

Technical Specification for Panel Mounted Power Quality Meter



Specification Number:: PQ-PanelMeter-CES-RO

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Revision records

Rev. No.	Rev. Date	Item/Clause No.	Nature of Change	Approved By

Abbreviation

Abbreviation	Full Form
API	Application Programming Interface
COMTRADE	Power Quality Data Interchange Format
PQDIF	Power Quality Data Interchange Format
ITIC	Information Technology Industry Council
SEMIF47	Semiconductor Equipment and Materials institute
CEA	Central Electricity Authority
PQ	Power Quality
SARFI	System Average RMS-variation Frequency Index
SIARFI	System Instantaneous Average RMS (Variation) Frequency Index
SMARFIX	System Momentary Average RMS (Variation) Frequency Index
STARFIX	System Temporary Average RMS (Variation) Frequency Index

1. Scope

This specification covers the design, manufacture testing, supply and delivery of A.C. static C.T operated, Panel Mounted Power quality meters with communication facility.

2. Codes & Standards

The equipment shall conform to this specification and latest revision of following codes with all amendments-

S No.	Standard Number	Title
2.1	IEC 61000-4-30	Class A :Measurements Power and Accuracy standard
2.2	IEC 61000-4-15	Flicker Measurement
2.3	IEC 61000-4-7	Harmonics Measurement
2.4	IEEE 519-2014	Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
2.5	IEEE 1159.3	Power Quality Data Interchange Format.
2.6	C37.111	Common Format for Transient Data Exchange
2.7	EN 50160	Voltage Characteristics in Public Distribution Systems
2.10	EN-61000-2-12	Compatibility levels for low-frequency conducted disturbances and signalling in public medium-voltage power supply systems
2.12	IS 14697	AC static transformer operated Watt-Hour and VAR-Hour meters, class 0.2 S, 0.5 S and 1.0 S —
2.13	IEC 62586-1	Power Quality measurement in Power System – Functional test and uncertainty requirement (with Normative references).
2.14	IPC-A-600 IPC-A-610	Acceptability of printed Circuit Board Acceptability of Electronic Assemblies

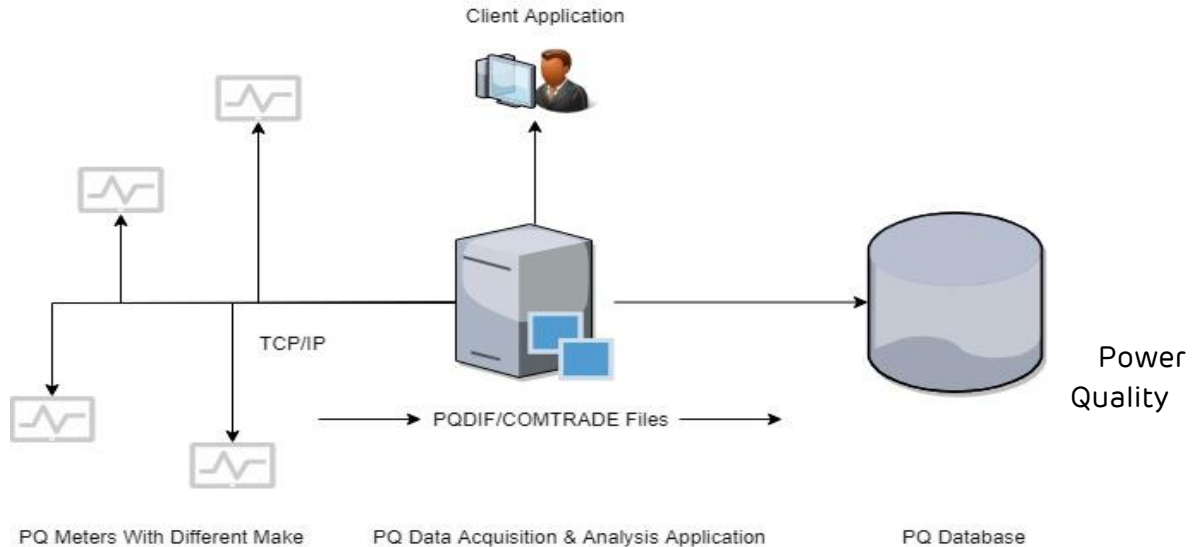
2.15	IEC 60529	Degrees of protection provided by enclosures (IP Code)
2.16	IEC 61000-6-5	Immunity for power station and substation Environments
2.17	IEC 61010-1:2010	Safety requirements for electrical equipment for measurement, control, and laboratory use
2.18	IEC 60068	Environmental testing
2.19	IEC 60721	Classification of environmental conditions
2.20	IEC 61000-4-4 IEC 61000-4-5 IEC 61000-4-6 IEC 61000-4-3 IEC 61000-4-16 IEC 61000-4-11	Testing and measurement techniques – Immunity to Electrical fast transient/burst, Surge , conducted disturbances, induced by radio-frequency fields, Electrostatic discharge, Radiated, radio-frequency, electromagnetic field, conducted common mode disturbances in the frequency range 0 Hz to 150 kHz, Voltage dips, short interruptions and voltage variations
2.21	IEC61180	High Voltage test techniques for LV equipments
2.22	IEC 61000-2-2	Compatibility levels for low-frequency conducted disturbances and signaling in public low-voltage power supply systems.
2.23	IEC 61000-6-1	Immunity for residential, commercial and light-industrial environments.

