



INDIAN INSTITUTE OF TECHNOLOGY BOMBAY
MATERIALS MANAGEMENT DIVISION
Powai, Mumbai 400076

PR No. 1000014587 (Rfx No. 6100000339)

Detailed Technical Specifications for Phasor Measurement Unit

1. General

The Bidders are invited to offer their standard products that meet or exceed the specification requirements. The products may be supplied from their in-house baseline offerings or from the others manufacturer. The proposal will be judged by its conformance to the specification. All deviations from the specification shall be clearly identified to examine the degree of conformance. The specification identifies some minimum requirements which are essentially required for measurement of complex quantities and transmitting the same to the Phasor Data Concentrator (PDC). The bidder shall also identify the functionalities in detail available in their offered product which are not the part of this specification but may be useful to the power system researcher. The PMU to be supplied under this specification shall be installed for field measurement and shall communicate to the Phasor Data Concentrator (PDC) on IEEE C37.118.1-2011 as amended by IEEE C37.118.1a-2014 and IEEE C37.118.2-2011

2. PMU Requirements

The PMU under this specification shall give output data at the selected periodicity. The offered PMUs shall be complete in all respect so that it can be installed at the field and can communicate with the Phasor Data Concentrator (PDC). The necessary cable and connector and installation hardware shall also be supplied by the bidder. The PMUs shall conform to the latest complete version of IEEE C37.118.2011 standard. Some of the requirements to be met are:

- a) The PMU shall be designed to measure the electrical parameters in the power system frequency band of 10% of the nominal frequency, 50 Hz.
- b) The PMU shall be suitable to operate on unearthed low DC nominal input supply voltage 24-48 V_{DC} ($\pm 20\%$) as well as AC input supply voltage 120-240 V_{ac} (-30% to $+10\%$), 40-60 Hz.
- c) The PMU shall be suitable for measurement of at least one set of 3-phase voltages, three sets of 3-phase currents and minimum 10 digital inputs.
- d) The PMU shall have suitable number of in-built CT-PT modules for AC metering.
- e) In addition to measuring 3-phase voltages and 3-phase currents, the PMU shall be also able to obtain the positive, negative and zero sequences of 3 phase voltages and currents. Frequency, rate of change of frequency, active and reactive power (per phase and three phase), and per-phase power factor shall be derived at PMU. The PMU shall be capable of transferring all the measured quantities, derived quantities and the digital inputs to PDC along with timestamp. Each quantity shall be reported to the PDC at least 50 messages per second.



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- f) All the measurements shall be tagged with UTC (Coordinated Universal Time). The time tagging accuracy shall be within ± 40 ns.
- g) The PMU output shall be in conformance with IEEE C37.118.1-2011 (as amended by IEEE C37.118.1a-2014) and IEEE C37.118.2-2011 and shall communicate with the PDCs in the same format. The accuracy of the measurements shall be as per the latest version of IEEE C37.118 standard Level-1, Electromagnetic compatibility (EMC), Immunity conforming to the requirements of IEC-60255/IEC 61000, Emission test conforming to the requirements of EN 55011, Insulation Test per IEC 60255-5, and Environmental Test as per IEC 60068-2-2. The bidder shall submit PMU type test reports along with the bid for the offered make and model.
- h) In case the type tests are conducted after placement of order, the Bidder shall get the Type Test procedure approved by the Owner and then these tests shall be conducted at bidder's own cost in presence of owner representative. The Bidder shall offer the PMUs for inspection & Factory acceptance Tests (FAT). During FAT the supplier shall demonstrate all the functions of PMU. The compatibility to integrate with PDC in accordance to IEEE C37.118 shall also be demonstrated. These functionalities shall also be demonstrated at site at the time of commission of PMUs at site. The procedure for all the testing shall be agreed between the supplier and purchaser before proceeding for the testing.
- i) The PMU shall be suitable for configuring the data sampling rate of 10, 25, 50 samples per cycle. Actual rate shall be user selectable. However, default sampling rate shall be 50 samples per cycle.
- j) Total Vector Error (TVE) $\leq 1\%$ for one or more:
 - Signal Frequency Range: ± 5 Hz of nominal (50Hz)
 - Voltage Magnitude Range: 30 V to 150 V
 - Current Magnitude Range: 0.1-2 times (1A or 5A)
 - Phase Angle Range: -180 to 180°
 - Harmonic distortion $\leq 10\%$ (any harmonic)
 - Out of band interfering signals $\leq 10\%$
- k) PMU shall be equipped with self-monitoring, diagnostic feature and capable of identifying and communicating problems. Abnormality, if any, shall generate alarm and shall be displayed locally and transferred to PDC.
- l) The PMU design shall ensure that the impact of frequency fluctuation on accuracy is within permissible limit as per prevailing standards. This aspect shall be demonstrated by the bidder.
- m) Event Reporting and Sequential Events Recorder: The PMU should automatically record disturbance events. Events should be stored in nonvolatile memory.
 - Sampling Rates: 1, 2, 4, 8, 24 kHz software selectable



