

Technical Specifications for Phasor Measurement Unit (PMU)

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Section 1: Phasor Measurement Unit (PMU) Requirements

1.0 Introduction

The intent of this specification is to specify the technical requirements for providing Phasor Measurement Units (PMUs) at the Substations / Power stations of voltage level from 132kV to 765kV. The PMUs shall be integrated with the existing Phasor Data Concentrator (PDC) installed at respective SLDC/RLDCs & NTAMC and shall communicate as per the latest version of IS/IEC/IEEE 60255-118-1 and IEEE C37.118.2 Standards with all amendments.

1.1 Scope of Work

The scope of work for PMUs shall include Survey, Planning, Design, Engineering, Documentation, Supply, transportation, Unloading, Insurance, Storing, Handling, placement to final locations, Installation, Termination, Integration, Testing, Demonstration for acceptance, and Commissioning:

- a) PMUs, GPS (Global positioning System) Time Receivers, LAN (Local Area Network) switches, and complete with all necessary accessories, cables etc. at the Substations / Power plants as identified in BOQ.
- b) Integration of supplied PMUs with PDCs at respective State Load Dispatch Centre (SLDC)/ Regional Load Dispatch Centre (RLDC) and NTAMC. The Contractor shall extend technical support at local end for seamless integration of PMU with PDC at SLDC/RLDC and NTAMC end. The integration work at RLDC/SLDC & NTAMC end shall not be under the scope of the Bidder. The Existing PDC Software/application at RLDC/SLDC and NTAMC is of M/s GE make.
- c) All cabling, wiring, terminations, and interconnections to the equipment including necessary trench/surface conditioning to interconnect the PMUs and associated accessories being supplied & integrated under this project.
- d) Any other work which is not identified in the specification but is required for completion of the project within intent of the specification shall also be in the scope of the Contractor.

1.2 PMU Requirements

The offered PMUs shall be complete in all respects so that they can be installed at the substation/power plant and can communicate with Phasor Data Concentrator (PDC) at respective SLDC/RLDCs and NTAMC. The necessary cabling, connector, and installation hardware, as required, shall be supplied by the bidder.

The PMUs shall be installed in Bay kiosks in Substations having Substation Automation System (SAS) or near to the control & relay panels in Conventional Substations. The CT/CVT connections to the PMU shall be extended accordingly from the relevant panels.

The typical PMU architecture at substations is given at Fig 1.1 & Fig 1.2 below: The actual no of PMUs required at each site shall be based on number of feeders/elements at a site and type of substation architecture like SAS/conventional C&R/GIS/HVDC etc.

The number of PMUs is only indicative, and the quantity of PMU shall be as per BOQ. The quantity of PMUs and the other components like Switch, GPS, LIU etc. may vary due to site requirements during post-award Engineering approvals.

