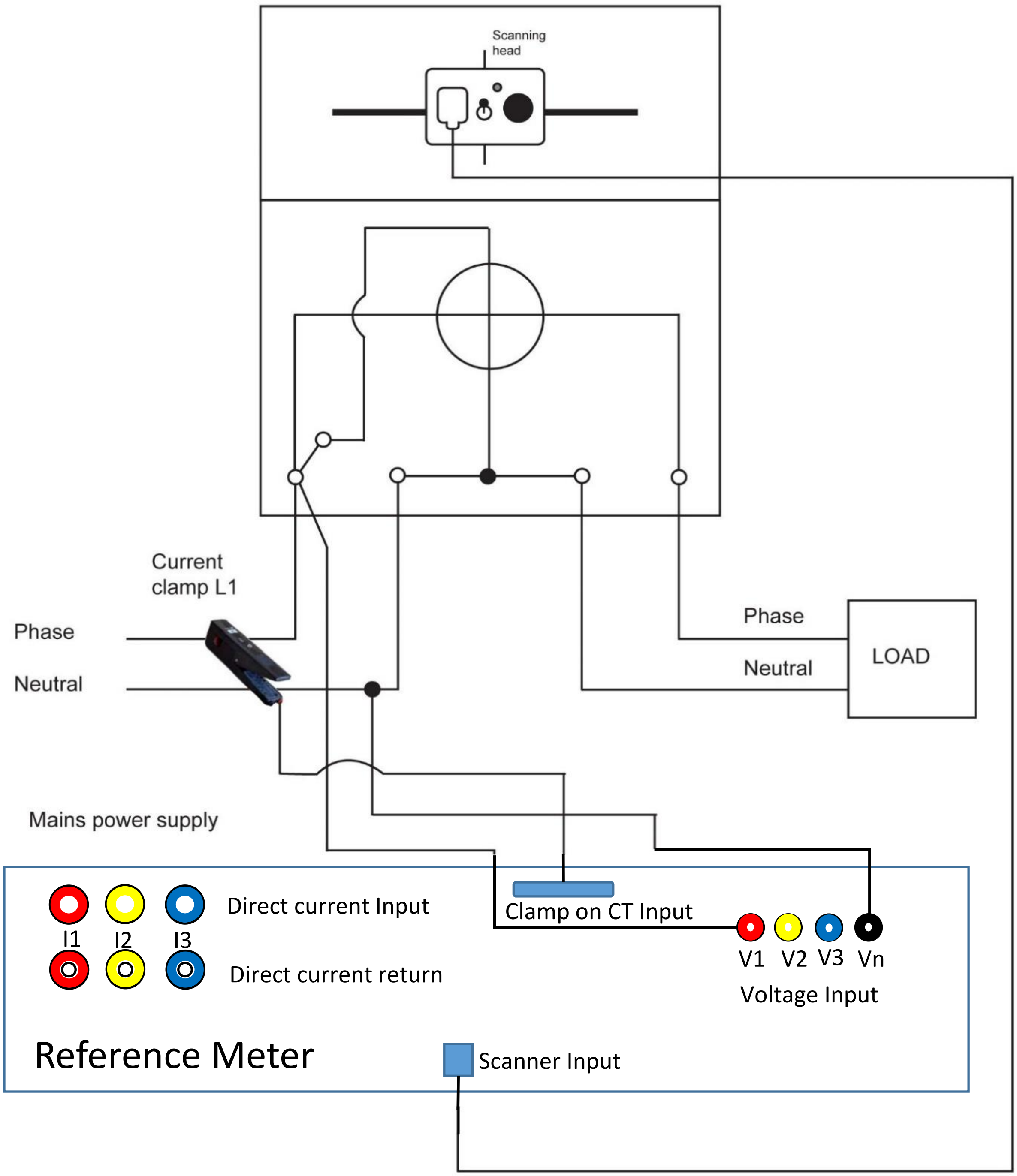


Figure 10–Connection of the reference meter for wiring check / error measurement for testing of Single Phase energy meter

G.2 Connection of the reference meter for wiring check / error measurement for testing of 3 Phase Direct connected energy meter

