Forward

The Central Board of Irrigation & Power (CBIP) a Premier Institution has been rendering dedicated services to professional organizations, engineers and individuals in the country and abroad for the last more than 85 years, resulting in accelerated development in the Water Resources, Power including Renewable Energy in the country and abroad. The main objective of CBIP is to disseminate technical knowledge through various modes, e.g., publication of journals, manuals, technical reports, guidelines, organizing conferences/ seminars etc. We have published till date about 1000 precious publications for the development of these sectors.

In 1992, CBIP brought out the 'Specification for AC Static Electrical Energy Meters' - Technical Report 88' for the first time and was decided to update this Specifications periodically by the CBIP's Standing Committee on Energy Meters. Between 1999 and 2006 a number of amendments had been issued. New series of IEC meter standards were published, replacing the old standards. The Standing Committee, therefore, decided to bring out fresh publication on the subject covering all relevant aspects which has been titled as '**Manual for Standardization of AC Static Electrical Energy Meters**' in 2008. Since, the last edition of the manual was brought about 4 years back and it is felt that same should be updated with latest information on the subject.

In July 2012, during the Expert Group meeting, based on various inputs from various key stake holders, it was felt that the role of meter is no longer confined to KWh measurement and now a days meters are multi functional and have multi features. Since meters is measuring various parameters apart from Kwh and these parameters are important as these are referred in various utilities tariff, so it was decided that CBIP will prepare standards on various meter related parameters, features and functions, which are otherwise not covered in BIS/ CEA documents.

In this context, a Sub-Committee has been constituted drawing members from Utilities, Manufacturers and Research Organizations etc. Following guidelines were kept in consideration while preparing the draft:

- Technology offers various options- Standardization is a task to select the best and most relevant one.
- Precautions is taken, so as standard can be followed by all stakeholders/ users i.e. chip designer, meter manufacturer, utilities, test lab, regulators and policy makes, test labs and finally consumers.
- This standard document is a guideline – Additional features, specifications can be added by users.

The first draft document is ready. This document is forwarded for comments from all stake holders. At the end of this document, we have also specified various topics, on which this sub committee is now planning to prepare standard/ guidelines. Kindly forward your technical contribution regarding these various upcoming topics.

Kindly forward your comments on draft document and your technical contribution by 8th March 2013, to CBIP at mail id meter@cbip.org; The document is also available on CBIP website www.cbip.org;

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Apparent energy - kVAh metering

Definition:

Active power & energy:

Active power for any sinusoidal waveform of single frequency is defined as the product of r.m.s. value of current and voltage and the cosine of the phase angle between them. In other words, active power is the product of the component of current vector that is in phase with the voltage vector and voltage.

It is also known as real power (P) and measured in watts. The time integral of active power is known as active energy. Unit of active energy is Wh. Hence,

$P = V.I.\cos\theta$

Active energy= $\int VI\cos\theta \, dt$

Reactive power & energy:

Reactive power for any sinusoidal waveform of single frequency is defined as the product of r.m.s. value of current and voltage and the sine of the phase angle between them. Reactive power(Q), measured in VAr, includes the product of the component of current that is 90 degrees out of phase to voltage vector and voltage.

Reactive energy is the time integral of reactive power and represented with VArh.

$Q = V.I.\sin\theta$

Reactive energy= $\int VI\sin\theta \, dt$

Representation of Active & Reactive power (Power Triangle):

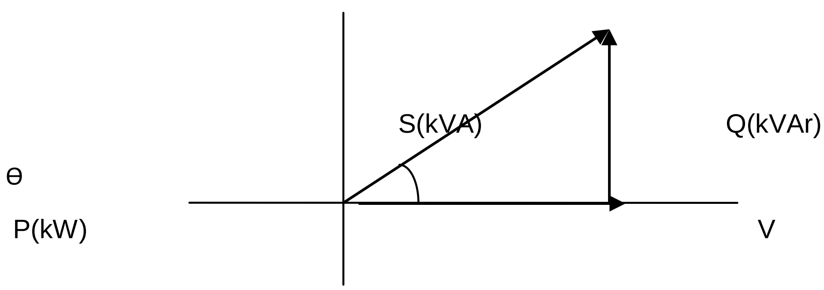


Figure1

Apparent Power and energy:

Apparent power is expressed in volt-amperes (VA) and it is the product of rms value of voltage and current. Apparent power (VA) is the Pythagoras sum of active power (W) and reactive power (VAr). Representation is as follows:

$S = \sqrt{(P^2 + Q^2)}$

The time integral of apparent power is called the apparent energy.

Apparent energy= $\int S dt$

Three phase measurement:

In three phase measurement, summation of signed active and signed reactive power is performed to derive three phase power.

Here is the mathematical expression:

Three phase active power kW = kW (R phase) + kW (Y phase) + kW (B phase)

Similarly, Three phase reactive power kVAr = kVAr (R phase) + kVAr (Y phase) + kVAr (B phase)

So, after calculation of active and reactive component, three phase apparent power can be derived with same expression i.e.

$kVA = \sqrt{(kW^2 + kVAr^2)}$

Note: The above equation is true for both balanced and unbalanced load conditions. For single phase system also the apparent calculation is done by Pythagoras sum of active and reactive power.

