Functional Requirements of

Advanced Metering Infrastructure (AMI)

In

India

CENTRAL ELECTRICITY AUTHORITY

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1. Functional Requirements for Advanced Metering Infrastructure (AMI)

These functional requirements define the minimum functionalities and performance for AMI system proposed to be developed in India. The main objective of AMI is to enable two way communication between smart energy meter and Head End System(HES) to enable remote reading, monitoring & control of electrical energy meters (consumer, feeder, DT meters etc.) to serve as repository of record for all raw, validated and edited data. The sanitized data may be subscribed by other utility function for higher order analysis and billing and collection engine etc.

2. Basic Functions of AMI

The AMI system shall help utility to manage their resource and business process efficiently. AMI system shall support the following minimum functionalities:

a) Remote Meter data reading at configurable intervals(push/pull)

b) Time of day (TOD)/TOU metering

c) Pre paid functionality

d) Net Metering/Billing

e) Alarm/Event detection, notification and reporting

f) Remote Load Limiter and connection/ disconnection at defined/on demand conditions

g) Remote firmware upgrade

h) Integration with other existing systems like IVRS, Billing & collection software, GIS mapping, consumer indexing, new connections & disconnection, analysis software, Outage Management System etc.

i) Import of legacy data from existing modules/ MDAS of RAPDRP where ever possible. The extent and modalities of integration with the existing system including RAPDRP has to be worked out by the bidder.

j) Security features to prevent unauthorized access to the AMI including Smart meter & meter data etc. and to ensure authentication of all AMI elements by third party.

This is only an indicative but not exhaustive list. The system should be capable to support the other functionalities as per the requirement of utilities.

The System should accurately maintain system time synchronization across all devices to ensure accuracy of data. The system should support the interfacing with the future Smart Grid functionalities like outage management system, distribution automation including self-healing system, distribution transformer monitoring units, Electric vehicle, distributed energy resources etc. The communication network shall preferably be able to support multiple applications.

The Bidder shall submit an approach paper describing overall architecture and operational philosophy of the proposed AMI solution and methodology for achieving different functionalities, specified in this document and also highlight additional features, if any.

3. General AMI System Requirement

Smart Meter (Single phase whole current, Three phase whole current, CT & PT operated three phase meters and CT operated three phase meters) for consumers/ system shall be provided based on Radio Frequency (RF) mesh in license free frequency band/ Power Line Carrier Communication (PLCC) or GPRS/3G/4G communication technology or combination of these technologies as per the site requirement and to ensure the performance level given in this document. The smart meter data using RF mesh/PLCC shall be collected by Data Concentrator Units(DCUs)/Access point and transported to HES through WAN while the data from smart meters using GPRS/3G/4G technology shall be transported directly to HES through WAN. The AMI Implementing Agency (AIA) shall be responsible for proper data exchange among Smart meter, DCU, MDM, HES and other operational/requisite software as part of fully functional AMI system.

AIA shall adhere with the appropriate security algorithm for encryption and decryption. For smooth functioning of the entire system, it is essential that the details of such algorithm including the mechanism of security key generation be kept in a secured escrow account which shall be used by the utility only in case of termination of the contract for reasons whatsoever.

AIA may design appropriate architecture for providing end to end metering solution. AIA is free to decide upon the best solution out of all the available options. However, the entire responsibility of fully functional AMI system shall rest with one agency i.e. AIA in order to meet the performance levels as given in this document. The communication provider may adopt Radio Frequency (RF) mesh in license free frequency band/ Power Line Carrier Communication (PLCC) or GPRS/3G/4G communication technology or RF based canopy system or a combination of these technologies as per the site requirement adopting best available technology in the proposed area of implementation.

The following core components of AMI system shall be provided:

a) Smart Meters

b) Communication infrastructure

c) Head End System(HES)

d) Meter Data Management System (MDM)

e) Web application with updated on-line data of consumers etc.

f) Mobile app: AMI Implementing Agency (AIA) shall provide a mobile app through which consumer shall be able to log in through android/iOS/Window based mobile app to see information related to his/her energy consumption. App shall also provide platform for implementation of peak load management functionality by providing existing tariff & incentives rates, participation options etc. This mobile

app shall be part of complete system and therefore no additional cost shall be payable for upgradation / maintenance separately.

4. Smart Meters (Single phase & Three phase)

- Single Phase & Three Phase whole current smart meters shall comply with the enclosed Technical Specifications. Three Phase CT operated meter shall comply IS 14697 till the relevant IS for CT operated smart meters is available. The supplier / manufacturer would furnish valid BIS certification before supply of meters.

- The Smart meter installation shall be done by the AMI Implementing Agency (AIA) as per the rules and regulations and practices of Utility.

After meter installation, customer identification no., meter ID, its hardware & software configuration, name plate details, make, type i.e. 1 Phase or 3 Phase, etc.(as per requirement of utility) shall be updated in DCU/HES/MDM. The information would also be updated on the portal/app for providing information to consumers.

5. Communication infrastructure

The communication infrastructure should either be based on RF mesh network / PLC or cellular network or a combination of these. The communication network shall be based on suitable standards from ITU/IEC/IEEE/CEN/ CENELEC/ ETSI for NAN and WAN network. Communication network shall provide reliable medium for two-way communication between various nodes (smart meter) & HES. RF based network should use license free frequency band available in India. The engagement of network service provider would be in the scope of AMI Implementing Agency to meet the performance level as given in the document.

5.1. General Requirement

The AMI Implementing Agency (AIA) shall design a reliable, interference free & robust communication network keeping in view the site conditions. It shall be flexible in terms of providing communication in variable terrain & urban density.

The AIA shall design the network architecture keeping in view the existing and planned infrastructure of the utility. During designing, suitable consideration shall be kept for future expansion as per requirement of Utility. Before designing the communication network, the AMI Implementing Agency (AIA) shall do the site survey and would provide the most efficient communication infrastructure.

The entire infrastructure & associated civil works required for installation & commissioning of equipment/devices like DCUs, repeaters, routers & access points etc. shall be in the scope of AMI Implementing Agency (AIA). The operational testing of all the network elements has to be demonstrated by the bidder to the satisfaction of the utility.

The network solution offered by the bidder should have disaster recovery mechanism in place. The redundancy mechanism of HES and MDM and their disaster recovery plan shall also be described by the Bidder.

The quality of installation of the various equipment & power supply wiring to all field equipment shall be as per standards/ regulations/prevailing practices of the utility. The supply of electricity needed for operation and maintenance of entire AMI system shall be the provided by the utility free of cost.

A suitable network management system (NMS) shall be provided to monitor the performance of the communication network round the clock. The NMS shall provide viewing of all the networking elements deployed at site and enable configuration & parameterization of the networking devices and the nodes.

5.2 Network Security

The Network shall have adequate cyber security measures not limited to the measures as described below. The network security would be extended to all the interfaces also.

- **Secure Access Controls:** The system shall include mechanisms for defining and controlling user access to the operating system environment and applications. Best practices from enterprise security including password strength, password aging, password history, reuse prevention etc. must be followed for access control.
- **Authorization Controls:** A least-privilege concept such that users are only allowed to use or access functions for which they have been given authorization shall be available.
- **Logging:** Logs must be maintained for all attempts to log on (both successful and unsuccessful), any privilege change requests (both successful and unsuccessful), user actions affecting security (such as password changes), attempts to perform actions not authorized by the authorization controls, all configuration changes etc. Additionally, the access to such logs must be controlled in accordance to the least-privilege concept mentioned above, so that entries may not be deleted, accidentally or maliciously.
- **Hardening:** All unnecessary packages must be removed and/or disabled from the system. Additionally, all unused operating system services and unused networking ports must be disabled or blocked. Only secure maintenance access shall be permitted and all known insecure protocols shall be disabled.
- **Malicious Software Prevention:** Implementation of anti-virus software and other malicious software prevention tools shall be supported for all applications, servers, data bases etc.
- **Network Security:** The network architecture of the HES must be secure with support for firewalls and encryption. The system shall also allow host-based firewalls to be configured, as an additional layer of security if the network firewall were to fail.

5.3. Communication Network Elements (DCU based or Router Based):

5.3.1. Data Concentrator Unit (DCU) based Communication Network

The Data Concentrator Unit is a gateway for communication of data between the Smart Meters and the HES. The Data Concentrator Unit receives information from the Smart Meter on a scheduled / need basis and stores the data, which can be accessed by HES for onward transfer to MDM.

The DCU provides the central link between Smart Meters and HES, enabling continuous/periodic meter read and control. DCU shall exchange data from smart meters on RF / PLC communication and with HES on WAN.

If communication system is DCU based RF network, then following requirement shall be met.

5.3.1.1 Hardware & Power Supply of DCU

- Enclosure/box of DCU shall be minimum IP55 or better compliant. A suitable mounting arrangement required for DCU installation shall also be provided.
- A suitable and optimum power supply shall be provided keeping in view that even in case of outage in one or two phases, DCU can be powered. DCU should be capable of withstanding surges & voltage spikes of 6KV as per IEC 61000-4-5 standards. Power supply shall be terminated on suitable sized MCB to facilitate isolation during on-site maintenance.
- DCU shall have battery with backup for 1 hour for normal meter reading, to push tamper event, carry out on demand reading and the network health status / connectivity continuity & check. DCU should have the suitable feature to send power outage and restoration message to the HES. The battery shall have a guaranteed life of 10 years.
- DCU shall have built in Real Time Clock (RTC) with separate battery backup. The battery shall have a guaranteed life of 10 years. It shall have self-diagnostic feature for RTC, memory, battery, communication module, etc. Alternatively, Software driven RTC may also be used as per agreement between supplier and utility.

5.3.1.2 Configuration, Functionality & Interface of DCU

DCU shall have following configuration functionalities:

- It shall be able to configure the communication with underlying nodes/meters.
- It shall pull data from the field devices and push the data at configured intervals to the HES. It should also support the HES in pulling data from the field devises/meters. The data acquisition (Push/Pull) frequency shall be programmable. DCU shall be capable to prioritize control commands.
- DCU shall ensure a secure communication to HES and shall have internal memory for storing interval data for at least 5 days.
- DCU shall support on demand read and ping of individual/group of meters.

- It shall support IPv4 / IPv6 network addressing.
- DCU shall push events like tamper, power off etc. to HES immediately on occurrence/receipt from field devices/meters.
- The equipment shall be weatherproof, dustproof and constructed for outdoor installation on poles (minimum rating: IP-55). A suitable mounting provision shall be made for the equipment.
- Enclosure: Provision for security sealing shall be provided and in case the gasket of the cover is used for protection against moisture, dust and insects, the gasket shall be made of weather and aging resistant material.
- The list of standards followed in all the devices/equipment used in communication network shall be furnished

5.3.1.3 DCU Communication

- The communication architecture shall be any, as defined under IS 16444.
- The DCU shall ensure the appropriate backhaul for secure transfer of data to HES. In case of GPRS/3G/4G backhaul, it shall support SIM card from any service provider. It shall have Wide Area Network (WAN) connectivity to the HES through suitable means.
- DCU shall be able to communicate with meters either on RF mesh (license free band) or PLC.
- DCU shall periodically monitor meter reads/downstream commands and shall retry and reconnect in case of failed events/reads.
- It shall push events like tamper, power off etc. to HES immediately on occurrence/receipt from field devices/meters. DCU shall be able to acquire and send data to HES for full capacity (as per designed for no. of meters/field devices) to ensure the performance level. Full capacity of DCU is required to be indicated in the offer.
- After Power Interruption, on restoration of power supply, DCU shall establish communication with underlying devices as well as upstream application automatically.
- DCU shall be able to communicate with the nearest meters depending on topographical features. For further communication among the meters, distance of the other meters with the DCU shall not be a constraint as communication of the nearest meters shall be established with other meters through appropriate mesh formation / other formation.
- Remote Firmware Upgrade: The DCU shall support remote firmware upgrades as well as remote configuration from the control center. Configuration of programmable parameters of smart meters shall be done through HES.

- All meters falling under one DCU shall be commissioned and checked for proper communication in presence of utility in-charge.

- DCU shall keep the records of minimum of the following events:

  - No of packet failures
  - Retry attempts
  - Missed periodic readings
  - Failure to connect
  - Tamper events

5.3.2 Router based RF Mesh Network

If communication system is router based RF mesh network, then following requirement shall be met. In this type of communication network, different nodes (smart meters) shall interconnect with each other using RF mesh network and they shall communicate with nearby routers to transfer the data to access points. In such communication network, if any routers/repeaters/access points fail, then nodes connected on that device shall automatically reconfigure the mesh with available nearby nodes.

5.3.2.1 General Requirement of Router based RF Mesh Network:

The general requirements for the Router based RF network are specified below:

i) The communication network shall have dynamic & self-healing capability. If one of the communication element like router or access point fails then nodes connecting to that element shall switch to best available element for communication of data to HES.

ii) It shall support IPv4 / IPv6 network addressing.

iii) Each node shall keep a track of best available nearby nodes.

iv) The communication network equipment shall use licence free frequency spectrum as defined by Government of India.

v) All the communication network equipment shall be certified by WPC, Government of India for operation in licence free frequency band.

vi) Suitable network management system (NMS) shall be available to monitor the performance of the communication network round the clock. The NMS shall provide viewing of all the networking elements deployed at site and enable configuration, parameterization of the networking devices and the nodes.

vii) It shall support remote firmware upgrading

viii) It shall be secure enough to avoid all cyber threats like DDoS, spoofing, malwares etc.

ix) The communication network shall ensure secure communication of data to HES.

x) The equipment shall be weatherproof, dustproof and constructed for outdoor installation on poles (minimum rating: IP-55). A suitable mounting provision shall be made for the equipment.

xi) Enclosure: Provision for security sealing shall be provided and in case the gasket of the cover is used for protection against moisture, dust and insects, the gasket shall be made of weather and aging resistant material.

xii) The list of standards followed in all the devices/equipment used in communication network shall be furnished.

xiii) Routers / Access Points shall have suitable power supply arrangements. Provision of battery backup for at least 1 hour shall be there to continue operation in case of power supply failure. The life expectancy of battery shall be 5 years or more.