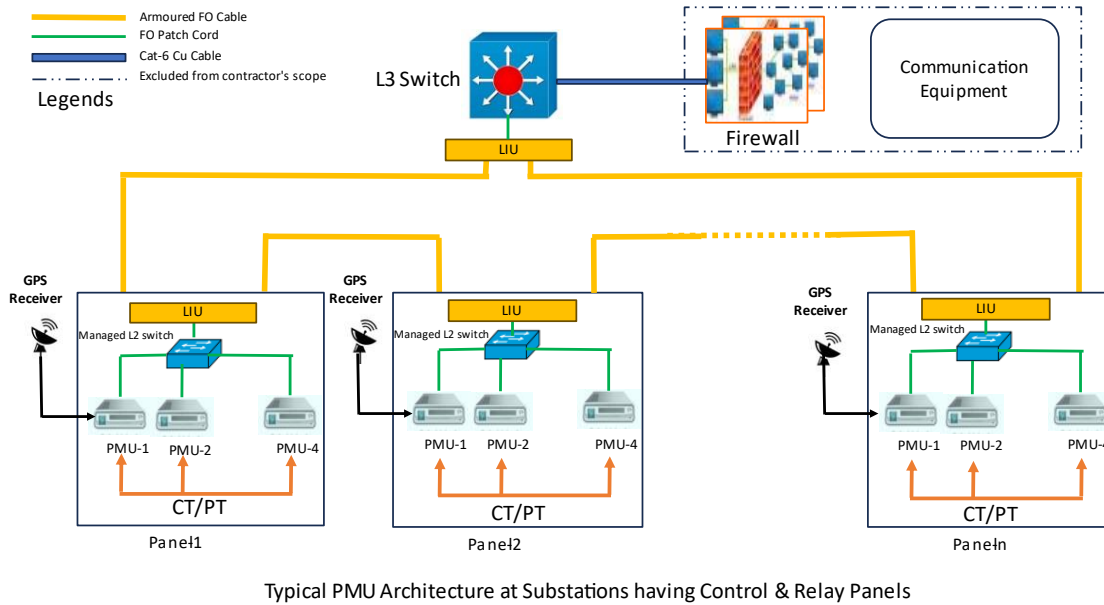


Fig 1.1: Typical PMU Architecture at Substations Control Room

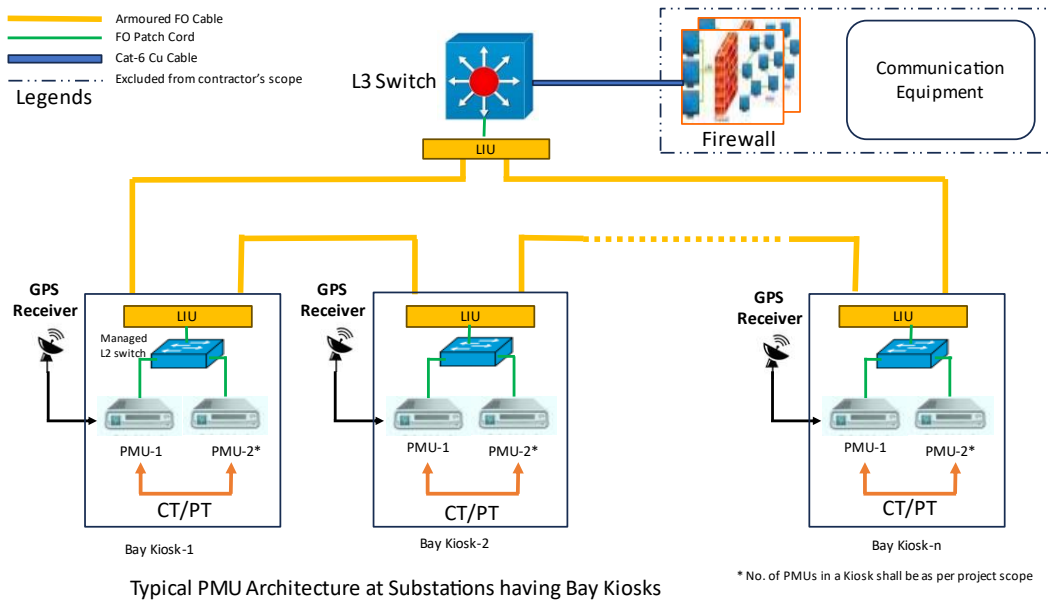


Fig 1.2: Typical PMU Architecture at Substations having Bay Kiosks at switchyard.

1.5.1 PMU Functional Requirements:

- a) The PMUs shall communicate with the PDCs at State Load Dispatch Centre/Regional Load Dispatch Center (RLDCs) & NTAMC over the communication link provided by the Employer/ Owner utility.
- b) PMU shall be provided with minimum One Ethernet port of 10/100 Base Tx and minimum one optical fiber port of 100 Mbps for streaming the data in UDP/IP multicast/unicast and TCP/IP in latest version of IS/IEC/IEEE 60255-118-1 and IEEE C37.118.2 standards with all amendments. The Ethernet port shall be used to connect the PMU directly to the LAN switches. The Optical fiber port shall be preferred for connectivity with the switch.
- c) The PMU shall perform synchro-phasor reporting simultaneously for at least 2 clients over TCP and/or 2 UDP clients for multicast or unicast. PMU shall be able to send data in multi-cast and Uni-cast.
- d) The PMUs shall be suitable to operate on unearthed 220V DC or 110V DC or 48V DC power supply with +10%, -15% variation as available in the substation.
- e) The PMUs shall support data 'Reporting Rates of 25 and 50 per second for 50Hz System. The PMUs with higher reporting rates shall be preferred. The actual rate to be used shall be user selectable. All the PMU hardware and software shall be sized considering a reporting rate of 50 frames per second.
- f) The sampling rate of the PMU shall be higher than the reporting rate.
- g) PMU shall be capable of measuring the electrical parameters in the power system frequency band of 48-52Hz with the accuracy as specified in latest versions of IS/IEC/IEEE:60255-118-1 and IEEE C37.118.2 Standards with all amendments, independent of number of Analog Input channels connected to the PMU. The PMU design shall ensure that the impact of frequency fluctuation on accuracy is within permissible limit as per prevailing standards.
- h) The contractor shall provide compliance and submit the PMU documents for review and approval which includes the following:
 - i. Data Requirement Sheet (DRS) of all items as per Data Requirement Sheet given at **Annexure-I (DRS of PMU and associated items)**.
 - ii. PMU installation and Layout, GA, schematics and internal wiring drawings, Local area network diagram etc., showing connectivity of the various components
 - iii. Type test reports
 - iv. Bill of Quantity (BoQ)
- i) For each feeder, The PMUs shall be able to measure/calculate but not limited to following:
 - i. 3-phase voltage Phasors (Magnitude and angle),
 - ii. 3-phase current Phasors, (Magnitude and angle),
 - iii. Positive sequence voltage, (Magnitude and angle),
 - iv. Positive sequence current, (Magnitude and angle),