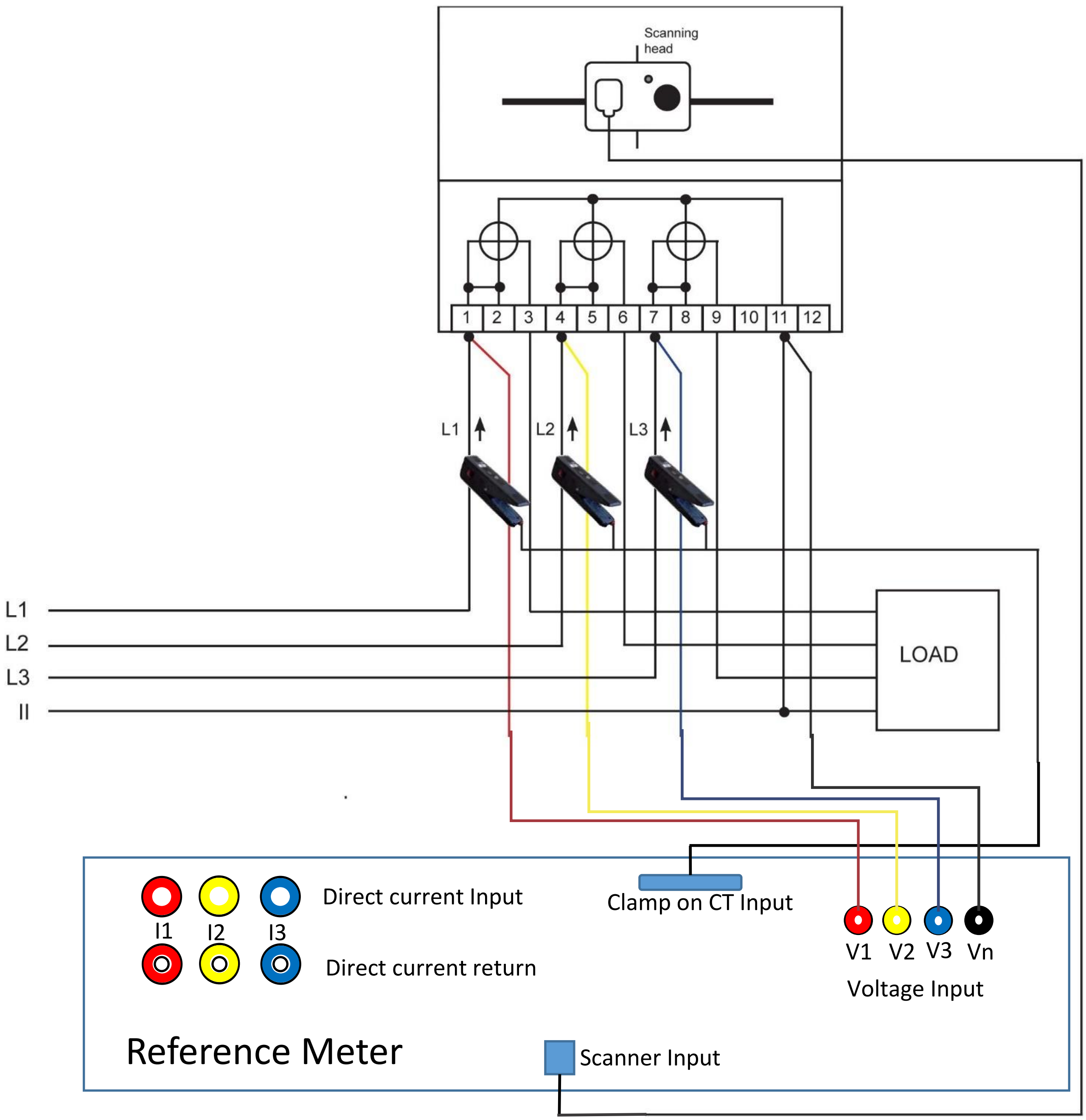


Figure 11–Connection of the reference meter for wiring check / error measurement for testing of 3 Phase Direct connected energy meter

G.3 Connection of the reference meter for wiring check / error measurement for testing of 3 Phase CT operated meter (from secondary side)