5.3.2.2 Configuration, Functionality & Interface

Access points shall have following configuration functionalities:

- It shall be able to configure the communication with underlying nodes/end points.
- It shall support on demand read and ping of individual/group of meters.
- It shall push events like tamper, power off etc. to HES immediately on occurrence/receipt from field devices/meters.
- It shall have Wide Area Network (WAN) connectivity to the HES through suitable means.
- It shall communicate with routers/nodes/end points on RF mesh (license free band).
- It shall periodically monitor meter reads/downstream commands and shall retry and reconnect in case of failed events/reads.
- After power Interruption, on restoration of power supply, it shall establish communication with underlying devices as well as upstream application (HES) automatically.
- Access point shall facilitate recording of
  - No of packet failures
  - Retry attempts
  - Missed periodic reading
  - Failure to connect
  - Tamper events
- It shall be capable to handle interval data of suitable nos. of any type of smart meter (1ph/3ph). Access point shall be able to acquire and send data to HES for full capacity (No. of meters/field devices it is designed for) within a suitable time period to achieve the performance level. Full capacity of access point is required to be indicated in the offer.
- Access point shall support remote firmware upgrades as well as remote configuration from the control center.

5.3.3 Testing of the DCU /Access Point

DCU/Access Point shall be tested for the following:

- Radio interference measurement (CIS PR 22)
- Surge test (IEC 610004-5)
- Fast transient burst test (IEC 61000-4-4)
- Test of immunity to electrostatic discharges (IEC 61000-4-2)
- Test of immunity to electromagnetic HF field (IEC 61000-4-3)
- Resistance to heat and fire

The bidder shall provide IP-55 compliance test certificate for DUC/Access Point.

6. Head End System (HES)

The main objective of HES is to acquire meter data automatically avoiding any human intervention and monitor parameters acquired from meters.

The AMI Implementing Agency (AIA) shall provide the HES suitable to support the collection and storage of data as per performance level for a defined no. of smart meters with facility of future expansion as per the requirement of the utility.

(NOTE: The no of smart meters/future expansion may be provided by utility as per their requirement)

HES would perform all the requisite functions as per the defined functionalities of AMI and it is the responsibility of the AMI Implementing Agency (AIA)/ System Integrator to supply the requisite software and hardware to achieve the defined functionalities of AMI. HES shall ensure data integrity checks, for example, checksum, time check, pulse, overflow, etc. on all metered data.

HES shall be developed on open platform based on distributed architecture for scalability without degradation of the performance using additional hardware. HES shall support storage of raw meter data, alarms and alerts for minimum 3 days. Adequate data base and security features for storage of data at HES need to be ensured.

The suggested functions of HES (not exhaustive) may be :

- Acquisition of meter data on demand & at user selectable periodicity
- Two way communication with meter/ DCU
- Signals for connect & disconnect of switches present in end points like meter
- Audit trail and Event & Alarm Logging
- Encryption of data for secure communication
- Maintain time sync with DCU / meter
- Store raw data for defined duration

- Handling of Control signals / event messages on priority
- Setting of Smart meter configurable parameters
- Communication device status and history
- Network information in case more than one technology is deployed in field between the two devices
- Critical and non-critical reporting functionality. The suggestive critical events may be alarms and event log for meter events like tamper/power failures etc., if data is not received from DCU/Meter, if relay does not operate for connect / disconnect or there is communication link failure with DCU/Meter or network failure while non critical events may be retry attempts on communication failure, periodic reading missing and failure to connect etc.

6.1 Configuration

HES shall facilitate programming of following meter parameters:

- Load profile capture period
- Demand integration period
- Setting of parameters for time of day (TOD/TOU) billing
- Prepaid function
- Net metering
- Billing date
- Clock setting/time synchronization
- Load curtailment limit
- Event setting for connect/disconnect
- Number of auto reconnection attempt
- Time interval between auto reconnection attempt
- Lock out period for relay
- Remote firmware upgrade
- Password setting
- Push schedule
- Setting threshold limits for monitored parameters
- Provision for adding more programming features in future

(The AIA may suggest more parameters as per the requirement)

6.2. Integration

HES shall preferably interface with MDM on standard interfaces and the data exchange models and interfaces shall comply with CIM / XML / IEC 61968 or any other open standard. The solution shall be Service Oriented Architecture (SOA) enabled.

7. Meter Data Management System (MDM)

The Meter Data Management System shall support storage, archiving, retrieval & analysis of meter data and various other MIS along with validation & verification algorithms. It shall act as a central data repository. MDM shall have capability to import raw or validated data in defined formats and export the processed and validated data to various other systems sources and services in the agreed format. It shall provide validated data for upstream systems such as billing, consumer Information system, customer care, analytics, reporting, Network planning & analysis, load analysis/forecasting, Peak Load Management, Outage management etc.

MDM should also support the future requirement of utility and should support the integration of other smart grid functionalities like Distribution Transformer Health Monitoring system, self-healing system etc. as and when implemented by the utility.

The vendor shall specify and deliver an initial system that supports the collection and storage of data for meeting the performance level for the ***defined no of consumers/ smart meters*** **(The exact Number have to be defined by the utility as per no of consumers of city/town/village)** with facility of future expansion.

The MDM shall have the ability to selectively choose which data to be maintained and which to be purged or archived as per requirement of Utility (user selectable).

7.1. Functional Requirements

7.1.1 Asset Management

- The MDM shall maintain information and relationships between the current installed meter location (apartment, shop, industry/ address etc.), Consumer information (Name etc.), Consumer account no, Meter ID, Type of Meter (type of consumer, 1 phase/3phase, with or without relay, etc.), Meter configuration (Demand integration period, Load profile capture period etc.), GIS supplied information (longitude, latitude , connection with feeder/ transformer/ pole etc.) etc.
- The software should support tracking the status of meters and communication equipment from the date when they are installed in the field. The history of in-service asset location is maintained throughout the device life with start and end dates associated with each in-service location reference.
- Ability to report and log any damage / deterioration in the meter attributable to consumer /utility.

7.1.2 AMI Installation Support

- The MDM shall also support device lifecycle management from device registration, installation, provisioning, operations and maintenance to decommissioning etc. The MDM shall generate exceptions for meter or modules not delivering the correct meter data after installation.

- The MDM shall provide a reconciliation report that identifies the meters that have been installed but not communicating for a designated (configurable) period. MDM shall generate reports on the number of meters installed in comparison to the number of meters successfully communicating.

7.1.3 Meter Data

- The MDM shall accept input, process, store, and analyze Meter data from HES and meter data collected through hand held meter reading instruments and manual meter reads. In case of manual reads, provision should be there to insert associated notes like assessed energy, etc.
- The MDM should accept input, process, store, and analyze non-billing meter data such voltage and power quality data (like under/over voltage etc) as they are available from AMI Head End Systems. The MDM should also support schedule and on-demand meter reads and pinging of meter energized states by authorized users and by other utility systems.

- The MDM shall provide storage of all collected Meter Data, events and alarm. It shall have capacity of storing 5 years data or more via archiving.

- Correctly track & resolve energy usage across meter changes with no loss of individual meter data.

- Provide complete history and audit trail for all data collected from meters including commands sent to meters and other devices for 30 days (configurable period).

- Execute on-demand read processes.

- Handle special metering configurations like net metering/multiple meters at same premises.

- The MDM shall have the ability to manage at a minimum 15 minute interval data.

- Data Integrity- AMI Implementing Agency (AIA) shall ensure data integrity checks on all metered data received from data collection systems.

7.1.4 Data Validation, Estimation, and Editing (VEE)

- The validation and estimation of metered data shall be based on standard estimation methods. The MDM should also support and maintain following data-

a. **Registered Read Data** including register reads, daily billing cycle, as well as derived billing determinants like TOU

b. **Interval Data** channels with variable intervals and variable units of measure

c. **Calculated Data** that is derived or computed such as billing determinants and aggregated loads.

d. **Event data** storage of all collected event and alarm data from meters, network equipment, and MDMS itself

- MDM shall flag, alarm and trigger an estimating process including but not limited to when the following anomalies occur in the cumulative ("CUM") register reads
  - o CUM Decrements within a billing cycle (except net-metering)
  - o CUM reads increments more than configurable threshold
  - o Future or old read dates
  - o Number of digits exceeds number of meter dials
- MDM shall detect, flag, alarm and trigger an estimating process including but not limited to when the following anomalies occur in Time of Use (TOU) register reads
  - o Register Decrements (except net-metering)
  - o Resets (to zero) (except net-metering)
  - o CUM reads increments more than configurable threshold
  - o Future or old read dates
  - o Erratic compared to CUM read (sum of TOU reads minus CUM read)
- MDM shall detect, flag, alarm and trigger an estimating process including but not limited to when the following anomalies occur in Demand register reads
  - o Do not reset on cycle
  - o Do not reset coincident with customer move-out or move-in
  - o Reset off cycle inappropriately
  - o Too high
- All data shall be transferred to billing system after meter data validation and estimation including transformer / feeder station wise energy audit.
- MDM shall estimate usage for non-metered service points such as street lights, farm lights, traffic signals, etc.
- The MDM shall maintain both the original received raw data in a non-manipulated state, in addition to VEE data.
- Notwithstanding the latency of data collection via the AMI system, once the MDM receives meter read data, the VEE process occurs in real-time and the post-VEE data is then immediately available to user or external systems.
- The MDM shall be able to automatically flag data changes from manual edits, VEE (Validating, Editing and Estimating) rules and data source corrections and electronically generate audit trail with timestamps and user-ids.

7.1.5 Billing Determinants Calculations

The MDM-

- Shall allow configuring multiple TOU/TOD options (e.g. the number and duration of TOU rate periods) by customer type, tariffs and day type (weekend, weekdays, and holidays) and by season.

- Shall support the processing of interval data into billing determinants to include the following at a minimum:

o Total Consumption

o Consumption in different time blocks for ToU billing

o Maximum Demand (in kW and kVA)

o Number of tamper counts

o Average power factor

- Shall process interval data and frame it into the appropriate TOU periods for consumption and demand; for example, roll up 15/30 minute data intervals into hourly data.

- Shall have the ability to properly account for special metering situations such as check metering, sub metering, prepaid metering and net metering when calculating billing determinants and sending them to billing and other systems.

- Shall have the ability to properly account for special situations including, but not limited to, curtailment requests, demand response scenarios when calculating billing determinants and sending them to billing software.

7.1.6 Exception Management

- Ability to capture and log data exceptions, problems and failures and to generate management reports, provide trend analysis, automate generation of service requests and track corrective actions.

- Ability to group, prioritize, filter and send system generated alarms and events to predetermined email addresses, cellular text messages to phone numbers/SMS/customer care etc.

- Exception Generation - MDM shall generate exceptions based on configurable business rules including but not limited to the following:

- Meter tamper alerts

- Communication module health alerts for Meter/DCU

- If the consumption is less/more than pre-defined average consumption

- Negative Consumption (not for net-metering)

- Power outage indications received from the Smart meter

7.1.7 Service Orders

- The MDM shall generate service orders based on configurable rules for various events and alarms such as stop meter, tampers, problem in communication networks, AMI host server, etc.
- MDM shall send service orders via SMS, email, etc. with the email addresses / phone numbers being configurable. MDM shall receive feedback on action taken on the service order and track the status of service orders.

7.1.8 Customer Service Support

- The solution shall provide customers with access to current and historical consumption and interval data, outage flags, voltage and power quality indications. The data shall be displayed in graphical and tabular form depending on user choice. The Customer may also access data through customer portal. The solution shall integrate via a user friendly graphical interface.
- MDM shall support email/SMS notification of configured alarms & events to selected users.
- The MDM shall support the web portal or shall have the ability to interface with the 3rd party portal/utility portal to provide the consumer near real time online views of both usage and cost and helping consumers to understand electricity usage and cost information, alerts and notifications and energy savings tips with different levels of detail. The portal should support the view for past electricity usage, last week's, yesterday's, current days or other period etc. as per selection. The portal should provide user friendly access to consumer for their data via colorful graphs and charts and can download the data into a spreadsheet.
- Shall support mobile app through which consumer shall be able to log in through android/iOS/Window based mobile app to see information related to his energy consumption. App shall also provide platform for implementation of peak load management functionality by providing existing tariff & incentives rates, participation options etc.

7.1.9 Analysis

The MDM shall have analysis capability based on configurable business rules including but not limited to the following:

- Display consumption/load profiles by configurable period (15/30 min, hour, day, month, year etc.) day type (weekday, weekend, holiday, festival wise etc.) and by tariff, customer type, or any user specified collection of meters.
- Generate peak & off-peak load patterns by aggregating all loads of DT/Feeder/consumer group.
- Perform DT/feeder wise energy audit.
- Perform load analysis for different groups and categories of consumers.
- Ability to provide the data to load forecasting, load research or demand response applications and perform error management like: Missed reads and

intermittent meter reads before taking into forecasting, load research or demand response

- Ability to configure the system to effectively visualize consumption trends, identify unusual patterns, and visualize load analysis to understand which assets are being over utilized.
- Analyzing data to identify new patterns of usage, Setting fraud alert / transformer overload alerts / demand – supply gap alert etc.
- Ability to receive and store outage and restoration event data from smart meters and outage systems and to log all such events for analysis.

7.1.10 Reporting

The solution shall include a list of the standard reports that are provided with the MDM including but not limited to following:

- Daily data collection report
- Usage exceptions
- VEE validation failures
- Missing interval Read date and times (on hourly, daily, weekly & monthly basis)
- Physical meter events (install, remove, connect, disconnect) & meter reset report
- Meter flags
- Meter inventory
- defective meters
- AMI performance measurements
- Threshold Exception

  The solution shall support users modifying standard reports to better meet specific reporting requirements.
- The MDM shall enable the Utility to deliver reports in standard digital format such as PDF, Excel, etc.
- Ability for GUI (Graphical User Interface) to set up or change report delivery to configurable email addresses, network file directories, ftp sites or printer systems without modifying source program code and without any proprietary language skills.
- All queries shall be generated through user driven drop down menu in GUI. The Bidder shall provide example queries to support internal report generation needs.
- Ability to provide daily & weekly interface exception reports between MDM and other subsystems e.g. billing, outage, etc.

- In case more than one technology of AMI (example PLC and RF between Smart Meter & DCU) deployed in the field The MDM shall generate report on the performance and availability of data being delivered per AMI technology.