Note 2: R phase, Y phase, B phase are denoted by R, Y, B or 1, 2, 3. i.e. KW(R phase) as KW1 or KW(R).

System Power Factor (Instantaneous):

The ratio of active power and apparent power in a circuit is called the power factor. Power factors are stated as "lagging" or "leading" to show vector position of current with respect to voltage.

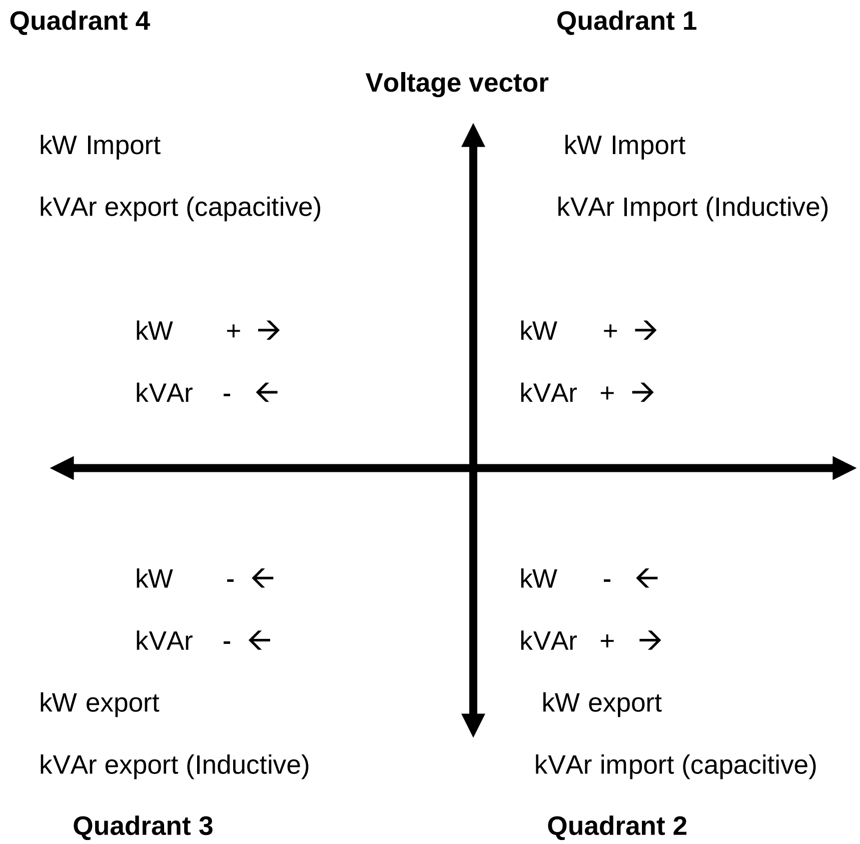
- When the current vector is behind the voltage vector, the power factor is said to be lagging.
- When the current vector is ahead of the voltage vector, the power factor is said to be leading.

Vectors are generally assumed to be rotating in anticlockwise direction.

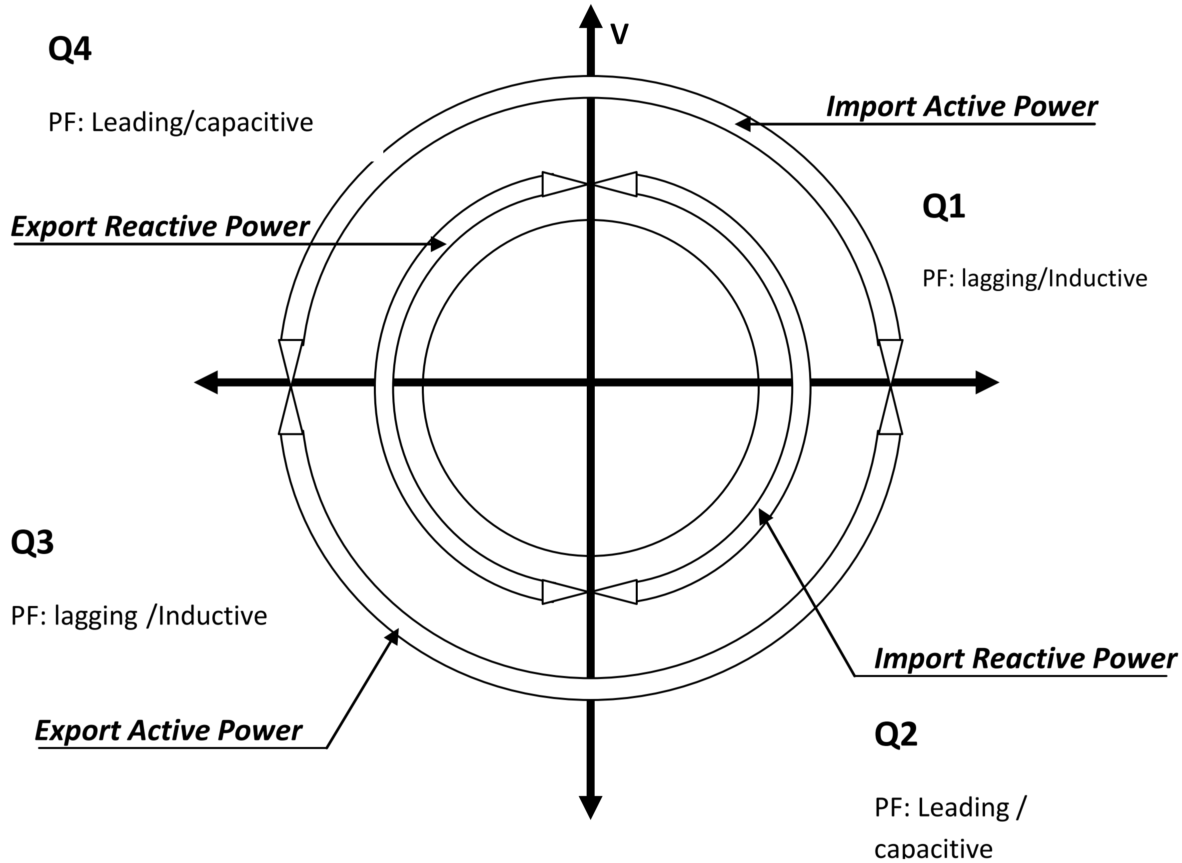
Where the waveforms are purely sinusoidal, the power factor is the cosine of the phase angle (ϴ) between the current and voltage sinusoidal waveforms.

