Draft of:

Technical Standard for Metering Systems

Authority for Public Services Regulation

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1. Introduction

1.1 Purpose

The purpose of this Technical Standard is to establish the requirements for metering equipment which shall be installed at all connections between networks of all licenced distribution companies and all network users.

1.2 Scope

This Technical Standard applies to all Metering Equipment owned by the Network User and/or the Network Operator for the provision of an electricity connection at the premises of a Network User and the financial settlement for electricity transferred. Where appropriate, it shall also apply to the transfer of electrical energy generated by the Network User and supplied to the network of the Network Operator.

This Technical Standard applies to all connections made to the networks owned or operated by all Licensed Network Operators in the Sultanate of Oman.

1.3 Interpretation

In addition to special meanings contained in the Definitions that follow, within this document:

- References to the masculine shall include the feminine and references in the singular shall include references in the plural and vice versa,
- Except where explicitly stated otherwise all references to section shall be a reference to a section in this document,
- All clock times or other references to time, shall refer to the standard time in the Sultanate of Oman, which is four hours in advance of Universal Time Co-ordinated (UTC),
- Any reference to a law or regulation shall be a reference to that law or regulation applicable in the Sultanate of Oman or, following the replacement of that law or regulation the new law or regulation from the date it comes into force,
- Any general reference to a standard shall be a reference to the current version of that standard from its date of implementation. A reference to a particular requirement in a standard shall be a specific reference to that requirement in the referenced version of the standard unless a later version of the standard has an equivalent requirement in which case it shall be a reference to that equivalent requirement in the current version of the standard.

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1.4 Definitions

The following definitions have, where appropriate, been taken from the International Electrotechnical Vocabulary as defined in IEC 60050:

Sector Law - means Royal Decree 78/2004 as amended by Royal Decree 59/2009, Royal Decree 47/2013 and 78/2020.

MoCIIP - means the Ministry of Commerce, Industry and Investment Promotion

APSR – means the Authority for Public Services Regulation

Basic Current – means the value of current in accordance with which the relevant performance of a direct connected meter is fixed. [IEV 314-07-06]

Check Meter – means a meter of the same class as the Main Meter but its function is to support the Main Meter readings in the event of its failure or large errors exceeding the limits specified.

Current Transformer – means an instrument transformer in which the secondary current, in normal conditions of use, is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections [IEV 321-02-01]

Display - (for static meters) means a device which displays the content(s) of (a) memory(ies). [IEV 314-07-11]

Interval Data – meter data collected at defined intervals for energy settlement or billing purposes.

Main Meter – means the primary Meter used for billing purposes.

Maximum Current – means the highest value of current at which a meter meets the specified accuracy requirements as specified by the manufacturer.

Memory - (for static meters) means the element which stores the digital information representing the measured energy. [IEV 314-07-10]

Network operator – means an entity holding a licence to transmit and/or distribute electricity issued pursuant to the Sector Law

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Network User – is a generic term that includes customers, generators and other network operators using a network of a licenced network operator.

OES – Oman Electricity Standard

Rated Current – means value of current in accordance with which the relevant performance of a transformer operated meter is fixed. [IEV 314-07-02]

Reference Frequency – means the value of the frequency in accordance with which the relevant performance of a meter is fixed. [IEV 314-07-05]

Reference Voltage – means the value of the voltage in accordance with which the relevant performance of a meter is fixed. [IEV 314-07-04]

Register - means an electromechanical or electronic device which stores and displays the information representing the measured energy

Note 1 – In static meters, the register comprises both memory and display.

Note 2 – A single display may be used with multiple electronic memories to form multiple registers. [IEV 314-07-09]

Terminal Block – means the support made of insulating material on which all or some of the terminals of the meter are grouped together. [IEV 314-07-18]

Terminal Cover – means the cover which protects the meter terminals and, generally, the ends of the external wires or cables connected to the terminals [IEV 314-07-19]

Year – means a calendar year according to the Gregorian calendar.