- v. Breaker Status
 - vi. Protection operated status
 - vii. Frequency
 - viii. Rate of Change of Frequency (ROCOF) -df/dt
 - ix. Analog Values (MW & MVAR)
- j) A GPS based time receiver and time synchronization system shall be provided for time synchronization of the PMU. The GPS can be a separate equipment or can be in-built in the PMU.
- k) The PMU shall have an internal clock, which shall be synchronized with the GPS time receiver's UTC time. In case of loss of signal from the GPS based time source, the PMU shall detect a loss-of-time signal and generate an alarm which will be transferred to PDC. Upon loss of signal, the PMU time facility shall revert to an internal time base. The internal clock shall have minimum stability of 1ppm.
- l) The PMU with supplied time receiver shall keep the total vector error (TVE), the frequency error (FE), and the Rate of Change of Frequency (ROCOF) within the limits as specified in latest versions of IS/IEC/IEEE:60255-118-1 and IEEE C37.118.2 Standards (with all amendments).
- m) The PMUs shall have continuous self-monitoring, diagnostic features and shall be capable of identifying & communicating problems and shall generate alarm in case of any abnormality which shall be displayed locally as well as shall be transferred to the PDC. The indication shall be available for each module on the front panel of the PMU.
- n) The PMU shall support Configuration frame 2 & Configuration frame 3.
- o) Remote configuration facility shall be supported by the PMUs and the Contractor shall provide the necessary software required for remote configuration of PMUs. The supplied software shall provide remote configuration of PMUs through the same data channel through which the PMUs are reporting to the PDCs at SLDC/RLDCs and NTAMC.
- p) The PMU shall support multiple data streams, i.e., a PMU can transmit its data in separate data streams (more than one). Each stream shall be configurable independently based on the following: -
- i. Contents
 - ii. Reporting rate
 - iii. Communication mode (TCP/UDP)
 - iv. Different destinations with separate IDCODE.

1.3 GPS based Time Facility

A GPS based Time Facility shall be provided to synchronize the PMU clock with Coordinated Universal Time (UTC). The GPS based time facility shall be provided separately or as in-built within each PMU.

The time receivers shall meet the requirement of the PMU's interfaces and accuracy requirements. The time receiver shall include propagation delay compensation and shall also include an offset to permit correction to local time to achieve time accuracy of at least ± 1 microsecond (μ s). Within Five minutes of reacquisition of signal, the time shall return to within 1 micro-second of UTC. Proper correction of leap second shall be provided.

The signal sent to PMU from the time facility shall be UTC or provide information to the PMU to correct the time to UTC by using the IRIG-B time profile as per IEEE Standard C37.118. The Time facility shall also be compliant with the latest version of IEEE1588 (Precision Time Protocol, PTP).

The supplied time system shall have "one IRIG-B port and two Ethernet ports as minimum". Additionally, if the PMU requires time synchronization over IRIG-B AM, then 1PPS port must be provided in the time system.

In some locations, the time facility shall be installed in the switchyard along with the PMU. The time facility must be suitable to work in such Electrical environment.

The time receiver shall detect the loss of signal from the UTC source. A loss-of-signal shall be sent to the PMU and result in an alarm/event in the PMU.

The specifications for GPS based time receiver are given in **Annexure-I (DRS of PMU and associated items)**.