Quadrant Definition

Power flow calculations is been done based on the angle between voltage and current. As angle between voltage and current can vary from 0 to 360 degree, energy calculation is also done w.r.t. it. Sign of active and reactive power based on different quadrant is shown in below figure for understanding.



The power flow quadrant as per IEC 62053-23 is shown below.



a. **Quadrant 1:** When current vector has an angle with voltage from 0 to 90 degree, power are to be referred in quadrant 1. Here, current vector is lagging from voltage vector with a certain angle. From start with zero angle, reactive component is zero. And at angle 90 degree angle, active component becomes zero. This quadrant represent that load is inductive.

b. **Quadrant 2:** When current vector has an angle with voltage from 90 to 270 degree, power are to be referred in quadrant 2. Here, current vector is leading from voltage vector with a certain angle. This quadrant represents the capacitive load. It is important to note that active power becomes negative (reverse flow) in this quadrant.

c. **Quadrant 3**: When current vector has an angle with voltage from 180 to 270 degree, power are to be referred in quadrant 3. Here, current vector is again lagging from voltage vector with a certain angle. This quadrant represents the inductive load with reverse flow of active power. As, both i.e. active and reactive component in quadrant 3 becomes negative, so effectively apparent power remains same as in quadrant 1.

d. **Quadrant 4:** When current vector has an angle with voltage from 90 to 180 degree, power are to be referred in quadrant 4. Here, current vector is leading from voltage vector with a certain angle. This quadrant represents the capacitive load. It is important to note that active power becomes positive in this quadrant.

Note: If current vector is taken as reference then also sign of active and reactive power will remain same as shown in above quadrant representation.

Tariff Type:

For apparent energy calculation, two different types of tariff are common which are as follows:

a. **Lag only tariff**: In lag only tariff, only lagging VAr is considered for calculation of apparent power Reactive lead VAr is not considered. Apparent power in quadrant 1 & 3 is calculated using both active and reactive component. Apparent power in quadrant 2 & 4 (leading load) is treated similar to active power. Reactive component of quadrant 2 & 4 are ignored in this type of tariff application.

b. **Lag + Lead tariff**: In this tariff application, apparent power is calculated based on both active and reactive component. Both lag and lead is considered for calculation of apparent power.

Apparent Energy calculation

Apparent energy calculation is done on instantaneous basis i.e. on a second interval. Each & every second, based on active and reactive power quadrant position; apparent energy is accumulated.

It will be clear through following scenario:

At time T1:

Let say, current vectors are in quadrant 1 with different angle with respective voltages. Based on this, three phase resultant power is in quadrant 1, so calculation is as follows:

kWh (T1) = $V_1L_1Cos\Theta_1 + V_2L_2Cos\Theta_2 + V_3L_3Cos\Theta_3$ (Vector addition) , for one second, Similarly;

kVArh (T1) = $V_1L_1Sin\Theta_1 + V_2L_2Sin\Theta_2 + V_3L_3Sin\Theta_3$, for one second, (Vector addition)

Hence, kVAh (T1) = $\sqrt{}$ (kWh(T1)^2 + kVArh(T1)^2) ……………………………….(A)

Apparent power thus calculated is accumulated with time in minimum duration (i.e. one second) and is added airthmetically to cumulative apparent energy register.

If after some time due to varying nature of load, power factor is changed but is still lagging and lies in quadrant 1 then apparent power calculation will be done with pythagoras sum of changed active and reactive power . This power will now be used to compute apparent energy.

Time T2:

Current vectors now are in quadrant 2 with different angle with respective voltages. Based on this, three phase resultant power is in quadrant 2, so calculation is as follows:

kWh (T2) = $V_1L_1Cos\Theta_1 + V_2L_2Cos\Theta_2 + V_3L_3Cos\Theta_3$, for one second, (Vector addition) , Similarly;

kVArh (T2) = $V_1L_1Sin\Theta_1 + V_2L_2Sin\Theta_2 + V_3L_3Sin\Theta_3$ (Vector addition)

Hence, kVAh (T2) = $\sqrt{}$ (kWh(T2)^2 + kVArh(T2)^2) for one second, ………………………………..(B)

Note: Equation B shall be used as it is for "lag + lead" tariff application but In lag only tariff application, reactive component shall be ignored. Means, equation B shall remain as follows:

kVAh (T2) = kWh (T2)

So as seen when quadrant is changed and depending of type of tariff definition apparent calculation is changed accordingly. Method to compute apparent energy remains same and will be integration of computed apparent power wrt time in minimum shortest duration.