2. Meter Technical Requirements

2.1 Application of meters

2.1.1 Requirement to Use Approved Meters

2.1.1.1 Only meters and, where appropriate, metering equipment that has been approved by MoCIIP for use in Oman shall be installed at any network connection point in Oman. In addition, all meters and, where appropriate, metering equipment shall meet the requirements of this technical standard.

2.1.1.2 Meters and metering equipment shall, where appropriate, meet the requirements of the following international standards except where varied by this technical standard:

a) IEC 62052-11 – Electricity metering equipment (AC) – General requirements, tests and test conditions - Part 11: Metering equipment;
b) IEC 62053-21 - Electricity metering equipment (AC) - Particular requirements - Part 21: Static meters for active energy (classes 1 and 2);
c) IEC 62053-23 - Electricity metering equipment (AC) - Particular requirements - Part 23: Static meters for reactive energy (classes 2 and 3);
d) IEC 62052-31 - Electricity metering equipment (AC) - General requirements, tests and test conditions - Part 31: Product safety requirements and tests;
e) IEC 61869-1 - Instrument transformers - Part 1: General requirements;
f) IEC 61869-2 - Instrument transformers - Part 2: Additional requirements for current transformers;
g) IEC 61869-3 - Instrument transformers - Part 3: Additional requirements for inductive voltage transformers
h) IEC 61869-4 - Instrument transformers - Part 4: Additional requirements for combined transformers;
i) IEC 61869-5 - Instrument transformers - Part 5: Additional requirements for capacitor voltage transformers; and
j) IEC 62055-31 – Electricity metering – Payment systems – Part 31: Particular requirements – Static payment meters for active energy (classes 1 and 2).

2.1.1.3 All metering equipment shall be suitable for operation in the electrical system and environmental conditions specified in OES 11: General Specification for Electrical Materials and Equipment, except as modified by this technical standard.

2.1.1.4 The manufacturer of all meters connected to the network of a licenced network operator shall hold a valid accreditation under ISO 9001 throughout the manufacturing period.

2.1.1.5 All meter types that are considered for purchase and installation are required to have successfully passed an assessment of reliability according to an internationally recognised procedure that indicates the meter type should have a minimum accurate life of at least 15 years.

2.1.1.6 In addition to meeting the requirements of this technical standard, meters shall be installed, operated and maintained in accordance with the requirements of the Regulation for Installation and Maintenance of Metering Systems

2.1.2 Meter Accuracy

2.1.2.1 The accuracy class for installed meters shall be as shown in Table 1.

Table 1 - Accuracy classes for meters

Connection Capacity	Meter active energy accuracy class	Reactive energy accuracy class
≤ 1MVA	2	2
> 1MVA - 20 MVA	1	2
> 20 MVA – 100 MVA	0.5S	2
> 100 MVA	0.2S	2

2.1.2.2 In all cases where class 0.2S and 0.5S meters are required, main and check meters shall be provided with separate CT and VT secondary windings. Both main and check meters shall record the same active power and energy quantities. Where four quadrant metering is required, it will be permitted that the main and check meters record reactive power and energy flows in opposite directions. Where practicable, to reduce the risk of common mode failure, main and check meters shall be of different manufacture and type.

2.2 Operating Conditions

2.2.1.1 Rated operating conditions for all meters shall be as shown in Table 2.

Table 2 - Rated operating conditions

Meter type	Condition	Value or Range
Direct Connected meters	U_{nom}	415/240 V
	Operating voltage range U	415/240 V -20% to +15%
	f_{nom}	50 Hz
	Operating frequency range f	50 Hz ± 5%
	I_b	20 A
	I_{max}	100 A

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Meter type	Condition	Value or Range
	Connection Mode – single phase	2 wire, 1 element
	Connection Mode – three phase	4 wire, 3 element
CT Operated Meters	U_{nom}	415/240 V
	Operating voltage range U	415/240 V -20% to +15%
	f_{nom}	50 Hz
	Operating frequency range f	50 Hz ± 5%
	I_n	5 A
	I_{max}	10 A
	Connection Mode	4 wire, 3 element
HV Metering	U_{nom}	110 V
	Operating voltage range U	110 V -20% to +15%
	f_{nom}	50 Hz
	Operating frequency range f	50 Hz ± 5%
	I_n	1 A
	I_{max}	6 A
	Connection Mode	3 wire, 2 element

Note: All voltages ≥ 1 kV are considered to be HV.