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- Record Duration: 0.1-second increments from 0.5 s to specified maximum for each sample rate.
- Maximum Record Duration:
 - 6 s at 24 kHz
 - 18 s at 8 kHz
 - 36 s at 4 kHz
 - 72 s at 2 kHz
 - 144 s at 1 kHz
- Record Pretrigger: 0.05 s minimum to a maximum of (record length minus 0.05 s)
- Waveform File Format: COMTRADE (IEEE C37.111-2013 compliant)

The PMU should also include a Sequential Events Recorder (SER) that stores the latest 1000 entries.

- n) The PMU shall communicate with PDC on Ethernet interface over the communication link. Two redundant communication ports of 10/100 Base Tx for TCP/IP for streaming data in latest version of IEEE C 37.118 format (IEEE C37.118.1-2011 (as amended by IEEE C37.118.1a-2014) and IEEE C37.118.2-2011) shall be provided in the PMU. The data update time to the PDC shall be indicated by the bidder in their offer. Additional optical remote communication ports 10/100 Base Tx for TCP/IP shall also be available for streaming data in latest version of IEEE C37.118 format.
- o) There shall be provision for HMI (Human Machine Interface) in PMU to perform setting changes. Provision should also be available to check the status, software version of PMU etc. In addition, HMI should display the measured quantities for ease during testing. The Operation indications and time tagged events shall be available by the Local HMI.
- p) PMU Panel shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-31 in accordance with IS: 2147
- q) The PMU shall include programmable logic functions for a wide range of user-configurable protection, monitoring, and control schemes. Logic should have the ability to use bay elements, math functions, comparison functions, and Boolean logic functions.
- r) PMU shall have security features:
 - Account management: user account, LDAP central authentication, strong passwords, and inactive account logouts.
 - Implement system security auditing, logging, and password restrictions to enforce government standard.
 - Encrypted communication: SSL/TLS, SSH, HTTPS



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- s) The PMU shall have IEC 61850 GOOSE, IEC 61850 MMS Client and File Services, IEC 61850 MMS Server and File Services.

3. GPS Satellite Synchronized clock with Antenna and safety auxiliaries

GPS based time facility to synchronize PMU clock with UTC source, shall be provided for the PMU. The time receiver shall include propagation delay compensation and shall also include an offset to permit correction to local time to achieve time accuracy to within ± 40 ns to UTC. It shall receive Global Navigation Satellite System (GNSS) time signals and distribute precise time via multiple output protocols, including IRIG-B and the Network Time Protocol (NTP). To provide Parallel Redundancy Protocol (PRP) support as a Dual Attached Node (DAN) device for NTP time distribution.

The time receiver shall detect the loss of signal from the UTC source and a loss-of-signal event shall be sent to the PMU which will be transferred to PDC and shall result in an alarm at PDC. In the event of a signal loss, PMU shall switch time source to the standard TCXO holdover, with 36 μ s/day accuracy, or to the optional OCXO holdover, with 5 μ s/day accuracy.

In the case of a GPS spoofing attack, in which a satellite system receiver locks to a counterfeit signal, GPS/GLONASS Precise-Time Antenna use signals from the GLONASS satellite constellation to validate GPS signals and identify the mismatches in timing information that this type of attack causes.

Easy and Secure Commissioning - Easily configure with an HTTPS web interface via the front Ethernet management port, which provides a graphical SkyView display for troubleshooting signal or antenna issues.

4. Warranty

Minimum 10 years of warranty.