At Time T3:

Current vectors now are in quadrant 3 with changed angle with respective voltages. Based on inductive load pattern, three phase resultant power is in quadrant 3, so calculation is as follows:

kWh (T3) = $V_1L_1Cos\theta_1 + V_2L_2Cos\theta_2 + V_3L_3Cos\theta_3$, for one second, (Vector addition) , Similarly;

kVArh (T3) = $V_1L_1Sin\theta_1 + V_2L_2Sin\theta_2 + V_3L_3Sin\theta_3$, for one second, (Vector addition)

Hence, kVAh (T3) = $\sqrt{}$ (kWh(T3)^2 + kVArh(T3)^2) , for one second, ………………………………. (C)

And at T4 :

Calculation is as follows:

kWh (T4) = $V_1L_1Cos\theta_1 + V_2L_2Cos\theta_2 + V_3L_3Cos\theta_3$ (Vector addition) , Similarly;

kVArh (T4) = $V_1L_1Sin\theta_1 + V_2L_2Sin\theta_2 + V_3L_3Sin\theta_3$ (Vector addition)

Hence, kVAh (T4) = $\sqrt{}$ (kWh(T4)^2 + kVArh(T4)^2) ……………………………… (D)

Note : Equation D shall be used as it is for “lag + lead” tariff application but In lag only tariff application, reactive component shall be ignored. Means, equation B shall remain as follows:

kVAh (T4) = kWh (T4)

So cumulative Apparent energy kVAh is sum of all kVAh(1), kVAh(2), kVAh(3) and kVAh(4),

So from above calculation, it clears that apparent energy registration is time based energy accumulation based on vector components position of active & reactive component. Apparent Register keeps on increasing based on vector position in different quadrant and applied tariff (lag only or lag + lead).

KVAh Energy – General

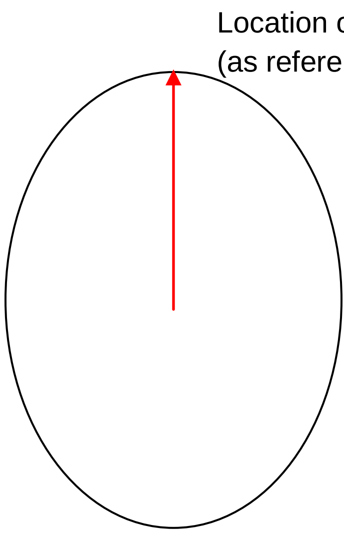
1. Meter with KVAh – feature should have provision of pulse output so as meter can be tested for KVAh accuracy.
2. The Apparent Energy/ Power parameter should have same display/ memory resolution and size that of Active Energy/ Power.
3. At no point cumulative KVAh Energy should not be less than cumulative kWh. In general cumulative KVAh is higher than cumulative kWh. Enough precaution should be taken to avoid confusion when KVAh counter rolls back & KWh counter yet to roll.
4. MD based on Apparent power, should be calculated on the similar principal i.e. Principal, as mentioned above to compute Apparent Energy.
5. The accuracy of apparent energy shall be same as Reactive energy accuracy class however shall not be inferior to active energy accuracy class by more than one class.

Phasor Diagram

Definition: Phasor diagram is a graphical representation of current and voltage vector ie. both magnitude and angle in an electric circuit.

Representation of Phasor diagram: In case, Phasor diagram feature is provided in 3 phase meter, it should show correct phasor diagram of the instantaneous parameters in the Base Computer Software and/ or display. The phasor diagram should adhere to the following points.

1) The Phasor diagram should be drawn taking R Phase voltage as reference. The location of R phase voltage will be fixed as shown



2) In case phasor diagram has colour option, R phase voltage/ current should be represented with red colour, Y phase voltage/ current should be represented with yellow colour, B phase voltage/ current should be represented with blue colour,

3) The Phasor diagram should be drawn clockwise ie. the sequence of voltage vectors should be R-Y-B under standard and correct wiring condition. This representation will be called as forward sequence. Forward sequence would also include sequence like Y-B-R, B-R-Y.

4) In case voltage applied across meter terminals is in order of R-B-Y, or Y-R-B, or B-Y-R, the representation will be called as reverse sequence

5) Phasor diagram should also calculate actual angle of each parameter ie. Vy, Vb and three currents with respect to Vr. The angles should be over 360 degree range.

