Technical Specification for FRTU suitable for 4 Way RMU

1.0 General

The Feeder Remote Terminal Unit (FRTU) shall be installed at 4 Way Ring Main Units (RMUs) sites. FRTU shall also be used for control of switching devices such as breaker, isolator switches etc. inside RMU panel from Master station(s). The supplied FRTUs shall be interfaced with the RMUs, communication equipment for which all the interface cables, TBs, wires, lugs, glands etc. shall be supplied, installed & terminated by the Vendor.

The FRTUs need to be installed in separate panel. The FRTU panel also must house the SMPS based DCPS and the Batteries, Modems/Routers and other accessories to be supplied by the Bidder. All necessary requirements for such arrangement within the panel must be made.

This specification covers design, engineering, manufacture, shop testing, inspection, packing and delivery of FRTU for RMU automation, complete with all accessories suitable for application for Distribution Automation system, installation & commissioning and integration to SCADA Control Centre, Kolkata with establishment of communication link. It is not the intent to specify completely herein all details of the equipments nevertheless the equipment shall be complete and operative in all respects and shall confirm to the highest standard of engineering, design and workmanship.

1.1 Design Standards

The FRTUs shall be designed in accordance with applicable International Electro-technical Commission (IEC), Institute of Electrical and Electronics Engineer (IEEE), American National Standards Institute (ANSI), and National Equipment Manufacturers association (NEMA) standards, unless otherwise specified in this Technical specification. In all cases the provisions of the latest edition or revision of the applicable standards in effect shall apply.

1.2 FRTU Functions

All functional capability described herein shall be provided by the Contractor even if a function is not initially implemented.

As a minimum, the FRTU shall be capable of performing the following functions:

(b) Acquiring analog values from Multifunction Transducers or alternatively through transducer- less modules and the status inputs of devices from the substation, processing and transmitting to Master stations. Two nos. PT100 sensor inputs shall be taken in FRTU directly or through transducers to measure temperatures for DistributionTransformers connected to the RMU. Supply , installation and commissioning of PT100 sensors shall be in the scope of the Bidder.

(c) Receiving and processing digital commands from the master station(s)

(d) Data transmission rates - 300 to 19200 bps for Serial ports forIEC60870-5-101 and Ethernet 10/100 Base T interface with IEC 60870-5-104 protocol

(e) Use of IEC 60870-5-104 protocol to communicate with the Master station(s)

(d) Use of MODBUS over RS485 interface, Protocol to communicate with the MFTs.

(e) Minimum number of I/O tags handling capacity shall be 100 I/Otags and 20,000 data points

(f) FRTU have inbuilt optical coupler to isolate field signals for Digital Inputs

(g) FRTU shall monitor suitable feature of external battery availability checkthrough potential free contact as DI signal to FRTU and Suitable provision in FRTU to supervise and prevent accidental serious discharge of battery.

(h) FRTU shall have the capability of automatic start-up and initialisation following restoration of power after an outage without need of manual intervention. All restarts shall be reported to the connected master stations.

(i) FRTU shall support web based monitoring/diagnostics and configuration from remote as well as local.

(j) Remote database downloading of FRTU from master station of SCADA/DMS Control Centre.
(k) Flash storage/ Internal battery backup to hold data in SOE buffer memory & also maintaining the time & date.
(l) FRTU Events shall be archived in logs.
(m) FRTU Events shall be stored in the archive logs with a time resolution of 1ms and a discrimination of 10ms.
(n) The capacity of the logs to be archivedshall be more than 30,000 events and measurement. All the logs shall be available from a maintenance tool connected to the FRTU or sent on request to the SCADA. The content of the logs shall be configurable and the name of the logs sent to the SCADA shall be configurable. It shall be formatted as a .csv file.
(o) As the SCADA/DMS system will use public domain such GPRS/CDMA etc, therefore it is mandatory to guard the data/ equipment from intrusion/damage/breach of security & shall have IPSecVPN based security.
(p) Communication with at least two master stations simultaneously on IEC 60870-5-104 through same subnet mask.
(q) FRTU shall be capable of acquiringanalog values through transducers having output as 4-20 mA, 0-10 mA, 0-+10 mA etc. usinganalog input modules.
(r) Supply , installation and commissioning of MFT in RMU Panel
(s) **Relevant diagnostic/status LEDs for each module shall be provided**

1.3CPU Modules

The FRTU shall provide CPU Module which is responsible for the main processing tasks and for the communication.

CPU shall handle all protocol emulation, perform data acquisition, and execute control requests. It shall accept commands from the master station, perform address recognition, assemble response messages in accordance with the received command messages, and transmit these messages to control center.

The main tasks of the CPU Modules are:

- Managing and controlling of the I/O modules
- Reading process events from the I/O modules
- Writing commands to the I/O modules
- Communication to control center and to subordinateddevices
- Managing of the time base and synchronizing the I/Omodules

The FRTU shall provide Data Archives in order to save data like system events from the FRTU, process events, and measuring values. It shall be possible to store this information with the time-stamp with 1 ms resolution in the data archive which will be saved in case of power-fail- in the Flash/EEPROM memory of the FRTU and not be erased in case of an outage of the power supply.

1.4Communication ports:-

The FRTUs shall have following communication ports to communicate with master station, MFTsand configuration & maintenance terminal.

- **FRTU shall have atleast two TCP/IP Ethernet port for communication with Master station(s) using IEC 60870-5-104 protocol.**

- FRTU shall have **minimum 2(two) number of RS 485 ports** for communication with MFTs to be connected in daisy chain using MODBUS protocol. Minimum 15 analogvalues(including 4 energy values) to be

considered per energy meter. The FRTU shall be designed to connect maximum 5 MFT per port. Further, bidder to demonstrate during testing that all analog values updated within 2 Sec.

- FRTU shall have one Ethernet/USB 2.0port for maintenance

The FRTU shall support the use of a different communication data exchange rate (bits per second) and scanning cycle on each port & different database for each master station.

1.4.1 Master Station Communication Protocol

FRTU shall use IEC 60870-5-104 communication protocol for communicating to master station. The FRTU communication protocol shall be configured to report analog (except energy values) & status changes by exception to master stations. However, FRTU shall support periodic reporting of analog data and periodicity shall be configurable from 2 sec to 1 hour. Digital status data shall have higher priority than the Analog data. The dead-band for reporting Analog value by exception shall be initially set to 1% (in %) of the full scale value. In addition, analog values shall also be reported to Master station by exception on violation of a defined threshold limit. All the analog values and status data shall also be assigned to scan groups for integrity check by Master stations at every 10 minutes configurable up to 60 minutes FRTU wise.

FRTU shall report energy values to master station periodically. The periodicity shall be configurable from 5 minutes to 24 hours (initially set for 15 minutes)

1.4.2Communication Protocol between FRTU & MFTs

The FRTU shall acquire data from the MFTs using the MODBUS protocol.

1.5 Analog Inputs(6 Input AI Card)

The real time values like Active power, Reactive Power, Apparent power, three phase Current & Voltage and frequency, and power factor & accumulated values of import /export energy values will be acquired FRTU from the following in the given manner:

1. MFTs installed in RMU
2. RTU shall also take 4-20 mA as analog inputs to acquire DC Batteryvoltage etc.

The FRTU analog-to-digital (A/D) converters shall have a digital resolution of at least twelvebits plus sign. The overall accuracy of the analog input system shall be at least 0.2 %(i.e. 99.8%) at 25 ºC of full scale .The FRTU shall be designed for common mode rejection ratio of voltage inputs for min 50 db from 1KHz to 5Khz and min 70 db from 5Khz to 1Mhz and better than 90 dB at 50/60 Hz. .Each input shall be galvanically insulated by transformer and have suitable protection and filtering to provide protection against voltage spikes and residual current at 50 Hz, 0.1 ma (peak-to-peak) and overload. Loading upto 150% of the input value shall not sustain any failures to the FRTU input.

The ability of the FRTU to accommodate dc inputs shall include the following signal ranges:

- Unipolar Voltage:0-0.5V, 0-1V, ~~0-5V~~, 0-10V,
- Unipolar Current: 0-1mA, 0-10mA, 0-20mA, 4-20Ma,
- Bipolar Voltage: 0.5V, 2.5V, 5V, ~~-20-0-20mA~~10V (- to +)

The total burden imposed by the FRTU analog input circuit shall not exceed 0.5 volt-ampere for current and voltage inputs. As an option, contractor may also provide transducer less solution to connect direct CT/PT secondary.