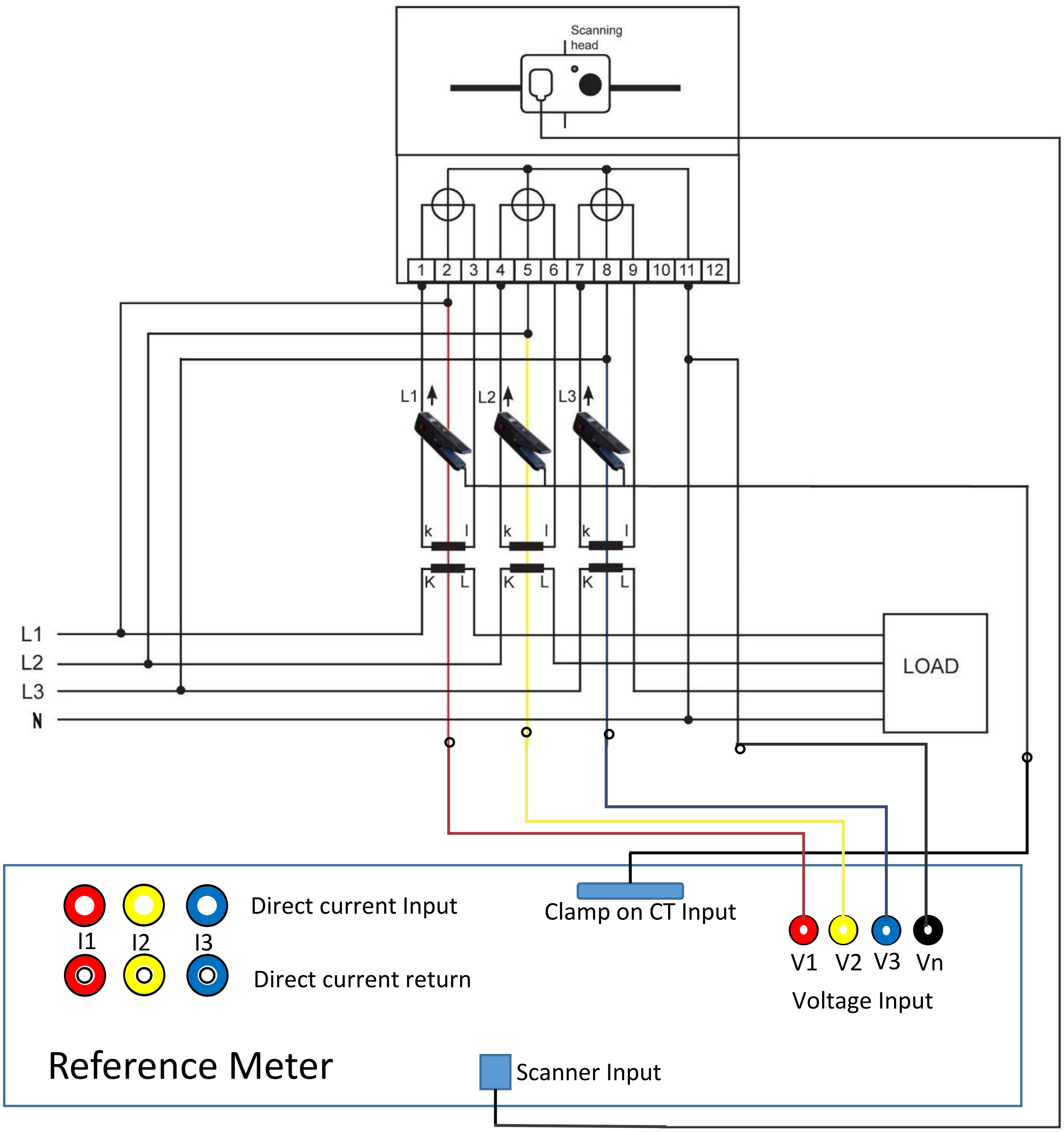


Figure 12–Connection of the reference meter for wiring check / error measurement for testing of 3 Phase CT operated energy meter (secondary)

G.4 Connection of the reference meter for wiring check / error measurement for testing of 3 Phase CT operated meter (from primary side-installation checking)

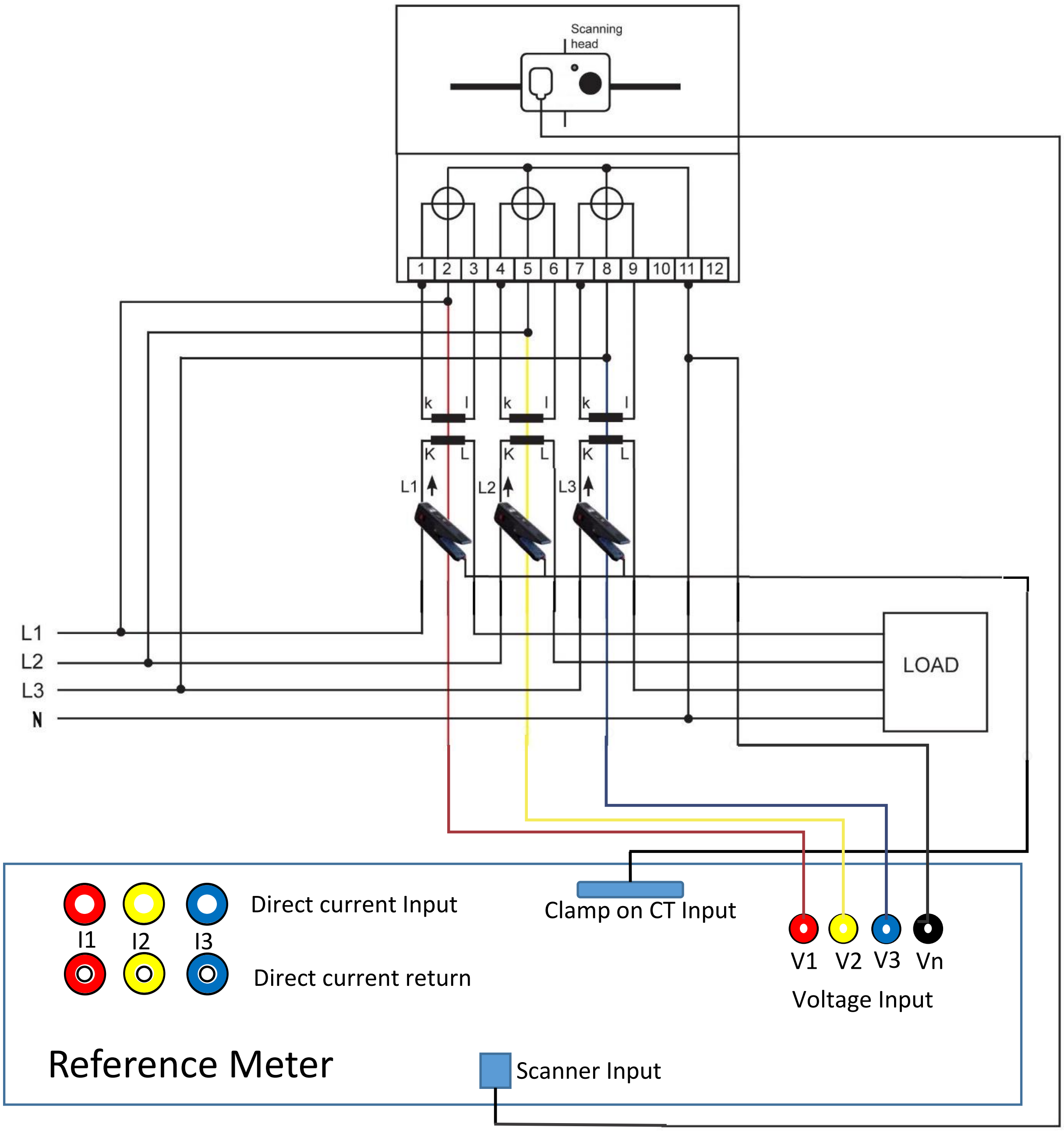


Figure 15–Connection of the reference meter for wiring check / error measurement for testing of 3 Phase CT operated energy meter (Primary side-installation checking)