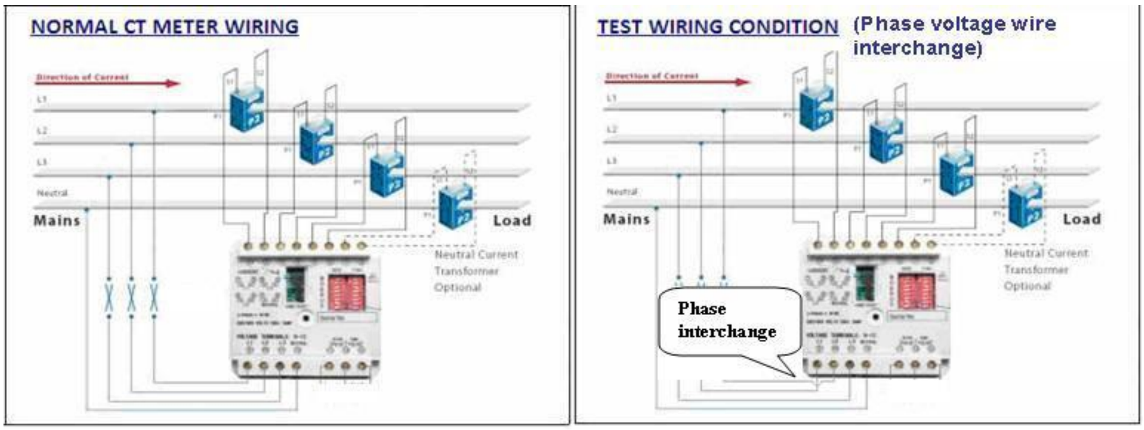
6) Vendor should clarify whether Phasor diagram would be formed even if only two phases with and without neutral, are present in a three phase meter. Also, vendor should clarify what reference is taken in absence of Vr.

7) R phase, Y phase, B phase are denoted either by r, y, b or 1, 2, 3. i.e. V1, Vr and is applicable for all parameters.

Phasor Diagram Test Circuit:

Test Circuit-1: In an LT CT meter, swap the phase voltage wires of two phase in a RYB network. This is a typical example of wrong phase association.

Check the phasor diagram and meter accuracy as claimed by vendor.



Test Circuit-2: Connect pure capacitor as load. Phasor diagram should consider it as leading power factor, and not as reverse lag.

Note: Voltage, power factor definition and quadrant definition should be followed as defined in Apparent energy document.

On Site meter testing procedure

Test Procedures

Procedure for testing shall be selected according to the Accuracy Class & Type of MUT.

- **(A) Testing with External Load:** This procedure is to be used for direct connected whole current meters of accuracy class 2.0 / 1.0. Use Reference Standard with "Total Uncertainty" level as specified in IS 15707 and external load.
- **(B) Testing with Phantom Load:** This procedure is to be used for CT/VT connected meters up to accuracy class of 0.5/0.2S. For class 0.5 MUT, minimum accuracy class of Reference Standard should be 0.2. However, use of Reference Standard of accuracy class 0.05 and electronic Phantom Load is preferred.

(A) Testing with External Load

- Disconnect the prevailing load running through the meter to be tested by removing the load connection from out-put end of the Main Switch / MCB / Fuses.
- Connect Reference Standard, external load on load side of MUT.
- **External load**: The current drawn due to external load should be minimum 10% of Ib but less than Imax. Typically it should be 1~2KW heating load per phase.
- It is recommended to "Select direct connection method" of testing in Reference Standard, and capture MUT pulse with scanning head. Ring type CT can also be used to tap wire current.
- Note down the instantaneous values of Voltage, Current, Power Factor. as displayed by the reference standard. Ensure the current value is greater than 10% of Ib.
- It is recommended to start testing 2 minutes after load is ON. Check the stability of the error of the MUT by checking the initial errors at 20 pulses.
- The typical test duration should be 2 minute but should not be more than 5 minutes.
- Start the test and note down the results in percentage error.

Note:- Incase consumer "Actual Load" is used as External load, than ensure Actual Load is :

a) Greater than 10% of Ib.
b) Stable load – better switch off all "unstable loads".

(B) Testing with Phantom Load:

- Remove MUT connection from the Terminal block (TTB) for testing.
- Connect Reference Standard with MUT & Phantom Load.
- It is recommended to "Select direct connection method" of testing in Reference Standard, and capture MUT pulse with scanning head. Ring type CT can also be used to tap wire current.
- Note down the instantaneous values of Voltage, Current, Power Factor. as displayed by the reference standard.
- It is recommended to start testing 2 minutes after load is ON. Check the stability of the error of the MUT by checking the initial errors at 20 pulses.

- Meter to be tested on various testing points: preferably 3 test points.
- The typical test duration should be 2 minute but should not be more than 5 minutes.
- Start the test and note down the test parameters &results in percentage errors.
- Reinstall the meter after completion of testing and restore supply.

Acceptance Criteria:

- MUT should always be tested for Active Energy mode (KWh). Unless agreed for other Energy or parameters.
- As per Standard IS: 15707:2006 Clause 12.3.2 Table -3.

Precautions:

- Ensure the test equipments are duly calibrated and have uncertainty level with in acceptance range.
- While using external heating load, place the external heating load sufficiently away from MUT & Reference Standard, so that heat generated by the load could not affect the performance of MUT or Reference standard
- Only certified / trained person should do testing.
- Observe all safety precautions and take all precautions while reinstalling the MUT or switching ON consumer load.

Test standard for abnormal ESD devices

Definition of abnormal ESD devices:

This is a set of electrical devices, which creates abnormal field/frequency/ spark and can affect working of meter including malfunctioning of meter microprocessor. The externally operated devices are primarily used to influence meter functionality far beyond permissible limit. This is not a specific device but a common name to all such tamper device commonly known as Spark gun, Jammers, loop devices, 35KV ESD, CD jammer etc.