1.6 Status input:

RTU shall be capable of acceptinggalvanically isolated dry (potential free) contact status inputs. The FRTU shall provide necessary sensing voltage, current, optical isolation and de-bounce filtering independently for each status input. The sensing voltage shall not exceed 24Vdc (for 24Vdc supply).

Data Acquisition shall be with a resolution of 1 ms.**Minimum 64 Digitalinputs atleast in two DI cards shall be provided in FRTU**.

The RTU shall be set to capture contact operations of 20 ms or more duration. Operations of less than 20 ms duration shall be considered no change (contact bounce condition). The RTU shall accept two types of status inputs i.e. Single point Status inputs and Double point status inputs.

To take care of status contact chattering, a time period for each point and the allowable number of operations per time period shall be defined. If the allowable number of operations exceed within this time period, the status change shall not be accepted as valid.

Single point status input will be from a normally-open (NO) or normally-closed (NC) contact which is represented by 1-bit in the protocol message.

The Double point status input will be from two complementary contacts (one NO and one NC) which is represented by 2-bits in the protocol message. A switching device status is valid only when one contact is closed and the other contact is open. Invalid states shall be reported when both contacts are open or both contacts are closed.

All status inputs shall be scanned by the FRTU from the field at 1 millisecond periodicity.

The FRTU shall make provision to stop transmission when a Transmission Disable command is received from Control Centre. This is to suppress spurious recurring indications/ alarms.

Local indication for healthiness of Card shall be provided.

1.7 Sequence of Events (SOE) feature

To analyse the chronology or sequence of events occurring in the power system, time tagging of data is required which shall be achieved through SOE feature of RTU. The FRTU shall have an internal clock with the stability of 10ppm or better. The RTU time shall be set from time synchronization messages received from master station using IEC 60870-5-104 protocol. SOE time resolution shall be 1ms or better.

The RTU shall maintain a clock and shall time-stamp the digital status data. Any digital status input data point in the RTU shall be assignable as an SOE point. Each time a SOE status indication point changes the state, the RTU shall time-tag the change and store in SOE buffer within the RTU. A minimum of 4000 events can be stored in the SOE buffer. SOE shall be transferred to Master Station as per IEC 60870-5-104 protocol. SOE buffer shall be maintained by FRTU on power supply interruption.

1.8 Control Outputs:

The FRTU shall provide the capability for a master station to select and change the state of digital output points. These control outputs shall be galvanically insulated and used to control power system devices such as Circuit breakers, isolator, reset, relay disable/enable and other two-state devices, which shall be supported by the RTU. Switching voltage is 24 V DC. **Bidder shall provide minimum 24no. DO Output interfaces in atleast two cards per FRTU.**

A set of control outputs shall be provided for each controllable device. On receipt of command from a master station using the select check-before-execute operate (SCBO) sequence, the appropriate control output shall be operated for a presettime period which is adjustable for each point from 0.1 to 2 seconds.

Each control output shall consist of one set of potential free NO contact. The output contacts shall be rated for atleast3Amp continuous at 24VDC. These output contact shall be compatible to operate Trip and Close coil of switching devices in RMU. In addition Vendor may provide heavy Duty Relay for safety reason. These relay coils shall be shunted with diodes to suppress inductive transients associated with

energizing and de-energizing of the relay coils & shall conform to the relevant IEC requirements.**Local indication for healthiness of Card shall be provided.**

1.9 Heavy duty Control Output Relays

The control output contact from the FRTU shall be used for initiating heavy duty relays for trip/close of switching devices. The contractor shall provide heavy duty relays. Each heavy duty relays shall consist of **atleast 2 NO contacts**. The output contacts shall be rated for at least 3 Amps Continuous at 24VDC (5A/1min) and shall provide arc suppression to permit interruptions of an inductive load. Relay coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-energizing of the relay coils. The relays shall conform to the IEC255-1-00 and IEC 255-5 requirements.

HDR Make- **Sulzar, Schneider, ABB**

2.0Control Security and Safety Requirements

The FRTU shall include the following security and safety features as a minimum for control outputs:

a. Select- check-before-operate (SCBO) sequence for control output.
b. No more than one control point shall be selected/executed at any given time.
c. The control selection shall be automatically cancelled if after receiving the "control selection" message, the "control execute" command is not received within the set time period.
d. No control command shall be generated during power up or power down of FRTU.

2.1 Local/Remote selector switch

A manual Local/Remote selector switch shall be provided for each FRTU to disable all control outputs by breaking the power supply connection to the control outputs. When in the "Local" position, the Local/Remote switch shall allow testing of all the control outputs of FRTU without activating the control outputs to field devices. A status input indication shall be provided for the Local/Remote switch to allow the SCADA system to monitor the position of the switch.FRTU with inbuilt local remote selector switch also will be acceptable.

2.2 Dummy breaker latching relay

The Contractor shall provide a latching relay to be used to simulate and test supervisory control from the Master station. The latching relay shall accept the control signals from the FRTU to open and close, and shall provide the correct indication response through a single point status input.

2.3 Contact Multiplying Relays (CMRs)

Contact Multiplying Relays (CMRs) are required to multiply the contacts of breaker, isolators and protection relays etc. The contacts of these relays shall be used to provide status inputs to the RTUs.

The relays shall be DC operated self reset type. The rated voltage for relay operation shall be on 24 DC depending on the RMU DC supply. The relay shall be able to operate for +/-20% variation from nominal voltage.

The relay shall have a minimum of two change over contacts, out of which one shall be used for telemetry purposes. The contacts shall be rated to carry minimum current capacity of 5A.

The relay shall conform to following requirement.

a. Power Frequency withstand voltage–2KV for 1 minute as per IEC 255-5.
b. Insulation Resistance of 100M ohms measured using 500V DC megger.
c. 5KV Impulse test as per IEC 255-5

The relays coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-energizing of the relay coils. The relays shall conform to the IEC 255-1-00 and IEC 255-5 requirements. The relays must be protected against the effects of humidity, corrosion & provide with a dust tight cover. The connecting terminals shall be screw type & legibly marked. The relays shall have a visual operation indicator. The relays are to be mounted in FRTU panel.

CMR Make- Sulzar, Schneider,ABB

2.4 Time facility

The internal FRTU time base shall have a stability of 10 ppm. The RTU shall be synchronised through synchronisation message from master station at every 5 minutes (configurable from 5 minutes to 60 minutes) over IEC 60870-5-104/NTP/SNTP.

2.5 Diagnostic Software

Diagnostic Software shall be provided to continuously monitor operation of the FRTU and report FRTU hardware errors to the connected master stations. The software shall check for memory, processor, and input/output ports errors and failures of other functional areas defined in the specification of the FRTU.

All FRTU modules, shall have light emitting diodes (LEDs) to indicate errors or operating modes. The application/configuration data shall be stored on SD Cards which makes it possible to exchange modules without new configuration download.The functional operation of the FRTU shall be guaranteed by a comprehensive monitoring concept. The hardware and software shall be continuously monitored from the I/O modules throughout the entire FRTU. The hardware and software monitoring shall be carried out by active checks at several levels.The FRTU shall report its system and error states to the Control Centre by means of System Events.The FRTU shall provide remote diagnostics capabilities. It shall be possible to connect to the FRTU from a remote computer in order toanalyze the system and error status, check-up of the configuration or signal values of the FRTU remotely, e.g. by means of a Web-Server via LAN/WAN.

Remote access via Intranet shall be combined with authority privileges for the user for following activities:

- Monitoring the FRTU-produced internal error messages
- Monitoring and checking the FRTU configuration and the status of all connected process signals
- Checking the current version of the configuration file
- Downloading or uploading the FRTU configuration file
- Checking and downloading revised software files for the FRTU CPU modules
- Uploading the archive files

2.6 Troubleshooting:

FRTU shall have proper diagnostic tool for trouble shooting the failures related to the following from remotely as well as locally. Supplier shall consider all required configuration and diagnosis cable and software witheach supplied FRTU.