G.5 Connection of the reference meter for wiring check / error measurement for testing of 3 Phase CT-PT operated meter

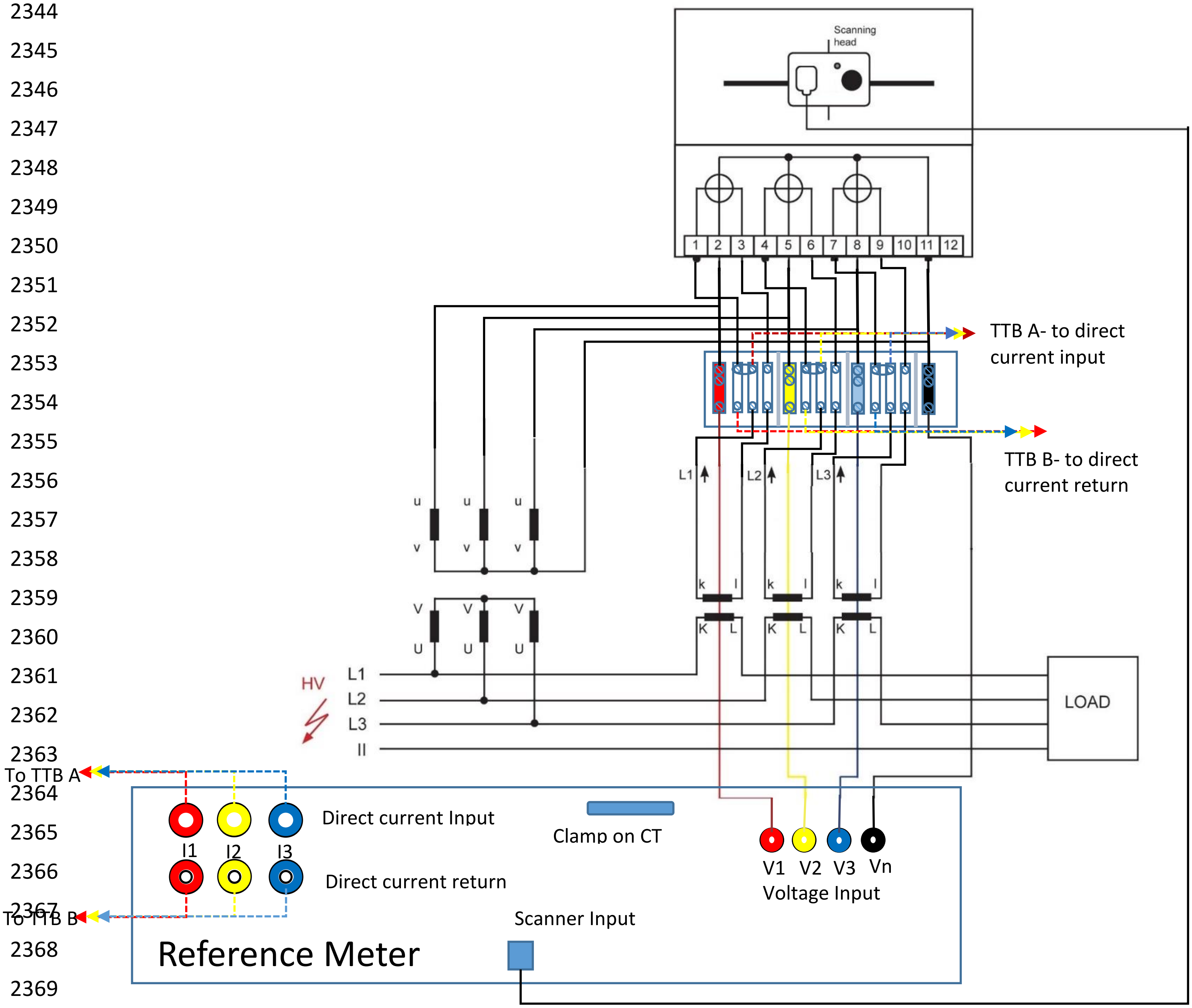


Figure 16–Connection of the reference meter for wiring check / error measurement for testing of 3 Phase CT-PT operated energy meter Using TTB)

Annex H
(informative)
Maintenance of meter test system

H.1 Maintenance of MTS (being used in laboratory)

For the maintenance of MTS it is must to use in dust free/pollution free environment as mentioned parameters for reference condition vide clause Annex B. For in-service check of MTS following procedure shall be followed.

