

Fully Automated 20 positioned three phase & 30 positioned single phase test bench with reference standard of 0.02Class for testing smart meters



| Rev No | Description | Prepared By | Approved & Reviewed By | Date |
|--------|--|-------------|------------------------|---------------------------|
| V1.0 | Fully automated test bench with reference standard of class 0.02 | Arvind Rai | Sandeep Kumbhar | 10 th Aug 2021 |
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A. Technical Specification of Fully Automated test bench with reference standard.

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1. Scope

This specification covers the design; engineering, delivery & commissioning of 20 Position, single phase and three phase 30 positioned fully Automatic Electronic Meter Testing Equipment with reference Meter of Accuracy Class 0.02.

In addition to above, vendor shall also be required to provide:

- a) Operations & Maintenance Manuals including drawings.
- b) Continued technical support during guarantee period of at least 60 months.
- d) The Major component like Source, Reference Standard Meter, and digital system of Meter Test System should be only from single manufacture to provide better integrity and after sales support of offered product.

2. Codes & Standards

Materials, equipment, and methods used in the manufacturing of above-mentioned equipment shall conform to the latest edition/ of following

| S No. | Standard Number | Title |
|-------|--------------------------|---|
| 2.0 | Indian Electricity Act | IE Act 2003 |
| 2.1 | CEA Metering Regulations | With latest amendments |
| 2.2 | CBIP Manual | Standardization of AC Static Electrical Energy Meters |
| 2.3 | IS- 16444 (Part 1): 2015 | AC Static Watt-hour Smart Meters, Direct Connected Class 1 and 2 |
| 2.4 | IS- 13779: 1999 | ac Static Transformer Operated Watt-hour and Var-hour Meters, Class 1 and 2 |
| 2.5 | IS- 11448 | Application guide for AC Electricity meters |
| 2.6 | IS-15959 (Part 1): 2011 | Data Exchange for Electricity Meter - Reading Tariff and Load Control - Companion Specification Part 1 Smart Meter |
| 2.7 | IS-15959 (Part 2): 2016 | Data Exchange for Electricity Meter Reading, Tariff and Load Control- Companion Specification Part 2 Smart Meter |
| 2.8 | IEC- 61052-11 | Electricity metering equipment (AC) - General requirements, tests and test conditions - Part 11: Metering equipment |
| | Operating Conditions | |

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|--|---|--|
| | Ambient Temperature | 10°C to 50°C |
| | Relative Humidity | 35% - 96% RH |
| | Mains Voltage | 240V ± 10% Protection: up to 440VAC max |
| | Frequency | 50Hz ± 5% |
| | Influence of Supply on measuring result | ≤ 0.0005% at 10% Variation |
| | Temperature Coefficient | ≤ 0.0005% / °C |
| | Influence of external fields | ≤ 0.05% / 1mT |
| | Frequency range of measured quantities | 45 Hz to 70 Hz |
| | Safety | |
| | Measurement Category | 300V CAT III |
| | Degree of Protection | IP – 51 |

2 Test to be performed: The offered meter-testing system shall be specifically capable to perform the following tests on all types of energy meters defined in this specification as per IS: 14697, IS- 16444 (Part 1) and IS: 13779 and / or, IEC 62052- 11, 62053-11, 62053- 21, 62053- 22 and 62053-23 using frequency output / LED /LCD pulse output method:

- Pre-warming
- Accuracy test as per BIS/IEC
- Starting current test (Test of starting condition)
- Test of no-load condition (Creep test)
- Dial/Meter constant test
- Influence quantity tests related to accuracy test
- Voltage, Frequency, Reverse Phase Sequence and Voltage Unbalance

- Influence of Harmonics component in voltage and current circuits in-phase & out phase, odd and sub harmonics.
- Generation of harmonics power up-to 51st order.
- Voltage dip and interruption test
- Simulation of tamper conditions
- The offered system shall be capable for testing/calibration of LTCT operated meters & CT-PT operated meters with & without using ICTs. Required cables shall be provided along with the test bench.
- Automated testing of phase channel, neutral channel and combined phase & neutral channel testing shall be possible with test bench.
- The offered system shall be capable for Testing of communicable Smart meters-
- Communicate with Smart meter on its Optical Port
- Communicate with Smart meter on its RF communication port (Meter level via TTL output at 3.3V)
- Verification of Smart meter functionality for Routine test (load limit feature check for single phase and three phase benches, load switch functioning i.e connect/disconnect)
- Provision for Burden measurement of the smart meter.(Current & Voltage Ckt Both)
- Verification of electrical tamper conditions
- Automated testing of Communication