2.2.1.2 Meters shall continue to function where:

a) One or more of the phases are missing, accurately measuring the energy flows in the remaining phases;
b) In the case of a 4 wire, 3 element meter, accurately measuring energy where the neutral is missing.

2.2.1.3 Electronic components shall be protected against overvoltages and voltage spikes using a system that does not require the replacement of any surge arresting component following its operation.

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2.3 Meter Markings and Information Requirements

2.3.1.1 The meter manufacturer or supplier shall comply with the information requirements of section 5.12 of IEC 62052-11 and section 5 of IEC 62052-31 with the clarifications stated in this section 2.3 regarding markings and information declared optional in section 5 of IEC 62052-31.

2.3.1.2 The designation of function shall be included on packaging, and all manuals and shall also be included on either the case marking or the display.

2.3.1.3 The meter serial number shall be marked on the packaging label.

2.3.1.4 Environmental conditions for storage shall be included on the packaging.

2.3.1.5 Full environmental conditions during operation shall be detailed in the installation manual and the maintenance manual.

2.3.1.6 The IP rating shall be shown on the meter case.

2.3.1.7 Handling and mounting information shall be included in the installation manual and with the packaging.

2.3.1.8 The case and display markings shall be indelible, distinct and legible from outside the meter. Symbols shall be at least 2.75 mm high. Text shall be at least 1.5 mm high and contrast in colour with the background [with a preference for black lettering on a white background].

2.3.1.9 The markings of meters intended for outdoor locations shall withstand solar radiation. Multiple values of U_{nom} and f_{nom} may be marked if so specified by the manufacturer and an appropriate conformity assessment certificate has been obtained.

2.3.1.10 The serial number shall be provided in a position where it is not readily disassociated from parts determining the metrological characteristics.

2.3.1.11 The language for all text included in meter case and display markings shall be English with all hazard warning details repeated in Arabic. Manuals shall be written in English.

2.3.1.12 The name of the meter owner may be included as a meter case marking.

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2.4 Registers and Displays

2.4.1.1 Values stored in all registers shall be maintained for a minimum period of 4500 hours before being overwritten. Values shall be overwritten on a FIFO basis. In all cases, the summation of interval data shall equal the advance in the cumulative register value over the same period. To ensure that these requirements are achieved, meter displays shall be specified to have the number of digits specified in Table 3.

Table 3 - Meter display formats

Meter type	Display format
Single phase, direct connected	Minimum 6 digits plus 1 decimal
Three phase, direct connected	Minimum 7 digits plus 1 decimal
LV CT Operated	Minimum 7 digits plus 1 decimal
HV CT Operated	Minimum 8 digits configured to match load flows.

2.4.1.2 All meters shall be capable of measuring and storing all data required for billing and financial settlement. As a minimum, the following values shall be available:

a) In the case of class 0.5S, 1 and 2 meters:
- Total cumulative active energy in kWh or in MWh;
- Cumulative kWh (or MWh) per billing period;
- Active energy by Time of Use with a minimum of four programmable registers;
- Active energy by Demand Period;
- Maximum demand of active energy by Billing Period;
- Maximum demand of active energy by Time of Use;
- Reactive energy by Demand Period
- total cumulative reactive energy in kvarh.

b) In the case of class 0.2S meters:
- Total cumulative active energy in MWh;
- Cumulative active energy per billing period;
- Active energy by Demand Period;
- Maximum demand of active energy by Billing Period;
- Total cumulative reactive energy;
- Reactive energy by Demand Period.

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2.4.1.3 Where required, meters shall record active and reactive energy separately in each direction of flow.

2.4.1.4 In the case of electronic registers, the minimum retention time for results is ten years for a disconnected meter. Electronic indicating devices shall be provided with a display test that switches all the display segments on then off for the purpose of determining whether all display segments are working.