- Communication of FRTU with master
- Communication of MFT with FRTU.
- Communication of DI/DO

2.7 Input DC Power Supply

The FRTU will be powered from a 24 V DC power supply system. The RTU shall not place additional ground on the input power source. The characteristics of the input DC power supply shall be

(a) Nominal voltage of 24 VDC with variation between 20.4 and 28.8 Vdc(+20%/-15%)
(b) 10% ripple of nominal voltage for 10 min

(c) Battery and battery charger should capable for all FRTU required operation and Aux. supply to Modem & MFT and DC transducers etc.

The FRTU shall have adequate protection against reversed polarity, over current and under voltage conditions, to prevent the FRTU internal logic from being damaged and becoming unstable causing mal-operation.

2.8 Cyber security:

The FRTU shall comply the advanced cyber security standard i.eISO 27002 2005(previously known as ISO IEC 17799 2005), NERC CIP-009-1, and ISA-99.02.01[5]–[7],IEEE 1686 standard and should have following features:

- User level configuration
- User wise authentication like system admin, configuration admin, control, operator.
- Disabling the DNS
- Disabling, enabling & configuration of the TCP and UDP ports.
- Door lock alarm integration with FRTU.
- Local and remote access connection shall be secured for maintenance (locally and remotely) with HTTPS, IPSEC protocols
- Role Based User Account Management (UAM) integrated in the Web Server
- User Activity Log (UAL) on the SD card or internal memory of the CPU
- Password Complexity enforcement based on at least one upper/lower/number/ non-alphanumeric character options
- Security Event Logging and viewing of the same through the web browser. It shall also be possible to upload this log into CSV files.
- The FRTU shall be hardened - Closing of unused TCP/IP ports and services
- Enabling/disabling of Web Server use
- Secured HTTPS connection to the FRTU through Web Browsershall be supported
- **FRTU should conform any of the following security standards in respect of above functionalities andto be tested as per following standard**:
  a. NERC/CIP - North American Electric Reliability Corporation - Critical Infrastructure ProtectionNERC CIP-009-1, and ISA-99.02.01[5]–[7]
  b. IEC 62351-5:2013,IEC 62351-3- Power systems management and associated information interchange - Data and communications security
  c. IEEE 1686 - Standard for Substation Intelligent Electronic Devices (IED) Cyber Security Capabilities.

2.9 Communication security

The FRTU shall support network layer security with IPSec and transport layer security with https and Web.

3.0 Security Log

- The FRTU shall provide a local audit trail for all security events that occur.
- Log files shall be produced in Syslog format.

3.2 Archives:

FRTU Events shall be archived in logs in CPU internal memory or externalSD card.FRTU Events shall be stored in the archive logs with a time resolution of 1ms, and a discrimination of 10ms.The capacity of the logs shall be more than 30,000events and measurement.All the logs shall be available from a maintenance tool connected to the FRTU or sent on request to the SCADA. The content of the logs shall be configurable and the name of thelogs sent to the SCADA shall be configurable. It shall be formatted as a .csv file.

3.3 Accessories:

- MCB for each AC and DC supply.
- All intra panel wiring and cable to connect the Batteries.
- FRTU panel should be earthed to the existing system earthing
- FRTU Panel to RMU Panel wiring.

3.4 Environmental Requirements

The FRTU will be installed in open environment with no temperature or humidity control. The RTUs shall be capable of operating in ambient temperature from 0 to +55 degree C and relative humidity less than 95%, non-condensing. FRTUs to be installed in the hilly region with the history of snowfall, the lower ambient temperature limit shall be - 5 degree C.

3.5 FRTU Size and Expandability

It shall be possible to expand the FRTU capability for additional 50 % of the basic point counts by way of addition of hardware such as modules, racks, panels, however, FRTU software and database shall be sized to accommodate such growth without requiring software , firmware or database regeneration.

3.6 FRTU Panels

At least 50% of the space inside each enclosure shall be unused (spare) space that shall be reserved for future use. FRTU panel dimension should be around 650mm (W), 450mm (D), 1200mm (H). Panel with lesser dimension is preferred.The Contractor shall provide required panels conforming to IEC 529 for housing the FRTU modules/racks, relays etc. and other required hardware. No IO module shall be placed outside the FRTU panel. The panels shall meet the following requirements:

(a) Shall be pole/ floor mounted compact size cabinet. The size shall be sufficient to accommodate the FRTUs and associated equipment required for telemetry and control and shall be designed according to the site requirement/locations at the time of design/ engineering. All doors and removable panels shall be fitted with long life rubber beading. All non load bearing panels/doors shall be fabricated from minimum 1.6 mm thickness steel sheet and all load bearing panels, frames, top & bottom panels shall be fabricated from minimum 2.0 mm thickness steel sheet

(b) Shall have maintenance access to the hardware and wiring through lockable doors.

(c) Shall have the provisions for bottom cable entry

(d) The safety ground shall be isolated from the signal ground and shall be connected to the ground network. Safety ground shall be a copper bus bar. The contractor shall connect the panel's safety ground to the owner's grounding network. Signal ground shall be connected to the communication equipment signal ground.

(e) All panels shall be supplied with 230 Vac, 50 Hz, single-phase switch and 15/5A duplex socket arrangement for maintenance.

(f) All panels shall be provided with an internal maintenance lamp and gaskets.

(g) **All panels shall be outdoor, dust-proof with rodent protection, and meet class of protection IP55**.

(h) There shall be no sharp corners or edges. All edges shall be rounded to prevent injury.

(j) All materials used in the enclosures including cable insulation or sheathing, wire troughs, terminal blocks, and enclosure trim shall be made of flame retardant material and shall not produce toxic gasses under fire conditions.

(k) Panels shall have padlocking arrangement.

3.7 Wiring/Cabling requirements

The FRTU panels shall gather all signals from and to the devices located in RMU panels. All wires that carry low-level signals shall be adequately protected and separated as far as possible from power wiring. All wires shall be identified either by using ferrules or by colour coding. In addition, cables shall

be provided with cable numbers at both ends, attached to the cable itself at the floor plate where it enters the cubicles.

Shielded cables shall be used for external Cabling from the FRTU panels. The external cables (except communication cables) shall have the following characteristics:

h) All cables shall have stranded copper conductor.
i) Minimum core cross-section of 2.5 mm_2 for PT cables, 2.5 mm_2 for CT cables, if applicable and 2.5 mm_2 for Control outputs and 1.5mm_2 for Status inputs
j) Rated voltage Uo/U of 0.6/1.1KV
k) 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.
l) Shielding, longitudinally laid with overlap.
m) Dielectric withstand 2.5 kV at 50 Hz for 5 minutes
n) 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.

3.8 Terminal Blocks (TBs)

Terminal blocks shall be having provision for disconnection (isolation), with full-depth insulating barriers made from moulded self-extinguishing material. Terminal blocks shall be appropriately sized and rated for the electrical capacity of the circuit and wire used. No more than two wires shall be connected to any terminal. Required number of TBs shall be provided for common shield termination for each cable.

All terminal blocks shall be suitably arranged for easy identification of its usages such as CT circuits, PT circuits, analog inputs, status inputs, control outputs, auxiliary power supply circuits, communication signals etc. TBs for CT circuits shall have feature for CT shorting (on CT side) & disconnection (from load side) to facilitate testing by current injection. Similarly, TBs for PT circuit shall have feature for disconnection to facilitate voltage injection for testing.

3.9 Training:

Bidder shall give training to 10 persons for 5 days on operation and configuration of FRTU and related accessories and auxiliary equipment to WBSEDCL Engineers at the manufacturing facility.
FRTU training course shall cover the following:

- FRTU operation including data flow.
- Troubleshooting, identification and replacement of faulty Modules.
- Preventive maintenance of the FRTU
- Use of FRTU configuration and Maintenance tool
- All functional and Diagnostic testing of FRTU
- Database modification and configuration of FRTU

3.10ARTU/FRTU Data base configuration & Maintenance software tool

The RTU/FRTU database configuration & Maintenance software tool shall be required to perform the database modification, configuration, compilation and documentation. The database compiler shall provide error detection services. It shall also perform the downloading of the compiled database into the RTU database. Bidder shall supply Licensed Software. Qty shall be supplied as per BOQ.