1.4 Industrial Grade LAN Switch (Ethernet Fibre Switch)

The industrial grade Ethernet switch shall be used for providing connectivity to the PMU and the connectivity to the communication equipment.

The Ethernet switches shall be of 2 types – Layer 2 and Layer 3 and shall support the features as specified in **DRS of PMU and associated items**.

The L2 LAN switches shall be provided for connecting the PMUs to the fault tolerant Ethernet ring and the L3 LAN switch shall be provided for connecting the PMUs to communication equipment. In substation projects of bay extension, the Ethernet ring could be existing, and the new PMUs are to be made part of the ring.

In new substations, the fault tolerant ring is to be formed using the L2 & L3 Ethernet switches.

The quantity of switches shall be as per the BOQ.

The PMUs shall be connected on Fibre port of L2 LAN switch. The fault tolerant ring shall be formed from the 1Gbps Fibre port of the LAN switch. LIUs shall be provided for termination of all the fibre cores of FO cable and the connection between the LIU and the Ethernet switch shall be through patch cords.

Detailed Technical specifications of the Industrial grade LAN switches is given at **Annexure-I (DRS of PMU and associated items)**.

1.5 Armoured Fibre Optic cables

Fibre optic cables shall be laid in the switchyard between bay kiosks and within the control room, shall be of armoured type for protection against rodents and physical stresses. The characteristics of the fibre optic shall be as per the IEC 60870-5-103 standard. The fibre optic cables shall be run in GI conduit pipes while passing through cable trenches / cable racks outside the control room building. The fibre optic cables inside the panel shall be neatly laid and tied. Data Requirement Sheets (DRS) of armoured FO cables are given in **Annexure-I (DRS of PMU and associated items)**.

1.6 Light Interface Unit (LIU) for FO cable termination:

Fibre optic cables to be laid within the control room and in the switchyard between bay kiosks, shall be terminated in a Light Interface Unit (LIU) having minimum 12 ports (6-in and 6-out). The LIU shall also have adapter plates for connector mounting to support all types of FO connectors such as ST, SC, LC, and FC etc. The LIU shall support managing splicing and termination of FO cables. The LIU shall be 19-inch rack mountable. The specification of LIU is given at **Annexure-I (DRS of PMU and associated items)**.

1.7 Cabling & Interconnections

All cabling and interconnection mentioned below shall be in the scope of the Contractor for Supply and installation. The cabling and interconnection shall be shown in the substation drawings for approval of Employer/Owner.

- i. PMU to time system along with antenna
- ii. PMU to LAN switch
- iii. PMU to the control and relay panels (located in the substation control room)
- iv. PMU to the relay panels in the bay kiosks in switchyard of SAS based substations etc.,

Plug-type connectors with captive fasteners or compression type connectors shall be used for all internal interconnections. The connectors shall be polarized to prevent improper assembly. Each end of interconnection cables shall be identified by a marker which includes the cable number and the identifying number and location of each of the cable's terminations. This information shall match with the Contractor's drawings.

Adequate space and hardware shall be provided for routing of the field wiring within the enclosures. The wiring within enclosures shall be neatly arranged and shall not be directly fastened to the enclosure frame. All internal interconnection wiring and cables shall be routed separately from field wiring to the PMU terminals & power wiring. All wiring shall use copper conductors and have flame retardant insulation and of low smoke. Conductors in multi-conductor cables shall be individually colour coded.

The use of non-flammable, self-extinguishing, plastic wire troughs is permissible. Metal clamps, if used, must have insulating inserts between the clamps and the wiring. Wiring between stationary and movable components, such as wiring across door hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wiring.

The bidder shall be responsible for laying and termination of all cables required under the project which includes interconnections among bidder supplied equipment and

their interconnection with employer's panels. Testing and commissioning of these interconnections shall also be done by the bidder.

1.8 Wiring/Cabling requirements

Armoured cables shall be used for external Cabling from the PMU/ SIC panels as per IS 1554 part-1. These external cables (except communication cables) shall have the following characteristics:

- a) All cables shall have stranded copper conductor.
- b) Minimum core cross-section of 2.5 sq.mm for PT cables, 4 sq.mm for CT cables and 2.5 sq.mm for Power & Control outputs and 1.5 sq.mm for Digital Status inputs, transducer mA current output
- c) Rated voltage U_0/U of 0.6/1.1KV
- d) External sheathing of cable shall have oxygen index not less than 29 & temperature index not less than 250. Cable sheath shall meet fire resistance test as per IS 1554 Part- I.
- e) Dielectric withstand 2.5 kV at 50 Hz for 5minutes.
- f) External marking with manufacture's name, type, core quantity, cross-section, and year of manufacture.