3. Service Condition

3.1	Power Supply	110 Volt DC or 230 Volt AC
3.2	Voltage Input	110/1.732 Vac or 433 VLLac-50 Hz—R-Y-B-N
3.3	Current Input	0-6 Amp RMS 3 Input (R, Y, B)
3.4	Environmental Condition	Instrument shall be suitable for environmental conditions as mentioned below

3.5	Temperature Range	Operation range: -10 Deg C to +55 Deg C Shall be Industrial grade components used.
3.6	Relative Humidity	Upto 95 %
3.7	Pollution	High Corrosive dust, smoke and rain
3.8	PQ Meter Input	From secondary of existing metering class Current and Voltage transformers installed in switchgears
3.9	Mounting arrangement	Din rail/ Rack/Panel mount in the existing panel
3.10	Dimensions Mounting & Housing	Compatible to installation at 11kV indoor switchboard.
3.11	Installation Voltage level	11kV and above

4. Power Quality Metering System Architecture:



- 4.1. Metering System with central monitoring of all the PQ metering devices is shown above in the architecture. Proposed monitoring system basically consists of one power quality analyzer software and multiple power quality meters from different make. All the power quality meters shall support for Recommended Practice for the Transfer of Power Quality Data (PQDIF)/ COMTRADE files via proposed

communication technology under above architecture. (As per IEEE Std 1159.3-2003).

- 4.2. Power quality meters shall support multiple communications technologies for data transfer. Bidder shall provide the minimum requirements of communication parameters.
- 4.3. Power quality meters only act as raw data acquisition components and power quality analyzer performs all calculations and have advance analysis algorithm on acquired data from all the power quality meters. Central data repository of PQ data from all the power quality meters shall be stored and used for system improvement, Event analysis, management dashboard and as supporting data for premium customer complaint analysis.
- 4.4. Software upgrade shall be available as and when the release is announced irrespective of the buyer placing a request for the same.
- 4.5. Power Quality Meter's of all make and type should integrate with Enterprise software.
- 4.6. PQ system (including PQ meter & software) shall support Indian power quality standards as and when available.
- 4.7. All PQ meters will integrate with enterprise software on common communication protocol.
- 4.8. PQ analysis reports, event records, notification and management dashboards should be web-based.