7.1.11 Revenue Protection Support

- Ability to analyze meter tampering flags, power outages, usage trends and usage profiles to identify potential energy diversion situations, and produce daily reports, monthly reports and service order requests for investigation.
- The business rules for revenue protection alerts shall be configurable via a user-friendly interface.
- The MDM shall filter out revenue protection alerts that may be caused by field activities if the field activity information is provided to the MDM.
- The MDM shall support the analytics/investigation (i.e. view current and historical usage patterns) to valid suspected revenue protection issues.

7.1.12 Demand Control/Demand Response Support

Bidder shall describe how its MDM supports Smart Grid Demand Response programs involving Demand Response (DR) systems as part of PLM. The solution shall support the following analysis:

- Totaling the actual consumption during the DR event.
- Totaling the actual consumption of different groups that participated in the DR event.
- Comparing the actual to baseline consumption for the groups in above.
- The MDM shall support the tracking, monitoring and managing of Smart Meter and events, and monitors customer response to facilitate payment of customer incentives.

7.1.13 OMS/ other smart grid functionality support

MDM shall support Smart Grid OMS system as per the requirement of the utility. MDM shall support the interfacing with OMS software for providing AMI meter data needed for fault location identification and other requisite services like updating the data after attending the fault etc.

MDM should also support the interfacing of other smart grid functionalities like Distribution Transformer Health Monitoring system, self-healing system, electric vehicle etc. as and when implemented by the utility.

7.1.14. Additional Features

➢ **Net-Metering**

- MDM shall flag, alarm and trigger an estimating process including but not limited to when the following anomalies occur:

  - CUM decrements of forward energy within a billing cycle
  - Register decrements for Time of Use (ToU) of forward energy
  - Power generated(exported) by any net-metering consumer more than the installed capacity of solar PV rooftop system
  - Energy exported(exported) in any given day by any net-metering consumer more than the programmable threshold value

➢ **Prepaid functionality**

The prepaid functionality can either be availed at smart meter level or through MDM. In case of MDM, following shall apply

- The MDM should support pre-payment metering and capability to interface with pre-payment application.
- The prepayment should support the system that payment and connection parameters are stored centrally and the details are being updated to consumer portal/ app.
- The system should periodically monitor the energy consumption of prepaid consumer and decrease the available credit based on consumption.
- The system should send connect/disconnect command on the basis of available credit as per notified rules & regulations.
- The system should send low-credit notifications to the consumer when their balance approaches a threshold.

7.2 User Interface

The AMI Implementing Agency (AIA) shall provide user interface for the following:

Utility:

User interface for utility shall have ability for at least the following functionality:

- Compare total energy costs on one rate schedule vs. one or many alternative rates.
- Enable the user to see how different options within a rate affect costs.
- Enable the user to see how adjusting load or consumption levels or shifting them to different time periods influences costs.
- Compare multiple facilities against each other based on costs, average spend, cost per area and cost by weather.

- Display meter data at a user defined configurable cycle through a GUI that allows authorized users to view energy usage patterns and the data behind them for selected customers.

- Allow authorized users to view metered data, initiate and view reports, modify configurations, and initiate and update service requests via a GUI.

- Display via a GUI the energy usage profile for a single meter or group of meters. The load profile shall illustrate energy consumption and peak demand in user defined intervals for a user-specified time period.

- Display via a GUI the energy usage profile for a single meter or group of meters according to Time of Use (ToU) tariff.

- Access to a minimum of 5 years of historical energy usage and meter reads through the GUI.

- GUI to clearly and visually distinguish between metered, estimated, allocated and substituted data.

- GUI to provide role-based access based on user identity and user role. Shall have following types of users:

  - Administrator
  - Operator
  - Field staff
  - Viewer/Guest

- Configure the look, feel, and functionality of the MDM in accordance with business needs, business processes, and business conventions. (e.g. GUI, content, look and feel of screens, validation rules, exception handling, etc.).

- Ability for utility through user interface to set up alarm and event notifications that can be directed to a combination of configurable email addresses, cellular text messages or phone numbers.

- User interface for utility to update the credit amount of prepaid consumers to MDM. Such type of user interface before login shall require password & login i.d. for authentication. User interface after getting information like consumer i.d., mobile number & recharge amount etc. shall update the same to MDM. The details of payment information shall also update to consumer through SMS, email etc.

Consumer:

User interface for all authorized consumers shall have ability for at least the following functionality:

- View metered data, initiate and view reports
- View data according to Time of Use(ToU) tariff
- Can make request for connection/disconnection
- User can update mobile number/email

- Can initiate service requests for maximum demand updating, meter checking etc.
- In case on net-metering consumers, user can view data for both import & export
- In case of prepaid consumers, consumers can view recharge history & present balance.
- Prepaid consumers shall be provided facility to recharge their account by logging on user interface. User interface shall require consumer id., mobile number & password for secure login. This user interface shall be integrated with the present online payment gateway of utility.

7.3 Integration with other Systems

MDM shall preferably interface with other systems on standard interfaces and the data exchange models and interfaces shall comply with CIM / XML / IEC 61968/IS15959/ Indian Companion Specification/ any other open standard. MDM solution shall be Service Oriented Architecture (SOA) enabled.

MDM integration with other systems shall include but not limited to the following:

- HES for data exchange from other AMI solutions
- Utility Administration
- Existing other Data Collection Systems
- IVR system, CRM, Consumer Portal
- Billing and collection system
- GIS Systems integration with CIS and with MDM system
- Support of interface with HHU or manual reading system etc.

AMI Implementing Agency(AIA) should provide suitable number of HHUs to read and update the data in MDM in case of any communication failure between meter and HES/MDM.

8. Performance Levels

(a) These performance levels shall apply to the complete AMI system.

(b) AMI system include the communications links provided by Network Provider /third parties such as telecommunications companies and AMI Implementing Agency (AIA) has to ensure the desired performance level.

(c) The performance levels are average performance levels over the period of a year and exclude force majeure events.

The following are the required performance levels -

- **Performance levels for collection of daily meter readings (as per IS 16444/15959 part 2)**

The following are the performance levels required for the daily collection of the previous day's interval energy data and total accumulated energy:

(1) All interval data from 95% of meters within 8 hours after midnight; and

(2) All interval data from 99.9% of meters within 24 hours after midnight.

- **Performance levels for remote reads of individual meters if data is not received on daily basis**

The performance level of an individual read applies to the collection of seven days of interval energy data and the current total accumulated energy from a particular AMI meter whose data is not being received on daily basis. The performance level required shall be:

(1) Action performed at 90% of meters within 1 Hour;

(2) Action performed at 99% of meters within 2 hours; and

(3) Action performed at 99.9% of meters within 6 hours.

- **Performance level for remote load control commands for selected consumers,**

The performance level required for individual meters shall be:

(1) Action performed at 95% of meters within 5 minutes;

(2) Action performed at 99% of meters within 10 Minutes

- **Performance level for remote connect/disconnect for selected consumers,**

The performance level required for selected individual meters shall be:

(1) Action performed at 90% of meters within 10 minutes;

(2) Action performed at 99% of meters within 1 hour; and

(3) Action performed 99.9% of meters within 2hours.

- **Performance levels for Meter loss of supply and outage detection**

Alarms to be received within 5 minutes for 90% of meters.

- **Performance levels for remotely altering settings in meter/ firmware upgrade**

The performance level required for individual meters shall be:

(1) Action performed at 99% of meters within 24 hours; and

(2) Action performed at 99.9% of meters within 36 hours.

- **Performance levels to remotely read events logs**

Performance level required for reading the full event log that pertains to an individual meter shall be:

(1) Action performed at 90% of meters within 30 minutes;

(2) Action performed at 99% of meters within 1 hour; and

(3) Action performed at 99.9% of meters within 6 hours.

To read the event logs pertaining to all meters:

(1) The data pertaining to 99.5% of meters with in 1 day;

- **Performance levels for updating of data on consumer portal/ app**

The performance level of updating of individual consumer data on portal/ app after receiving the data in MDM shall be:

(1) Action performed for 90% of consumers within 1 hour after receiving the data in MDM;
(2) Action performed at 99.5% of meters within 6 hours after receiving the data in MDM.

The performance level for generation of bills would be as per requirement of the utility. The performance levels regarding meter discovery time line after installation, on demand reading of meter data for operational purposes, outage restoration enquiry response time etc. would also be declared by the bidder.

Additionally, the Disaster Management timelines in terms of Recovery Time Objective (RTO) and Recovery Point Objective (RPO) of HES have to be defined by the bidder.

9. Performance Requirement for User Interface

The user interface performance testing shall be done as per following criteria-

S.No.	User Interface Requirements	Response Time
1	Any real time display and application display on workstation console along with data values shall appear on screen.	Within 2 sec
2	Manual data entry of the new value appears on screen.	Within 2 sec
3	Display Update rate	2 sec for 4 displays together
4	Response time for display of Alarm and event after receipt in system	Within 1 sec of receipt in system

5	Requests for printing of displays (to be acknowledged with an indication of request is being processed).	Within 2 sec
6	Requests for generation of reports (to be acknowledged with an indication of request is being processed).	Within 2 sec

10. Technical Obsolescence

The systems including communication technologies, which are at a risk of technical obsolescence over the next few years and over the operating life of the system should be identified and reported. This may also include end-of-sale and end-of-support policies governing the proposed technologies. The compatibility between the various elements of the system need to be considered and mitigation options, not be limited to periodic update from OEM/System supplier, shall be indicated in detail.

Technical Specification
of
Single phase whole current
Smart Meter

TECHNICAL SPECIFICATIONS FOR WHOLE CURRENT A.C. SINGLE PHASE TWO WIRE SMART ENERGY METER OF ACCURACY CLASS 1.0 WITH BI-DIRECTIONAL COMMUNICATION FACILITY SUITABLE FOR ADVANCED METERING INFRASTRUCTURE (AMI)

1. SCOPE

The specification covers the design, manufacturing, testing, supply and delivery of AC whole current 1 phase 2 wires Smart Energy Meter with bidirectional communication facility. The meter shall be suitable for Advanced Metering Infrastructure (AMI). The meter shall communicate with DCU/Access Point/ HES on any one of the communication technologies mentioned in IS16444, as per the requirement of the utility.

2. BASIC FEATURES

The Smart Meter would have the following minimum basic features-

- Measurement of electrical energy parameters
- Bidirectional Communication
- Integrated Load limiting switch
- Tamper event detection, recording and reporting
- Power event alarms such as loss of supply, low/ high voltage
- Remote firmware upgrade
- Net metering features
- On demand reading

3. GENERAL STANDARDS APPLICABLE FOR METERS

Unless otherwise specified elsewhere in this specification, the performance and testing of the meters shall conform to the following standards with latest amendments thereof:

S. No.	Standard No.	Title
1	IS 13779 with latest amendments	AC Static Watt-hour Meter class 1& 2
2	IS 16444 with latest amendments	A.C. Static Direct Connected Watt Hour Smart Meter Class 1 and 2- Specification
3	IS 15884 with latest amendments	Alternating Current Direct Connected Static Prepayment Meters for Active Energy (Class 1 and 2)- Specification

4	IS 15959 Part 1 & Part 2 with latest amendments	Data Exchange for Electricity Meter Reading, Tariff and Load Control- Companion Standards

4. COMMUNICATION

Meter shall have ability to communicate with DCU/Access Point/HES on any one of the technologies mentioned in IS16444 in a secure manner, as per the site conditions and as per design requirement of AMI Implementing agency. In case of GPRS/3G/4G based meter, the meter shall accommodate SIM card of any service provider. In case of Plug in type communication module, the meter shall log communication module removal /non responsive event with snapshot.

4.1 Remote Load control facility would be as per IS 16444.

5. OTHER SPECIFICATIONS

Particulars	**Specification**
Applicable Standards	The meters shall comply with IS 16444 for all requirements. Those parameters which are not covered in IS 16444 have been specifically mentioned in this specification.
Reference Voltage	As per relevant IS
Current Rating	5-30 A/ 10-60 A (as per the requirement of the utility)
Starting Current	As per IS 16444
Accuracy	Class 1.0 as per IS 16444
Limits of error	As per IS 16444
Operating Temperature range	As per IS 16444
Humidity	As per IS 16444
Frequency	As per IS 16444
Influence Quantities	As per IS 16444
Power Consumption of meter	As per IS 16444
Current and Voltage Circuit	As per IS 16444
Running at No Load	As per IS 16444
Test output device	As per IS 16444
Meter Display	As per IS 16444
Name Plate & marking Meter Display	As per IS 16444
Parameters to be measured	As per IS 16444 / As per IS 15959 Part-2

Maximum Demand resetting	As per IS 15959 Part 2
Time of Use registers	As per IS 15959 part 2
Power Quality Information	As per IS 15959 part 2
LED/LCD Indicators	As per IS 16444
Load Survey/Interval Data	As per IS 15959 part 2
Tamper/ Event Recording	As per IS 15959 part 2
Measuring Elements	As per IS 16444
Alarm	As per IS 16444/ 15959 Part 2
Load Control	As per IS 16444
Connect/Disconnect and status of load switch	As per IS 16444
Programmability	As per IS 16444
Communication	As per IS 16444.
Communication Protocol	As per IS 16444
Remote Firmware upgrade	As per IS 15959 part 2
Real Time Clock(RTC)	As per IS 16444/ IS 15884 The clock day/date setting and synchronization shall only be possible through password/Key code command from one of the following: • From remote server through suitable communication network. • Hand Held Unit (HHU) or Meter testing work bench and this shall need password enabling for meter; (The methodology for the synchronization would be as per requirement of utility)
Data Retention	As per CEA regulations
Battery Backup	Meter shall be supplied with separate battery backup for RTC.

Guarantee	Manufacturer Shall undertake a guarantee to replace meter up to a period of 60 months from the date of supply. The meter which are found defective/inoperative within the guarantee period, these defective/inoperative meters shall be replaced within one month of receipt of report for such defective/inoperative meters
First Breath(power on) and Last gasp (power off) condition detection and communication to HES	As per IS 16444

5.1 DATA DISPLAY FACILITY (AUTO/MANUAL)

Data Display shall be in three modes-

1. Auto Scroll
2. Scroll with Push Button
3. High Resolution (Shall display energy values with resolution of 2 digits before decimal and 3 digits after decimal in push button mode)

The display order shall be:

- Auto Scroll
  - Cumulative Active Energy kWh along with legend.
  - Current calendar month MD in kW with legend.
  - Instantaneous voltage
  - Instantaneous current

These parameters should be displayed on the LCD/LED continuously for a period of 15 seconds on Auto scroll. In case of power failure, the meter should display above parameters with push button.