The Communication cable shall be of shielded, twisted pairs and of minimum 0.22sq mm size Copper cable or Fibre optic cable. The shielding shall be longitudinally laid with overlap.

1.9 PMU TESTING

a) Type Testing

The reports for all type tests as per this technical specification shall be furnished by the Contractor along with equipment / material drawings. However, type test reports of equipment/ material already accepted in POWERGRID can be accepted for all projects with similar requirement. The type tests conducted earlier should have either been conducted in a NABL accredited laboratory, or accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located or witnessed by POWERGRID/representative authorized by POWERGRID/representative of Utility /representative of accredited test lab/ representative of the National Accreditation Board for Certification Bodies (NABCB) certified agency shall also be acceptable.

Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted **within the last Seven (7) years from the date of NOA**. In case the test reports are of the test conducted earlier than seven (7) years from the date of NOA, the contractor shall repeat these test(s) at no extra cost to the Employer.

The type testing requirements are described below:

The list of Type tests applicable on the PMU is mentioned in **Table-1** and type test requirements are mentioned in **Table-2**. The contractor may optionally submit type

test reports for all the tests conducted at accredited laboratory for review & approval by Employer. However, in the event, the type test reports are not meeting the specification requirement, Employer may ask for the repeat type testing of above tests (EMI/EMC, Environmental & Functional tests) as required. at no additional cost. The supplied Phasor Measurement Units (PMUs) shall comply with type test requirement as per below mentioned standards:

- i) **For Functional Type Tests:** As per the latest versions of IS/IEC/IEEE 60255-118-1 and IEEE C37.118.2 standards with all amendments.
- ii) **For EMI/EMC Immunity & Environmental Tests:** As specified in below **Table-1 & Table-2.**

b) Routine Testing (Factory Acceptance Testing)

Each complete unit shall undergo routine testing as part of factory acceptance testing. The list of Routine tests to be performed in the factory is mentioned in **Table-1.**

c) Field Tests (Site Acceptance Testing)

The Contractor shall carry out the field-testing (Site Acceptance Testing) of PMUs after installation, commissioning, and integration with upstream PDC. The list of field tests is mentioned in **Table-1.**

Table-1: List of Tests on PMU:

Test Nos.	DESCRIPTION OF THE TEST	Type test	Routine test (FAT)	Field test (SAT)
FUNCTIONAL TESTS FOR PMU				
1.	Check for BOQ, Technical details, Construction & Wiring as per PMU drawings	√	√	√
2.	Check for PMU database & configuration settings	√	√	√
3.	Check the operation of all Analog inputs, Digital and Status input points of PMU	√	√	√
4.	Check operation of all communication ports of PMU	√	√	√
5.	Check for communication between PMU and PDC	√		√
6.	Test for PMU time synchronization from GPS	√		√
7.	Test Power Supply Voltage Margin, Ripple Levels and Short Circuit Protection	√		
8.	Test for PMU operation with DC power supply voltage variation	√		
9.	Check for auto restoration of PMU on DC power recovery after its failure	√	√	√
10.	Test for PMU diagnostic feature	√		
11.	Accuracy tests as per the latest versions of IEEE C37.118.2 and IS/IEC/IEEE 60255-118-1 standards with all amendments	√		
12.	Test for PMU internal Clock stability	√		

13.	End to end test (between PMU&PDC) for all I/O points			√
14.	Testing and Configuration of PMU from HMI or Portable Configuration tool	√	√	√
EM/EMC IMMUNITY TESTS FOR PMU				
15.	Surge Immunity Test as per IEC 61000-4-5& IEC 60255-22-5 with Severity Level 3	√		
16.	Electrical Fast Transient Burst Test as per IEC 61000-4-4 Level-4 or IEC 60255-22-4 with Severity Level 3	√		
17.	Damped Oscillatory Wave Test as per IEC 61000-4-18 & IEC 60255-22-1 with Severity Level 3	√		
18.	Electrostatic Discharge test as per IEC 61000-4-2 Level-4 or IEC 60255-22-2 with Severity Level 3	√		
19.	Radiated Electromagnetic Field Test as per IEC 61000-4-3 or IEC 60255-22-3 Severity Level 3	√		
20.	Damped Oscillatory magnetic Field Test as per IEC 61000-4-10 with Severity Level 3	√		
21.	Power Frequency magnetic Field Test as per IEC 61000-4-8 with Severity Level 3	√		
INSULATION TEST FOR PMU				
22.	Power frequency voltage withstand Test as per IEC 60255-5 for 1kV	√		
23.	1.2/50 μ s Impulse voltage withstand Test as per IEC 60255-5	√		
24.	Insulation resistance test	√		
ENVIRONMENTAL TEST FOR PMU				
25.	Dry heat test as per IEC60068-2-2 / 2-3	√		
26.	Damp heat test as per IEC60068-2-78	√		
27.	Cold Test as per IEC60068-2-1	√		

