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**GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS**



**सत्यमेव जयते**

**TECHNICAL SPECIFICATION  
FOR  
POWER QUALITY ANALYZER & RECORDER WITH REMOTE DISPLAY**

**SEPTEMBER' 2008**

**ISSUED BY**

**TRACTION INSTALLATION DIRECTORATE  
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## **SPECIFICATION FOR POWER QUALITY ANALYZER & RECORDER WITH REMOTE DISPLAY**

### **1. SCOPE**

- 1.1. This specification covers supply, testing and commissioning of Power quality analyzer & recorder with remote display for traction substations on Indian Railways. Tenderers while quoting shall ensure that they have gone through this document and understood the requirements clearly.
- 1.2. The equipment shall be complete with all accessories considered necessary for its efficient operation & functionality. All such equipment, part and accessories shall be deemed to be within the scope of supply, irrespective of being specifically mentioned or not.
- 1.3. The equipment shall be commissioned by the successful tenderer, and the offer shall include deputing of engineers for adequate training towards handling, operation & testing to the satisfaction of the purchaser at site.
- 1.4. All the components, sub system and accessories shall unless otherwise specified herein conform to the latest edition of respective Indian/International standards and specifications as mentioned in different clauses.

### **2.0 Service Conditions**

The equipment shall be suitable for use in moist tropical climate and in areas subjected to heavy rainfall, pollution due to industry and marine atmosphere and severe lightning in India.

Operating temperature range	:	-10 to +60 °C.
Maximum relative humidity	:	100%.

### **3.0 POWER QUALITY ANALYZER & RECORDER WITH REMOTE DISPLAY**

#### **3.1 General information**

- i. The equipment shall be portable and capable of field testing.
- ii. The equipment shall have measurement, display and recording facilities and it shall be able to record data.
- iii. The CT/PT output shall be connected to the equipment without any additional interface.
- iv. The equipment must be able to measure and record harmonic current & voltage distortion (individual as well as total).
- v. The equipment shall be capable of continuously logging all voltage and current waveforms on internal memory of at least 8 GB. The data shall be stored with suitable Data Compression Technology.
- vi. The equipment shall have wide bandwidth, high sampling rate for accurately capturing waveforms (at least 1024 samples/cycle), at high resolution and fast data storage with modern communication features.
- vii. The equipment shall have suitable LCD type user interface/ display arrangement.

- viii. The equipment shall be supplied with data analysis software (including any other support software) to clearly display and analyze recorded data.
- ix. The equipment shall have necessary communication interface to collect the data from the devices to the central processing computer, by means of GPRS, Modem or Ethernet connection.

### **3.2 Technical details**

#### **3.2.1 Environmental Conditions and standard compliance**

- i. The equipment shall be suitable for installation inside electrical cabinets for long duration recording purpose.
- ii. The equipment shall comply with safety standard EN61010-1.
- iii. The equipment shall comply with following electromagnetic compatibility standards, EN55011, EN61000-6-2, EN60439-1 paragraphs 8.2.8, 7.10 and 7.9 and FCC part 15.

#### **3.1.2 Input Channels**

##### ***I. Voltages***

- i. The equipment shall accept real time measurement of minimum four (4) voltage inputs. The nominal voltage on the incoming connections shall be at least 600V RMS without the use of potential transformers. The equipment shall be capable of measuring values from 0 (zero) volts. In addition, the unit shall be capable of measuring impulses for at least 6kV peak. Both measurement scales shall be automatically selected and displayed using one unified interface.
- ii. The voltage inputs shall be sampled at a minimum of 1024 samples per cycle.
- iii. Voltage input impedance shall be at least 2 M Ohms.
- iv. The user shall have the option to set PT ratio and it shall be possible to change the ratio and adjust the data accordingly after the data is logged and collected for all the data or for user defined periods.