3. Power Source specification

| S. N. | Function /Feature | Technical Requirements |
|-----------------------|-------------------------------------|--|
| Voltage Source | | |
| 1. | Ranges RMS (Phase / Neutral) | 30V - 450VAC (P-N) (Software programmable) |
| 2. | Output power | 3X1500VA |
| 3. | Efficiency | ≥ 85% |
| 4. | Distortion factor (Linear load) | ≤ 0.05% |
| 5. | Distortion factor (non-linear load) | ≤ 0.1% |
| 6. | Accuracy of amplitude | ≤ 0.02% |
| 7. | Stability of amplitude | ≤ 0.01% (linear & non-linear load) at maximum integration time or 100ppm/h at 50Hz |
| 8. | Resolution | ≤ 0.01% of full scale |
| 9. | Harmonics in Voltage Circuit | <p>Provision for super- imposition of harmonics in the range of 2nd to 51st</p> <p>Amplitude setting span shall be 50% of output value for frequency range of harmonics to 500Hz with linear decrease to 10% of output value for 2000Hz.</p> <p>Phase setting span shall be 0°~ 359.99°.</p> |
| 10. | Voltage Circuit protection | Electronic protection in case of Overload & Short Circuit conditions. |
| Current Source | | |
| 1. | Ranges RMS (Phase / Neutral) | 1mA – 120A (Software programmable) |
| 2. | Output power | 3X3000VA |
| 3. | Efficiency | ≥ 85% |
| 4. | Distortion factor (Linear load) | ≤ 0.05% |

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| 5. | Distortion factor (non-linear load) | $\leq 0.1\%$ |
| 6. | Accuracy of amplitude | $\leq 0.02\%$ |
| 7. | Stability of amplitude | $\leq 0.01\%$ (linear & non-linear load) at maximum integration time or 100ppm/h at 50Hz |
| 8. | Resolution | $\leq 0.01\%$ of full scale |
| 9. | Harmonics in Current Circuit | <p>Provision for super- imposition of harmonics in the range of 2nd to 51st</p> <p>Amplitude setting span shall be 50% of output value for frequency range of harmonics to 500Hz with linear decrease to 10% of output value for 2000Hz.</p> <p>Phase setting span shall be 0°~ 359.99°.</p> |
| 10. | Current Circuit protection | Electronic protection in case of Overload & Short Circuit condition, failure of power supply |
| Phase Angle | | |
| 1. | Ranges | 0°~ 359.99° |
| 2. | Adjustment Resolution | $\leq 0.01^\circ$ |
| 3. | Phase shift short term [10min] stability | $\pm 0.01^\circ$ |
| 4. | Setting Accuracy of phase | 0.01° |
| Fundamental Frequency | | |
| 1. | Range | 45 – 70 Hz (Synchronized with network frequency) |
| 2. | Adjustment resolution | 0.01Hz |
| 3. | Accuracy | 0.01% |
| Isolation Current transformer | | |

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| <p>Isolating Current Transformer (ICT's): The meter test system shall have ICT to test three phase closed link whole current meters.</p> <p>There shall be provision to bypass the individual position ICT automatically when secondary is kept open. Sufficient protection shall be provided to protect the ICT in case if secondary of ICT remain open while full load is running in primary.</p> <p>Secondary of ICT shall be designed permanently wounded core with multiple turns in such a way that its secondary leads can be connected directly to Meter under Test and fixed with ICT.</p> <p>Primary connection of ICT should be fixed type and all primary connection on each ICT terminal shall be connected permanently.</p> <p>Primary & Secondary leads of ICT shall be able to carry its maximum Current i.e., 120A continuously without any malfunction in ICT.</p> <p>Overall accuracy of entire test system (including ICT) at each meter test position should not be more than class of test setup / pf.</p> <p>LED indication shall be provided on ICT to indicate healthiness of ICT.</p> <p>Associate Software shall have facility to indicate fault in ICT like open circuit and over-load on PC.</p> <p>It should have facility to display message on computer screen about any fault in ICT during testing of meters.</p> | | |
| 1. | Maximum Current | 120A |
| 2. | Current primary | 10mA to 120A |
| 3. | Ratio Error | ≤ 0.02% |
| 4. | Phase displacement | ± 0.3 min |
| 5. | Max. rated burden | 60VA |
| 6. | Fundamental frequency | 45Hz to 70Hz |
| 7. | Max Burden | 5mΩ |
| <p>Multi Secondary voltage Transformer (MSVT)</p> | | |
| <p>MULTY SECONDARY VOLTAGE TRANSFORMER (MSVT): The meter test system shall have Multi Secondary Voltage Transformer (MSVT) to test Single phase closed link meters.</p> <p>MSVT shall provide isolation in voltage circuit for testing of single-phase meters with IP link short.</p> <p>The MSVT shall have single Primary and 30 nos. of secondary.</p> | | |