Note: Test levels for above type tests are elaborated in Table 2

Table-2: PMU Type Test Requirements

Test Nos	Test Name	EUT Status	Test Level	Power Supply		I/O Points	Passing Criteria
				CM	DM	CM	
1	Surge Immunity Test	ON	Level 3	2 kV	1 kV	2 kV	A
2	Electrical Fast Transient Burst Test	ON	Level 3	2 KV	-	1 kV	A
3	Damped Oscillatory Wave Test	ON	Level 3	2.5 kV	1 kV	2.5 kV	A

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4	Electrostatic Discharge Test	ON	Level 3	+/- 6 kV in Contact discharge mode or +/- 8 kV in Air discharge mode	A
5	Radiated Electromagnetic Field Test	ON	Level 3	10 V/m electric field strength	A
6	Damped Oscillatory Magnetic Field Test	ON	Level 3	10 A/m at 1MHz of magnetic field strength	A
7	Power frequency magnetic field	ON	Level 3	30 A/m of magnetic field strength (Continuous duration sine wave)	A
8	Power frequency voltage withstand	OFF	-	1 kV rms for 1 minute	No break down or flashover shall occur
9	1.2/50 μ s impulse voltage withstand	OFF	-	2 kVp	No break down or flashover shall occur
10	DC Voltage Dips & Interruptions / Variation as per IEC 61000-4-29 or IEC 60255-11	ON	-	-	-
11	Insulation Resistance Test	OFF	-	Measure Insulation resistance using 500 VDC Megger before & after Power Freq& Impulse voltage withstand tests	As per manufacturer standard
12	Dry heat test	ON	-	Continuous operation at 55 ⁰ C for 16 hrs	0
13	Damp heat test	ON	-	at 95% RH and 40 ⁰ C for 16 hrs	0
14	Cold test	ON	-	Continuous operation at 0 ⁰ C for 96 hrs	0

Note:-

1. EUT - Equipment Under Test
2. CM - Common Mode; DM - Differential mode
3. I/O points do not include Communication ports
4. Passing Criteria
0 - no failure: normal performance within the specified limits
A: minor failure: temporary degradation or loss of function or performance which is self-recoverable
5. Functional test as per the sl. nos. 1-14 of Table-1 shall also be done during type testing.

Annexure-I: Data Requirement Sheets (DRS) of PMU and associated items

1. Phasor Measurement Unit (PMU) – M class:

The Phasor Measurement Units (PMUs) shall communicate to the Phasor Data Concentrator (PDC) at respective SLDC/RLDC and NTAMC as per the latest version IS/IEC/IEEE 60255-118-1 and IEEE C37.118.2 Standards with all amendments.

S.No	Description of the Features	Minimum Quantity of the features	Offer by the Bidder
1	Device	Phasor Measurement Unit (PMU)	
2	Manufacturer		
3	Model No.		
4	Country of origin		
Inputs			
5	Minimum Analog Channel	PMU shall measure at least 2 sets of 3 phase voltage inputs and 2 sets of 3 phase current inputs. (i.e., Current and voltage of two feeders/elements)".	
6	Minimum Digital Channels	16 (i.e., 8 Digital Inputs per feeder)	
7	CT core	Capable for accepting Metering Core	
8	Auxiliary Power Supply Source	220V DC or 110V DC or 48V DC (+10%, -15%) power supply source	
9	Communication ports	Minimum One Ethernet port (RJ45) of 10/100 Base Tx and one optical fiber port of 100Mbps	
10	Interface ports for Time synchronization	Time synchronization shall be through any of the following: a) Built-in GPS based time system b) IRIG-B interface port for either a standard or high-accuracy demodulated IRIG-B time- synchronization input signal c) SNTP through Ethernet port d) 1 PPS (only if the offered PMU supports time synchronization over IRIG-B AM) e) Latest version of IEEE 1588 Protocol (PTP)	
11	Communication Protocols	UDP/IP multicast/unicast & TCP/IP	
Measurement Output			