3.10 B Laptop PC for above software tools along with interfacing hardware

A laptop PC shall be used for the above mentioned software tools. The laptop PC shall be provided with all hardware accessories including cables, connectors etc. required for interfacing with Master station,

RTU/FRTU and MFT. A suitable Hub shall be provided to use the tool in monitor mode. A carrying case and a suitable power adaptor (input 230VAC, 50Hz) for laptop PC shall also be supplied.Qty shall be supplied as per BOQ.

3.11Nameplate and Markings:

Nameplate showing all technical parameters shall be provided on all equipments. "PROPERTY of West Bengal State Electricity Distribution Company Ltd." shall be suitably engraved on the nameplate.

3.12Painting:

All paints shall be applied on clean, dry surfaces under suitable atmospheric and other conditions in accordance with the as per **seven tank process**and paint manufacturer's instructions. The system shall be capable of performance for five years in the environment specified without any need for maintenance**.**

Color Code:

Exterior- SMN SIEMNES GRAY –RAL 7035(Texture)

Interior- SMN SIEMENS GRAY – RAL 7035(Texture)

Paint thickness: 60-90 Microns

3.13Factory Inspection:

Equipment shall be subject to inspection by a duly authorized representative of the Purchaser. Inspection may be made at any stage of manufacture at the option of the purchaser and if the equipment found unsatisfactory as to workmanship or material, the same is liable for rejection. Supplier shall grant free access to the place of manufacture to the purchaser's representative at all times when the work is in progress.To and Fro travel expenses and accommodation will be in the purchaser scope.

Supplier shall give prior inspection notice of **15 days for domestic and 30days for international location.**

Factory inspection will be carried as per approved QAP.Material shall be dispatched after Dispatch Clearance only.

3.14Guarantee:

Supply of all equipment's and associated accessories shall be guaranteed for satisfactory performance for period of **60** months from the date of commissioning. In case of failure of equipment / part of equipment during guarantee period it shall be replaced or repaired by supplier free of cost.

Supplier should replace the faulty part with operational part during the Guarantee period. Supplier has to provide remote and on-site support to resolve the hardware and software related issue.

3.15Quality control:

Manufacturer shall have adequate Quality Control Facilities. *Quality assurance plan & Field quality plan shall be submitted*.

Testing facilities:

Manufacturer shall have adequate in house testing facilities for carrying out all routine tests & acceptance tests as per relevant International / Indian standards.

Manufacturing activities:

Separate sheet showing detail-manufacturing activities shall be submitted alongwith bid.

3.16Spare parts:

The Bidder shall give an assurance that spares will continue to be available through the life of the equipment which shall be 10years minimum. However, the supplier shall give a minimum of 12 months' notice in the event of plan to discontinue manufacture of any component used in this equipment.

Any parts shall be subject to the same specification, tests and conditions as similar material supplied under the Contract. They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the plant and must be suitably marked and numbered for identification.

However, Bidder shall offer 5% mandatory spares for FRTU and DCPS and other accessories for five years operation.

3.17Packing and Shipping:

Packing:

The equipments are to be transported adequately sealed against water ingress, All accessories and spares shall be packed and securely clamped against movement in robust, wooden, non returnable packing cases to ensure safe transit in rough terrain, cross country road conditions and in heavy rains from the manufacturer's works to the specified destinations.

Equipment or material liable to deterioration by sea water, moisture, or ingress of foreign matter shall be totally sealed in strong polythene bags and those -liable to deterioration due to condensation shall be protected by packs of silica gel or other approved desiccant.

All accessories shall be carefully packed so that they are fully protected during transport and handling operations and in storage. Internal surfaces of loose accessories shall be sealed by means of gaskets and blanking off plates. All parts liable to rust shall receive an anti-rusting coat and shall be suitably protected. It shall be the responsibility of the Contractor to make good any damage caused through insufficient packing.

Each packing case shall be indelibly marked, on two adjacent sides and on the top, with the following,

Individual serial number

Purchaser's name

Order number

Destination (A color coded marking to indicate destination)

Manufacturers /Suppliers name

Description and numbers of contents

Country of origin

Case measurements

Gross and net weights in kilogram.

Necessary slinging and stacking instructions.

Each crate or container shall be marked clearly on the outside of the case to show TOP and BOTTOM positions with appropriate signs to indicate where the mass is bearing and the correct positions for slings. All component parts, which are separately transported, shall have permanent identification marks to facilitate correct matching and assembly at site.

Welded parts shall be marked before welding.

3.18FRTU I/O LIST FOR 4-WAY RING MAIN UNIT

RMU CONFIGURATION: 2 INCOMING LBS, 2 OUTGOING CB				
11kV Load Break Switch				
Sl. No.	**SIGNAL NAME**	**POINT TYPE**	**SIGNAL SOURCE**	**QUANTITY**
1	LBS- OPEN	DIGITAL INPUT	RMU	2
2	LBS- CLOSE	DIGITAL INPUT	RMU	2
3	EARTH SWITCH-CLOSE	DIGITAL INPUT	RMU	2
4	FPI FAULT	DIGITAL INPUT	RMU- FPI	2
5	LBS- OPEN CMD	DIGITAL OUTPUT	FRTU	2
6	LBS- CLOSE CMD	DIGITAL OUTPUT	FRTU	2
7	FPI RESET CMD	DIGITAL OUTPUT	FRTU	2
11kV Circuit Breaker				
Sl. No.	**SIGNAL NAME**	**POINT TYPE**	**SIGNAL SOURCE**	**QUANTITY**
1	CIRCUIT BREAKER OPEN	DIGITAL INPUT	RMU	2
2	CIRCUIT BREAKER CLOSE	DIGITAL INPUT	RMU	2
3	EARTH SWITCH-CLOSE	DIGITAL INPUT	RMU	2
4	CIRCUIT BREAKER SPRING CHARGE	DIGITAL INPUT	RMU	2
5	EARTH FAULT	MODBUS	RMU-PROTECTION RELAY	2
6	OVER CURRENT	MODBUS	RMU-PROTECTION RELAY	2
7	CIRCUIT BREAKER-OPEN CMD	DIGITAL OUTPUT	FRTU	2
8	CIRCUIT BREAKER-CLOSE CMD	DIGITAL OUTPUT	FRTU	2
8	RELAY RESET CMD	DIGITAL OUTPUT	FRTU	2
9	Analog POINTS(MFT)	MODBUS	RMU/MFT (2 nos. one in each CB)	Three Ph-Current, Three PH Voltage, Freq, Active Power, Reactive

				Power, Energy
10	Battery Charger Signal	DC Transducer	FRTU/RMU	Battery Voltage(2)
11	Transformer Supervision Signal	Digital Input	RMU	Transformer Supervision Relay(2)
COMMON SIGNALS				
Sl. No.	**SIGNAL NAME**	**POINT TYPE**	**SIGNAL SOURCE**	**QUANTITY**
	COMMUNICATION STATUS	FRTU INTERNAL SOFT SIGNAL		1
	BATTERY CHARGER FAIL	DIGITAL INPUT	BATTERY CHARGER of RMU	1
	PANEL DOOR OPEN	DIGITAL INPUT	RMU	1
	SF6 PRESSURE LOW	DIGITAL INPUT	RMU	1
	RMU IN LOCAL	DIGITAL INPUT	RMU	1
	RMU IN REMOTE	DIGITAL INPUT	RMU	1
	FRTU in Local	DIGITAL INPUT	FRTU	1
	FRTU in Remote	DIGITAL INPUT	FRTU	1
	FRTU Door Open	DIGITAL INPUT	FRTU	1
	System AC SUPPLY FAIL	DIGITAL INPUT	RMU	1
	BATTERYLOW VOLTAGE (PRE CUT OFF)	DIGITAL INPUT	DCPS(FRTU)	1
	DCPS MODULE FAIL	DIGITAL INPUT	DCPS(FRTU)	1

N.B Any other INPUT/OUT PUT points as per Technical specification need to be provided and shall be decided at the time of detailed design and engineering.