##### ***II. Currents***

- i. The equipment shall accept real time measurement of minimum four (4) independent current inputs. The nominal current on the incoming connections shall be 5A RMS. The equipment shall be capable of measuring values from 0 (zero) amperes. In addition, the unit shall be capable of measuring at least 50A RMS and withstand continuous 100A RMS. Both measurement scales shall be automatically selected and displayed using one unified interface.
- ii. The current inputs shall be sampled at a minimum of 1024 samples per cycle.
- iii. Current input burden shall be maximum 0.1 VA.
- iv. The user shall have the option to set CT ratio and it shall be possible to change the ratio and adjust the data accordingly after the data is logged and collected for all the data or for user defined periods.

### **3.1.3 Measurements**

Power meter shall be capable of measuring and reporting at least the following parameters:

- i. Voltage, both phase to neutral and phase to phase for all three phases, neutral to ground and Phase angles for each voltage relative to each other. The values shall be reported for every cycle and averaged for 200 milliseconds as per IEC 61000-4-30 simultaneously.
- ii. Per phase Current and Phase angles for each current relative to voltages. The values shall be reported for every cycle and averaged for 200 milliseconds as per IEC 61000-4-30 simultaneously.
- iii. Watts (total and per phase), VARs (total and per phase), VA (total and per phase), True Power Factor (total and per phase), Displacement Power Factor (total and per phase) and Frequency. The values shall be reported for every cycle and averaged for 200 milliseconds as per IEC 61000-4-30 simultaneously.
- iv. Watt-hr, VA-hr, and VAR-hr; VAR-hr and VA-hr readings shall be stored in the equipment itself for each of the 4 quadrants of power for every 15 minute period. Power demand shall be calculated using a sliding window comprising of a configurable amount of 1 second sub-intervals. The meters shall be supplied with preset to 15 minute intervals.
- v. THD (Total Harmonics Distortion), K-Factor, Crest-Factor and individual harmonics for a minimum of 511 harmonics for every cycle (In addition, the meter shall measure and display the THD, K-Factor, Crest-Factor and individual harmonics with accordance to IEC 61000-4-30 simultaneously to the cycle-by-cycle harmonics).
- vi. Graphical Phasors of line-to-neutral voltages, line-to-line voltages and currents. The equipment shall allow the user to select which parameters to show.
- vii. Real time display of minimum 3 cycles of line-to-neutral and line-to-line voltages and currents. The equipment shall be capable of displaying at least 3 different parameters waveforms simultaneously.
- viii. Voltage flicker shall be measured and displayed in accordance to IEC 61000-4-15 ( $P_{LT}$ ,  $P_{ST}$ ). Fast flickering shall also be measured and displayed for shorter periods. The minimum is displaying short voltage flicker of 1 second and 1 minute. The short period flickering shall be similar to IEC 61000-4-15 and on the same scale and calculation methods.

### **3.1.4 Logging of Parameters**

#### **3.1.4.1 Parameters, Accuracy and Duration**

- i. The equipment shall be capable of logging all of its input channels continuously, using its native sampling rate i.e., 1024 samples per cycle, for a period of minimum 1 year in internal memory of the equipment. The raw data (waveforms) shall be logged. Other parameters, except energy that will be stored separately, can be calculated in post-processing from the raw data.

- ii. The logging shall be done automatically without any setup (e.g., triggers or levels) or configuration. i.e All the data is Logged in the internal memory of the equipment at all the times.

#### **3.1.4.2 Storage**

The logged data shall be kept onboard on flash memory. The records in the equipment shall not be lost even if all voltage sources disappear for a year. It shall be possible to change/upgrade the onboard flash memory without any soldering.

#### **3.1.5 Display**

- i. The supplied software shall be able to retrieve every cycle of the recorded waveforms according to user request.
- ii. The resolution shall be from one year to one sample (i.e., 16 microseconds for 1024 samples per cycle at 50 Hz network). The time period can be from 1 millisecond to few years.
- iii. There shall be no limit between the time period and resolution (e.g., it shall be possible to display data from one year with 1 millisecond resolution). If the display doesn't have sufficient resolution, the software shall display the minimum, maximum and average for each displayable pixel.
- iv. The supplied software shall be able to display all the electrical parameters that the equipment can measure, to any period with minimum resolution of 1 cycle.