Impact of abnormal ESD on meters:

It is observed that following impacts observed by ESD application on meter and can be characterized as below:

High Severity: Processor of meter gets hang and starts functioning only after on/off cycle, meter behaviour becomes unpredictable & intermittent, display becomes permanently defective and corruption of energy registers & Real Time Clock (RTC) and meter becomes dead forever.

Low Severity: Stop communicating, display hangs temporarily, wrong ON/OFF of LED.

Expectation from meter:

- Minimum immunity: Up to EMI/EMC tests conditions limit as mentioned in relevant IS, the meter should comply Standard conditions and Under such condition the meter should not log it as abnormal/ theft event.
- Designed immunity: The meter can be designed to higher level of immunity so as there is no unacceptable impact of ESD devices on meter functioning.
- Logging of such events : In case the tampering device severity is high and it affects the working of meter, resulting in no/low consumption of energy or corruption of data/ RTC, then meter should clearly log such event preferably with time stamping. It may be noted that if the ESD device is used on meter, but could not affect the working of meter due to extra immunity, then it is not necessary such usage of devices may also be logged.
- Irreversible damage: If the severity of ESD devices is too high that it permanently damage the functioning of meter (mainly energy computation/ total burning), then the same is acceptable if the damage is irreversible, with time.

Test Methods, application area & duration:

Switch ON the meter with actual load (Load should be preferably near Ib) as per following Wiring connection. The test should not be done with Phantom load.

1 Phase: Actual load condition.

3 Phase: ***(a)*** Three phase voltage and load with neutral (b) Three phase voltage and load without neutral

Also connect a normal meter in series with MUT to compare energy recording between MUT and this reference meter. Ensure this reference meter is fully protected.

<u>Application area and duration:</u>

<u>Test 01:</u>

Identify all the potential points on meter body, which are susceptible to ESD devices and are accessible through test finger, should be treated as test point. Joints, display, optical port are few such points. Abnormal ESD test shall be performed on all such test points typically for 2 minute duration but not more than 10 minute durations. RS 232 wired port if covered with terminal cover and after sealing the T cover, not accessible with test finger, should not be treated as test point. How ever cable connected with port can be treated as test point.

Before and after conducting test, down load meter data of both meter and analyze.

Test 02: (to be done in meter with logging facility)

Cause sparking on meter terminal (as if loose connection), at load side (by shorting load/ loose connection), use fan regulator on normally connected meter. This test can be done in meter with battery and with out battery (as if battery is drained).

Before and after conducting test, down load meter data of both meter and analyze.

Pass criteria:

If meter is guaranteed for Immunity :

- No flashover or insulation breakdown
- No effect on meter basic functionalities: Accuracy, display and LED's (compare to 2nd meter used as reference).
- No effect on Real time clock(RTC)
- No effect on data : Serial number, Energy values, Billing histories
- Meter shall not hang permanently after removal of the disturbances and get reset/ start behaving normally after reset.
- Lower energy consumption should not be more than 4% during the test.
- In case display/LED's mis-behaved during the test and regain after removing the abnormal ESD effect, the product will be considered as acceptable.

If meter is guaranteed for Immunity and also have logging facility :

- In case of any effect as mentioned above, the event with time stamping should be logged in meter.
- The meter should not log specific event during test 2.
- Deterrent mode facility: if the meter detects and registers the abnormal disturbances with time, date and kWh register stamp, meter can start recording energy at a rate up to the maximum power rating of the meter.

Meter should get permanent irreversible damage:

Any act of tampering which permanently damage meter (no more energy recording) and the damage is irreversible, than that cannot be treated as tamper device/ method and both test method and result should be treated void. It can also be treated as meter is complying for that tamper test method.

Computation of Maximum Demand

1. Definitions

1.1 Indicated Maximum Demand

The highest value of the mean power (Active or Apparent) indicated by the maximum demand register during successive equal intervals of time between one zero resetting of the maximum demand register and the next resetting.

1.2 Demand Integration Period

The duration of the consecutive equal intervals of time, upon which the maximum demand measurement is based (For example 15/30 minutes).

2. Display of Maximum Demand

Maximum Demand should be displayed on the meter display. The resolution of (Last count) MD display should be better than the resolution (last count) of the Energy Display.

The minimum resolution of MD should be capable of displaying MD corresponding to load at 5% of Ib at Vref. and Upf.

The M.D. should be provided for kW / kVA or both as per the utility practice.

3. MD Reset

The meter should have any of the following MD reset options:

a. Automatic reset at the end of a certain vendor predefined period. If not specified default value should be at 2400 hrs on the last day of the month.

b. Resetting through CMRI or remote communication.

c. Manual resetting arrangement through a push button with sealing facility.

Note:- If no option is specified then option (a), should be default option.

4. Maximum Demand Type - Block Window / Sliding Window

MD can be of Block or fixed window type such as 00.00 to 00.30 etc. or a sliding window type with sub-integration period of 1/3 time the demand integration period.

TOD MD: By default, LT Meters & Meters with TOD tariff should have only Block window MD Type.

5. Maximum Demand Integration Period (DIP)

The DIP should be either 15 minutes or 30 minutes.

a) Following is the recommended time for DIP:

- All LT meter – 30 minutes.
- HTconsumer meter – 15/30 minutes (default 30 minutes)
- Grid meters/ feeder meter – 15/30 minutes (default 15 minutes) (HT/EHT)

In case DIP is field selectable using CMRI / Remote communication should be duly password protected. Any change of DIP in the field should be logged as an event in the meter with date & time stamp.