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| | Connection/Disconnection of MSVT shall be done by provided software without changing in physical connection for primary. (Single Wire operation) | |
| 1. | No of Windings | 30 |
| 2. | Secondary Voltage | 240V |
| 3. | Secondary burden @ Rated Voltage | 30VA per winding |
| 4. | Error between primary and secondary | $\leq 0.05\%$ & $\leq \pm 0.5$ min |
| | | |

4 Reference Standard

| | | |
|-----|---|----------------------------------|
| 1. | Influence of Supply on measuring result | $\leq 0.0005\%$ at 10% Variation |
| 2. | Temperature Coefficient | $\leq 0.0005\% / ^\circ\text{C}$ |
| 3. | Influence of external fields | $\leq 0.05\% / 1\text{mT}$ |
| 4. | Frequency range of measured quantities | 45 Hz to 70 Hz |
| 5. | Safety | |
| 6. | Measurement Category | 300V CAT III |
| 7. | Degree of Protection | IP – 51 |
| 8. | Isolation protection | IEC 61010 – 1:2010 |
| 9. | Voltage Measurement (P- N) | |
| 10. | Range | 0 to 480V |
| 11. | Measurement Error | 0.01% |
| 12. | Voltage measurement temperature Drift | $\leq 0.0005\% / ^\circ\text{C}$ |
| 13. | Voltage measurement Stability | $\leq 0.05\%$ |

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| 14. | Current Measurement | |
| 15. | Range | 1mA to 120A |
| 16. | Measurement Error | 0.02% of measured value |
| 17. | Power / Energy (30V to 300V) | |
| 18. | Measurement Error(P/Q/S) (No additional error at reactive measurement) | 0.02% |
| 19. | Current measurement temperature drift | 0.0005% to 0.001% / °C |
| 20. | Current measurement Stability | 0.005% |
| 21. | Drift / year at power / energy | 0.001% |
| 22. | Frequency Range | 40Hz to 70Hz |
| 23. | Phase angle 0° to 359.99° | 0.01° |
| 24. | Power Measurement under influence of harmonics | |
| 25. | Active Power | Reference shall be able to display individual harmonics order upto 51 st |
| 26. | Reactive Power | <p>Reference shall be able to measure harmonics under following methods, Natural Mode i.e low pass filter Fundamental mode And Triangle mode</p> <p>Shall be able to display individual harmonics order upto 51st</p> <p>Shall be able to comply national / international method of reactive harmonics measurement</p> <p>Also, total Reactive harmonics power measurement shall be actual theoretical value in absence of national / international standards</p> |

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| 27. | Apparent Power | Selection of formula for calculation of total apparent power shall be selectable, Vector Method Arithmetic Method Shall be able to display individual harmonics order up-to 51 st |
| 28. | Connection Mode | Reference standards shall comply both 4 wire mode and 3 wire mode (Neutral left open) |
| 29. | Pulse Input / Output | |
| 30. | Reference Meter Constant (P, Q, S) | Minimum 1000 times better of selected DUT meter constant |
| 31. | Pulse Output | TTL |
| 32. | Output | Open Collector |
| 33. | Frequency | More than 200kHz |
| 34. | Harmonics Analysis in Voltage, current & power | Up to 51 st |
| 35. | Long-time Dosage Testing | Meter Constant & Dial Test (shall have separate registers for Active kWh, Reactive lag, Reactive lead & kVAh for long time dosage testing) |

SCANNING HEADS: Scanning head shall be capable to detect LCD & LED pulses of hybrid or static meters.

During testing these photoelectric scanners shall give optical indication of pulses by LCD & LED to indicate the status of scanning/ sensing.

Mounting arrangement for scanning head shall have facility to move vertical, horizontal, forward or backward directions.

It shall be insensitive to ambient light. It shall give optical indication of pulses by LED.

Technical data of Scanner as general:

The technical data of scanner viz, wavelength, distance to meter LED, pulse data, square wave etc. are to be stated by bidder.

Wavelength: 450 ... 950 nm

Distance to meter LED: 25.50 mm

Pulse data:

Max. frequency 1000Hz

Scanning head shall have one potentiometer to adjust the sensitivity of scanning head

ERROR CALCULATOR & DISPLAY UNIT

For simultaneous error measurement of meters under test, each meter position in the test rack shall be equipped with individual error calculator display unit. Display resolution for error shall be minimum $\pm 0.00\%$ or $4\frac{1}{2}$ digits with decimal point configurable by software.

Provision for serial optical communication interface along with error calculator per measuring position shall be made.