TESTING and DOCUMENTATION

FRTU Testing

1.1 This chapter describes testing and documentation requirement for FRTU.

(a) Type Testing:

FRTU including Transducers shall conform to the type tests listed in the relevant table. Type test reports of tests conducted in NABL accredited Labs or internationally accredited labs within last 5years from the date of bid opening may be submitted. **Bidder shall offer only Type tested Product**. A complete integrated unit shall be tested to assure full compliance with the functional and technical requirements of the Specification. The testing sample shall include one of each type of cards/modules and devices. The list of Type tests to be performed on the FRTU is mentioned in **Table-A and Table-B of this chapter**. For other items also such as MFT, sensor etc the requirements are mentioned in the respective sub sections of specification. However, the type tests shall be only be limited to the specification of that item only. **Type Test reports shall be in the name of the Bidder for FRTU.**

(b) Factory Acceptance test (FAT):

Each complete unit shall undergo FAT. The list of Routine tests to be performed in the factory is mentioned in **Table-A**.

(c) Site Acceptance Test (SAT)

(i) Field Tests

After FRTU panel installation, interface cabling with RMU panels/Termination boxes, communication panel and interface cabling with field & communication equipment, the Contractor shall carry out the field-testing. The list of field tests for FRTU is mentioned in **Table-A.**

(ii) Availability Tests

After field testing, FRTU shall exhibit a 99% availability during test period (15 days). Availability tests shall be performed along with Master station. The FRTU shall be considered available only when all its functionality and hardware is operational. **The non-available period due to external factors such as failure of communication link etc., shall be treated as hold-time & availability test duration shall be extended by such hold time**.

Table-1: List of Tests on FRTU

Test Nos.	DESCRIPTION OF THE TEST	Type test	Routine test	Field test
A	**FUNCTIONAL TESTS FOR RTU/FRTU**			
1.	Check for BOQ, Technical details, Construction & Wiring as per RTU/FRTU drawings	√	√	√
2.	Check for database & configuration settings	√	√	√
3.	Check the operation of all Analog inputs, Status input & Control output points of RTU/FRTU	√	√	√
4.	Check operation of all communication ports of RTU/FRTU	√	√	√
5.	Check for communication with master stations including remote database downloading from master station	√		√
6.	Check for auto restoration of RTU/FRTU on DC power recovery after its failure	√		√
7.	Test for self-diagnostic feature	√		√
8.	Test for time synchronization from Master	√		√
9.	Test for SOE feature	√		√
10.	End to end test (between RTU/FRTU & Master station) for all I/O points			√
11.	Test for MODBUS protocol implemented for acquiring data from MFT/ transducers and updation time demonstration in daisy chain configuration	√		√
12.	Test for IEC 60870-5 -104,101 protocol implemented	√		√
13.	Test for supporting other protocol	√		
14.	Test for operation with DC power supply voltage variation	√		
15.	Test for internal Clock stability	√		
16.	Test for Noise level measurement	√		
17.	Test for Control Security and Safety for Control outputs	√		
18.	Test for functionality/parameters verification of , CMRs & Heavy duty trip relays	√	√	√
21.	Test for SOE buffer & time data back up	√		
22.	Other functional tests as per technical specification requirements including features in support/ capability (for future)	√		
24.	Test for compliance of standards for bought items viz. CMRs, Heavy duty trip relays , MFT,weather sensor etc	√		

25.	Test for functionality/parameters for bought items viz. CMRs, Heavy duty trip relays ,	√	√	
	MFT , weather sensor etc			
26.	Test for test tools		√	√
B	**EMI/EMC IMMUNITY TESTS FOR RTU/FRTU**			
28.	Surge Immunity Test as per IEC 60870-2-1	√		
29.	Electrical Fast Transient Burst Test as per IEC-60870-2-1	√		
30.	Damped Oscillatory Wave Test as per IEC 60870-2-1	√		
31.	Electrostatic Discharge test as per IEC 60870-2-1	√		
32.	Radiated Electromagnetic Field Test as per IEC 60870-2-1	√		
33.	Damped Oscillatory magnetic Field Test as per IEC-60870-2-1	√		
34.	Power Frequency magnetic Field Test as per IEC-60870-2-1	√		
C	**INSULATION TEST FOR RTU/FRTU**			
35.	Power frequency voltage withstand Test as per IEC 60870-2-1	√		
36.	1.2/50 µs Impulse voltage withstand Test as per IEC 60870-2-1	√		
37.	Insulation resistance test	√		
D	**ENVIRONMENTAL TEST FOR RTU/FRTU ——**			
38.	Dry heat test as per IEC60068-2-2	√		
39.	Damp heat test as per IEC60068-2-3	√		

1. **Contractor can provide test certificates for the type tests mentioned in B,C,D& supporting protocols from Govt of India/NABL/International accredited Labs. If not provided, the same needs to conducted at Govt of India/NABL/International accredited Labs**

2. **Transducer type test requirements are mentioned in the respective sub section of specification**.

Table--2

RTU/FRTU Type Test Requirements

Test Name	**EUT Status**	**Test Level**	**Power Supply Points**		**I/O Points**	**Passing Criteria**
			CM	DM	CM	
Surge Immunity Test (Test 28)	ON	Level 3	2 kV	1 kV	2 kV	A
Electrical Fast Transient Burst Test (Test 29)	ON	Level 3	2 KV	-	1 kV	A
Damped Oscillatory Wave Test (Test 30)	ON	Level 3	2.5 kV	1 kV	2.5 kV	A
Electrostatic Discharge (Test 31)	ON	Level 3	+/- 6 kV in Contact discharge mode or +/- 8 kV in Air discharge mode			A
Radiated Electromagnetic Field (Test 32)	ON	Level 3	10 V/m electric field strength			A
Damped Oscillatory Magnetic Field test (Test 33)	ON	Level 3	30 A/m at 1MHz of magnetic field strength			A
Power frequency magnetic field (Test 34)	ON	Level 3	30 A/m of magnetic field strength (Continuous duration sine wave)			A
Power frequency voltage withstand (Test 35)	OFF	-	1 KVrms for 1 minute			No break down or flashover shall occur

1.2/50µs impulse voltage withstand (Test 36)	OFF	-	2 kVp	No break down or flashover shall occur
Insulation Resistance Test (Test 37)	OFF	-	Measure Insulation resistance using 500 V DC Megger before & after Power Freq& Impulse voltage withstand tests	As per manufacturer standard
Dry heat test (Test 38)	ON	-	Continuous operation at 55^0 C for 16 hrs	0
Damp heat test (Test 39)	ON	-	at 95% RH and 40^0 C	0

2.0 DOCUMENTATION

The Contractor shall submit 3 sets of all the standard and customised FRTU documents for review and approval which includes the following:

- FRTU Function design document
- FRTU Hardware description document & all the documents referredtherein to meet all the clauses of the specification.
- FRTU Test equipment user documents.
- FRTU user guide
- FRTU Operation & Maintenance document
- FRTU Training documentation
- FRTU database document
- FRTU I/O list (as build) after the execution
- FRTU Test procedures
- Data Requirement Sheet (DRS) of all items
- Protocol documentation including implementation profile etc.
- FRTU installation and Layout, GA, BOQ, schematics and internal wiring
- drawings for each FRTU site
- FRTU to RMU panels/ field device cabling details for each FRTU site
- Design and Engineering document for DCPS and Battery including load requirement calculation, battery installation diagram etc.

After approval of all the above documents, the Contractor shall submit three sets as final documents. The site-specific drawings as indicated above shall be submitted in three sets for each site before installation of FRTU. In case some modifications/corrections are carried out at site, the contractor shall again submit as built site-specific drawings in three sets after incorporating all such corrections as noticed during commissioning of the FRTU.

Technical Specification for 24V DC POWER SUPPLY SYSTEM for FRTU

The DC Power Supply system shall be capable of meeting the load requirements for various Telecom equipments, FRTUs and other associated equipment to be supplied by the Bidder. The AC input to the DCPS system shall be single phase AC 240 V will be provided from the existing system. At these locations the class B & C level of surge protection (between phase-neutral and neutral – protective earth) as specified under and conforming to IEC 61312, IEC 61024 and VDE 0100-534 shall be installed in the DCPS system.