The rising demand with the elapsed time should be held in the memory in the event of power interruption within the same DIP and it should not fall to zero under instances like power interruption, MD reset, abnormal power condition etc. After resetting of MD using manual reset or resetting through CMRI, the maximum demand shall also go to zero. On completion of current DIP, the demand value shall be treated as MD until next demand value is higher.

b) The DIP should always start or end from at HH:00 or HH:30 in a fixed block type MD.

6. During Defraud Energy Metering such as during magnet tamper, maximum demand shall not take into account the energy recorded during defraud metering in meters applicable for MD tariffs.

Time of the Day Tariff

Also known as Time of Use, this feature enables the utility to apply different tariff for different time zones of the day, depending upon the consumption during these time zones. For example, the utility can apply a higher tariff during peak load time (between 6:00 p.m. t0 10:00 p.m.) and lower tariff during off peak hours.

The day, from 00:00 hours to 24:00 hours is divided into several time zones. Each time zone is then attributed a particular tariff slab. Thus several time slots in each day can have the same tariff, while others can have a different tariff depending upon the load on the network during these time zones.

For standardization it is recommended that time zones should start from T1 and the day should be defined from 00:00 hours to 24:00 hours.

An example is given below:

Time Zone	**Load on distribution network**	**Tariff**
00:00 hrs to 06:00 hrs	Off Peak	T1
06:00 hrs to 10:00 hrs	High	T2
10:00 hrs to 17:00 hrs	Low	T3
17:00 hrs to 19:00 hrs	High	T2
19:00 hrs to 22:00 hrs	Peak	T4
22:00 hrs to 24:00 hrs	Off Peak	T1

Thus, in this example, we have 6 Time Zones but only 4 Tariffs.

Once the time zone and tariff structure is defined in the meters, the meters record the energy consumed during the defined time zones in different registers. These different registers are read at the time of data collection and energy in each register is multiplied by the tariff for the appropriate time zone.

The cumulative consumption recorded in the meter is then a sum of the consumptions in the individual time zones. However the minor difference may occur due to register resolution and value packing and the difference shall be accumulated in next billing cycle without any value loss.

Seasonal Profiles (Optional) : Once again an optional feature and supported by meters on demand, this feature enables different day profiles for different seasons. This is because based on the season, the distribution network loading pattern may be different for the day. For example, in the summer season, load during the day time will be high due to Air Conditioning. On the other hand, during winters, the load during the day time may be very low, but may peak up during the early morning and late night when water heaters and room heaters are in use. In some areas, load on the distribution network may change with season due to presence of seasonal industries, like Sugar Mills, Rice mills which work only for few months in a year.

Once again the number of seasons that can be programmed in the meter depends on the memory available in the meter and the specifications of the Utilities.

For example

Season: Winter – September to February				Season: Summer – March to August		
Time Zone	**Load on distribution network**	**Tariff**		**Time Zone**	**Load on distribution network**	**Tariff**
00:00 hrs to 06:00 hrs	Off Peak	T1		00:00 hrs to 06:00 hrs	Off Peak	T1
06:00 hrs to 10:00 hrs	High	T2		06:00 hrs to 19:00 hrs	High	T2
10:00 hrs to 17:00 hrs	Low	T3		19:00 hrs to 22:00 hrs	Peak	T3
17:00 hrs to 19:00 hrs	High	T2		22:00 hrs to 24:00 hrs	Off Peak	T1
19:00 hrs to 22:00 hrs	Peak	T4				
22:00 hrs to 24:00 hrs	Off Peak	T1				

Programmability : Since the time of the day tariff may be redefined by the regulators from time to time, the time of the day zones in the meter are field programmable. It is therefore possible to redefine the time zones and associated tariff slab in the field. Programming can be done in 3 conditions :

a) Redefining of existing time zones

b) Adding of new time zones and redefinition of the zones

c) To implement seasonal tariff.

1. During reprogramming, if tariff slabs are reduced and few tariff slab became initiative then, it is found that the cumulative energy in the meter is no longer a sum of the active TODs. This is because some consumption has already been recorded in the inactive TOD registers and cumulative energy register is a sum of both, active and inactive TOD registers. The programming of TOD tariff should be associated with Billing and history can be reset.

It is recommended that the meter should display both Active and Inactive TODs on display as well as in data with proper identification. In this case the reading of the inactive TODs will not increment and only that of active TODs will increment during consumption or meter shall follow IS15959.

For example :

Before programming

Time Zone	**Consumption**
T1	**400**
T2	**500**
T3	**300**
T4	**200**
Cumulative kWh	**1400**

After Programming (to reduce number of time slots in a day) & after subsequent consumption, the active TODs will increment but inactive TOD will have constant value.

Time Zone	**Consumption**
T1	**450**
T2	**550**
T3	**350**
T4 (Inactive)	**200**
Cumulative kWh	**1550**

2. The cumulative energy register of each tariff slab should have adequate resolution facilitating the comparison of values with cumulative energy

3. While defining time zone, it should be multiple of 00:30 hrs and then start and end time should be XX:00 or XX:30 hrs. For high end metering, option shall be available for TOD zones in multiple of 15 minutes

4. All whole current meters should have minimum 6 time zones and 4 tariffs.

5. All LT/CT and HT meters should have minimum 8 time zones and 4 tariffs along with provision for seasonal tariff planning.