- Scroll with Push-button
  - Internal diagnostics
  - Cumulative kWh
  - Date
  - Real Time
  - Voltage in (V)
  - Current (I)
  - Power (kW)
  - Current month MD in kW
  - Last month cumulative kWh
  - Last month MD in kW
  - Last month MD occurrence Date

- Last month MD occurrence Time
- Meter Serial Number

The meter's display should return to default display mode (continues auto scroll) if push button is not operated for more than 10 seconds. (The order of display may be revised as per requirement of the utility)

6. ANTI TAMPER FEATURES

The meter shall continue recording energy under any tamper condition and would log the event and send alarm at Head End System after detection of the defined theft features as per IS 15959 Part 2.

(Optional test as per requirement of utility: The Meter shall be immune under external magnetic influences as per CBIP 325. Meter shall be tested for high voltage discharge (Spark) up to 35 KV as per CBIP 325.)

7. TESTS

7.1 Type Tests & Test Certificates

Smart meter shall be type tested for all the type tests as per IS: 16444 (latest version) in a third party independent lab. The number of sampling for testing of meters and criteria for conformity would be as per IS 16444.

Necessary copies of test certificates shall be submitted as per agreement with the utility.

7.2 Routine & Acceptance Tests

The Factory Acceptance and Routine tests shall be carried out as per IS 16444. Apart from above test, meter shall be also be tested for all functional requirement through communication as part of acceptance test

8. GENERAL & CONSTRUCTIONAL REQUIREMENTS

8.1 Meter Shall be BIS marked as per IS 16444.

8.2 General & construction requirement shall be as per IS 16444/IS 13779

8.3 In Home Display (IHD) shall be optional and the specifications of the same would be as per agreement between the bidder and the utility.

9. METER BASE & COVER- Meter base & cover shall be as per IS 16444/ IS 13779. The meter Base & cover shall be break to open design. The material for meter base and cover shall be made of high grade polycarbonate.

10. **TERMINAL BLOCK & COVER** - As per IS 16444/IS 13779

11. DESIGN

Voltage circuit, sealing arrangement, terminal block, terminal cover and nameplate etc. shall be in accordance with IS-16444 (latest version).

The meter shall be compact and reliable in design, easy to transport and immune to vibration and shock involved in transportation and handling.

12. CIRCUITRY - as per IS 16444

The supplier should submit the details of source/agencies from whom purchase of various components of meters used by them to the utility/purchaser.

13. NAME PLATE AND MARKING

The meter should bear a name plate clearly visible, effectively secured against removal and indelibly/distinctly marked in accordance with relevant IS. In addition, in the middle of the name plate the words “Name of the Utility”, purchase order no. & year/month of manufacturing shall either be punched or marked indelibly. The rating plate information shall be as per relevant IS.

14. CONNECTION DIAGRAM: As per IS 16444

15. FIXING ARRANGEMENTS:

The meter shall be mounted type. The Meter should have three fixing holes, one at top and two at the bottom. The Top hole should be such that the holding screw is not accessible to the consumer after fixing the meters. The lower screws should be provided under sealable terminal cover. The requisite fixing screws shall be supplied with each meter.

16. SEALING ARRANGEMENT:

Arrangements shall be provided for proper sealing of the meter cover so that access to the working parts shall not be possible without breaking the seal. The sealing arrangement and number of seals shall be as per relevant IS/ requirement of utility.

17. **METER BOX:** The Meter Box would be provided as per requirement of the utility/ purchaser.

18. PACKING

The meters shall be suitably packed for vertical/horizontal support to withstand handling during transportation. The meter shall be packed appropriately to ensure safe transportation, handling, identification and storage. All packing materials shall be as per environment law in force. The primary packing shall ensure protection against humidity, dust, grease and safeguard the meter’s performance until its installation. The secondary packing shall provide protection during transportation. The packing case shall indicate “Fragile in nature” and

direction of placement of box. Each packing shall indicate marking details like Manufacturer's name, S.No. of meters, quantity etc.

19. TRANSPORTATION

The meter shall be compact in design. The meter block unit shall be capable of withstanding stresses likely to occur in actual service and rough handling during transportation. The meter shall be convenient to transport and immune to shock and vibration during transportation and handling.

The meter should not be exposed to undue shock and mishandling during transportation. The stacking of box inside transport media should be such as to avoid their free movement. The packing should also be protected from rain and dust by transport media. The Bidder shall be responsible for any damage during transit due to inadequate or improper packing.

20. TESTING AND MANUFACTURING FACILITIES AT MANUFACTURER'S PLACE

The manufacturer shall have NABL accredited laboratory to ensure accurate testing calibration as per IS 13779 for acceptance test.

21. INSPECTION

❖ All meters shall be duly tested and sealed by the firm at their premises prior to inspection. Manufacturer seal may be provided on one side of meter. For the other side, the seal with engrave as Utility name may be sent in a pack for provision by utility after completion of test by the utility & after receipt of the meter.

❖ The utility/ purchaser may inspect the meter randomly as per sampling plan for acceptance test as per IS 16444. The meters shall be tested for all functional requirements as part of acceptance test as per IS 16444. After testing, these sample meters shall be additionally sealed and would be kept in safe lock for verification if needed.

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Technical Specification
of
Three phase whole current
Smart Meter

TECHNICAL SPECIFICATIONS FOR WHOLE CURRENT A.C. THREE PHASE FOUR WIRE SMART ENERGY METER OF ACCURACY CLASS 1.0 WITH Bi DIRECTIONAL COMMUNICATION FACILITY SUITABLE FOR ADVANCED METERING INFRASTRUCTURE (AMI)

1. SCOPE

The specification covers the design, manufacturing, testing, supply and delivery of AC whole current 3 phase 4 wires Smart Energy Meter with bidirectional communication facility. The meter shall be suitable for Advanced Metering Infrastructure (AMI). The meter shall communicate with Data Concentrator Unit (DCU) / Access Point / HES on any one of the communication technologies mentioned in IS16444, as per the requirement of the utility / authorized system integrator.

2. BASIC FEATURES

The Smart Meter would have the following minimum basic features-

- Measurement of electrical energy parameters
- Bidirectional Communication
- Integrated Load limiting switch /relay
- Tamper event detection, recording and reporting
- Power event alarms such as loss of supply, low/ high voltage
- Remote firmware upgrade
- Net metering features
- On demand reading

3. GENERAL STANDARDS APPLICABLE FOR METERS

Unless otherwise specified elsewhere in this specification, the performance and testing of the meters shall conform to the following standards with latest amendments thereof:

S.No.	**Standard No.**	**Title**
1	IS 13779 with latest amendments	AC Static Watt-hour Meter class 1& 2
2	IS 16444 with latest amendments	A.C. Static Direct Connected Watt Hour Smart Meter Class 1 and 2- Specification
3	IS 15884 with latest amendments	Alternating Current Direct Connected Static Prepayment Meters for Active Energy (Class 1 and 2)- Specification

4	IS 15959 Part 1 & Part 2 with latest amendments	Data Exchange for Electricity Meter Reading, Tariff and Load Control- Companion Standards

4. COMMUNICATION

Meter shall have ability to communicate with Data Concentrator Unit (DCU) / Access Point / HES on any one of the technologies mentioned in IS16444 in a secure manner, as per the site conditions and as per design requirement of AMI Implementing agency. In case of GPRS/3G/4G based meter, the meter shall accommodate SIM card of any service provider. In case of Plug in type communication module, the meter shall log communication module removal/ non responsive event with snapshot.

4.1 Remote Load control facility would be as per IS 16444.

5. OTHER SPECIFICATIONS

Particulars	**Specification**
Applicable Standards	The meters shall comply with IS 16444 for all requirements. Those parameters which are not covered in IS 16444 have been specifically mentioned in this specification.
Reference Voltage	As per relevant IS
Current Rating	10-60 A /10-100 A (as per the requirement of the utility)
Starting Current	As per IS 16444
Accuracy	Class 1.0 as per IS 16444
Limits of error	As per IS 16444
Operating Temperature range	As per IS 16444
Humidity	As per IS 16444
Frequency	As per IS 16444
Influence Quantities	As per IS 16444
Power Consumption of meter	As per IS 16444
Current and Voltage Circuit	As per IS 16444
Running at No Load	As per IS 16444
Test output device	As per IS 16444
Meter Display	As per IS 16444
Name Plate & marking Meter Display	As per IS 16444
Parameters to be measured	As per IS 16444 / As per IS 15959 Part-2

Maximum Demand resetting	As per IS 15959 Part-2
Time of Use registers	As per IS 15959 Part-2
Power Quality Information	As per IS 15959 Part-2
LED/LCD Indicators	As per IS 16444
Load Survey/Interval Data	As per IS 15959 Part-2
Tamper/ Event Recording	As per IS 15959 Part-2
Measuring Elements	As per Is 16444
Alarm	As per IS 16444/ As per IS 15959 Part-2
Load Control	As per IS 16444
Connect/Disconnect and status of load switch	As per IS 16444
Programmability	As per IS 16444
Communication	As per IS 16444.
Communication Protocol	As per IS 16444
Remote Firmware upgrade	As per IS 15959 Part-2
Time Synchronization	As per IS 16444/IS 15884 The clock day/date setting and synchronization shall only be possible through password/Key code command from one of the following: • From remote server through suitable communication network. • Hand Held Unit (HHU) or Meter testing work bench and this shall need password enabling for meter; (The methodology for the synchronization would be as per requirement of utility)
Data Retention	As per CEA regulations
Battery Backup	Meter shall be supplied with separate battery backup for RTC.

Guarantee	Manufacturer Shall undertake a guarantee to replace meter up to a period of 60 months from the date of supply. The meter which are found defective/inoperative at the time installation or become inoperative/defective within the guarantee period, these defective/inoperative meters shall be replaced within one month of receipt of report for such defective/inoperative meters
First Breath(Power on) and Last gasp(Power off) condition detection and communication to HES	As per Is 16444

5.1 DATA DISPLAY FACILITY (AUTO/MANUAL)

Data Display shall be in three modes-

1. Auto Scroll
2. Scroll with Push Button
3. High Resolution (Shall display energy values with resolution of 2 digits before decimal and 3 digits after decimal in push button mode)

The display order shall be-

- Auto Scroll
  - Cumulative Active Energy kWh along with legend.
  - Cumulative Energy in kVAh with legend
  - Current calendar month MD in kW with legend.
  - Current calendar month MD in kVAh with legend
  - Instantaneous voltage V_{RN}
  - Instantaneous voltage V_{YN}
  - Instantaneous voltage V_{BN}
  - Instantaneous current I_R
  - Instantaneous current I_Y
  - Instantaneous current I_B

These parameters should be displayed on the LCD/LED continuously for a period of 15 seconds on Auto scroll. In case of power failure, the meter should display above parameters with push button.

- Scroll with Push-button
  - Internal diagnostics

- Cumulative kWh
- Cumulative kVAh
- Date
- Real Time
- Voltage V_{RN} (V)
- Voltage V_{YN} (V)
- Voltage V_{BN} (V)
- Current I_R (I)
- Current I_Y (I)
- Current I_B(I)
- Power (kW)
- Power (kVA)
- Current month MD in kW
- Current month MD in kVAh
- Last month cumulative kWh
- Last month cumulative kVAh
- Last month MD in kW & occurrence Date
- Last month MD in kVAh & occurrence Date
- Average power factor
- Meter Serial Number

The meter's display should return to default display mode (continues auto scroll) if push button is not operated for more than 10 seconds. (The order of display may be as per the requirement of utility)

6. ANTI TAMPER FEATURES

The meter shall continue recording energy under any temper condition and would log the event and send alarm at Head End System after detection of the defined theft features as per IS 15959 Part 2.

(Optional test as per requirement of utility: The Meter shall be immune under external magnetic influences as per CBIP 325. Meter shall be tested for high voltage discharge (Spark) up to 35KV as per CBIP 325)

7. TESTS

7.1 Type Tests & Test Certificates

Smart meter shall be type tested for all the type tests as per IS: 16444 (latest version) in a third party independent lab. The number of sampling for testing of meters and criteria for conformity would be as per IS 16444.

Necessary copies of test certificates shall be submitted as per agreement with the utility.

7.2 Routine & Acceptance Tests

The Factory Acceptance and Routine tests shall be carried out as per IS 16444. Apart from above test, meter shall also be tested for all functional requirement through communication as part of acceptance test.

8. GENERAL & CONSTRUCTIONAL REQUIREMENTS

8.1 Meter Shall be BIS marked as per IS 16444.

8.2 General & construction requirement shall be as per IS 16444/IS 13779.

8.3 In Home Display(IHD) shall be optional and the specifications of the same would be as per agreement between the bidder and the utility.

9. METER BASE & COVER-

The meter Base & cover shall be as per IS 16444/IS 13779. The meter base and cover break to open design. The material for meter base and cover shall be made of high grade polycarbonate.

10. **TERMINAL BLOCK & COVER** - As per IS 16444/IS 13779

11. DESIGN

Voltage circuit, sealing arrangement, terminal block, terminal cover and nameplate etc. shall be in accordance with IS-16444 (latest version).

The meter shall be compact and reliable in design, easy to transport and immune to vibration and shock involved in transportation and handling.

12. CIRCUITRY – As per IS 16444

The supplier should submit the details of source/agencies from whom purchase of various components of meters used by them to the utility/purchaser.

13. NAME PLATE AND MARKING

The meter should bear a name plate clearly visible, effectively secured against removal and indelibly/distinctly marked in accordance with relevant IS. In addition, in the middle of the name plate the words “Name of the Utility”, purchase order no. & year/month of manufacturing shall either be punched or marked indelibly. The rating plate information shall be as per relevant IS.

14. CONNECTION DIAGRAM: As per IS 16444

15. FIXING ARRANGEMENTS:

The meter shall be mounted type. The Meter should have three fixing holes, one at top and two at the bottom. The Top hole should be such that the holding screw is not accessible to the consumer after fixing the meters. The lower screws should be provided under sealable terminal cover. The requisite fixing screws shall be supplied with each meter.

16. SEALING ARRANGEMENT:

Arrangements shall be provided for proper sealing of the meter cover so that access to the working parts shall not be possible without breaking the seal. The sealing arrangement and number of seals shall be as per relevant IS/ requirement of utility.