- Cleaning of filter/vent/Fan of MTS- User shall have planned maintenance whereas cleaning of filter/vent /Fan shall be checked.
- Tightening of terminals – inspection of MTS connection terminals shall be done frequently (once in 3 months- as per planed maintained schedule), tightening shall be made in case of loose contact found.
- Reference meter of MTS shall be calibrated. The calibration frequency shall be decided on the basis of National regulations, its frequency of use and manufacturer recommendation.
- Other components such as MSVT/ICT also shall be calibrated, in case any recommendation from manufacturer is not provided. The calibration frequency shall be decided on the basis of National regulations, its frequency of use and manufacturer recommendation.
- The complete check of the MTS for its overall error shall be made each year according to procedure mentioned 14.2 .The measurement shall be taken at each measuring position and on basic measurement load points as mentioned in 15.1.2.7. acceptance limits defined in Table 35 and Table 33

H.2 Maintenance of MTS (being used at Onsite)

For the maintenance of MTS following procedure shall be followed.

- Cleaning of filter/vent/Fan of MTS- User shall have planned maintenance whereas cleaning of filter/vent /Fan shall be checked.
- Tightening of terminals – inspection of MTS connection terminals shall be done frequently (once in 3 months- as per planed maintained schedule), tightening shall be made in case of loose contact found.
- Connection of the MTS at field shall be made according to procedure defined by manufacturer or as per best field testing practices. Wherever earthing of MTS is applicable it must be done by suitable means and relevant terminal of MTS.
- Up keeping of connection accessories – all connection accessories such as cables, terminals shall be check. In case MTS is used with clamp on CTs, Clamp on CT’s jaw has to be cleaned regularly by fine cotton cloth using corrosion cleaning spray regularly to avoid and false measurement.
- The MTS shall be calibrated. The calibration frequency shall be decided on the basis of National regulation, frequency of use and manufacturer recommendation.

Annex I
(informative)
Testing of Smart Meter

Test system may have capability to test smart meters complies with IS16444 (part 1 and Part 2) and IS15959 (part 1, 2 and 3). The test shall be performed to prove the functionality of smart meters as per IS16444 (part 1 and 2) and IS15959 (Part 1, 2 and 3),

Following facility may be included as a part of smart meter testing

I.1 End to End testing

Facility to perform End to End testing of smart meter communication infrastructure. The test system hardware and software shall be capable to integrate DCU/receiver/gateway or any other compatible technology to obtain data from communicable energy meter over the cloud or any remote medium. Testing shall be performed by sending command over integrated infrastructure and receive response from the integrated infrastructure. Reporting shall be made for each sent command and received response within test system software. As per clause 10.6.2 of IS16444 (part-1 & 2)

I.2 Test for parameter verification as per IS15959 (part 2 and 3) of implemented commands

Test software, power source measuring system is required to test smart meter for parameter verification as per IS15959 (part 2 and 3) of implemented commands. For meter conformance test facility as per IEC62056 and parameter verification as per IS15959 part 2 and 3.

I.3 Recommended test facility as per IS15959 part 2 and 3

I.3.1 Functional test

The Test system shall perform all the routine functional test as mentioned below simultaneously on all connected meters on the test bench over the communication port (wired and wireless both).

I.3.1.1 As per Table A30 of IS15959 Part2 and Table 29 of IS15959 Part3

- **Associations**

  The associated test system software shall have facility to check object list of the current association of all connected smart meters on meter test bench.
  The test shall be conducted using each association at a time such as Public Client, MR and US (LLS) via communication port by sending OBIS code to read the object list.
  The report for each association shall be generated for its accessible attributes i.e. object list using associated test system software.
- **Data read**

  The associated test system software shall have facility for selecting any five or more readouts from instantaneous parameter list table of IS15959 Part2 (Table A1 and Table A14) and IS15959 Part3 (Table 1 and Table 14). The user can select/ deselect the random parameters from the instantaneous parameters list table as per requirement of the specification using associated test system software.
  The test shall be conducted using any suitable association such as MR and US (LLS) via communication port and sending OBIS code command for individual parameter read (instantaneous Voltage, PF, frequency, energy etc.).

The report for each readout shall be generated for its response from the smart meter using associated test system software.

- **Connect/disconnect**

  The associated test system software shall have facility to readout the status of connect disconnect state of all connected meters simultaneously with the test bench. The test shall be conducted using any suitable association such as MR and US (LLS) via communication port and sending OBIS code command for reading the status of load switch.

  The report for readout status of load switch shall be generated using associated test system software.

I.3.1.2 Name plate details

The associated test bench software shall communicate with the smart meter to read its name plate details as per corresponding table of IS 15959 Part2 (Table A12 and A26), IS15959 Part3 (Table 12 and Table 25).

The test shall be conducted once the HDLC connection is establish between client and server using any association at a time such Public Client, MR and US(LLS) via communication and sending OBIS code command for name plate details (Serial No. manufacturer year etc.).

The report for response i.e. readout of nameplate details from the smart meter for each OBIS code shall be generated using associated test system software.

I.4 Provision for Burden measurement of the smart meter:

Facility to measure burden (power consumption) as per clause no 6.10.1 of IS16444 (part 1and 2) using suitable methods:

The power consumption in voltage circuit has to be measured in following conditions:

- During idle mode of communication module
- If a separate module to service a IHD is present
- During data transmission per communication module.