5. Functionality of PQ Meters

S No.	Parameter	Description
5.1	Power Supply	3P-4W and 3P-3W Supply. Should work with or without neutral or with any two wires. AC Range: 85- 265 Vac/ (50Hz with + / - 5% variation) DC Range: 24-375 VDC
5.2	Voltage Input	4 Input: 3P-4W with Max Surge Protection of 6kV -0-460 Vac- R-Y-B-N--50Hz

5.3	Current Input	0-6 Amp RMS 3 Input (R, Y, B)
5.4	Retention of Data and RTC	Required for Data and RTC.
5.5	Display	General LED indicators for Power ON, Data Communication, Status
5.6	Measurement Parameters	<ul style="list-style-type: none"> All data measured should have minimum, maximum and average value. Refer Annexure A,B and C
5.7	Events	<p>Following are indicative events list:</p> <ul style="list-style-type: none"> Voltage dips, swell and Short/Long interruption with waveform record Voltage transients with waveform Current Transients Selectable pre-trig $20\text{ms} < T < 5\text{s}$ for All Event capture (Voltage and current waveform) Selectable post-trig $1\text{s} < T < 10\text{s}$ for All Event capture (Voltage and current waveform) Discrimination between upstream and downstream events .
5.8	Communication Standard for Data Exchange	<ul style="list-style-type: none"> Support TCP/IP for data exchange Support IEC 61850 protocol for data exchange as and when available (Optional)
5.9	Communications Interface	<ul style="list-style-type: none"> Built-in Ethernet interface RJ45 (10/100 Mbit) , DHCP enabled. Full UART RS232/RS485 Configurable with DB9 connector – Interfacing Communication device USB Port – Configuration locally
5.10	Programmability of PQM	<p>Should Support</p> <ul style="list-style-type: none"> Remote configuration of parameters - Web /Window application based configuration Locally/ Remote Firmware Upgrade

5.11	Memory	<ul style="list-style-type: none"> Local Memory capacity to store the data of all parameters for duration of one month. (On Maximum Data Collection frequency). Circular Memory-FIFO (for long Term data). Non-volatile memory independent of battery backup, Data should be retained up to 10 years.
5.12	Calibration	<ul style="list-style-type: none"> Meters shall be calibrated at accredited Labs, Required hardware and software support to be provided by vendor.
5.13	Digital Input /output	Input and Output 200 V DC, max 200mA – 2 No.
5.14	Time synchronization	Auto Time Synchronization (NTP)
5.15	Electrical isolation	Isolated from all internally potentials
5.16	Event direction discrimination	Discrimination of Upstream/downstream event (sag, harmonics)
5.17	Sampling Frequency	should be above: 10KHz
5.18	Data collection interval and parameter list	Configurable
5.19	Body of Meter	Front cover & base should be with IP65 grade enclosure.
5.20	Warrantee	5 Years.
5.21	Insulation	Instrument shall withstand an insulation test of 6 KV and impulse test at 6 KV
5.22	ADC Resolution	Min 12 bit
5.23	Bandwidth for time series data	3 kHz minimum

6. General requirements

6.1. Meter Sr. Nos. to be printed in on the name plate, with date and year of manufacturing.

- 6.2. Meter shall be enabled with communication inside hence hardware ID shall be compulsory mentioned in the front.
- 6.3. Meters shall be suitably packed with environmental friendly material in order to avoid damage or disturbance during transit or handling and to prevent ingress of moisture and dust.
- 6.4. Meters shall be supplied along with configuration cable/Ethernet cable suitable to read/configure meters at one unit per meters.
- 6.5. PQ meter should use standard sign convention for import (+)/export (-) of energy/power and lag (+)/lead (-) Power factor and Reactive Power.
- 6.6. Product and Software Training, Verification and technical support, calibration support shall be available in India.
- 6.7. At least two Power Quality training workshops should be conducted by OEM for AEML users.
- 6.8. Integration of PQ meter with Enterprise software is sole responsibility of Bidder.
- 6.9. Successful bidder should deploy only single piece of product to integrate with enterprise software. Subsequently, on successful integration and after two month of performance check period, remaining quantity should be supplied and deployed.
- 6.10. PQ meters should provide data in PQDIFF/COMTRADE format to central remote server with enterprise software either directly or using data collection software.
- 6.11. There will be single data repository for storing PQDIFF/ COMTRADE data for PQ meters of all make.
- 6.12. The data for Time Series and Event should be communicated to enterprise software on regular preselected intervals.
- 6.13. PQ Meter should have remote setting facility for threshold levels of parameters necessary to generate event (Annexure A, B and C).
- 6.14. PQ meters should be able to measure phase to ground voltage and based on it threshold settings events are triggered.
- 6.15. The PQ meter Bidder should understand / consider specification of enterprise software also.
- 6.16. PQ Meter should have support (including hardware, software etc) for the period of 10 years.
- 6.17. Considering the sampling frequency, anti aliasing filter (specification) incorporated should be specified in detail by the successful Bidder(s).