6. The information about time zone and tariff slab should be available when the meter data is viewed on BCS. If utility ask for same information then it should be either available on display or BCS.

Meter “Power off” Data

Apart from billing, Meter Data is also used to know Quality of Supply and to detect theft. “*Power Off”* data as recorded by consumer meter, plays a vital role in analyzing the supply quality and also to find theft (Tamper Method, which switch off meter).

It is important as how to define *“Power Off”* situation. Various logics are:-

- When meter circuratory get Switch Off.
- When $V \approx 0$.
- When $V \leq$ VThreshold (VTh) where VTh is a low level voltage, which practically of no use to consumer.

Based on above *“Power Off”* can be defined as:-

Logic I :- When meter processor see “Switch Off”.

OR

Logic 2 :- When voltage is below VTh.

Any situation complying with above logic will be called as *“Power Off”* situation. Utility can define their Vth.

In India, standard LT voltage is 230 V and unless specified VTh is standardize as 80V.

In case of three phase meter, regarding ***Logic 2***, unless all three phase are below VTh, then only, it will be called as “*Power Off”.* If only one phase is below VTh, then, it will not be defined as “Power Off”. (However, it may be called as *Phase Missing*).

Following Guidelines to be followed:-

- Single wire (also called as *Neutral Missing*) in single phase meter should also be treated as “*Power Off*” event.
- In case meter has load survey, and if for Entire Integration Period, the meter record “*Power Off”,* then, load survey of all parameters should be void. During Power Off – NO MD etc, should be calculated.
- “*Power Off”* should be recorded in two formats.

- **Cumulative Power Off DD:HH:MM**

The reading resolution is one minute and even if “Power is Off” for one minute, the register should increment.

- **Event Logging**

Regarding occurrence period and restoration period, following logic should be used:-

Meter Type	Occurrence	Restoration
LT- WC Meter	10 min.	When meter fully functional on power up
LT-CT/ HT meters	5 min	When meter fully functional on power up
Audit/ Grid Meters	1 min	When meter fully functional on power up

List of topics short listed for phase 2 of standardization

1. **Load survey**:

As per CEA metering Regulation 2006, all three phase meters should have load survey facility. The need is that all meters should perform identically regarding this feature. Most important thing is definition of load survey parameters, behaviors of load survey parameters under tamper condition etc. Technical contribution is required for following:

- Load survey parameters and their definitions
- Precaution to be taken duration load survey data compilation
- Load survey data characteristics during abnormal condition say tampering, etc.

2. *Test for theft proof capabilities*:

Since revenue is associated with energy meter, so in order to protect the meter from tampering, the meter should have built in tamper proof capabilities. A meter can be called as tamper proof if either it is immune to tamper method or it logs correctly the event. This document will have test techniques, along with pass/ fail criteria to test tamper proof capabilities of meters. Further, it will help to harmonize various terminologies associated with “tampering”. The document will have many subparts, each for one type of tampering. Technical contribution is required for following:

- List of prevalent tamper techniques
- Test method – to check tamper proof capability for a defined tamper method
- Acceptance criteria – for a defined tamper method.
- Acceptance criteria – for various severity levels.
- Proposals about harmonization of various terminology used in context of theft.

3. *Reliability test*:

Entire electricity Generation, Transmission and Distribution business revolves around meters. Presently meter quality and reliability is assessed by conducting various “type test” as specified in relevant IS. Since the present meters have many features and functionality, so the reliability of meter cannot be confined to its KWh capabilities only. Battery, display, contact, memory etc also palsy the most vital role. This document will standardize on “Reliability test method and computation of Reliability Indices” of entire meter or any key components/ sub assembly. Technical contribution is required for following:

- List of key components
- Performance expectation of key components
- Reliability test method – for individual components/ entire meter
- Computation of Reliability indices.
- System to ensure periodically computation of reliability indices.

4. Standardization of various Energy meter parameters affecting its working in field:

Utilities are the biggest user of energy meters. Apart from measuring capabilities, there are various other features of meters which affect its usage and performance in field. Non standardization of these features result in improper usage of meters, high inventories of accessions and inconvenience in usage. Mounting pole position, terminal block non standard pitch are few such parameters, which can create lot of inconvenience due to lack of standardization. Technical contribution is required for following:

- List of key parameters – critical from usage point of view.
- Critical ness of that parameters and present practices.
- Standardization of EACH key parameters

The document will be compilation of "standard on each key parameter".

5. Standardization of various accessories associated with energy meters:

All new electronics meters have interface and communications capabilities. In order to take full benefit of meter capabilities, one has to use lot of accessories. In field, the accessories are playing vital role. Due to non standardization of same, the meter can remain under utilized or the accessories need to be changed when ever the meter is changed. This can create lot of inconvenience due to lack of standardization. Technical contribution is required for following:

- List of key accessories – critical from usage point of view.
- Purpose and Key features of the accessories.
- Standardization of EACH key accessories

The document will be compilation of "standard on each accessory".

Disclaimer: The above topics list above can be changed with time. Technical contribution on any other topic(s) is also welcome.