Under each of above mentioned condition the burden measurement in the voltage circuit shall be performed

I.5 Verification of electrical tamper conditions.

Following Electrical Tamper conditions wherever applicable, shall be created for its occurrence and restoration by the test bench. The created event shall be verified over the optical port and wireless port (Such as RF/GPRS/GSM etc.) for connected meters against the test conditions simulated by operator. These tests shall run in automatic mode simultaneously for all connected meters on test bench. Test shall be performed for both occurrence and restoration of corresponding tamper condition.

- Voltage missing
- Low voltage in any phase
- Voltage unbalance
- Current missing
- Current reversal
- Current unbalance

The associated test bench software shall have the possibility to show the response received over different communication port such as optical and wireless port (Such as RF/GPRS/GSM etc.) on the same connected Smart meter on the test bench.

I.6 Influence of metrological stress on communication

Test bench shall be able to create the metrological stress conditions to all connected meters on the test bench as mentioned below:-

- 10% of 3rd harmonics in phase in current, As per IS13779/14697
- 10% 5th harmonics in voltage and 40% of 5th harmonics in current,
- 120% of Vref, As per IS13779/14697
- Imax applied to the meter, As per IS13779/14697
- 60% of Vref,
- frequency variation +10%
- frequency variation -10%
- low PF such as 0.1PF

All above conditions shall be simulated by test system and the communication of the smart meter shall be verified in the influenced conditions through performing any one functional test as per above mentioned clause. The associate test system software shall having facility to report any discrepancy in the response from meter in normal condition and stressed condition.

I.7 Automatic testing of Communication:

The associated test bench system software shall communicate with all connected meters mounted on the test bench either as a single communication command OR combination of several communication commands included in one test sequence i.e. for meter read out and generation/simulation of the tamper conditions/ stress conditions by the test bench. The testing shall be carried out in automatic mode to test the communication correctness on communication ports between all connected smart meters and the test bench.

Annex J
(Informative)
Software requirement and Validation Points

- Programming facilities for setting and measurement of test parameters. Generation and storage of test programs: the program shall allow generating and storing test programs, with proper identifiers. It shall be possible to adapt the programs to different meter types, nominal values and ranges of current and voltage, and test purposes such as type test, calibration, sampling inspection, initial verification etc. It shall be possible to verify and approve such programs by Legal Metrology Bodies;

- Error compensation (optional): the program shall allow, as agreed and authorized by Legal Metrology Bodies, the compensation of the errors of the MTS and its components (standard meters, MSVTs, ICTs);

- Execution of test programs:
  - the program shall allow automatic or step-by-step execution of test programs;
  - it shall control, display and log the test parameters, such as connection mode, voltages, currents, frequency, phase angles, power factor, power, energy;
  - the program shall be able to send defined data and commands to the meter, as well as to receive and safely store data from the meter using the communication protocol and security features specified;
  - it shall also allow to give instructions to the operator and accept commands and parameters from duly authorized operators at specified points during the execution of the program;
  - the program shall monitor the operation of the MTS during execution of the program and if parameters are outside acceptable limits, give a warning sign or alarm and / or abort the program as appropriate;
  - The program shall provide information on its status, for example “Initialization”, “Measurement running”, “Waiting for input from operator”, “Aborted”, Finished” etc.
- Evaluation, presentation and archiving results: the program shall automatically calculate the errors; evaluate the results of the tests for each test points, for each meter position, and for defined meter lots. It shall display and print the results and store them safely and with proper identifiers for further processing.
- Some of these aspects are further explained and augmented in the following sub-clauses.

J.1 Control and supervision of the meter test system by the software

The software shall perform hardware supervision. Any malfunctions and faults of hardware components shall be detected in order to prevent incorrect meter calibrations or test results.

All data received from the measuring hardware shall be checked for plausibility and consistency. A warning or hint message shall be given to the operator in case of implausible or inconsistent results.
If some measurements cannot be completed, this shall not lead to program interruptions or malfunctions as far as this is feasible. Incomplete measurements shall not be evaluated, or if they are evaluated, then they shall be marked unambiguously. They shall not affect the presentation and storage of the results of other measurements, or if those measurements are affected by any way, they shall be marked unambiguously.

J.2 Creation, protection and storage of test programs

All test programs and parameter sets used for legal metrology purposes shall be easily understandable, properly documented, identifiable, adequately protected against inadmissible changes and safely stored on suitable storage media (paper or electronic data storage devices). Any changes shall be properly documented and, when necessary, approved by the responsible authority. The documentation shall include data such as name of the operator, time and date, reason for and list of changes, version etc.

Parameter sets used for legally relevant purposes shall be stored with or unambiguously linked to the test protocols and may not be changed afterwards.

J.3 Software logs

The user shall maintain a logbook.

When the software is installed on a given hardware and under a given operating system, or when any changes are made, the following information shall be logged:

- Date and time of installation or modification;
- Name of operator having installed or modified the software;
- Program name and version;
- Identifiers of the relevant elements of the hardware controlled by the software;
- List of changes;
- Documentation of how the changes influence the results;
- Date and time of authorizing the use of the software by the responsible authority.

It shall be possible to prevent the use of the software or any modifications for legally relevant purposes until its use has been authorized by the responsible authority.