- 6.18. Successful Bidders should provide updates for next 5 years, necessary to remain integrated with upstream enterprise software.

7. System Requirements

- 7.1. PQ meter shall be robust and based on following basic attributes: scalability, availability, reliability, safety, confidentiality, integrity and maintainability.
- 7.2. PQ meter data shall be accessible from application through business processes and managed APIs.
- 7.3. PQ Meter shall provide end-to-end data protections to ensure no data is lost or corrupted during processing, storage, and transportation between meter and interfaces.
- 7.4. PQ Meter/System should be able to discriminate events viz. sags, swell, harmonics occurred due to upstream and Downstream separately.
- 7.5. PQ Meter/ System should have capability for Automatic generation of E-mail and SMS to stakeholders for user configured events viz. Sags, Swell, RVC, and Harmonic etc (as per EN60150 limits).
- 7.6. A single consolidated PQ reports generated by Enterprise Software for all the meters, shouldn't include the "common events/sags" registered by all meters. This happens specifically in case of upstream events which are seen by all downstream meters. This is to avoid/eliminate investigation/ updating duplicity.
- 7.7. Enterprise Software will automatically notify Monthly/Weekly meter wise and universal event analysis report and Power Quality report as per EN50160 standard.
- 7.8. PQ product should comply data requirement for Enterprise Software to generate statistical reports viz. ITC, SEMIF47, SARFI indices, SAG classification Table/ Chart, SAG Timeline Chart/ Table , three dimension histogram (for no of sag, duration and % of depth) and TDD table as per IEEE519 standard for user selected duration. Moreover, generated reports by Enterprise software viz. EN50160 and user configured will be device specific and also collated for all devices.
- 7.9. PQ product should comply data required for classification of downstream and upstream sag/swell/interruption/harmonic events. Moreover, reason transients should be interpreted Thereafter, all the events will be shown in tabular form with nature of events viz. sag/swell/interruption (short, long), transients with direction, time stamp and duration with depth characteristics. Also in enterprise software there will be comment field against event to specify its reason by user.
- 7.10. Enterprise software will also integrate with GIS for identification of fault distance based on voltage sag observed at point of installation. In view of it, PQ meter should have digital inputs from relay trip contact of breaker tripped for identification of tripped feeder.

- 7.11. The instantaneous waveform captured by PQ Meter for triggered parameters should be made available in PQDIFF format to enterprise software for graphical representation.
- 7.12. PQ Meter's should record parameters needed by enterprise software for report generation and event notification.

8. Testing Requirement

- 8.1. The testing specified in IEC 61000-4-30 clause 6.2 or IS 14697-CI12 (whichever supersedes) should be followed and subsequent reports should be submitted.
- 8.2. Testing and calibration of all PQ meters shall be carried out every 5 years. Moreover, as and when required by the buyer.
- 8.3. To achieve the accuracy stated as stated in IEC61000-4-30 and IEC61000-4-7 some simple adjustment of the instrument, according to clear indications to be given by the manufacturer, by means of an internal or external calibrator may be required. The uncertainty of the calibrator (if internal) shall be specified.
- 8.4. The IP65 enclosure protection test certificate should be submitted by successful bidder.
- 8.5. Successful Bidder(s) should provide compliance certificate (IEC61000-4-30 latest edition) for meters supplied. Moreover, it should submit routine accuracy/calibration test certificate for all the supplied meters as per IEC 62856 standard.
- 8.6. Successful Bidder(s) should submit list of components (Bill of Material) with manufacturer's details and corresponding material invoice copy and routine test certificates. The processors and component used in the meter should be of reputed brand. The performance test certificate of CT and PT used inside the product should be submitted.
- 8.7. Printed Circuit Board used in the meter should be tested as per standard (IPC-A-600) and submitted by successful Bidder.