17. METER BOX: The Meter Box would be provided as per requirement of the utility.

18. PACKING

- The meters shall be suitably packed for vertical/horizontal support to withstand handling during transportation.
- The meter shall be packed appropriately to ensure safe transportation, handling, identification and storage.
- All packing materials shall be as per environment law in force. The primary packing shall ensure protection against humidity, dust, grease and safeguard the meter's performance until its installation.
- The secondary packing shall provide protection during transportation.
- The packing case shall indicate "Fragile in nature" and direction of placement of box.
- Each packing shall indicate marking details like Manufacturer's name, S.No. of meters, quantity etc.

19. TRANSPORTATION

- The meter shall be compact in design. The meter block unit shall be capable of withstanding stresses likely to occur in actual service and rough handling during transportation.
- The meter shall be convenient to transport and immune to shock and vibration during transportation and handling.
- The meter should not be exposed to undue shock and mishandling during transportation.
- The stacking of box inside transport media should be such as to avoid their free movement.
- The packing should also be protected from rain and dust by transport media.

- The Bidder shall be responsible for any damage during transit due to inadequate or improper packing.

20. TESTING AND MANUFACTURING FACILITIES AT MANUFACTURER'S PLACE

The manufacturer shall have NABL accredited laboratory to ensure accurate testing calibration as per IS 13779 for acceptance test.

21. INSPECTION

❖ All meters shall be duly tested and sealed by the firm at their premises prior to inspection. Manufacturer seal may be provided on one side of meter. For the other side, the seal with engrave as Utility name may be sent in a pack for provision by utility after completion of test by the utility & after receipt of the meter.

❖ The utility/ purchaser may inspect the meter randomly as per sampling plan for acceptance test as per IS 16444. The meters shall be tested for all functional requirements as part of acceptance test as per IS 16444. After testing, these sample meters shall be additionally sealed and kept in a safe lock for verification, if needed.

****

(Reaffirmed 0)

भारतीय मानक
Indian Standard

IS 16444 : 2015

ए.सी. स्थैतिक सीधा जुड़ा वाटआवर स्मार्ट मीटर वर्ग 1 एवं 2 — विशिष्टि

a.c. Static Direct Connected Watthour Smart Meter Class 1 and 2 — Specification

ICS 91.140.50

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली-110002
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August 2015 **Price Group 4**

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

FOREWARD

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

Several programmes have been launched by Government of India to reform the energy and power sector. One such initiative was introduction of IT enabled services that has set the platform for deploying Smart Grids in India. The Smart Grid via its environment friendly and consumer centric approach would offer enhanced reliability, security, safety and efficiency for grid operations. The transition to Smart Grid would achieve the overarching objectives of Government to reduce AT&C losses and provide 24×7 power for all.

Advanced Metering Infrastructure (AMI) is a crucial part of a Smart Grid. It is an integrated system of smart meters, communication networks and data management systems that enables two way communication between the utilities and consumer premises equipment. The functional blocks of AMI typically include HES — Head end system, WAN — Wide area network, NAN — Neighbourhood area network, Data concentrator unit (DCU)/ Gateway and HAN — Home area network.

Smart Meter is a composite unit consisting of metrology elements, two way communication module/modules and control elements. It will have functions such as measurement, computation, event capturing, storing, communication and control. The smart meter would be required to provide data and information that are needed by various Smart Grid applications.

Smart grid deployment process is still evolving. Various domains of Smart Grids are infused with professional interventions to adopt and rollout standards-based technologies and products. Many standard making bodies like IEC, IEEE, NIST, CEN, CENELEC, ITU, ETSI, IETF are engaged in standardization activities pertaining to Smart Grids.

The Electrotechnical department of Bureau of Indian Standards has prepared many metering standards such as IS13779 : 1999 'ac Static watthour meters (Class 1 and 2) (*first revision*)', IS 14697 : 1999 'ac Static transformer operated watthour and var-hour meters, class 0.2S and 0.5S — Specification', IS 15884 : 2010 'Alternating current direct connected static pre-payment meters for active energy (Class 1 and 2) — Specification' and IS 15959 : 2011 'Electricity metering — Data exchange for meter reading, tariff and load control — Companion specification'. This standard on the smart meter has been prepared by Bureau of Indian Standards based on the technical specifications and functional requirements published in June 2013 by Central Electricity Authority.

While preparing this standard it has been endeavoured not to contradict on principle of the adopted/referred standards of other International organizations/institutions on which this standard is based upon. However, in case of any divergence/disparity, not amounting to conflict of interpretations that may be revealed later, provisions of this standard will prevail.

This standard specifies the requirements for smart meters only. Requirements for any other components shown or referred in the text or diagrams such as DCU, HES, IHD, HHU may be specified separately for functional and technical aspects taking into consideration the features and provisions of this standard for deployment of AMI. The requirements of other components chosen shall be finalised between buyer and seller.

While finalizing this standard a separate standard covering requirements for data exchange specific to smart meter has been prepares and it is in the final stage of approval. Therefore IS 15959 : 2011 is being revised as follows:

IS 15959 (Part 1) : 2011 'Data exchange for electricity meter reading, tariff and load control: Part 1 Comparison specification' (through Amendment)

IS 15959 (Part 2) : 2011 'Data exchange for electricity meter reading, tariff and load control: Part 2 Comparison specification for smart meter (*under preparation*)

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)' . The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

a.c. STATIC DIRECT CONNECTED WATTHOUR SMART METER CLASS 1 AND 2 — SPECIFICATION

1 SCOPE

1.1 This standard specifies static watt-hour smart meters of accuracy class 1 and 2 for the measurement of alternating current electrical active energy of frequency 50 Hz for single phase and three phase balanced and unbalanced loads. It applies to their type tests, routine tests and acceptance tests.

1.2 It applies to:

a) static watt-hour direct connected meters consisting of measuring element(s), time of use of register(s), display, load switch and built in type bi-directional communication module all integral with the meter housing.

b) alternately the bi-directional communication module could be plug-in type on a dedicated slot with suitable sealing arrangement. The plug-in module shall be field swappable with suitable integrated communication module as agreed between buyer and seller.

1.3 The smart meter types as specified in **1.2** (a) and **1.2** (b) shall be suitable for indoor/outdoor usage and capable of forward (import) or both forward (import) and reverse (export) energy measurement.

1.4 It does not apply to:

a) watt-hour meters where the voltage across the connection terminal exceeds 600 V (line to line voltage for meters for poly phase systems,

b) meters operated with external current transformers,

c) portable meters, and

d) meters without internal load switch.

2 REFERENCES

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

IS No./ International Standards	*Title*
13779 : 1999	a.c. Static watthour meters, Class 1 and 2 — Specification
15884 : 2010	Alternating current direct connected static prepayment meters for active energy (Class 1 and 2) — Specification
15959 (Part 1) : 2011	Data exchange for electricity meter reading, tariff and load control : Companion specification
15959 (Part 2) : 2011	Data exchange for electricity meter reading, tariff and load control: Part 2 Companion specification for smart meter
IEEE 802.15.4 : 2003	Standard for local and metropolitan area networks
IEEE 1901 : 2010	Standard for broadband over power line networks: Medium access control and physical layer specifications
IEEE 1901.2 : 2013	Standard for low-frequency narrow band power line communications for smart grid applications
ITU-T G.9901 : 2014	Narrowband orthogonal frequency division multiplexing power line communication transceivers — Power spectral density specification
ITU-T G.9903 : 2014	Narrowband orthogonal frequency division multiplexing power line communication transceivers for G3-PLC networks
ITU-T G.9904 : 2012	Narrowband orthogonal frequency division multiplexing power line communication transceivers for prime networks

3 TERMINOLOGY

3.1 General Definitions — For the purpose of this standard all definitions given in IS 13779, IS 15884 and IS 15959 (Part 1) shall apply. In addition definitions given in **3.2** shall be applicable.

3.2 Definitions of General Smart Metering Terms

3.2.1 *Smart Meter* — Smart meter is an ac static watt-

hour meter with time of use registers, internal connect and disconnect switches with two way communication capability. It is designed to measure flow of forward (import) or both forward (import) and reverse (export), store and communicate the same along with other parameters defined in this standard. It shall be remotely accessed for collecting data/events, programming for select parameters.

3.2.2 *Neighbourhood Area Network [NAN]* — This is a network comprising of group of smart meters and any other network elements such as DCU all of which communicate in a two way mode.

3.2.3 *Data Concentrator Unit [DCU]* — This device is part of NAN. It acts as a secured aggregate router and is an interface between smart meter and HES. It shall facilitate secured two way data transfer either in transparent/store and forward mode as per system designs. The other terminologies like/Network Element/Grid Router/Access point/edge router shall be synonymously used in place of DCU. This standard does not cover the requirements of DCU.

3.2.4 *Head End System [HES]* — This entity is a set of ICT based systems situated at the top of AMI system and receives data and events over NAN/WAN. HES is responsible for using these data/information and manage NAN/WAN components, smart meters and IHD. HES is also responsible for handling security keys, passwords intended for smart meter programmability and firmware upgrade and host applications such as remote connect/disconnect, analytics, billing, messaging etc. This standard does not cover the requirements of HES.

3.2.5 *In Home Display [IHD]* — This is a compact display module meant for mounting inside the consumer premises. The IHD shall receive data/ messages from smart meter and send responses to smart meter as and when required from HES. This standard does not cover the requirements of IHD

3.2.6 *Hand Held Unit [HHU]* — This is a device used to communicating locally over the optical port to the smart meter. Communication functionality requirements are as mentioned in IS 15959 (Part 2).

4 GLOSSARY OF TERMS

AMI : Advanced metering infrastructure
AT&C : Aggregate technical and commercial
CEA : Central electricity authority
COSEM : Companion specification for energy metering
DCU : Data concentrator unit
DLMS : Device language message specification
DoT : Department of telecom
DSM : Demand side management
DR : Demand response
ETA : Equipment type approval
ETSI : European telecommunications standards institute
HAN : Home area network
HES : Head end system
HHU : Hand held unit
ICT : Information and communications technology
IEC : International electrotechnical commission
IEEE : Institute of electrical and electronics engineers
IETF : Internet engineering task force
IHD : In home display
IS : Indian standard
ITU : International telecommunication union
LCD : Liquid crystal display
NAN : Neighbourhood area network
OFC : Optical fibre communication
PLC : Power line communication
RF : Radio frequency
ToU : Time of use
WAN : Wide area network
WPC : Wireless planning co-ordination
NFAP : National frequency allocation Plan

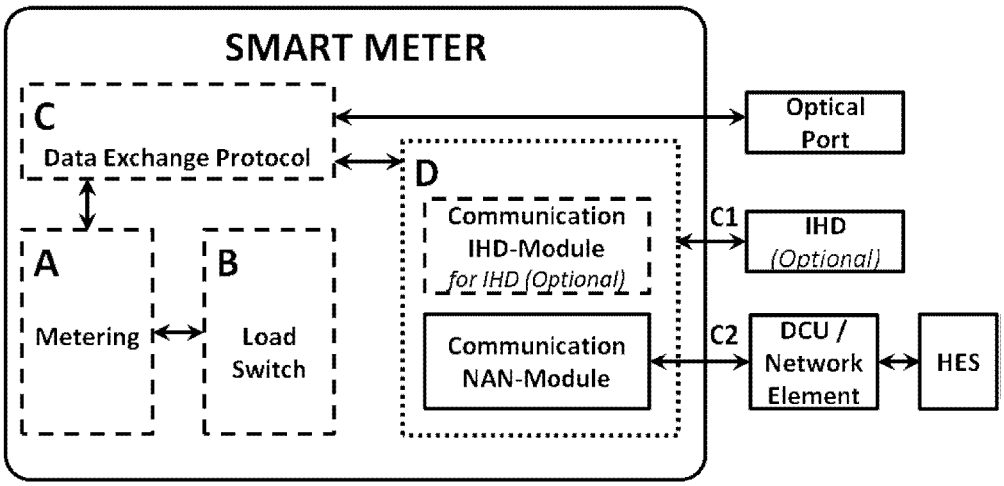
5 SMART METER ARCHITECTURE

5.1 The smart meter is a component of Advanced Metering Infrastructure. For the purpose of this standard the smart meter is conceived as single unit comprising of following functional zones:

a) Metering,
b) Load switch,
c) Metering protocol, and
d) Communication modules.

5.2 The Smart Meters may have wide usage and the buyer may like to choose desired features to meet the objectives of their overall system and site conditions. In order to facilitate such a flexible approach, the Smart Meter architecture are categorized into two variants. Based on the technical feasibility buyer may choose the combination of the variants best suited for a given geographical area. The Smart Meter shall have either NAN or WAN module as mandatory communication module for communicating to DCU or HES respectively. If IHD is chosen, then there could be a suitable additional communication module within the Smart Meter. The two variants are diagrammatically represented in Fig. 1 and Fig. 2. These variants are applicable to both built in type and pluggable type of Smart Meters.

Variant 1



LEGEND

A – Metrology
B – Load switch for control
C – Metering protocol
D – Communication

Optical port — As per IS 15959 (Part 2)
C1 – IHD Connectivity SM ↔ IHD (optional)
C2 – NAN Connectivity SM ↔ DCU

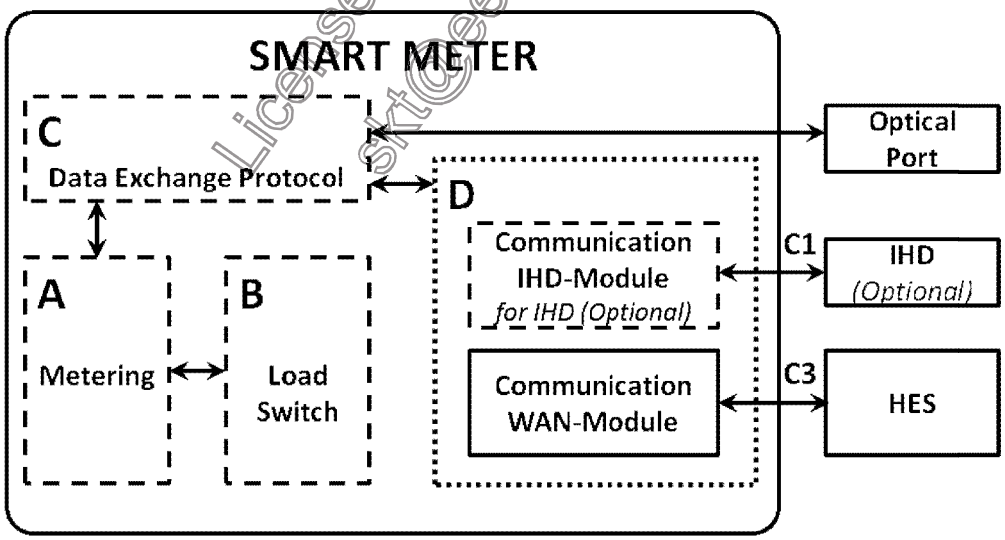
NOTES

1 The Smart Meter variant based on Fig. 1 shall provide connectivity C2 for two way communication with DCU using a NAN module.