2.4.1.5 Where meters are accessible, the register being displayed shall be scrolled using a push-button using a sequence that allows access to all registers. It shall be possible to programme the display to show any register as the default register.

2.4.1.6 Where a meter is not accessible, it shall have an automatic sequencing display with a display period of 5 seconds for each register.

2.4.1.7 The display shall show the existence of any alarm condition which, in the case of an accessible meter shall be interrogated by using a push-button. In the case of a meter which is not accessible, the nature of the alarm shall also be displayed except for the tamper alarm where only the existence of an alarm condition shall be displayed.

2.4.1.8 The duration of each Demand Period shall be within ± 0.1%, except where time synchronisation has occurred in a Demand Period. It shall be possible to set Demand Periods of:

- 30 and 60 minutes in the case of single phase direct connected meters;
- 5, 10, 15, 30 and 60 minutes in the case of all other meters.

2.4.1.9 The start and end time of billing periods shall be programmable.

2.5 Environmental Conditions

2.5.1 Operating Temperature and Humidity

2.5.1.1 Meter shall operate within the temperature range:

- Minimum temperature - 0 ^{o}C
- Maximum temperature - 60 ^{o}C
- Maximum mean temperature over 24 hours - 50 ^{o}C
- Mean temperature over 1 year - 35 ^{o}C

2.5.1.2 Meter shall operate within the humidity range:

- Minimum relative humidity – 0%
- Maximum relative humidity – 100%

2.5.2 Protection against Penetration of Dust and Water

2.5.2.1 The minimum IP rating as defined in IEC 60529 shall be IP 54 for metering equipment mounted in enclosed locations (including locked meter cabinets) and IP 55 for equipment mounted externally.

2.6 Access to Settings and other Parameters

2.6.1.1 It shall not be possible to locally upgrade non-legally relevant software, change settings or modify any relevant parameters without first breaking a seal that is not a calibration seal.

2.6.1.2 For meters that are remotely read, it shall be possible to remotely change settings and parameters only following the entry of a higher-level password than that used to control data collection.

2.6.1.3 For meters that are remotely read, it shall be possible to remotely upgrade non-legally relevant software only following the entry of a higher-level password than that used to remotely change settings and parameters.

2.6.1.4 Details of all changes to settings or parameters shall be retained in an event record that shall have the capacity to retain 100 parameter setting change events. Details of software upgrades shall be retained in a separate event log.

2.6.2 Form of Crimped Calibration Seal

2.6.2.1 A calibration seal shall be comprised of two parts – a piece of wire rope 150 mm long with a minimum diameter of 0.9mm and a sealing ferrule - which, when fitted together and compressed by a sealing tool, will prevent the removal of a seal without clear evidence of that removal.

2.6.2.2 The full specification for this seal and management of sealing tools shall be as determined by MoCIIP.

2.7 Terminations

2.7.1.1 The terminal block shall cater for a conductor size of 35 mm^2 for direct connected meters.

2.7.1.2 The terminal block shall cater for a wiring size of 6 mm^2 for CT operated meters and CT/VT operated meters.

2.7.1.3 All terminal blocks shall have covers to which a termination seal can be fitted.

2.7.2 Form of Termination Seal

2.7.2.1 Individually numbered, tamper evident security seals as specified and provided by the relevant network operator shall be used to seal all terminations. At the discretion of the relevant network operator, these may be indicative seals or barrier seals.

2.7.3 Required Record

2.7.3.1 The relevant network operator shall maintain a record of the individual numbered seal, its location and the specific equipment to which it is attached. This record shall include details of the date and time the seal was applied and by whom.

2.7.3.2 The relevant network operator shall establish a mechanism to allow any authorised party to notify the relevant network operator that a seal has been broken and the circumstances. The relevant network operator shall carry out such investigation as it deems appropriate and reseal the installation.

2.8 Communications

2.8.1 Communications Requirements

2.8.1.1 Meters shall be capable of interfacing with third party AMR systems. To achieve this:

- Meters shall use a protocol that allows it to be automatically detected when connected to a communications bus using e.g. the DLMS/COSEM protocol to IEC 62056 Parts 1 to 9, Euridis bus to IEC 62056-3-1, or similar proprietary protocol.

