1.20   METERS AND INSTRUMENTS

The contestable customer meter scheme shall be implemented.

Meters, instruments and relays for external panel mounting shall be of flush pattern, with square escutcheon plates finished matt black. Indicating instruments shall comply with IEC 60051, IEC 61010, IEC 60529. They shall be of accuracy Class 0.5. Scale shall be of length 90 degree with external zero adjustment. Integrating meters shall comply with BS 5685. kWh meter shall be of direct reading type.

Instruments, meters and relays located on the front of the switchboard shall be so positioned that as far as possible, each instrument, meter and relay is adjacent to the unit with which it is associated. Meter panels shall be hinged to provide ready access to connections and small wiring shall be enclosed in flexible plastic conduit. All meters and instruments shall be fully tropicalised. All terminals shall be completely insulated and potential circuits shall be suitably fused.

Removable or hinged covers shall be provided with dust exclusion gaskets.   Protective instruments shall be provided with provision for locking to prevent unauthorised adjustments to the settings. Where vibration is present arising from electro-mechanical devices in the vicinity, the meter/instruments shall be mounted on vibration absorbing material to prevent malfunctioning of the devices.

Voltmeters shall be provided with selector switches for phase-to-phase and phase-to-neutral voltage indication.

Ammeters shall be provided with selector switches for indication of all phase currents.

1.20.1   Standard

Indicating meters of analogue type shall comply with class 2.5 of BS EN 60051 or IEC 60051. Multi-function electronic meters shall comply with BS EN 61557-12 or IEC 61557-12.

1.20.2   Mounting

Meters of analogue type with approximate 75 mm dial and with an external zero adjustment, and multi-function electronic meters shall be flush mounted on the front cover of the ASSEMBLY.

1.20.3   Monitoring

Multi-function electronic meters, analogue type ammeters and voltmeters etc. shall be provided as shown on the Drawings. The analogue type ammeters used for monitoring the total current carried by the incoming circuit breaker shall be of the combination type with the thermal demand and the instantaneous values shown. The thermal demand shall indicate the mean r.m.s. current over the past 15 minutes with a slave pointer showing the maximum value reached.

1.20.4 Multi-Function Electronic Meters

a) Multi-function electronic meter shall be of a digital display type to measure the following electrical parameters by means of microprocessor technology

Function of Measurement	Minimum Accuracy
True Root Mean Square (RMS) Current: per phase & neutral	±0.5%
True RMS Volts: all phase-to-phase & phase-to-neutral	±0.5%
Real Power (kW): per phase & three phase total	±0.5%
Apparent Power (kVA): per phase & three phase total	±0.5%
Reactive Power (kVAr): per phase & three phase total	±0.5%
Total Power Factor: per phase & three phase total	±0.5%
Frequency (Hz)	±0.5%
Maximum Demand Current (Id): per phase, present & peak	±0.5%
Real Power Demand (kWd): three phase total, present & peak	±0.5%
Apparent Power Demand (kVAd): three phase total, present & peak	±0.5%
Reactive Power Demand (kVArd): three phase total	±0.5%
Real Energy (kWh): three phase total	±0.5%
Total Harmonic Distortion (THD): per phase, voltage & current (at least up to 31st harmonic order)	±1%

b) The meter shall be suitable for operation at 400V/230V, 50Hz and accepts current inputs from standard measuring current transformers with rated secondary current of 5A. The meter shall be rated for an operating temperature up to 50°C and have a minimum overcurrent withstand rating of 100A for 1 second;

c) The meter shall be capable to trend the required parameters as stipulated in the EMA at every 15 minutes and include hourly, daily, monthly and annual data. The meter shall be equipped with sufficient built-in memory capable of maintaining all data collected for a minimum of 36 months. The Contractor shall retrieve the data files from all meters and submit to the Employer on annual basis or as required by the Employer during the Defect Liability Period;

d) The meter shall be equipped with a communication port at front panel, using either RS485, RJ45 or similar socket and plug as Approved, for communication with portable personal computer for energy control and audit purpose. The connection cable with the appropriate plug and a copy of proprietary-made software for data retrieval shall be provided;

e) The meter shall be flush mounted with protection to not less than IP2X at front face. All wiring shall be connected via terminal blocks to allow easy removal of the cable connectors in the event that the meter requires replacement;

f) The meter shall comply with the general electrical safety requirements as specified in IEC 61010-1 and should be suitably suppressed to fall within the limits allowed by BS EN 61000-6-4 or IEC 61000-6-4 and BS EN 61000-6-2 or IEC 61000-6-2 for electromagnetic emission and immunity;

g) The manufacturer shall operate a quality management system conforming to ISO 9001 or other equivalent national/international quality system. The manufacturer shall issue a calibration certificate for every meter at time of production and the calibration certificate shall be submitted to the CM. Such calibration shall be conducted by the manufacturer within one year prior to delivery of the meter on site or prior to the date of factory acceptance test if the meter is installed in a switchboard that factory acceptance test is required. The manufacturer shall also declare in writing that the meter shall require no re-calibration for a minimum of 10 years from the time of issue of calibration certificate. A label marking the manufacturer's calibration date shall be fixed adjacent to the meter.

1.20.5 Power Quality Meters (PQM)

Where indicated on the drawings (HV/LT MSB) provide a microprocessor based DIN LCD Quality Power Meter with RS485 and/or TCP/IP communications to interface with the EMS system.

PM denotes for HT switchboards and PQM for LV switchboards.