2 If IHD is chosen this Smart Meter shall provide connectivity C1 for two way communication with IHD using the same NAN module or a suitable additional module as per buyer-seller agreement.

FIG. 1 SMART METER ARCHITECTURE

Variant 2



LEGEND

A – Metrology
B – Load switch for control
C – Metering protocol
D – Communication

Optical port — As per IS 15959 (Part 2)
C1 – IHD Connectivity SM ↔ IHD (Optional)
C3 – WAN Connectivity SM ↔ HES

NOTES

1 The Smart Meter variant based on Fig. 2 shall provide connectivity C3 for two way communication with HES using a WAN module.

2 If IHD is chosen this Smart Meter shall provide connectivity C1 for two way communication with IHD using a suitable additional module as per buyer-seller agreement.

FIG. 2 SMART METER ARCHITECTURE

6 METERING

6.1 Metering Requirement

Metering and metrology requirement shall be according to IS 13779.

6.1.1 *Classification*

The classification as per **4** of IS 13779 shall apply.

6.1.2 *Ratings*

6.1.2.1 *Standard reference voltage*

As per **5.1** of IS 13779.

6.1.2.2 *Standard basic current*

As per **5.2** of IS 13779.

6.1.2.3 *Maximum current*

As per **5.3** of IS 13779 with maximum current not exceeding 100A for both 3 Phase and 1 Phase meters.

6.1.2.4 *Standard reference frequency*

As per **5.4** of IS 13779

6.2 General Constructional Requirements

The requirements given in **6.1** to **6.4** of IS 13779 shall apply.The communication modules shall be either built in type or plug in type as mentioned in **1.2**. The plug-in communication modules shall be properly secured on the smart meter, both physically and electrically, so as to avoid any possible tampering with adequate provision for sealing. The load switch for disconnect/ connect purpose shall be mounted inside the meter with suitable arrangement.

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

The requirements given in **6.4** of IS 13779 shall apply.

6.2.2 *Terminal Cover*

The requirements given in **6.5, 6.5.1, 6.5.2** and **6.7** of IS 13779 shall apply

6.3 Clearance and Creepage Distances

The requirements given in **6.6** of IS 13779 shall apply.

6.4 Resistance to Heat and Fire

The requirements given in **6.8** of IS 13779 shall apply.

6.5 Mechanical Requirements

The requirements for mechanical shall be as per **12.3** of IS 13779 and the requirements for protection against penetration of dust and water shall be as per **6.9** and **12.5** of IS 13779 shall apply.

6.6 Display of Values

The requirements given in **6.10** of IS 13779 shall apply. The non-volatile memory shall support retention period of 10 years.

6.7 Output Device

The requirements given in **6.11** of IS 13779 shall apply. Distinct LED/LCD indicators shall be provided for Communication in Progress (for example — TxD mode, RxD mode), Load switch Close/Open conditions.

6.8 Marking of Smart Meter

6.8.1 The requirements given in **7** of IS 13779 shall apply.

The following additional information shall also be provided as applicable in the name plate:

a) Communication technology for WAN or NAN (with carrier frequency).
b) Communication technology if IHD is supported (with carrier frequency).
c) Symbol of load switch.

6.8.2 The use of Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

6.9 Climatic Condition

The requirements given in **8** of IS 13779 shall apply.

6.10 Electrical Requirements

6.10.1 *Power Consumption*

The measurement of power consumption in the voltage and current circuits shall be determined as described in the followings.

6.10.1.1 *Voltage circuits*

The active and apparent power consumptions of a direct-connected composite Smart Meter for each circuit at reference voltage, reference temperature, and reference frequency shall not exceed 5.0 W and 15 VA during the idle mode of communication module. This applies to either one NAN or one WAN module present in the Smart Meter. If a separate module for servicing to IHD is present, the above figures shall not exceed 6W and 18VA during the idle mode of communication module.

The additional power requirement during data

transmission shall not exceed 7W per communication module. In the case of plug in communication modules, the Smart Meter shall be capable of sourcing 7W for powering the plug in communication module during data transmission.

6.10.1.2 *Current Circuit*

The apparent power taken by each current circuit of a direct connected payment meter at maximum current, reference frequency and reference temperature shall not exceed a maximum of 4 VA.

6.10.2 *Influence of Supply Voltage*

The requirements given in **4.4.2** of IS 15884 shall apply.

6.10.3 *Influence of Short —Time Overcurrents*

The requirements given in **4.4.3** of IS 15884 shall apply.

6.10.4 *Influence of Self-Heating*

The requirements given in **4.4.4** of IS 15884 shall apply.

6.10.5 *Influence of Heating*

The requirements given in **4.4.5** of IS 15884 shall apply.

6.10.6 *Insulation Requirements*

The requirements given in **9.5** of IS 13779 shall apply.

6.10.7 *Immunity to Earth Fault*

The requirements given in **9.6** of IS 13779 shall apply.

6.11 Electromagnetic Compatibility

The requirements given in **4.5** and **5.5** of IS 15884 shall apply.

6.12 Accuracy Requirements

The requirements given in **11, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6** and **11.7** of IS 13779 shall apply.

6.13 Test and Test Conditions

Given in **10** of this standard.

7 LOAD SWITCH REQUIREMENT

7.1 Load Switching Capability

The smart meter shall be provided with switching elements, integral with the meter enclosure, to control the flow of electricity to the load at the instance of connect/disconnect commands as per functional needs of the system. For Single Phase Smart Meter, two load switches one each in phase and neutral shall be provided. For Three Phase Smart Meters load switches one in each phase shall be provided. The switches are to be rated to carry maximum current continuously under normal operating conditions and to withstand the switching transients during make and break operations.

7.2 Performance Requirements for Load Switching

The requirements given in **4.6.6.2** of IS 15884 shall apply.

8 DATA EXCHANGE PROTOCOL

The requirements as per IS 15959 (Part 1) shall apply. The data exchange protocol chosen for Smart Meter shall be as per IS 15959 (Part 2) including specific requirements for Smart Meters for the application layer. This application layer protocol which is primarily DLMS/COSEM shall work through the other layers as given in **9**.

9 COMMUNICATION REQUIREMENT

The NAN, WAN and IHD communication modules that are shown in Fig. 1 and Fig. 2 are for establishing connectivity with Smart Meter by the external entities such as DCU and HES respectively and optionally with IHD. These are either wired or wireless communication technology, the choice of technology shall be chosen by the buyer based on the technical feasibility best suited for a given geographical area. The communication module(s) may be of PLC or RF for NAN and cellular technologies or OFC technology for WAN.

9.1 Connectivity Technologies

9.1.1 The connectivity C1, C2 and C3 in variant 1 (Fig. 1) and variant 2 (Fig. 2) are generally designed with wired or wireless technology for the physical medium. For connectivity C1 and C2 if PLC (wired) technology is chosen the standards may be any one of those given in **2**. For connectivity C1 and C2 if RF (wireless) technology is chosen the standard may be as per IS 15959 (Part 2).

9.1.2 Wherever PLC technology is used the "AC line connection for coupling/decoupling shall be from within for both plug-in/built in type smart meter".

9.1.3 The technology for WAN may be any of the cellular technologies supporting: 2G/3G/4G or an optical fiber communications network complying to IPv6.

9.1.4 The standards cited in **9.1.1** are indicative and non-exhaustive. Other suitable standards from ITU/IEC/IEEE/CEN/CENELEC/ETSI may be considered for NAN and WAN as per agreement between the supplier and the purchaser.

9.2 RF Technology Requirements

The RF technology if used for NAN/IHD communication modules shall be in the frequency bands notified by Government of India.

Wireless technologies need to comply with the Indian statutory bodies that govern communication related aspects such as WPC (Wireless Planning Co-ordination wing) which oversees licensing and management of all wireless spectrums in India. Equipment Type Approval (ETA) is to be obtained for communication modules as per Department of Telecom, Government of India requirements.

Radio emission characteristics for the chosen band shall comply with latest NFAP and the G.S.R (General Statutory Rules) notifications from Department of Telecom, Government of India.

9.3 Communication Layer Protocol

9.3.1 The smart meter may use a layered Communication protocol stack. The top four layers of such a stack shall be as mentioned below:

Application	IS 15959 (Part 1) and IS 15959 (Part 2)
Transport	TCP/UDP
Network	IPv6 RPL
Adaptation	6LoWPAN RFC (6282)

9.3.2 For Connectivity C1 and C2 the network protocol shall be IPv6 RPL and 6Low PAN [RFC 6282] for convergence/adoption layer. For Connectivity C3 the network protocol shall be IPv6 RPL and IETF RFC 2464, 5072 and 5121, PPP (IETF RFC 1661).

9.3.3 The other layers may be as per **9.1**.

10 TESTS AND TEST CONDITIONS

The smart meter both built-in and pluggable types as a composite unit shall be subjected to specified tests for meteorology, for load switching capability, for data exchange protocol and for smart meter communicability.

10.1 Test for Metrology

The tests for metrology shall include the "Type Tests, Routine Tests, and Acceptance Tests" identified in IS 13779. The schedule and recommended sequence of type tests shall be as given below in Table 1. In Table 1, the sequence of tests mentioned is as that of Table 20 in IS 13779. The clause numbers in Table 1 against the name of the tests are the numbers of this standard.

10.2 Number of Samples and Criteria for Conformity

The requirements given in **12** of IS 13779 shall apply.

Table 1 Schedule of Type Tests

(*Clause* **10.1**)

Sl No.	Test	Ref. to Clause of this Standard
(1)	(2)	(3)
i)	**Test of Insulation Properties**	**6.10.6**
	Impulse voltage test	
	ac High voltage test	
	Insulation resistance test	
ii)	**Test of Accuracy Requirements**	**6.12**
	Test on limits of error	
	Interpretation of test results	
	Test of meter constant	
	Test of starting condition	
	Test of no-load condition	
	Test of ambient temperature influence	
	Test of repeatability of error	
	Test of influence quantities	
iii)	**Test of Electrical Requirement**	**6.10**
	Test of power consumption test	**6.10.1**
	Test of influence of supply voltage	**6.10.2**
	Test of influence short-time over currents	**6.10.3**
	Test of influence of self-heating	**6.10.4**
	Test of influence of heating	**6.10.5**
	Test of influence of immunity to earth fault	**6.10.7**
iv)	**Test for Electromagnetic Compatibility**	**6.11**
	Radio interference measurement	
	Fast transient burst test	
	Test of immunity to electrostatic discharges	
	Test of immunity to electromagnetic HF field	
	Surge Immunity Test	
v)	**Test for Climatic Influences**	**6.9**
	Dry heat test	
	Cold test	
	Damp heat cyclic test	
vi)	**Test for Mechanical Requirements**	**6.5**
	Vibration test	
	Shock test	
	Spring hammer test	
	Protection against penetration of dust and water	
	Test of resistance to heat and fire	

NOTES

1 Following tests shall be carried out to assess for smart meter functional condition after the "Type test and acceptance test" for metrology is carried out but before 'test of resistance to heat and fire'.

a) Accuracy of the meter at pre-defined points [5 percent I_b, I_b and I_{max}] UPF.

b) Access and data read test.

c) Remote disconnect/connect

2 For procedure to conduct functional tests [(b), (c) of note 1] reference may be made to IS 15959 (Part 2).

10.3 Display

Minimum 6+1 digits LCD display. For testing purpose, high resolution display having at least 3 decimal digits shall be provided.

10.4 Test for Load Switch

The requirements as per **4.6.6.2** of IS 15884 shall apply. This test shall be tested on a separate sample.

10.5 Test for Data Exchange Protocol

This test shall be carried out on optical port and the tests shall be performed as per IS 15959 (Part 1) and IS 15959 (Part 2) for conformity.

10.6 Tests for Smart Meter Communicability

10.6.1 The modules for WAN/NAN/IHD shall be approved by designated agency authorized by DoT and shall have ETA as mentioned in **9.2**.

10.6.2 *Test for Smart Meter Communicability*

This standard provides for use of suitable communication technologies in the design of smart meters. However to assess the communication capability a few tests including a test for end to end communication capability are identified and included in IS 15959 (Part 1) . These tests are meant for carrying out using Connectivity C1, C2 and C3.

11 SMART METER FUNCTIONAL REQUIREMENTS

The Smart Meter developed as per this standard is required to support handling of following operational requirements:

11.1 Disconnection Mechanism

The Smart Meter shall support disconnection (all the switches shall operate) under the following conditions:

a) Over current (minimum 105% of I_{max} in any phase for predefined persistence time),
b) Load control limit (programmable and set by utility),
c) Pre-programmed event conditions (factory set),
d) Disconnect signal from utility control centre, and
e) In case of pre-paid facility under defined/ agreed conditions.

NOTES

1 Persistence time value to be provided by utility.
2 List of events for disconnection to be pre-programmed shall be provided by utility.

11.2 Reconnection Mechanism

The local reconnection due to disconnection under over current and load control limit shall be as follows:

a) The switch re-connection shall be decided by meter locally. It will try to re-connect the load up to predefined time, with predefined interval (time and interval is programmable by utility). If the consumption is within limits meter shall remain in normal connect mode,
b) If the consumption is still more than the programmed limits, it will lock out and wait for 30 min (lock out period). After this period the meter shall reconnect the load and if the consumption is still above the limit, the procedure as defined above in (a) shall be repeated with status update to HES, and
c) In all conditions other than 'Over current and load control limit' reconnection shall normally be done from HES. In case of failure of communication with HES, reconnection shall be possible through optical port locally with specified security.