- All protocols employed shall use an open system architecture based on publicly available international standards, and be freely available to any third party for integrating into an AMR/AMI central collection system.

- The protocol employed shall demonstrate compliance and/or certification to IEC 62056 or other relevant standards.

- Meters shall be capable of being multi-dropped onto the same communication bus for remote interrogation and programming purposes.

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- The electrical interface for remote communications shall at minimum comply with the RS-485 standard.

2.8.1.2 It shall be possible to undertake local meter programming and interrogation through a separate optical port to IEC 62056 – 21 with a magnetic coupler/ring connection. This access shall be protected by an appropriate authentication regime that contains at minimum 2 stages. Access via the optical port shall not give access to any wider communications system to which the meter is connected.

2.8.1.3 Meters shall also be capable of connecting directly to a remote communications carrier via a suitable communications module to GSM/GPRS, PLC, PSTN and RF carrier systems. Access to the communications module shall not permit the transmission of data to the carrier system unless first polled by the remote device.

2.8.1.4 AMR systems using class 2 meters shall be based on PLC, GPRS or IoT cloud based wireless services. The use of private (point-to-point) radios, drive by reading, and walk by reading is discouraged, unless necessary to establish GPRS or IoT based communications in a specific location due to low signal strength. The use of local data concentrators is permitted only where PLC systems are used.

2.8.1.5 Communications systems shall be designed and operated to ensure the protection of data and meet cyber security requirements specified by APSR that are no less rigorous than would be developed by following the requirements of the ISO/IEC 27001 suite of standards.

2.8.2 Permitted Communications with AMR System

2.8.2.1 Where a message is sent directly from the AMR system to the meter via a communications channel, communication between the meter and the AMR system shall be limited to:

a) Communications initiated by the meter without password:
   i. Alarms generated by the meter;
   ii. Provision of confirmatory messages as per section 2.8.2.3;
b) Communication controlled by Meter Reading Password:
   i. Provision of meter readings;
   ii. Interrogation of alarms generated by the meter;
c) Communication controlled by Meter Setting Password:
   i. Provision of details of setting parameters;
   ii. Modification of setting parameters;
d) Communication controlled by Load Switching Password:

i. Opening of the Load Switch where fitted;
ii. Priming Load Switch for local closing.

2.8.2.2 Before acknowledging and acting on any such electronic transmission, the prepayment meter shall:

a) Establish that the communication has entered the meter by the expected mechanism;
b) Establish that the necessary identification of the source of the communication has been accurately demonstrated;
c) Establish that the communication is a permitted communication;
d) Establish that the appropriate password for the instruction type has been provided.

In the event that the communication fails any one of the necessary proofs of accuracy, the meter shall not react to the receipt of any such message but shall send an alarm to the AMR system.

2.8.2.3 Where a validated instruction to change meter parameters or to change the position of a load switch is received by the meter then, without prompting by the AMR system, the meter shall transmit a confirmatory message of the receipt of such a message 24 hours following its validation. The confirmatory message shall either include all relevant details or force the AMR system to initiate an interrogation.

2.8.3 Communications Module Location

2.8.3.1 Where provision for a communications module is required, the case should contain space for the installation of the specified communication modules. This space shall not conflict with the space intended for other purposes and shall be located either under the terminal cover or below a special cover, but not within the area protected by the calibration seal. It shall be possible to fit a termination seal to this cover.

2.8.4 Communication with In-House Units

2.8.4.1 The meter shall be programmed to only provide the scheduled information to the in-house unit. The meter shall only accept requests for the scheduled information. It shall not be possible to program either the in-house unit or the meter parameters using the communications link between them.

2.8.4.2 Where the meter provides signals that are intended to cause the operation of customer's devices via the IoT, these signals shall be communicated via the In-

House Unit which shall operate as a communications hub. The communications link between the meter and the In -House Unit shall meet the requirements specified in section 2.8.1.4.