As a minimum the Meter shall provide the following information, with a minimum of 0.5% accuracy through a LCD display:

- True RMS voltage (Line to Line Voltage)

- True RMS voltage (Line to Neutral Voltage)

- Frequency

- Line and system currents

- System power (active, apparent and reactive)

- Peak average demand, kVA and kW

- Harmonics, Vthd and Ithd and harmonic spectrum up to 50th harmonic

- Power factor

1.20.6   Waveforms (voltage and current)

The meter shall also provide disturbance monitoring, capable of capturing waveform on voltages and currents on trigger. After a trigger the meter can store up to 100 waveforms with a resolution from 1024 samples/cycle as a minimum

As a minimum, the meter shall be able to provide the following functions:

- On-board memory up to 8 GB.

- Up to 10 programmable recordings with different start and stop time

- provides event recording, waveform capture, waveform display, phasor diagrams, historical trending, time-of-use etc.

- records of individual order for even and odd harmonic of voltage and current up to 50th order

- Provide a RS485 and/or TCP/IP communication interface to the metering communication network

- Meters shall be tested to IEC 60255 & 61000 Pt 4 & 6.

Others include:

a)   Cross triggering. All disturbances will cause all channels (voltage, current, and any additional channels) to be recorded.

b)   Triggering shall be on both the line-to-neutral and line-to-line channels. All disturbances will result in recording of both line-to-neutral and line-to-line voltage waveforms.

c)   RMS Disturbances.

   i)   The unit will trigger on one-cycle or longer variations in the rms voltage level, outside user-defined thresholds. Triggering thresholds will be user-defined for both voltages (L-N and L-L) and currents.

   ii)   The monitor shall characterize rms disturbances according to the requirements of IEC 61000-4-30.

   iii)   Both waveforms and rms plots will be recorded for rms disturbances.

   iv)   The initiation of a trigger will cause the instrument to store a trend plot of the rms voltage during the disturbance (both L-N and L-L rms plots will be recorded). This trend will include a minimum of 5 cycles of pre-trigger data, and 25 cycles of post-event data. The pre-event and post-event durations will be user-defined.

   v)   The initiation of a trigger will cause the instrument to store the actual waveforms (voltage and current) during the disturbance. The waveform recording will include user-defined pre-event and post-event cycles.

1.20.7 PQM Characterizing steady state quantities

a) The unit shall trend Voltage, current, power factor, kW, kVAR, and energy. Individual phase quantities and three phase quantities shall be available. These will be provided as maximum, minimum, and average values at user-specified intervals based on continuous sampling and calculation.

b) Steady state voltage and current profiling

    i) A daily trend of envelope data shall be recorded for voltage and current. This trend shall store for each sampling interval (user-specified with a default to ten minutes per IEC specifications) the minimum cycle rms value, maximum cycle rms value, and average rms value over all cycles in the ten minute interval. This information shall be available for all three phases of the voltage and current.

    ii) Any violations of the sustained RMS voltage regulation values (duration > 60 seconds and magnitude user definable) shall be recorded and "alarmable". The total amount of time the regulation limit was violated for each event shall also be recorded.

c) Frequency envelopes (min, max and average) time trends shall be available.

1.20.8 Digital Power Meter (DM)

a) All digital power meter shall be verified by either tested and certification by a laboratory accredited by SAC-SINGLAS or recognised by SAC-SINGLAS.

b) Provide manual link bypass for direct connected meters to maintain continuity of supply during meter servicing or replacement.

c) All meters receiving supply from a PV solar connection shall be bi-directional.

d) Records confirming the satisfactory testing of power meter required to be tested under sections 2.4.2 and 2.4.3 of Singapore Metering Code are to be produced when requested upon.

e) The power meter accuracy shall comply to Singapore Metering Code 2.4.29 with accuracy class 0.5 or better. While the metering current transformers of accuracy class 0.5 with 5 amperes secondary current and 5VA burden.

f) The meter memory shall be tamper-free and allow no resettable of kWh value.

g) The data from the meter shall be collected via built in communication interface Modbus RTU (RS485).

h) Communication terminals shall be protected by suitable surge protective device.

i) The kWh meter shall be applied in three-phase, four wired systems. In four-wire connection, the kWh meter shall utilise the circuit neutral common reference and not earth ground to provide metering accuracy.

j) The kWh meter shall be capable of being applied without modification at nominal frequency of 50Hz.

k) The kWh meter shall include instantaneous quantity and accessible via communication interface to an energy management software:

   i) Current, per phase RMS, three-phase.

   ii) Voltage, phase-to-phase, phase to neutral, and three-phase average (phase-to-phase and phase-to-neutral)

   iii) Real power, per phase and three-phase total

   iv) Power factor, per phase and three-phase total

   v) Frequency

l) The electricity meter shall have the following EMC compatibility:

   i) Impulse voltage test: 6 kV 1.2/50 µs (IEC 60060-1)

   ii) Surge voltage test: 4kV 1.2/50 µs (IEC 61000-4-5)

   iii) Immunity to disturbance with harmonics: 2kHz – 150kHz

   iv) Immunity to electromagnetic HF-fields: 80 MHz – 2 GHz at 10 V/m

   v) IEC 61000-4-3

   vi) Radio frequency emission: EB 55022, class B

   vii) Electrostatic discharge: 15 kV (IEC 61000-4-2)

m) All sub meters (electrical, medical gas, water etc) shall be able to communicate with the EMS for analysing. The energy analyser shall have built-in web user interface via IP connection to allow remote monitoring. The user interface shall have configurable dashboards and graphical analysis functions (historical data, benchmark, instantaneous values, and consumption).

   Meters/devices connected via Modbus RS485 shall be limited to 15 nos. for maximum latency.