Surge protection devices shall be installed in the DCPS panel to provide adequate protection against current and voltage transients introduced on input AC due to load switching and low energy lightning surges. These protection devices shall be in compliance with IEC- 61312, IEC-61024 and VDE 0100-534 for following surges:

a) Lightning Electromagnetic impulse and other High Surges (Class B):

Between	**Requirement**
Ph& N	$I_{imp} \geq 50$ kA, 10/350 µS for each phase
N & PE	$I_{imp} \geq 100$ kA, 10/350 µS

I_{imp}= Value of Lightning Impulse Current

b) Low Voltage Surges (Class C)

Between	**Requirement**
Ph& N	$I_n \geq 10$ kA, 8/20 µS for each phase
N & PE	$I_n \geq 20$ kA, 8/20 µS

I_n= Value of Nominal Discharge Current.

1.1 General Technical Requirements for SMPS based DC power supply units

SMPS based DC power supply system is to be used in Auto Float-cum-Boost Charge mode as a regulated DC Power source. DCPS system is to be installed outdoors in FRTU panels. The System shall consist of the following:

b SMPS modules
c Controller module to control and monitor all DCPS modules.
d

The minimum number and rating of SMPS modules shall be 10Amp/module each with atleast two modules per DCPS. However, Load requirement calculation should be submitted during Bidding. The Panel, Distribution/Switching arrangement shall be provided for the ultimate system capacity. Ultimate capacity is defined as 150% of the present capacity specified. The ultimate capacity is over and above the requirement of redundancy wherever specified. All factory wiring for the panel shall be for the ultimate capacity so that only plugging-in of SMPS module shall enhance the DC power output. The size of fuses, MCBs, switch, bus etc shall be suitable for the ultimate capacity.

The system shall be sufficiently flexible to serve any load depending on manufacturer's design, rating and number of SMPS modules used in panel and system configuration. To cater for higher load requirements, same type of SMPS modules mounted in the same rack or different racks shall be capable of working in parallel load sharing arrangement. The DCPS system shall be suitable for operation from single phase A.C. mains.

1.2 Operational/Component Requirements

The basic modules shall operate at specified ratings and conform to requirements stipulated in this specification. The DCPS system shall meet requirement of the latest TEC specification / IEC/BS for other parameters not specified in this specification. The component parts of the

equipment shall be of professional grade of reputed manufacturer to ensure prompt and continuous service and delivery of spare parts. The component shall confer to relevant IEC/IS standards. The contractor shall obtain Employers approval of major component before procurement of the same.

The DCPS shall be suitable for operation at ambient temperature of 0-50 deg and relative humilities up to 95 %.

1.3 Wiring

All insulated conductors except those within the confines of a printed circuit board assembly shall be of the rating enough to withstand the maximum current and voltage during fault and overload. All insulated conductors/cables used shall conform to IS 1554 or equivalent international standard.

All wiring shall be neatly secured in position and adequately supported. Where wires pass through any part of metal panel or cover, the hole through which they pass shall be suitably secured.

1.4 Earthing

Two earth terminals shall be provided in the frame of the system. The Contractor shall connect these earth terminals to the earth bus. All modules and devices shall be connected to these earth terminals. The hinged door shall be connected to the panel with braided Cu at two point at least.

1.5 Finish and Painting

The finish of Steel/Aluminium alloy structure and panels shall conform to relevant IS specification (or equivalent international specifications). The colour scheme for panel, Door and Modules shall be decided during detailed engineering.

1.6 Marking and Labelling of Cables

The Contractor shall propose a scheme for marking and labelling the inter panel cables and get it approved from the Employer. A cabling diagram, screen printed or any other better arrangement ensuring better life expectancy shall be placed in the inside of the front door or any other convenient place for ready reference of the maintenance staff.

1.7 Name Plate

A name plate etched, engraved, anodized or any other better arrangement ensuring better life expectancy shall be suitably fixed on each panel /module and contain at least the following information :

(a) Type of the Unit / Model No
(b) Manufacturer's Name and identification
(c) Unit serial No
(d) Year of manufacture
(e) Input voltage and phase
(f) Output Voltage and Current
(g) PO No. Warranty Period-5 Years
(h) "Property of WBSEDCL"

1.8 System and Panel Configuration

The mechanical and electrical requirements of the Panel are described as below:

1.8.1 System Configuration

The SMPS modules shall be accommodated in panels. The system shall employ a modular configuration to provide flexibility, keeping in view the future load requirements of DC Power. The system shall be configured for ultimate capacity as brought out in General Technical

Requirements. The control, Monitoring, Alarm arrangement and DC distribution shall be provided suitably in the panel.

The number of SMPS modules to be provided in the DCPS system shall be provided in N+1 configuration, where N is the number of SMPS modules to meet the battery charging current (10% of C_{10} AH Capacity) of the offered battery @ 20 hours for 12V monoblock rate of discharge plus the load requirement. The current rating of each module shall be considered as output current of the SMPS module at nominal voltage (24V).

It shall be possible to easily mount/remove the modules from the front side of the panel. The SMPS modules/SMPS module sub-racks shall be designed to slide into the panels and fixed securely by a suitable mechanical arrangement.

1.8.2 Constructional Features of Panel

Panel (Enclosure) shall be freestanding type of design. Cable entry shall be from the bottom of the enclosures. The enclosures doors shall be hinged with locking as per standard design of the manufacturer. Keyed locking is required with identical keys for all enclosures. The size of the enclosure should be such that the same can be easily placed in FRTU panel. The thickness of the structural frames and load bearing members shall be minimum 2.0 mm and for others shall be 1.5 mm. The panels/boards shall be equipped with necessary cable gland plates. The Contractor shall state the type, size, and weight of all enclosures and indicate the proposed manner of installation.

Wiring within panel shall be neatly arranged and securely fastened to the enclosure by non-conductive fasteners. Wiring between all stationary and moveable components, such as wiring across hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wire. Conductors in multi conductor cables shall be individually colour coded, and numbered at both ends within enclosures.

The enclosures shall be painted inside and outside. The finish colour of all enclosures shall be an aesthetically pleasing and shall be approved by the owner. Further, finish colour of external surfaces shall be preferably of same colour for all enclosures/panels.
Maintenance access to the hardware and wiring shall be through lockable, full height, from doors.

Each panel shall be supplied with 240 VAC, 50Hz single-phase sockets with switch and lighting lamp for panel illumination.

The manufacturer so as to ensure the uninterrupted use of the equipment shall do proper thermal engineering of hardware design. The Panel shall be designed to allow cooling preferably by natural convection and shall be operating in the specified ambient conditions.

1.8.3 Electrical Requirements:

AC input supply: The nominal input frequency is 50 Hz, which may vary from 47.5-52.5Hz. Theinput voltage shall be single phase (Nominal 240V) varying from 190V to 265V for power supply for DCPS.

There shall be an automatic arrangement for shutting off of the SMPS module whenever the input voltage is beyond the specified operating limits with suitable alarm indication. The SMPS module shall resume normal working automatically when the input is restored within the working limits. Hysteresis within specified working limits shall not cause shutting down of the SMPS. A tolerance of ±5V may be acceptable for protection & alarm operation.

1.9 DC output Characteristics of Modules

The module shall be capable of operating in "Auto Float-cum-Boost Charge" mode depending on the condition of the battery sets being sensed by the Control unit.

(a) The float voltage shall be continuously adjustable & pre-settable at any value in the range of -24 to 28V (for 24V) either at the module or may be set from the common controller

configuration. Further, the prescribed float voltage setting shall be based on recommendations of the VRLA battery supplier.

(b)In Boost charge mode SMPS shall supply battery & equipment current till terminal voltage reaches set value, which is normally 13.8V/cell in case of 12V monoblock or as recommended by the VRLA battery supplier & shall change over to constant voltage mode

(c) The DC output voltage variation shall not be more than 2% for load variation from 25% load to full load.

1.10 Current Limiting (Voltage Droop)

The current limiting (Voltage Droop) shall be provided in DCPS modules in float and boost charge modes of operation. The float/boost charge current limiting shall be continuously adjustable between 50 to 100% of rated output current for output voltage range of 22.2 to 28 for 24V DC.