9. Safety & Security requirements

- 9.1. Meter Data stored in the devices shall be encrypted and compressed format.
- 9.2. Encrypted data shall be obtained by compliance Software provided by the vendors.
- 9.3. Meter shall not be affected by any external control device & shall continue recording data under any influence external conditions.
- 9.4. However, a potential free watch dog contact shall be provided to use as alarm hook up with SCADA/remote server in case of PQM failure.

- 9.5. The cover of PQ meter shall not be removable without the use of a tool. The case shall be so constructed and arranged that any non-permanent deformation cannot prevent the satisfactory operation of the meter.
- 9.6. The meters having a case wholly or partially made of metal, shall be provided with a protective earth terminal.
- 9.7. Terminals with different potentials which are grouped close together shall be protected against accidental short circuiting. Protection may be obtained by insulating barriers. Terminals of one current circuit are considered to be at the same potential.
- 9.8. Every meter shall be indelibly marked with a diagram of connections.
- 9.9. The instrument manufacturer shall specify the fuse size; this will be low enough to protect the test lead against overload conditions. Furthermore, the interrupting capacity of the fuse will be consistent with the available power-frequency fault current at the point of connection.
- 9.10. If screw terminals are used in the measurement instrument, appropriate covers will be used to insulate the terminations.
- 9.11. Care should be taken that the secondaries of current transformers, if used, do not become open circuit, i.e. there shall be no fuse in the secondaries of such circuits, and the connection to the burden shall be mechanically secure.
- 9.12. If PQ meter should provide inbuilt protection to withstand input high current. Furthermore, instruments should not lose its declared accuracy/ linearity during normal current flow with precedence of huge short circuit current (IEC61000-4-7 clause 5).

Note:

- A. Annexure A, B, C and D are to submitted (duly filled /signed) by Manufacturer with Product Code
- B. Necessary Test Certificates/reports complying standards should be submitted.
- C. Brief explanation for Deviation or any other should be attached with reference clause Number.

1. Annexure A

Time Series Data recording (every 200msec for 50Hz system)

Sr. No	Time Series parameter	Feature Availability Yes /No-(Model Number)				
		Average / Max/Min	R-Phase	Y-Phase	B-Phase	SUM- Σ
A.1	Voltage Frequency					
A.2	RMS Voltage Value--L-L and L-Ph					
A.3	RMS Current Value					
A.4	Voltage Peak (+/-)					
A.5	Current Peak (+/-)					
A.6	Active Power					
A.7	Reactive Power					
A.8	Apparent Power					
A.9	True and displacement PF					
A.10	Voltage Unbalance Factor					
A.11	Current Unbalance Factor					
A.12	Harmonic Voltage--up to 50th					
A.13	Current Harmonic-up to 50th					

A.14	Harmonic Power --up to 50th					
A.15	Harmonic Voltage -current Phase and also its difference					
A.16	Inter-Harmonic Voltage--0.5 to 49.5th					
A.17	Inter Harmonic Current--0.5 to 49.5th					
A.18	THD Voltage					
A.19	THD and TDD Current					
A.20	THD –Inter harmonic current					
A.21	K-Factor					
A.22	Rapid Voltage Change					
A.23	All Energy Measurement					
A.24	TDD current based on user set Peak load current					
A.25	Positive, Negative and zero sequence for voltage					
A.26	Positive, Negative and zero sequence for current					