11.3 Reconnection Mechanism for Prepayment Meter

As per agreed prepayment structure with utility.

11.4 Status of Load Switch

Indication of status of load switch (that is connected/ disconnected) shall be available on display as well as at HES.

11.5 All connections and disconnections shall also be logged as events.

11.6 Smart Meters shall respond to:

a) Meter readings on demand from HES,
b) Scheduled meter reading from HES,
c) Remote Firmware upgrade from HES, and
d) All programming requests from HES.

11.7 Smart Meter shall detect 'First breath (power on) and Last gasp (power off)' condition and communicate to HES.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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भारतीय मानक
Indian Standard

IS 16444 (Part 2) : 2017

ए. सी. स्थैतिक ट्रान्सफार्मर संचालित वाट ऑवर एवं वार ऑवर स्मार्ट मीटर वर्ग 0.2S, 0.5S तथा 1.0S

भाग 2 विशिष्टि ट्रान्सफार्मर संचालित स्मार्ट मीटर

a.c. Static Transformer Operated Watthour and Var-Hour Smart Meters, Class 0.2S, 0.5S and 1.0S

Part 2 Specification Transformer Operated Smart Meters

ICS 91.140.50

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
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FOREWORD

This Indian Standard (Part 2) was adopted by the Bureau of Indian Standards, after the draft finalized by the Equipment for Electrical Energy Measurement, Tariff and Load Control Sectional Committee had been approved by the Electrotechnical Division Council.

Several programs have been launched by Government of India to reform the energy and power sector. One such initiative was introduction of IT enabled services that have set the platform for deploying Smart Grids in India. The Smart Grid *via* its environment friendly and consumer centric approach would offer enhanced reliability, security, safety and efficiency for grid operations. The transition to Smart Grid would achieve the over arching objectives of Government to reduce AT&C losses and provide 24×7 power for all.

Advanced Metering Infrastructure (AMI) is a crucial part of a Smart Grid. It is an integrated system of smart meters, communication networks and data management systems that enables two way communications between the utilities and consumer premises equipment. The functional blocks of AMI typically include HES — Head end system, WAN — Wide area network, NAN — Neighborhood area network, Data concentrator unit (DCU)/ Gateway and HAN — Home area network.

Smart meter is a composite unit consisting of metrology elements, two way communication module/modules and control elements. It will have functions such as measurement, computation, event capturing, storing, communication and control. The smart meter would be required to provide data and information that are needed by various Smart Grid applications.

Smart grid deployment process is still evolving. Various domains of Smart Grids are infused with professional interventions to adopt and rollout standards-based technologies and products. Many standard making bodies like IEC, IEEE, NIST, CEN, CENELEC, ITU, ETSI, and IETF are engaged in standardization activities pertaining to Smart Grids.

The Electrotechnical department of Bureau of Indian Standards has formulated many metering standards such as IS 13779 : 1999 'a.c. Static watthour meters (Class 1 and 2) (*first revision*)', IS 14697 : 1999 'a.c. Static transformer operated watthour and var-hour meters, class 0.2S and 0.5S — Specification', IS 15884 : 2010 'Alternating current direct connected static pre-payment meters for active energy (Class 1 and 2) — Specification', IS 15959 (Part 1) : 2011 'Electricity metering — Data exchange for meter reading, tariff and load control — Companion specification Part 1 Static Energy Meter' and IS 16444 : 2015 'a.c. Static Direct Connected Watthour Smart Meter Class 1 and 2 — Specification'. This standard on the smart meter has been formulated by Bureau of Indian Standards based on the technical specifications and functional requirements published in June 2013 by Central Electricity Authority.

The letter 'S' denotes special measuring range designated for transformer operated applications, generally for large power measurements. Current transformers also 'S' designated as per IS 2705 (Part 2) : 1992 'Current transformers: Part 2 Measuring current transformers (*second revision*)' have measuring ranges comparable to those of static meters covered by this standard. For the sake of overall accuracy throughout the measuring range, static meters covered by this standard should preferably be connected with 'S' designated current transformers. For example class 0.5 S meters is used with 0.2 S CT and class 0.2 S meter is used with 0.2 S CT.

While formulating this standard it has been endeavored not to contradict on principle of the adopted/referred standards of other International organizations/institutions on which this standard is based upon. However, in case of any divergence/disparity, not amounting to conflict of interpretations that may be revealed later, provisions of this standard will prevail.

This standard specifies the requirements for smart meters only. Requirements for any other components shown or referred in the text or diagrams such as DCU, HES, IHD, HHU may be specified separately for functional and

Indian Standard

a.c. STATIC TRANSFORMER OPERATED WATTHOUR AND VAR-HOUR SMART METERS, CLASS 0.2S, 0.5S AND 1.0S

PART 2 SPECIFICATION TRANSFORMER OPERATED SMART METERS

1 SCOPE

1.1 This standard (Part 2) specifies ac static transformer operated watthour and var-hour smart meters of accuracy class 0.2S,0.5S and 1.0S for the measurement of alternating current electrical active and reactive energy of frequency in the range 50 Hz for single phase and three phase balanced and unbalanced loads. It applies to their type tests, routine tests and acceptance tests.

1.2 It applies only to transformer operated static watthour and var-hour meters consisting of measuring element(s) and register(s) enclosed together in the meter case. It also applies to operation indicator(s) and test output(s). It also applies to multirate tariff meters and meters which measure energy in both directions.

1.3 Some versions of static reactive energy (var-hour) meters may deemed to be covered by this standard as if these are active energy (watthour) meters of appropriate accuracy class with necessary adjustment to power factor. Although it is possible to achieve Class 0.2 S accuracy in static var-hour meters, it is of general opinion that accuracy attainable for var-hour measurement is one level inferior to that in the case of kWh measurement with identical design of measuring elements. Therefore, it is possible for this standard to cover static var-hour meter, Class 0.2 S, and 0.5 S for reactive energy measurement in all transformer operated applications. Only 'power factor' wherever it has appeared in this standard, shall be read as 'sin Ø inductive' or 'sin Ø capacitive'. Where Ø is respectively the lagging or the leading power factor angle

1.4 It applies to,

a) transformer operated static watt-hour meters consisting of measuring element(s), time of use of register(s), display and built in type bi-directional communication module all integral with the meter housing.

b) Alternately, the bi-directional communication module could be plug-in type on a dedicated slot with suitable sealing arrangement. The plug-in module shall be field swappable with suitable integrated communication module as agreed between the buyer and the seller.

1.5 The smart meter types as specified in **1.4** (a) and **1.4** (b) shall be suitable for indoor usage and capable of 'forwarded only' or 'import and export' energy measurement.

1.6 It does not apply to,

a) watthour meters and var-hours meters where the voltage across the connection terminal exceeds 600 V (line to line voltage for meters for poly phase systems), and

b) portable meters, and outdoor meters.

1.7 For rack-mounted meters, the mechanical requirements are not covered in this standard.

2 REFERENCES

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

IS No./ International Standard	*Title*
14697: 1999	a.c. Static transformer operated watt-hour and var-hour meters, Class 0.2S, 0.5S and 1.0S — Specification
15959 (Part 1): 2011	Data exchange for electricity meter reading, tariff and load control — Companion : specification Static energy meter
(Part 2): 2016	Smart meter
IEEE 802.15.4: 2003	Standard for local and metropolitan area networks
IEEE 1901: 2010	Standard for broadband over power line networks: Medium access control and physical layer specifications
IEEE 1901.2: 2013	Standard for low-frequency narrow band power line communications for smart grid applications
ITU-T G.9901: 2014	Narrowband orthogonal frequency division multiplexing power line communication transceivers — Power spectral density specification

IS No./ International Standard	*Title*
ITU-T G.9903 : 2014	Narrowband orthogonal frequency division multiplexing power line communication transceivers for G3- PLC networks
ITU-T G.9904: 2012	Narrowband orthogonal frequency division multiplexing power line communication transceivers for prime networks

3 TERMINOLOGY

3.1 General Definitions — For the purpose of this standard all definitions given in IS 14697, IS 15959 (Parts 1, 2 and 3) and the following shall apply.

3.2 Definitions of General Smart Metering Terms

3.2.1 *Smart Meter* — Smart meter is an a.c. static transformer operated watthour and Var-hour meter with time of use registers and two way communication capabilities.

It is designed to measure 'forwarded only' or 'import and export' energy, store and communicate the same along with other parameters defined in this standard. It shall be remotely accessed for collecting data/events, programming for selected parameters.

Load switch is not applicable for the meters covered in this standard.

3.2.2 *Neighborhood Area Network [NAN]* — This is a network comprising of group of smart meters and any other network elements such as DCU all of which communicate in a two way mode.

3.2.3 *Data Concentrator Unit [DCU]* — This device is part of NAN. It acts as a secured aggregate router and is an interface between smart meter and HES. It shall facilitate secured two way data transfer either in transparent/store and forward mode as per system designs. The other terminologies like Network Element/ Grid Router/Access point/edge router shall be synonymously used in place of DCU. This standard does not cover the requirements of DCU.

3.2.4 *Head End System [HES]* — This entity is a set of ICT based systems situated at the top of AMI system and receives data and events over NAN/WAN. HES is responsible for using these data/information and manage NAN/WAN components, smart meters and IHD. HES is also responsible for handling security keys, passwords intended for smart meter programmability and firmware upgrade and host applications such as remote connect/disconnect, analytics, billing, messaging etc. This standard does not cover the requirements of HES.

3.2.5 *In Home Display [IHD]* — This is a compact display module meant for mounting inside the consumer premises. The IHD shall receive data/ messages from smart meter and send responses to smart meter as and when required from HES. This standard does not cover the requirements of IHD.

3.2.6 *Hand Held Unit [HHU]* — This is a device used to communicating locally over the optical port to the smart meter. Communication functionality requirements are as mentioned in IS 15959 (Part 2).

3.2.7 *Forwarded Energy*

It is the measurement of energy in import register for energy in both forward and reverse direction.

3.2.8 *Import Energy*

It is the measurement of energy in import register for energy in forward direction only

3.2.9 *Export Energy*

It is the measurement of energy in export register for energy in reverse direction only.

4 GLOSSARY OF TERMS

AMI	:	Advanced metering infrastructure
AT&C	:	Aggregate technical and commercial
CEA	:	Central electricity authority
COSEM	:	Companion specification for energy metering
DCU	:	Data concentrator unit
DLMS	:	Device language message specification
DoT	:	Department of telecom
DSM	:	Demand side management
DR	:	Demand response
ETA	:	Equipment type approval
ETSI	:	European telecommunications standards institute
HAN	:	Home area network
HHU	:	Hand held unit
ICT	:	Information and communications technology
IEC	:	International electro technical commission
IEEE	:	Institute of electrical and electronics engineers
IETF	:	Internet engineering task force
IHD	:	In home display
IS	:	Indian standard
ITU	:	International telecommunication union
LCD	:	Liquid crystal display
NAN	:	Neighborhood area network
PLC	:	Power line communication
RF	:	Radio frequency

ToU : Time of use
WPC : Wireless planning co-ordination
NFAP : National frequency allocation plan

5 SMART METER ARCHITECTURE

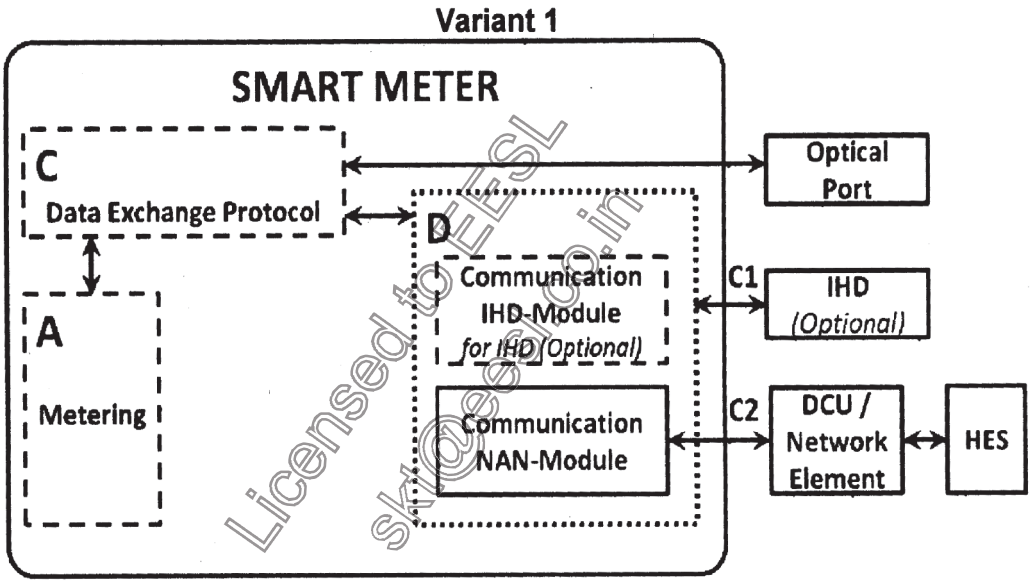
5.1 The smart meter is a component of Advanced Metering Infrastructure. For the purpose of this standard the smart meter is conceived as single unit comprising of following functional zones:

a) Metering,
b) Load switch (not applicable in this part of standard for transformer operated meters),
c) Data exchange and communication protocol, and
d) Communication modules.

2.2 The smart meters may have wide usage and the buyer may like to choose desired features to meet the objectives of their overall system and site conditions. In order to facilitate such a flexible approach, the Smart meter architecture are categorized into two variants.

Based on the technical feasibility buyer may choose the combination of the variants best suited for a given geographical area. The Smart meter shall have either NAN or WAN module as mandatory communication module for communicating to DCU or HES, respectively.

If IHD is chosen, then there could be a suitable additional communication module within the Smart Meter. The two variants are diagrammatically represented in Fig. 1 and Fig. 2. These variants are applicable to both built in type and pluggable type of smart meters.