#### **3.2 EN 50160 Compliance**

- i. The equipment shall be capable of automatically store and check the compliance to EN 50160.
- ii. The equipment shall be capable of display the compliance to EN 50160 in details, including detailed information about every parameter in the standard.
- iii. The display shall be both tabular and graphical.
- iv. The equipment shall be capable to store the timestamp and data on all channels during events as per EN 50160.
- v. The equipment shall be suitable to accept modifications to the standard (e.g., changing voltage levels or thresholds). In addition, it will allow adding current measurement to the modified standard. All changes can be defined as "New Standard" and changing from EN 50160 to the "New Standard" shall be done by the user in single command.

#### **3.3 Accuracy of the equipment**

- i. The equipment shall provide measurement accuracy in accordance to IEC 61000-4-30 Class A.
- ii. The accuracy shall remain with IEC 61000-4-30 Class A regardless of the operational condition.
- iii. All channels shall be sampled simultaneously.

- iv. The equipment shall have 16 bit Analog to Digital converters, both for normal measurement scale and high-scale.
- v. The tenderer shall inform the routines for calibration of the equipment and shall have the capability to provide local calibration services upon request and at additional cost.

### **3.4 Time Synchronization**

- i. The equipment shall have provision for time synchronization via GPS. The equipment's time accuracy shall be better than 10 microseconds.
- ii. The equipment shall also offer time synchronization algorithm allowing synchronization with attached devices/computers even without GPS.
- iii. All data shall be time stamped with 1 microsecond resolution.
- iv. It shall be possible to specify offset from the GPS time and to display both GPS time and local time (GPS + Offset).

### **3.5 Communication**

- i. The equipment shall have the following minimum communication ports:
  - Two (2) integral fast Ethernet ports
  - RS-422/485, both 2- and 4-wire
  - 1USB
- ii. The equipment shall have integral web server, which allows monitoring all real-time information using standard Internet Explorer 4 or higher and provide access to all equipment features, such as real-time monitoring, power quality status, remote control and full equipment configuration.

### **3.6 Expansion**

- i. The equipment shall be capable to have at least 6 simultaneous expansion modules/cards.
- ii. The equipment shall accept standard off-the-shelf compact flash expansion for additional communication (e.g., Bluetooth or Wi Fi), as well as for locally downloading the integral stored data.

### **3.7 Security and Encryption**

Access to the equipment as well as to the software shall be obtained according to minimum three access levels: Viewer, Operator and Administrator. Each level shall have a pre-set access password, which can be changed.

### **3.8 Power**

- i. The equipment shall be capable of working on single phase 240 V ac (varies from 165-270 V), frequency  $50 \pm 3\%$  Hz and 110 V DC -30% to +15%.
- ii. The equipment shall be capable of accepting its power supply using IEEE 802.3af (Power over Ethernet).

- iii. The equipment shall be capable of delivering power using IEEE 802.3af (Power over Ethernet).
- iv. The equipment shall have automatic changeover between all power sources.
- v. When all power sources are down, the equipment shall continue its full operation for at least 20 second.

#### **4 Remote LCD display**

- i. External LCD Remote Display with function keys shall be provided to accommodate access to readings locally and/or remotely.
- ii. LCD Remote Display shall interface with the equipment. It shall provide access to all real-time measurements, as well as status and configuration.
- iii. LCD Remote Display shall connect directly to the equipment using single cable for both data and power.

#### **5 Data collecting**

It shall be possible to collect the information from the equipment in three ways:

- Over Ethernet, either locally or through the Internet.
- Using optional GPRS modem or router. The vendor shall describe the GPRS solution and its connection to the system.
- By connecting locally compact flash or disk-on-key to the equipments, while it is up and running, the data shall be automatically transferred to the handheld device.