2. Annexure B

Time Series data but not at every 200msec

Sr. No	Time Series parameter	Feature Availability Yes /No			
		Average / Max/Min	R-Phase	Y-Phase	B-Phase
B.1	Short Interval IEC Voltage Flicker measurement---Pst – 10 minute interval				

B.2	Long Interval IEC Voltage Flicker measurement – Plt – 2hour interval.				
B.3	Each Phase V10 flicker --1 minute				
B.4	Instantaneous Flicker as per IEC61000-4-15				

3. Annexure C

Triggered Events (that has to be triggered) with Threshold setting

S.No	Triggerable parameter	Threshold	Channel	Feature Availability Yes /No
C.1	Voltage Frequency	+ - 0 to 30Hz to nominal	Only One Channel	
C.2	RMS Voltage Value	± % Nominal	R-Y and B Phase	
C.3	RMS Current Value	± % Nominal	R-Y and B Phase	
C.4	Voltage Peak (+/-)	% Nominal	R-Y and B Phase	
C.5	Current Peak (+/-)	% Nominal	R-Y and B Phase	
C.6	Active Power	% Nominal	R-Y, B and sum	
C.7	Reactive Power	% Nominal	R-Y, B and sum	
C.8	Apparent Power	% Nominal	R-Y, B and sum	

C.9	True/displacement PF	%	R-Y, B and sum	
C.10	Voltage Unbalance Factor	Higher than %	Sum (Σ)	
C.11	Current Unbalance Factor	Higher Than %	Sum (Σ)	
C.12	Harmonic Voltage--1st To 50th	% Nominal of 50Hz Value	R-Y and B Phase	
C.13	Current Harmonic-1st To 50th	% Nominal of 50Hz Value	R-Y and B Phase	
C.14	Harmonic Power --1st To 50th	% Nominal of 50Hz Value	R-Y, B and sum	
C.15	Harmonic Voltage -current and Phase difference	Absolute Value	R-Y and B Phase	
C.16	Inter-Harmonic Voltage-- 0.5 to 49.5th	% Nominal of 50Hz Value	R-Y and B Phase	
C.17	Inter Harmonic Current	% Nominal of 50Hz Value	R-Y and B Phase	
C.18	THD Voltage	% Absolute value	R-Y and B Phase	
C.19	THD Current	% Absolute value	R-Y and B Phase	
C.20	THD -Inter harmonic current	% Absolute value	R-Y and B Phase	
C.21	K-Factor	Higher than Absolute Value	R-Y and B Phase	
C.22	Transient Voltage	% of nominal RMS Volt	R-Y and B Phase	
C.23	Voltage Swell	% of nominal RMS Volt	R-Y and B Phase	
C.24	Voltage Dip	% of nominal RMS Volt	R-Y and B Phase	

C.25	Voltage Instantaneous ,Long ,Short Interruption	% of nominal RMS Volt	R-Y and B Phase	
C.26	For Every Events Triggered min 10 cycle of Voltage and current (before and after event subdues) has to be captured		R-Y and B Phase	

4. Annexure D

PQ Meter Details

S No.	Parameter	Description	Comply Yes /No
D.1	Power Supply	<ol style="list-style-type: none"> 3P-4W and 3P-3W Supply. Should work with or without neutral or with any two wires. AC Range: 85- 265 Vac/ (50Hz with + / - 5% variation) DC Range: 24-375 VDC 	<ol style="list-style-type: none">
D.2	Voltage Input	4 Input: 3P-4W with Max Surge Protection of 6kV -0-460 Vac- R-Y-B-N--50Hz	
D.3	Current Input	0-6 Amp RMS 3 Input (R, Y, B)	
D.4	Retention of Data and RTC	Required for Data and RTC.	
D.5	Accuracy	Class A as per IEC61000-4-30 latest edition & IEEE 519-2014 (Gapless measurement)	
D.6	Display	General LED indicators for Power ON, Data Communication, Status	
D.7	Communication Standard for Data Exchange	<ol style="list-style-type: none"> Support TCP/IP for data exchange Support IEC 61850 protocol for data exchange as and when available. 	<ol style="list-style-type: none">
D.8	Operating Conditions / Climatic Conditions	<ol style="list-style-type: none"> Operational temperature -10°C to +55°C Humidity: up to 95% non-condensing , 	<ol style="list-style-type: none">