The float and boost charge current limit adjustment shall be provided in the DCPS system. The SMPS modules shall be fully protected against short circuit. It shall be ensured that short circuit does not lead to any fire hazard.

1.11 Soft/Slow Start Feature:

Soft/Slow start circuitry shall be employed such that SMPS module input current and output voltage shall reach their nominal value within 10 seconds.

The maximum instantaneous current during start up shall not exceed the peak value of the rectifier input current at full load at the lowest input voltage specified.

1.12 Voltage overshoot/Undershoot:

The requirements of (a) to (c) given below shall be achieved without a battery connected to the output of SMPS module.

(a) The SMPS modules shall be designed to minimise DC output voltage Overshoot/Undershoot such that when they are switched on the DC output voltage shall be limited to ± 5% of the set voltage & return to their steady state within 20 ms for load variation of 25% to 100%.
(b) The DC output voltage overshoot for a step change in AC mains as specified in clause 4.3.12 Electrical Requirements shall not cause shut down of SMPS module and the voltage overshoot shall be limited to ± 5% of its set voltage and return to steady state within 20ms.
(c) The modules shall be designed such that a step load change of 25 to 100% and vice versa shall not result in DC output voltage Overshoot/Undershoot of not more than 5% and return to steady state value within 10 ms without resulting the unit to trip.

1.13 Electrical Noise :

The Rectifier (SMPS) Modules shall be provided with suitable filter at output with discharge arrangements on shut down of the modules. The Psophometric Noise and ripple shall be as per relevant standards.

1.14 Parallel Operation

SMPS modules shall be suitable for operating in parallel with one or more modules of similar type, make and rating, other output conditions remaining within specified limits.

The current sharing shall be within ± 10% of the average current per rectifier module individual capacity of each rectifier module in the system (mounted in the same or different Panels) when loaded between 50 to 100% of its rated capacity for all other working conditions.

1.15 Protection

The SMPS module, which has failed (for any reason) shall be automatically isolated from the rest of the modules and an alarm shall be initiated for the failure.

A. DC Over voltage protection

DCPS shall be fitted with an internal over voltage protection circuit.

In case output DC voltage exceeds 28V (24V DC) or as per the recommendations of the manufacturer of batteries, the over voltage protection circuit shall operate & shut off the faulty module. A tolerance of ± 0.25V is permitted in this case.

Shutting off of faulty SMPS module shall not affect the operation of other SMPS modules operating in the Panel. Operation of over voltage shut down shall be suitably indicated and extended monitoring/control unit. The circuit design shall ensure protection against the discharge of the Battery through the SMPS module in any case. The over voltage protection circuit failure shall not cause any safety hazard.

B. Fuse/Circuit Breakers

Fuses or miniature circuit breakers (MCB) shall be provided for each SMPS module as follows:

- Live AC input line
- Control Circuit
- Load Circuit

All fuses/circuit breaker used shall be suitably fault rated.

C. AC Under/Over Voltage Protection

AC input Under/Over voltage protection shall be provided for Electrical Requirements.

D. Over Load/Short Circuit Protection

The SMPS shall be protected for Over load/Short circuit Current Limiting (Voltage Droop).

1.16 Alarms and indicating lamps

Visual LED indications/display shall be provided on each SMPS module for detection of SMPS module failure.

1.17 Termination

Suitable termination arrangements shall be provided in the panel for termination of inter cubicle cables from other equipment such as owners ACDB, Telecom and other associated equipments and alarm cables. All the termination points shall be easily accessible from front and top. AC and DC terminals shall be separated by physical barriers to ensure safety. All the terminals except AC earth shall be electrically isolated.

DC Terminations

All terminations including through MCBs shall be through lock and screw type terminations. Load and batteries shall be connected to DCPS through appropriate MCBs. The isolation of any of the battery from the load shall create an alarm.

DC distribution may be done on the DCPS panel. The proper rated MCB shall be provided at the combined output of the SMPS modules (if not provided at each SMPS module). All the AC, DC and Control/alarm cabling shall be supplied with the Panel. All DC +ve and – ve leads shall be clearly marked. All conductors shall be properly rated to prevent excessive heating.

1.18 Power Cables

All power cables shall be stranded copper conductor XLPE/PVC insulated FRLS type and PVC sheathed, single core/two core/three core/four core, 1100V grade as per IS 1554 Part-I.

1.19 Earthing Cables

Earthing cables between equipment and grounding bus bars shall be minimum size 70 mm^2 stranded conductors copper/copper strip, rated at 300 volts. All hinged doors shall be earthed through flexible earthing braid. Signal and Safety earthing shall be provided separately.

1.20 Alarms

Following Visual indications/display such as LEDs, LCDs or a combination of both shall be provided to indicate :

Functional Indications for local monitoring:

- Mains available (not mandatory if provided at module level)
- DCPS/SMPSs in Float
- DCPS/SMPSs in Charge Mode

Alarm Indication for local monitoring:

3. Load Voltage High /Low
4. DCPS module/SMPS fail
5. Mains out of range
6. System Over Load
7. Mains "ON"/Battery Discharge
8. Temp. Compensation fail
9. Battery fail/isolated

All the protections/alarms shall be within tolerance of 0.25V in case of DC voltage, 1% in case of DC current and ± 5V for AC voltage

Alarm Indication for remote monitoring:

(12) Input AC mains supply fail alarm
(13) Battery low voltage (Pre cut off) alarm
(14) DCPS module fail

Potential free Contacts in two numbers for each of the above remote monitoring alarms (one for remote alarm interfaced through FRTU and one redundant for local monitoring at suitable location) shall be provided. All these potential free contacts are to be wired and terminated at the suitable location for termination to FRTU.

1.21 Temperature Compensation for Battery

There shall be provision for monitoring the temperature of battery and consequent arrangement for Automatic temperature compensation of the SMPS output voltage to match the battery temperature dependant charge characteristics. The output voltage of the rectifier in Float/Charge operation shall decrease or increase at the rate of 72 mV (24 cell battery) per degree increase or decrease in temperature over the set voltage or as may be recommended by the VRLA Battery supplier. The output voltage shall decrease till the open circuit voltage of the battery is reached. The open circuit voltage range shall be settable between 2.1V/cell to 2.2V/cell or as specified by the battery manufacturer. The increase in output voltage due to decrease in temperature has been taken care of

by the tripping of the unit due to output voltage high 28.5V for 24V DC protection. Failure of temperature compensation circuit including sensors shall create an alarm and shall not lead to abnormal change in output voltage.

1.22 Digital Meters/Display Unit

There shall be provision to monitor the following parameters through digital meters or digital display units:

- Input AC voltage.
- Output DC voltage
- Output DC current of charger
- Battery current
- Load current

The Digital display of meters or display unit shall be with minimum $3_1/_2$ digital display of height 12mm and shall have an accuracy 1.5% or better.

1.23 Type Testing of DCPS

The contractor shall supply DCPS System, which was already type tested. The test reports for immunity, Emission and surge must be in accordance with relevant standards shall be submitted. The Contractor shall submit the DCPS type test reports of earlier conducted tests on the same make, model, type & rating which shall include the following tests.

Type Tests on DCPS

1	Surge immunity (Level 4- as per IEC 61000-4-5)
2	Electrical Fast Transients/Burst (Level 4 – as per IEC 61000-4-4)
3	Electrostatic Discharge (Level 4 – as per IEC 61000-4-2)
4	Radiated Electromagnetic Field (Level 3 – as per IEC 61000-4-3)
5	Conducted disturbances induced by radio-frequency field (Level 3 – as per IEC 61000-4-6)
6	Damped oscillatory magnetic field (Level 3 – as per IEC 61000-4-10)
7	Voltage dips, short interruptions and voltage variations (Level 2 – as per IEC 61000-4-11)
8	Conducted Emission (Level - Class A, Group 1 as per IEC CISPR 11)
9	Radiated Emission (Level - Class A, Group 1 as per IEC CISPR 11)
10	Verification of Protection class (IP 21) for enclosure
11	Safety Tests (as per IEC 60950)
12	Burn in test for 72 hours at maximum operating temperature

1.24 Factory/Site Testing of DCPS

The factory/site tests to be carried out on DCPS system/module in the factory and site are listed respectively in Table-A below. The manufacturer shall conduct routine tests on all the systems/modules and submit the report before offering for FAT. The routine tests shall include atleast the tests mentioned under FAT.