Test Bench:

The test bench shall be provided and shall be suitable for calibrating 20 three phase / 30 single phase meters at a time. It shall contain the following for each meter.

METER TEST RACK:

The test rack shall consist of a non-ferrous, preferably aluminum, frame for mounting of scanning heads, error calculator/display units and meters. It shall carry the rails on

which either single phase or three phase meters can be quickly mounted / connected for testing. Design of the frame shall be such that meters could safely and easily accommodate on it. The Rack shall have necessary arrangement to connect externally (with necessary terminals on the rack) any reference meter / calibrator for calibration.

The distance between the scanner head and the meter under test shall be in the range of 3.5 cm. to 10 cm.

To facilitate quick loading/un-loading of meters on to test bench quick connectors shall be provided to reduce loading time while ensuring proper electrical connection.

- a) Scanning Head
- b) Optical communication for reading data
- c) Error Indicators to display error at each position.
- d) Interface for connection with PC such as RS232, CS current loop etc.

- e) Necessary BNC type socket to test the ERSS against a precision standard of higher accuracy shall be provided on Meter Mounting Rack.
- f) Necessary BNC type socket or any other suitable arrangement shall be provided on the Meter Mounting Rack to test the inbuilt ERSS against a precision standard of higher accuracy without removing the inbuilt ERSS from the source cabinet.
- g) The Meter Mounting Racks shall be provided BNC type sockets for the simultaneous testing of minimum one ERSS of lower accuracy for all position.
- h) Necessary cables shall be provided along with equipment to test ERSS having frequency output on BNC type socket.
- i) There should be a warning lamp and two emergency pushbuttons fitted on the Meter Mounting Rack.

TESTING SOFTWARE: Application software in English language shall be Windows based, user friendly, menu driven type to facilitate sequential (fully automatic) and continuous mode of testing on meters. The software shall support at least the following tasks:

- a) Automatic test runs in the area of Routine verification, acceptance and certification
- b) User interface to operate the system
- c) Easy to prepare test points.
- d) Supervision and control of the test procedure
- e) Supervision and display of the test parameters
- f) Indication of the errors of the meters under test.
- g) Capable of storage of test results at the end of testing.
- h) Manual testing, manual control and automatic testing facility
- i) Absolute measurement with higher precision / more accurate standard in Fully automatic mode using BNC type socket provided on Meter Mounting Rack.
- j) It shall have facility to interrupt the testing at any point of time and restart it again
- k) Facility to apply error offset at each load points.
- l) Printout & Export to PDF, Excel facility for test reports
- m) Backup facility on CD drive
- n) Testing facility of meters with different meter constant
- o) Search and retrieval of the saved meter test results shall be available only by referring to some special identification no. e.g., Meter serial number, certification report no., date of testing etc.
- p) The software also should have facility so that the Meter Under Test can be protected from high voltage and high current applied by operator by any mistake.
- q) Display of following quantities:
 - True RMS value of voltage (each phase)
 - True RMS value of Current (each phase)
 - Power factor / Phase angle (each Phase & total)
 - Active, Reactive & Apparent power (each phase)
 - Total Active, Reactive & Apparent Power
 - Total Active and Reactive Energy

- Frequency
- Total apparent power/ energy
- Harmonics

The program shall support the following tasks:

- Easy to prepare test table by using "drag & drop "concept
- Evaluation and report of the test results
- Manual testing, semiautomatic and automatic testing facility
- It shall have facility to interrupt the testing restart it again.
- Password facility for each main and sub-option
- Print out facility with desired header
- Back up facility in the CD drive.
- Absolute measurement with more precious standard
- Testing facility of at-least 5 different meters with 5 different constants.
- Software shall have facility to display of different voltage and current
- Display of curve of test voltage and current in presence of harmonics.
- Protection of Meter under test form high voltage and current
- Selection capacity of different curve
- Test format shall be flexible to have desired type of format
- Test data shall be available as raw data format/ ASCII format
- Large and graphical display.
- Measurement mode
- Vectorial display
- Analog view

On the computer monitor

During the automatic certification, the following values shall be displayed:

- * Applied load point
- * Error of the meter
- * Deviation between actual value & pre-adjusted value of test voltage and current
- * Evaluation pass / fail

An interruption and re-continuation of the test procedure should be possible anytime.

Method for software validation shall be provided by vendor.

Guarantee: 66 months from supply/60 months from installation including RSM licenses of software.

During guarantee period, complain shall be rectify within 7 days from the date of complain registration.

Also, the Vendor shall confirm that the after sales services and necessary spare parts required if any, shall be made available in India at least for a period of 5 year from the date of expiry of guarantee period.