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12	Performance Class	M class	
13	Test Compliance as per IEEE 37.118 and IEC/IEEE 60255-118-1 Standards	PMUs shall meet all performance requirements for the given class and reporting rate as per the latest version of IS/IEC/IEEE 60255-118-1 and IEEE C37.118.2 Standards with all amendments. Bidder to fill the values as per test conducted in the lab for each individual values both in steady state and Dynamic State.	
14	Protocol support for SAS	Shall be IEC 61850 Compliant for Edition 1.0 and Edition 2.0	
15	Environmental Condition	As per TS	
16	Reporting rates (Frame per second)	25 and 50 frames per second for 50 Hz System. The actual rate to be used shall be user selectable. All the PMU hardware and software shall be sized considering 50 frames per second.	
17	Configuration Frame	PMU shall support Configuration Frame - 2 & Configuration Frame-3	
18	Minimum reporting clients	Minimum 2 clients over TCP and/or 2 UDP clients	
19	Active & Reactive Power	3 Phase active and reactive power measurement/computation for a feeder should be possible in PMU.	
Other features			
20	HMI facility	Display on PMU for display of real time measured values & buttons to make configuration changes to HMI.	
21	Remote configuration Change	PMU shall provide remote configuration capability through same data channel from which the PMUS are reporting to PDC at respective SLDC/RLDC and NTAMC from the supplied Configuration software.	
22	Configuration software	Yes (only software)	
23	PMU integration with PDC	The PMU shall be capable of reporting with its full features to the PDC installed at respective SLDC/RLDC and NTAMC under the URTDSM Project. It is the responsibility of the bidder to coordinate with SLDC/RLDC and NTAMC for successful integration of PMUs with the PDC.	

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24	Station Name, Phasor Name, Analog name, Digital Name	These should be user configurable in PMU.	
25	Event Recorder	Up to 1024 event records	
26	Cyber Security	<ul style="list-style-type: none"> a) Cyber Security compliance as per IEC 62351 b) The PMUs shall support Syslog feature. c) The Access of PMU must be through password and log of same shall be maintained. d) Any configuration change must be through access right and log of the same must be maintained, e) All logs of event shall report to Syslog server. 	
27	Self-monitoring, diagnostic features, and alarm to PDC.	<ul style="list-style-type: none"> a) The PMUs shall have continuous self-monitoring, diagnostic features and shall identify & communicate hardware or software errors/faults. b) It shall generate alarm in case of any abnormality displayed locally and transferred to the PDC. c) The indication shall be available for each module on the front panel of the PMU. 	
28	Multiple data streams configurable independently.	<p>PMU shall support multiple data streams i.e. a PMU shall be capable of transmitting its data in separate data streams (more than one). Each stream shall be configurable independently based on the following: -</p> <ul style="list-style-type: none"> a) Contents b) Reporting rate c) Communication mode (TCP/UDP) d) Different destinations with separate IDCODE. 	
Environmental condition			
29	Temperature	-10 to +55 degrees Celsius	
30	Humidity	10% to 95%	

2. GPS based time facility:

S.No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		

S.No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor
3.	Time stability of internal time base	Minimum 1ppm	
4.	Propagation delay compensation	Yes	
5.	Include an offset to permit correction to local time	Yes	
6.	Reverting to internal time base upon loss of signal from UTC source	Yes	
7.	Resynchronization Delay	Not more than 5 minutes.	
8.	Accuracy of resynchronization	≤ 1 Microsecond	
9.	Interfaces (minimum)	a) Ethernet port Copper – 2 no. (10/100 Mbps) b) IRIG-B port – 1 Additionally, if the PMU requires time synchronization over IRIG-B AM, then 1PPS port must be provided in the time system.	
10.	Environmental Compliance	Relevant parts of IEC 61000, IEC 60068 as applicable for EMI/EMC	
11.	Power Supply (in Watts)		
12.	Heat Load		