LEGEND

A – Metrology
C – Data Exchange and Metering Protocol
D – Communication

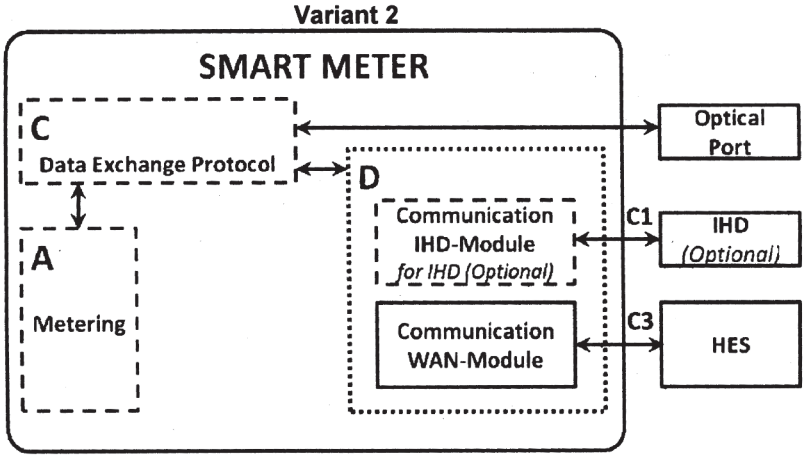
Optical port — As per IS 15959 (Part 2)
C1 – IHD Connectivity SM →IHD (optional)
C2 – NAN Connectivity SM→DCU

NOTES

1 The smart meter variant based on Fig. 1 shall provide connectivity C2 for two way communication with DCU using a NAN module.

2 If IHD is chosen this smart meter shall provide connectivity C1 for two way communication with IHD using the same NAN module or a suitable additional module as per buyer-seller agreement.

FIG. 1 SMART METER ARCHITECTURE (FOR TRANSFORMER OPERATED METERS)



LEGEND

A – Metrology
C – Metering protocol
D – Communication
Optical port — As per IS 15959 (Part 2)
C1 – IHD Connectivity SMIHD (Optional)
C3 – WAN Connectivity SMàHES

NOTES

1 The smart meter variant based on Fig. 2 shall provide connectivity C3 for two way communication with HES using a WAN module.

2 If IHD is chosen this smart meter shall provide connectivity C1 for two way communication with IHD using a suitable additional module as per buyer-seller agreement.

FIG. 2 SMART METER ARCHITECTURE (FOR TRANSFORMER OPERATED METERS)

6 METERING

6.1 Metering Requirement

Metering and metrology requirement shall be according to IS 14697.

6.1.1 *Classification*

The classification as per **4** of IS 14697 shall apply.

6.1.2 *Ratings*

6.1.2.1 *Standard reference voltage*

As per **5.1** of IS 14697.

6.1.2.2 *Standard basic current*

As per **5.2** of IS 14697.

6.1.2.3 *Maximum current*

As per **5.3** of IS 14697.

6.1.2.4 *Standard reference frequency*

As per **5.4** of IS 14697.

6.2 General Constructional Requirements

The requirements given in **6.1** to **6.4** of IS 14697 shall apply. The communication modules shall be either built in type or plug in type as mentioned in **1.4**. The plug-in communication modules shall be properly secured on the smart meter, both physically and electrically, so as to avoid any possible tampering with adequate provision for sealing.

6.2.1 *Terminals-Terminal Block(s) —Protective Earth Terminal*

The requirements given in **6.4** of IS 14697 shall apply.

6.2.2 *Terminal Cover*

The requirements given in **6.5, 6.5.1, 6.5.2** and **6.7** of IS 14697 shall apply.

6.3 Clearance and Creepage Distances

The requirements given in **6.6** of IS 14697 shall apply.

6.4 Resistance to Heat and Fire

The requirements given in **6.8** of IS 14697 shall apply.

6.5 Mechanical Requirements

The requirements for mechanical shall be as per **12.3** of IS 14697 and the requirements for protection against penetration of dust and water shall be as per **6.9** and **12.5** of IS 14697 shall apply.

6.6 Display of Values

The requirements given in 6.10 of IS 14697shall apply. The non-volatile memory shall support retention period of 10 years.

6.7 Output Device

The requirements given in **6.11** of IS 14697 shall apply. Distinct LED/LCD indicators shall be provided for communication in progress.

6.8 Marking of Smart Meter

6.8.1 The requirements given in **7** of IS 14697 shall apply.

The following additional information shall also be provided as applicable in the name plate:

a) Communication technology for WAN or NAN (with carrier frequency).
b) Communication technology if IHD is supported (with carrier frequency).

6.8.2 *BIS Certification Marking*

The use of Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act,* 1986 and the Rules and Regulations made thereunder. The details of conditions under which the license for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

6.9 Climatic Condition

The requirements given in **8** and **12.6** of IS 14697 shall apply.

6.10 Electrical Requirements

6.10.1 *Power Consumption*

The measurement of power consumption in the voltage and current circuits shall be determined as described in the followings.

6.10.1.1 *Voltage circuits*

The active and apparent power consumptions of a transformer operated Smart meter for each circuit at reference voltage, reference temperature, and reference frequency shall not exceed 5.0 W and 15 VA during the idle mode of communication module. This applies to either one NAN or one WAN module present in the smart meter. If a separate module for servicing to IHD is present, the above figures shall not exceed 6W and 18VA during the idle mode of communication module.

The additional power requirement during datatransmission shall not exceed 7 W per communication module. The smart meter shall be capable of sourcing additional power for powering the plugin communication module as agreed to between the buyer and the seller.

6.10.1.2 *Current circuit*

The apparent power taken by each current circuit of a CT operated smart meter at maximum current, reference frequency and reference temperature shall not exceed a maximum of 1 VA.

6.10.2 *Influence of Supply Voltage*

The requirements given in **9.2.1** and **9.2.2** of IS 14697 shall apply.

6.10.3 *Influence of Short —Time Over currents*

The requirements given in **9.2.3** of IS 14697 shall apply.

6.10.4 *Influence of Self-Heating*

The requirements given in **9.3** of IS 14697 shall apply.

6.10.5 *Influence of Heating*

The requirements given in **9.4** of IS 14697 shall apply.

6.10.6 *Insulation Requirements*

The requirements given in **9.5** of IS 14697 shall apply.

6.10.7 *Immunity to Earth Fault*

The requirements given in **9.6** of IS 14697 shall apply.

6.11 Electromagnetic Compatibility

The requirements given in **10** of IS 14697 shall apply.

6.12 Accuracy Requirements

The requirements given in **11**, **11.1**, **11.2**, **11.3**, **11.4**, **11.5**, **11.6** and **11.7** of IS 14697 shall apply.

6.13 Test and Test Conditions

Given in **9** of this standard.

7 DATA EXCHANGE PROTOCOL

The requirements as per IS 15959 (Part 1) shall apply. The data exchange protocol chosen for Smart Meter shall be as per IS 15959 (Part 3) including specific requirements for Smart Meters for the application layer. This application layer protocol which is primarily DLMS/COSEM shall work through the other layers as given in **8**.

8 COMMUNICATION REQUIREMENT

The NAN, WAN and IHD communication modules that are shown in Fig. 1 and Fig. 2 are for establishing connectivity with smart meter by the external entities such as DCU and HES, respectively and optionally with IHD. These are either wired or wireless communication technology, the choice of technology shall be chosen by the buyer based on the technical feasibility best suited for a given geographical area. The communication module(s) may be of PLC or RF for NAN and cellular technologies or OFC technology for WAN.

8.1 Connectivity Technologies

8.1.1 The connectivity C1, C2 and C3 in variant 1

(*see* Fig.1) and variant 2 (*see* Fig. 2) are generally designed with wired or wireless technology for the physical medium. For connectivity C1 and C2, if PLC (wired) technology is chosen the standards shall be any one of those given in Fig. 2. For connectivity C1 and C2, if RF (wireless) technology is chosen the standard may be as per IS 15959 (Part 2).

8.1.2 Wherever, PLC technology is used the 'AC line connection for coupling/decoupling shall be from within for smart meter with plug-in/built in type smart meter'.

8.1.3 The technology for WAN may be any of the cellular technologies supporting: 2G/3G/4G or an optical fibre communications network complying to IPv6.

8.1.4 The standards cited in **8.1.1** are indicative and non-exhaustive. Other suitable standards from ITU/IEC/IEEE/CEN/CENELEC/ETSI may be considered for NAN and WAN as per agreement between the supplier and the purchaser.

8.2 RF Technology Requirements

The RF technology, if used for NAN/IHD communication modules shall be in the frequency bands notified by Government of India.

Wireless technologies need to comply with the Indian statutory bodies that govern communication related aspects such as WPC (Wireless Planning Co-ordination wing) which oversees licensing and management of all wireless spectrums in India.

Equipment Type Approval (ETA) is to be obtained for communication modules as per Department of Telecom, Government of India requirements.

Radio emission characteristics for the chosen band shall comply with latest NFAP and the G.S.R (General Statutory Rules) notifications from Department of Telecom, Government of India.

8.3 Communication Layer Protocol

The smart meter may use a layered Communication protocol stack. The top four layers of such a stack shall be as mentioned below:

Application	:	IS 15959 (Part 1) and IS 15959 (Part 2)
Transport	:	TCP/UDP
Network	:	IPv6 RPL
Adaptation	:	6LoWPAN RFC (6282)

8.3.1 For Connectivity C1 and C2 the network protocol shall be IPv6 RPL and 6Low PAN [RFC 6282] for convergence/adaptation layer. For Connectivity C3 the network protocol shall be IPv6 RPL and IETF RFC 2464, 5072 and 5121, PPP (IETF RFC 1661).

NOTE — For network and adaptation layers, the connectivity option is valid only for C1 and C2 not for C3, mentioned in Fig. 1 and Fig. 2.

8.3.2 The other layers may be as per **8.1**.

9 TESTS AND TEST CONDITIONS

The smart meter with plug-in/built in communication modules as a composite unit shall be subjected to specified tests for metrology, for data exchange protocol and for smart meter communicability.

9.1 Test for Metrology

The tests for metrology shall include 'Type Tests', 'Routine Tests' and 'Acceptance Tests', as identified in IS 14697. The schedule and recommended sequence of type tests shall be as given below in Table 1. In Table 1, the sequence of tests mentioned is as that of Table 16 in IS 14697. The clause numbers in Table 1 against the name of the tests are the numbers of this standard.

9.2 Number of Samples and Criteria for Conformity

Type tests shall be applied to three test specimens. In the event of one specimen failing to comply in any respect, further three specimens shall be taken, all of which shall comply with the requirement of standards. Additional one sample for test for data exchange protocol shall be submitted.

The requirement given in **12** of IS 14697 shall apply

NOTE — Smart meter is to be submitted along with communication module in its place as integral part of the meter.

9.3 Display

Minimum 7 digits LCD display. For testing purpose, high resolution display having at least 3 decimal digits shall be provided.

9.4 Test for Data Exchange Protocol

This test shall be carried out on optical port as per IS 15959 (Part 3) Table 27 (List of tests Category D3 Transformer operated three phase a.c. static watthour smart meters for HV/LV consumer application) and Table 28 (List of tests for Category D4 Transformer operated three phase a.c. static watthour smart meters for Boundary/Bank /Ring /ABT metering application). The test shall be performed on a separate sample.

9.5 Tests for Smart Meter Communicability

9.5.1 The modules for WAN/NAN/IHD shall be approved by designated agency authorized by DoT and shall have ETA as mentioned in **8.2**.

Table 1 Schedule of Type Tests
(*Clause* 9.1)

Sl No.	Test	Ref to, Clause of this Standard
(1)	(2)	(3)
i)	**Test of Insulation Properties**	**6.10.6**
	Impulse voltage test	
	a.c. High voltage test	
	Insulation resistance test	
ii)	**Test of Accuracy Requirements**	**6.12**
	Test on limits of error	
	Interpretation of test results	
	Test of meter constant	
	Test of starting condition	
	Test of no-load condition	
	Test of ambient temperature influence	
	Test of repeatability of error	
	Test of influence quantities	
iii)	**Test of Electrical Requirement**	**6.10**
	Test of power consumption test	**6.10.1**
	Test of influence of supply voltage	**6.10.2**
	Test of influence short-time over currents	**6.10.3**
	Test of influence of self-heating	**6.10.4**
	Test of influence of heating	**6.10.5**
	Test of influence of immunity to earth fault	**6.10.7**
iv)	**Test for Electromagnetic Compatibility**	**6.11**
	Radio interference measurement	
	Fast transient burst test	
	Test of immunity to electrostatic discharges	
	Test of immunity to electromagnetic HF field	
	Surge Immunity Test (as per Clause 7.2.6 of IEC62052-11)	
v)	**Test for Climatic Influences**	**6.9**
	Dry heat test	
	Cold test	
	Damp heat cyclic test	
vi)	**Test for Mechanical Requirements**	**6.5**
	Vibration test Shock test	
	Spring hammer test	
	Protection against penetration of dust and water	
	Test of resistance to heat and fire	

NOTE — Following tests shall be carried out to assess for smart meter functional condition and functionality of communication module after the 'Type test and acceptance test' for metrology is carried out but before 'Test of resistance to heat and fire':

a) Accuracy of the meter at pre-defined points [5 percent I_b, I_b and I_{max}] UPF.
b) Manufacturer shall demonstrate the functionality of communication module by data read test, that is reading kWh energy register through the communication module.

9.5.2 *Test for Smart Meter Communicability*

Test for Smart meter communicability shall be carried out as per the provisions of **28** of IS 15959 (Part 3).

NOTE — This note is optional test to be mutually decided between the buyer and the seller.

10 SMART METER FUNCTIONAL REQUIREMENTS

The smart meter developed as per this standard is required to support handling of following operational requirements:

10.1 Smart meters shall respond to the following:

a) Meter readings on demand from HES,
b) Scheduled meter reading from HES,
c) Remote Firmware upgrade from HES, and
d) All programming requests from HES.

10.2 Smart meter shall detect 'First breath (power on) and Last gasp (power off)' condition and communicate to HES.

technical aspects taking into consideration the features and provisions of this standard for deployment of AMI. The requirements of other components chosen shall be finalized between buyer and seller.

A separate standard covering requirements for data exchange specific to smart meter has been formulated and released. Therefore IS 15959 : 2011 has been revised as follows:

IS 15959	Data exchange for electricity meter reading, tariff and load control — Companion specification:
(Part 1) : 2011	Static energy meter
(Part 2) : 2015	Smart meter
(Part 3) : 2017	Smart meter (Transformer operated kWh and kvarh, Class 0.2S, 05S and 1.0S) *under print*

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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SECTION-5

1. Measurement and Verification (M&V)

NA for this tender.