2.9 Alarms and Indications

2.9.1.1 All meters shall maintain an event log of at least 100 events of the following types:

a) Low Battery;
b) Physical tampering attempts;
c) DC Magnetic induction > 200 mT;
d) Detected meter error;
e) Meter setting changes including changes to parameter settings;
f) Loss of voltage (by phase);
g) Phase/neutral inversion;
h) In the case of unidirectional meters – reverse power flows;
i) In the case of polyphase meters, phase currents in different directions.

2.9.1.2 All meters shall maintain a separate event log of at least 100 events of the type of software upgrade conducted in accordance with the requirements of section 2.6.

2.9.1.3 In the case of all meters which are remotely read, the meter shall force the delivery of all alarm and indication data as part of the first normal reading following occurrence and weekly thereafter for as long as the situation continues.

3. Load Switches and Auxiliary Switches

3.1.1 General Requirements

3.1.1.1 Where specified, meters shall have a fault making/load breaking load switch and a minimum of two auxiliary switches that comply with the requirements of IEC 62055-31 and mirror the operation of the load switch.

3.1.1.2 It shall be possible for the load switch (and associated auxiliary switches) to be controlled by remote signals from the AMR system. Whether this facility is utilised shall be one of the parameters available to be set by the distribution company.

3.1.1.3 Where a close signal is sent from the AMR system to a meter whose load switch is in the open position, the contactor shall not close until a local action is taken – either by pressing a physical pushbutton on the meter or by sending a close signal from a local control unit in the charge of the customer.

3.1.1.4 The meter shall display the status of the load switch (and auxiliary switches) and record the number of openings in a billing period and the time and duration of each

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opening. Where meters provide data to the AMR system via a communications channel this information shall also be transferred.

3.1.2 Direct Connected Meters

3.1.2.1 Load switches that are part of direct connected meters shall comply with the requirements of IEC 62055-31. The utilisation category shall be indelibly marked on the meter. The person responsible for the installation of a prepayment meter shall ensure that meter is capable of meeting the load breaking and fault making requirements of the location at which it is installed.

3.1.3 CT Operated Meters

3.1.3.1 The customer shall provide an appropriate load switch operated by a signal within the operating capability of the auxiliary switches and capable of meeting the load breaking and fault making requirements of the location at which it is installed.

3.1.3.2 An appropriate load switch shall meet the performance requirements for load switches contained in the same case as a meter as specified in Annex C of IEC 62055-31 modified as appropriate for the maximum load current and prospective fault current at the location at which it is to be installed.

3.1.3.3 The load switch shall be constructed such that it cannot be dismantled without the breaking of a seal applied by the distribution company.

3.1.3.4 All terminations of the control and load circuitry associated with the load switch shall be protected by terminal covers of a type that can be sealed by the distribution company.

3.1.4 Tamper Detection

3.1.4.1 In the event that meter tampering is detected, in addition to the display of an alarm condition and the transfer of any alarm sent to the metering management system, the load switch shall open. Where tampering is detected outside normal working hours, the distribution company may specify that opening of the load switch will be delayed until the start of normal working hours on the following day.

3.1.4.2 Where a load switch opens as a result of the detection of an incidence of meter tampering, it shall only be possible for the switch to be closed following the entry of a password directly at the meter. The password shall either be the password that permits access to parameters and settings or a separate password specifically allocated to control of the load switch as determined by the distribution company.

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4. Power Quality measurements

4.1.1.1 Where APSR so directs, the metering service provider or network operator shall ensure that the installed meter is capable of measuring, recording and delivering power quality measurements by the same mechanism as the meter is read.

4.1.1.2 Where an installed meter is capable of providing instantaneous power quality measurements, these shall be downloaded at routine meter reading, in the case of meters that are read remotely, and, in the case of meters that can only be read locally, in the event that any network user connected to the same primary substation complains about power quality.

4.1.1.3 The meter shall be capable of displaying instantaneous values of:

a) Frequency;
b) Phase voltage;
c) Current per phase
d) Power factor;
e) V to I phase angle per phase; and
f) Phase rotation.

4.1.1.4 Power Quality measurements shall be accurate to within ± 1%.

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