Note 1: These requirements are verifiable by the local certification bodies and depend on the code of practice.

J.4 Software Validation

Manufacturer shall validate the software as per the functions provided and supply software validation compliance certificate to purchaser. Once this compliance certificate is provided no revalidation is required.

Annex K (informative)

Example of Uncertainty calculation of MTS (without ICT or MSVT)

Based of Document NABL141 + GUM

The uncertainty of MTS shall be calculated at respective measurement point and an example is elaborated hereunder

Parameter for Uncertainty Calculation:		
Active Energy Measurement		
Range:	115200	W
Description of Device Under calibration :		Reference meter with test bench
Range :	115200.0	W
Value:	115200.0	W
Least Count / Resolution:	0.000	%
Calibrated value:	115200.0	W

Type A:

Observation method: reading of %error by MTS

Number of observations: 10

X1	0.016	%
X2	0.015	%
X3	0.016	%
X4	0.017	%
X5	0.016	%
X6	0.015	%
X7	0.016	%
X8	0.018	%
X9	0.019	%
X10	0.017	%
Mean value:	0.0165	%
Standard deviation	0.00127	%
Repeatability error = (s n-1) / √n	0.00040	%
Degree of freedom (n-1)	**9**	

TYPE B

Source of uncertainty	Uncertainty of reference standard from calibration certificate (B1)
Distribution	Normal
Divisor	1.96
Parameter value B1	0.008%
Ub1 Uncertainty due to B1 = B1/Divisor	0.00408%
Degree of freedom	∞

Source of uncertainty	Uncertainty of reference Standard from its specification
Distribution	Rectangular
Divisor	1.7323
Parameter value B2	0.02%
Ub2 Uncertainty due to B2 = B2/Divisor	0.01155%
Degree of freedom	∞

Source of uncertainty	Uncertainty due to Resolution of error indication of MTS
Distribution	Rectangular
Divisor	1.7323
resolution	0.001%
Limit	2
Parameter value B3	0.002%
Ub3 Uncertainty due to B3 = B3/Divisor	0.00116%
Degree of freedom	∞

Source of uncertainty	Uncertainty due to Temperature co-efficient of Reference meter
Distribution	Rectangular
Divisor	1.7323
Temperature co-efficient	0.001%/ deg C
Temperature variation limit	4
Parameter value B4	0.004%
Ub4 Uncertainty due to B4 = B4/Divisor	0.00231%
Degree of freedom	∞

Source of uncertainty	Uncertainty due to Long term stability of Reference meter
Distribution	Rectangular
Divisor	1.7323
Parameter value B5	0.01%
Ub5 Uncertainty due to B5 = B5/Divisor	0.00577%
Degree of freedom	∞

Combined Uncertainty

U_c	$= \sqrt{(U_a^2 + U_{b1}^2 + U_{b2}^2 + U_{b3}^2 + U_{b4}^2 + U_{b5}^2)}$				
Ua	Ub1	Ub2	Ub3	Ub4	Ub5
0.00040	0.00408	0.01155	0.00116	0.00231	0.00577
Combined Uncertainty Uc	0.01379				

Effective degree of freedom $v_{eff} = \frac{u_{c(y)}^4}{\sum_{i=1}^{n} \frac{u_{(x_i)}^4}{v_i}}$ **= 12530703 (∞)**

Coverage factor (k) = 1.96

Expanded uncertainty (k x Uc) = ± 0.02703

UNCERTAINTY BUDGET

Source of Uncertainty	Estimate of Quantity	Probability Distribution	Divisor	Standard Uncertainty	Sensitivity Coefficient	Uncertainty Contribution	Degree of freedom
Uncertainty of reference standard from calibration certificate	115200	Normal	1.96	0.00408	1.000	0.00408	∞
Uncertainty of reference Standard from its specification	115200	Rectangular	1.7323	0.01155	1.000	0.01155	∞
Uncertainty due to Resolution of error indication of MTS		Rectangular	1.7323	0.00116	1.000	0.00116	∞
Uncertainty due to Temperature co-efficient of Reference meter		Rectangular	1.7323	0.00231	1.000	0.00231	∞
Uncertainty due to Long term stability of Reference meter		Rectangular	1.7323	0.00577	1.000	0.00577	∞
Repeatability Error, Ua.		Normal	2	0.00040	1.000	0.00040	9
Combined Uncertainty Uc	U_c			0.01379		0.01379	∞
Expanded Uncertainty		k=	**1.96**	0.01379		0.02703	∞

Final Result = **0.017 ± 0.027 %**

Example of Uncertainty calculation of MTS (with ICT)

Based of Document NABL141 + GUM

The uncertainty of MTS shall be calculated at respective measurement point and an example is elaborated hereunder

Parameter for Uncertainty Calculation:		
Active Energy Measurement		
Range:	115200	W
Description of Device Under calibration :		Reference meter with test bench
Range :	115200.0	W
Value:	115200.0	W
Least Count / Resolution:	0.000	%
Calibrated value:	115200.0	W

Type A:

Observation method: reading of %error by MTS

Number of observations: 10

X1	0.016	%
X2	0.015	%
X3	0.016	%
X4	0.017	%
X5	0.016	%
X6	0.015	%
X7	0.016	%
X8	0.018	%
X9	0.019	%
X10	0.017	%
Mean value:	0.0165	%
Standard deviation	0.00127	%
Repeatability error = (s n-1) / √n	0.00040	%
Degree of freedom (n-1)	**9**	

TYPE B

Source of uncertainty	Uncertainty of reference standard from calibration certificate (B1)
Distribution	Normal
Divisor	1.96
Parameter value B1	0.008%
Ub1 Uncertainty due to B1 = B1/Divisor	0.00408%
Degree of freedom	∞

Source of uncertainty	Uncertainty of reference Standard from its specification
Distribution	Rectangular
Divisor	1.7323
Parameter value B2	0.02%
Ub2 Uncertainty due to B2 = B2/Divisor	0.01155%
Degree of freedom	∞

Source of uncertainty	Uncertainty due to Resolution of error indication of MTS
Distribution	Rectangular
Divisor	1.7323
resolution	0.001%
Limit	2
Parameter value B3	0.002%
Ub3 Uncertainty due to B3 = B3/Divisor	0.00116%
Degree of freedom	∞

Source of uncertainty	Uncertainty due to Temperature co-efficient of Reference meter
Distribution	Rectangular
Divisor	1.7323
Temperature co-efficient	0.001%/ deg C
Temperature variation limit	4
Parameter value B4	0.004%
Ub4 Uncertainty due to B4 = B4/Divisor	0.00231%
Degree of freedom	∞

Source of uncertainty	Uncertainty due to Long term stability of Reference meter
Distribution	Rectangular
Divisor	1.7323
Parameter value B5	0.01%
Ub5 Uncertainty due to B5 = B5/Divisor	0.00577%
Degree of freedom	∞

Source of uncertainty	Uncertainty due to Isolation current transformer (ICT) Ratio and phase error (UPF)
Distribution	Rectangular
Divisor	1.7323
Parameter value B6 Error Due to ICT	0.01%
Ub6 Uncertainty due to B6 = B6/Divisor	0.00577%
Degree of freedom	∞

(How to calculate Error in Power/Energy at Power factors and due to phase error is elaborated at the end of this example)

Combined Uncertainty

U_c	$= \sqrt{(U_a^2 + U_{b1}^2 + U_{b2}^2 + U_{b3}^2 + U_{b4}^2 + U_{b5}^2)}$					
Ua	Ub1	Ub2	Ub3	Ub4	Ub5	Ub6
0.00040	0.00408	0.01155	0.00116	0.00231	0.00577	0.00577
Combined Uncertainty Uc	0.01495					

Effective degree of freedom $\nu_{eff} = \frac{u_{c(y)}^4}{\sum_{i=1}^{n} \frac{u_{(x_i)}^4}{v_i}}$ **= 17321243 (∞)**

Coverage factor (k) = 1.96

Expanded uncertainty (k x Uc) = ± 0.02930

UNCERTAINTY BUDGET

Source of Uncertainty	Estimate of Quantity	Probability Distribution	Divisor	Standard Uncertainty	Sensitivity Coefficient	Uncertainty Contribution	Degree of freedom
Uncertainty of reference standard from calibration certificate	115200	Normal	1.96	0.00408	1.000	0.00408	∞
Uncertainty of reference Standard from its specification	115200	Rectangular	1.7323	0.01155	1.000	0.01155	∞
Uncertainty due to Resolution of error indication of MTS		Rectangular	1.7323	0.00116	1.000	0.00116	∞
Uncertainty due to Temperature co-efficient of Reference meter		Rectangular	1.7323	0.00231	1.000	0.00231	∞
Uncertainty due to Long term stability of Reference meter		Rectangular	1.7323	0.00577	1.000	0.00577	∞
Uncertainty due to Isolation current transformer (ICT) Ratio and phase error (UPF)		Rectangular	1.7323	0.00577	1.000	0.00577	∞

Repeatability Error, Ua.		Normal	2	0.00040	1.000	0.00040	9
Combined Uncertainty Uc	U_c			0.01495		0.01495	∞
Expanded Uncertainty		k=	**1.96**	0.01495		0.02930	∞

Final Result = 0.017 ± 0.029 %

For example if we include phase error of ICT in the uncertainty calculation following will be the type B factor (B5)

Source of uncertainty	Uncertainty due to Isolation current transformer (ICT) Ratio and phase error (**0.5Lag**)
Distribution	Rectangular
Divisor	1.7323
Parameter value B5 Error Due to ICT	0.06% (0.01%+0.05%)
Ub5 Uncertainty due to B5 = B5/Divisor	0.034636%
Degree of freedom	∞

Note: in above case Error in energy measurement due to phase error of ICT will also be considered. For eg.

Applied Voltage		320	V
Applied Current		120	Amp
Power factor (COS Ø)		0.50	lag
Three phase active power		57600	W
additional error in minutes		1	Min
phase angle		0.016666667	deg
Apparent power		115200	VA
Angle		60.0000	deg
Additional error		60.01666667	deg
PF incl additional error		0.49975	
Active power calc (PF*S)		57570.97677	
%error		-0.050	
Error % in reported power		± 0.050	%

Similarly in case of MSVT, the additional error in power/energy measurement shall be calculated.