D.9	Communications Interface	<ol style="list-style-type: none"> 1. Built-in Ethernet interface RJ45 (10/100 Mbit) , DHCP enabled. 2. Full UART RS232/RS485 Configurable with DB9 connector – Interfacing Communication device 3. USB Port – Configuration locally 	<ol style="list-style-type: none"> 1. 2. 3.
D.11	Programmability of PQM	<p>Should Support</p> <ol style="list-style-type: none"> 1. Remote configuration of parameters - Web /Window application based configuration 2. Locally/ Remote Firmware Upgrade 	<ol style="list-style-type: none"> 1. 2.
D.12	Dimensions Mounting & Housing	Compatible to installation at 11kV indoor switchboard.	
D.13	Memory	<ol style="list-style-type: none"> 1. Local Memory capacity to store the data of all parameters for duration of one month. (On Maximum Data Collection frequency) 2. Non-volatile memory independent of battery backup, Data should be retained up to 10 years. 	<ol style="list-style-type: none"> 1. 2.
D.14	Calibration	Meters shall be calibrated at accredited Labs, Required hardware and software support to be provided by vendor.	
D.15	Digital Input /output	Input and Output 200 V DC, max 200mA – 2 No.	
D.16	Time synchronization	Auto Time Synchronization (NTP)	
D.17	Electrical isolation	Isolated from all internally potentials	
D.18	Event direction discrimination	Discrimination of Upstream/downstream event (sag, harmonics)	
D.19	Sampling Frequency	<ol style="list-style-type: none"> 1. For Time Series Data i.e. 200 msec (Specify). 2. For Disturbance Records (Specify). 	

D.20	Data collection interval and parameters	Configurable	
D.21	Mounting arrangement	Din rail/ Rack/Panel mount in the existing panel(Specify)	
D.22	Body of Meter	Front cover & base should be with IP65 grade enclosure.	
D.23	Warrantee	5 Years.	
D.24	Insulation	Instrument shall withstand an insulation test of 6 KV and impulse test at 6 KV	
D.25	ADC Resolution	Min 12 bit	
D.26	Bandwidth for time series data	Above 3 kHz ---specify the bandwidth	
D.27	PQ Meter Input	From secondary of existing metering class Current and Voltage transformers installed in switchgears	
D.28	PQ Diff (.pqd)	Data Format—IEEE1159.3 communicated to Central repository (also specify which data is in this format)	
D.29	COMTRADE	Data Format (also specify which data is in this format)	
D.30	Integration	Bidder should integrate with Enterprise Software	
D.31	Software /Product Firm ware support	Bidder should give support for product software, hardware and firmware for next 10 years	
D.32	Test Certificate	Test certificate and test results (as per compliance to Section 2)	
D.33	Dimensions	Provide Lx B x D (mm)	
D.34	Section 6		

D.35	Section 7	Specify clause Number here for deviation in sub sections with detail explanation in separate document.	
D.36	Section 8		
D.37	Section 9		
D.38	Dip ,Sag and Swell	The Urms (1/2 cycle) methodology adopted.	
D.39	Allowable DC component	Specify maximum allowable DC component so that additional influence error does not exceed the stated accuracy.	
D.40	Rated operating condition and magnitude of error	<p>Specify magnitude of error introduced by changes in</p> <ol style="list-style-type: none"> 1. Temperature 2. Humidity 3. Common Mode Interference voltage between earth connection of instrument 4. Static electric discharge 5. Radiated electromagnetic field. 	<ol style="list-style-type: none"> 1. 2. 3. 4. 5.

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