#### **6 Power Quality Analysis Software**

##### **6.1 Analysis program**

- i. Comprehensive power quality analysis and management software shall be provided. The software shall be designed to support multiple devices (the tenderer shall explain how the software structure handles large amount of devices).
- ii. The software shall perform both automatic and manual data collection from the equipments.
- iii. The software shall allow device managements including defining device names, description etc., adding/removing devices, setting the device polling frequency; allow manual polling and showing device status.
- iv. The software shall be compatible with Microsoft Windows latest operating systems.

##### **6.2 Display and reports**

- i. The software shall be able to display all parameters in tabular view and graphical trends.
- ii. It shall be capable to display trend graph of all RMS parameters.
- iii. It shall be capable to display trend graph of all harmonics (THD and individual).
- iv. It shall be capable to display trend graph of all waveforms.

- v. It shall be capable to display trend graph of frequency.
- vi. It shall be capable to display power quality events on timeline graph.
- vii. It shall be capable to display information from different devices on the same graph.
- viii. The trends shall be for any period from 1/10<sup>th</sup> of a cycle to few years.
- ix. The maximum time to display one graph, or to perform zoom in or out operations, shall not be more than 30 seconds on an average computer.
- x. It shall be possible to change line colours and as well as line types for any trend.
- xi. It shall be possible to add drawings on the graphs, such as texts, lines, circles and rectangles.
- xii. All graphs shall allow exporting the data in Windows compatible graphic format.
- xiii. The software shall be able to generate periodic and on-demand reports, both pre-defined and customized.
- xiv. The reports shall include as a minimum summary report of all RMS values and Harmonics (Min / Max / Avg), energy consumption report and EN50160 report.
- xv. The software shall be able to display events and alarms information from the equipment, including list of all active alarms and indication when an alarm is activated.
- xvi. The software shall be able to display all power quality events, as per EN 50160 and/or user defined events (both level and parameter), in a tabular view. It shall be possible to filter and sort the data based on time, event's type, event's duration, event's depth and event's severity.
- xvii. It shall be possible to display the total working time of the equipment on any graph and report.
- xviii. The vendor shall provide free of charge updates to the software for at least 36 months and even after that at a price. The software license shall be for minimum 5 computers.
- xix. All the data shall be stored in Microsoft SQL database. In order to reduce operation costs, it is important to keep the size of the database as small as possible. The data from single equipment for 1 year, including all the channels every cycle at 1024 samples per cycle, shall generally consume maximum of 10GB of memory.

## **7.0 TESTS**

### **7.1 General**

- 7.1.1 The inspection and functional testing of equipment will be carried out by RDSO representative prior to dispatch of equipment. This shall include verification of all the features of the equipment as per this specification.
- 7.1.2 The accuracy of the measurements of all input voltage, current channels shall be verified. The functioning of equipments at the specified range of the incoming supply including automatic changeover shall also be verified.
- 7.1.3 All the features of power quality analysis software, communication compatibilities and remote display features shall also be verified.
- 7.1.4 Tenderer shall furnish all the test certificates for EN 50160, and other safety and environmental compatibility as per respective IEC, IEEE standards to RDSO.



7.1.5 Any other test on the equipments considered necessary to verify its working and performance as per this specification, if required by RDSO shall be arranged by the successful tenderer.

#### **8.0 Training of Indian Railways' Engineers**

The offer shall include organizing training of three engineers free of cost at the manufacturer's works and at the traction substation of a railway system. The total duration of training shall be 4 days of which approximately 2 days will be at the manufacturer's works and 2 days on a railway substation. The travelling and boarding expenses shall be borne by the purchaser.

#### **9.0 Guarantee/Warranty**

The power quality analyzer including all equipment supplied against a purchase order/contract in which this specification is quoted, irrespective of origin (imported or indigenous), shall be guaranteed for trouble free and satisfactory performance for a period of 24 months from the date of commissioning. Details of warranty clause, the extent of responsibility and other relevant aspects shall be included in the purchase order or contract. The tenderer shall furnish detailed terms and conditions in this regard in his offer.