3. Industrial grade LAN Switch (Layer 2 & Layer 3):

S.No	Description of the Features	Minimum Quantity of the features required	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		
3.	Country of origin		
4.	Performance	Minimum 5 Gbps Switching Capacity	
5.	Functions	Data Exchange between the PMUs and PDC	
6.	Layer-2 & Layer-3	Static Routing (at least 32 nos.) for IPv4 IGMP Spoofing	

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	features required	Port Rate Limiting	
		Support for Multicast VLAN at least 4096	
		Support for Jumbo frames	
		Should provide for 32K MAC Address Table and 16K for L2 switch Managed Switch	
7.	Features to support	<ul style="list-style-type: none"> a) Shall comply with IEEE 802 Series Standards for the following features. b) Support Auto-negotiation on TP, c) flow control and prioritization, 802.1p d) VLANs, maximum 32 VLANs, 802.1q e) Spanning Tree, f) Rapid Spanning Tree including RSTP 2004 extensions providing sub-second hop on rings, DiffServ (for L3 switch) g) Traffic prioritization for routed IP flows/ports (for L3 switch) h) Shall support Multicast and Unicast. i) QoS (802.1p) for real time traffic j) SNTP time synchronization k) Support for CLI, ASCII, Telnet for remote configuration l) Shall support MRP (IEC 62439-2) for ring redundancy 	
8.	Network management	<ul style="list-style-type: none"> a) Console port for configuration of software features b) Shall be able to manage the switch through Command-line interface, Web browser. c) Support SNMPv3 d) SNTP 	
9.	Security	<ul style="list-style-type: none"> a) Access Control Lists for IPv4 for filtering traffic to prevent unauthorized users from accessing the network. b) Port-based rate limiting, and access control list (ACL) based rate limiting. c) IEEE 802.1x to provide port-based user authentication with multiple 802.1x authentication sessions per port. d) Media access control (MAC) authentication to provide simple authentication based on a user's MAC address. e) Port disabling and port isolation. f) MAC based port security. g) Port based Network Access Control (802.1x) h) SNMP v3 i) SSH/SSL Encryption j) Multi-level user passwords 	
10.	Interface ports	<ul style="list-style-type: none"> a) L3 Switch- 10 ports minimum <ul style="list-style-type: none"> i. 1 Gbps Fibre port- 4 nos. ii. 1 Gbps Cu ports- 2 nos. iii. 100 Mbps Cu ports- 4 nos 	

		b) L2 Switch-10 ports minimum i. 1 Gbps Fibre port- 4 nos. ii. 100Mbps Fibre ports- 4 nos. iii. 100Mbps Cu ports – 2 nos.	
11.	Mounting	Rack mountable 19 inch	
12.	Cable standard	Cat 6 or higher bandwidth cable	
13.	Environmental Compliance	IEC61850-3 (Electric Utility Substation) standard for EMI/EMC	
14.	Operating temp	- 20 to 70°C, no fans	
15.	Power supply	220VDC, 110VDC, 48V DC (+10% & -15%) (As per site requirement)	

4. Armored FO Cables

S. No	Description of the Features	Minimum requirements	Offered by the Bidder
1	Manufacturer	POWERGRID Approved Vendor	
2	Application	Between kiosks & Control Room and within control room	
3	Cable Type	6F Multimode Cable 62.5/125 um	
4	Armoured/Un-Armoured	Armoured	
5	Wavelength	850nm/1300nm	
6	Attenuation	< 3.5 dB/km @850nm, <1.0 dB/km @1300nm	
7	Band Width	>= 200 MHz/km @850nm, >=500 MHz/km @1300nm	
8	No. of Fibers	6	
9	Cladding Diameter	125um ± 2	
10	Core Diameter	62.5 um ± 3	
11	Cable Diameter	Vendor Specific	
12	Numeric Aperture	0.275+/- 0.015	
13	Bending Radius	20xD where D is diameter of cable	

14	Armored Type	ECCS Tape (Electromagnetically Coated Corrugated Steel Tape)	
15	Operating Temperature	-20°C to +70°C	

5. LIU

S. No	Description of the Features	Minimum requirements	Offered by the Bidder
1	Manufacturer	Of any reputed vendor	
2	Application	Between Ethernet Switch (Kiosk/ Control Room) and FO cable	
2	Mounting	19-inch Rack mountable Fixed Optical Fiber Interconnection Units	
3	No of ports	12 (6-in and 6-out)	
4	Features	a) Shall manage both splices and terminations. b) Snap-in locker design. c) Capable of storing up to 3meters of 900um tight buffered fiber per adapter	