Table-A

Sl. No.	Test	FAT	SAT
Tests on DCPS System			
1.	Mechanical & Visual Check Tests	√	√
2.	Insulation Test.	√	
3.	High Voltage Withstand Test	√	
4.	Switch On Test	√	√
5.	DCPS Low voltage & High voltage limits check Test	√*	√
6.	Pre-alarm test for Battery Voltage Low	√*	√
7.	Battery Low Voltage Disconnect Level Test	√*	√
8.	AC Input Low and High voltage limits check Test	√*	
9.	Rectifier Fail Alarm Test	√*	√
10.	Voltage Regulation Test	√*	√
11.	Current Sharing Test	√*	
12.	Total Output Power Test	√*	√
13.	Hot Plug In Test	√*	√
14.	Calibration & Parameter settings	√*	√
15.	Automatic Float cum Boost Charge Mode Change Over Test	√*	√
16.	Battery Path Current Limiting Test	√*	√
17.	Battery Charging and full load Current Test	√*	√
18.	Battery Temperature Compensation Test	√*	
19.	Total Harmonic distortion Test	√*	
20.	Burn in Test for 8 hours at max operating temperature	√*	
Tests on SMPS module			
21	Mechanical & Visual Check Test	√*	
22	Module-On Test	√*	
23	Input low/high voltage cut-off test	√*	
24	Voltage Droop Test	√*	

25	Voltage Regulation Test	√*	
26	Power Output & Current Limit Test	√*	
27	DC High Voltage Test	√*	
28	O/P Voltage Ripple Test	√*	
29	Psophometric Noise Test	√*	
30	Efficiency Test	√*	
31	Power Factor	√*	
32.	Input Current Limit	√*	
33.	Input AC Frequency Range Test	√*	
34.	Rectifier Dynamic Response	√*	
35.	Output Short Circuit Test	√*	
36.	Hold up Time Test	√*	

Note* : These tests (Sl. No. 5-36) shall be conducted on 10% samples of the offered batch and other tests (Sl. No 1-4) shall be conducted on each equipment during the FAT.

1.25 BATTERY REQUIREMENTS

The contractor shall supply Valve Regulated Lead Acid (VRLA) maintenance free Battery for DCPS system. Each battery set shall have sufficient capacity to maintain output at full rated load for 8 hrs. duration. The Bidder shall furnish detailed battery sizing calculations along with all arrangements and supporting structures, for DCPS system being proposed, along with the bid. In all cases the battery is normally not allowed to discharge beyond 80% of rated capacity (80% DOD) at 10 hours rate of discharge for 12V monoblocks rate of discharge at DCPS at FRTU only.

The contractor supplying the cells/12V monoblocks batteries as per this document shall be responsible to replace/repair free of charge, the battery/cell becoming faulty, owing to defective workmanship or material as per the provisions of the bid document.

Battery sizing calculation for DCPS shall be done considering the actual charging achieved in eight hours i.e. in case 100% charging is not achieved in eight hours the Ah of the battery shall be enhanced by the ratio of charging actually achieved in eight hours. **However, minimum battery rating shall not be less than 26AH.**

1.25.1 Constructional Requirements

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module. It shall be possible to easily replace 12V monoblock of the battery at site in normal working condition. The 12V monoblock terminals shall be closed with flap on terminal which will avoid accidental shocks during their service.

1.25.2 Containers

The container material shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least

28%. The porosity of the container shall be such that so as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such that so as to handle the internal cell pressure of the cells in the worst working condition. 12V monoblock shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigours of transport, storage and handling. The containers shall be enclosed in a steel tray.

1.25.3 Cell Covers

The 12V monoblock covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

1.25.4 Separators

The separators used in manufacturing of battery cells, shall be of glass mat or synthetic material having high acid absorption capability, resistant to sulphuric acid and good insulating properties. The design of separators shall ensure that there is no misalignment during normal operation andhandling.

1.25.5 Pressure Regulation Valve

Each cell shall be provided with a pressure regulation valve. The valve shall be self re-seal able and flame retardant. The valve unit of 2V cell shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

1.25.6 Terminal Posts

Both the +ve and –ve terminals of the 12V monoblocks shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve and –ve posts shall be clearly and unambiguously identifiable.

1.25.7 Connectors, Nuts & Bolts, Heat Shrinkable Sleeves

Where it is not possible to bolt the 12V monoblock terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid at a very high rate of charge or discharge for 2V cells only.

Nuts and bolts for connecting the cells shall be made of copper, brass or stainless steel. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion. Stainless steel bolts and nuts can be used without lead coating.

All inter cell connectors for 12v monoblocks shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

1.25.8 Flame Arrestors

Each 2v cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

Equivalent mechanism shall also be considered also for 12v monoblocks as per manufacturer standards.

1.25.9 Battery Bank Stand

All batteries shall be mounted in FRTU Panel itself.

1.25.10 Capacity Requirements

When the battery is discharged at 10-hour rate, it shall deliver 80% of C (rated capacity, corrected at 27ºCelcius) before any of the cells in the battery bank reaches 10.5V/12V monoblock battery (for 20 hour rate)

All the cells of 12v monoblocks in a battery shall be designed for continuous float operation at the specified float voltage throughout the life. Float voltage of each cell in the string shall be within the average float voltage/cell $\pm$0.05V band.

The capacity (corrected at 27ºCelcius) shall also not be less than C and not more than 120% of C before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at C/10 rate for 2v cell and C/20 rate for 12v monoblock :

(a) After Six minutes of discharge : 1.98V/cell, 12v/module
(b) After Six hours of discharge : 1.92V/cell, 11.9v/module
(c) After 8 hours of discharge : 1.85V/cell, 11.0v/module
(d) After 10 hours of discharge : 1.75V/cell, 10.5v/module

Loss in capacity during storage at an average ambient temperature of 35º Celsius for a period of 6 months shall not be more than 60% and the cell of 12v monoblock battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within 0.05V of the average voltage throughout the storage period. Ampere-hour efficiency shall be better than 90% and watt-hour efficiency shall be better than 80%.

1.25.11 Expected Battery Life

The battery shall be capable of giving more than 1200 charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27º Celsius and 400 charge/discharge cycles at 80% DOD (Depth of Discharge) at an average temperature of 27º Celsius in case of 12v monoblock. DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected operational life of 5 years for 12v monoblock at normal operating conditions at 20 degrees C.

1.25.12 Testing of Battery

The contractor shall supply the battery type test reports of earlier conducted tests on the same make, model, type and rating as offered as per the IEC 60896 or equivalent IS/EN/BIS/JIS standards. The contractor shall supply type tested battery as required for DCPS.

Table- B shall be conducted on the battery at site and factory.

TABLE- B LIST OF FACTORY & SITE TESTS FOR BATTERY

S. No.	Test	Factory Tests	Site Tests
1.	Physical Verification	√	√
2.	C/10 for 2v cell or C/20 for 12V monoblock Capacity test on the cell	√	
3.	8 Hrs. Charge and 30 minutes		√
	(duration as specified) discharge test at full rated load for DCPS.		

1.25.13 Testing Requirements

The requirements for type tests, factory acceptance tests and field acceptance testing have been specified under the respective clauses. After completion of field acceptance testing the auxiliary power supply system shall be put under availability test for fifteen (15) days. Availability test shall be carried out by the employer/owner. During the availability test the DCPS shall be used as required to be used for rest of the life. In case of any failure or mal-operation during this period the contractor shall take all necessary action to rectify the problems. The DCPS shall be accepted only after rectification of the problems by the contractor in a manner acceptable to the employer.

1.25.14 Battery Make

1. **Amara Raja only**

A.Transducer

All transducers shall use a 24 VDC auxiliary power supply as provided for the FRTU. All transducers shall have a maximum power consumption of 10 watts. Transducer shall be din rail or wall/plate mounted. **Each FRTU shall be provided with two nos. DC Voltage Transducers for monitoring DC battery Voltage for RMU and FRTU Battery**.

The input, output and auxiliary circuits shall be isolated from each other and earth ground. The transducer output shall be ungrounded and shall have short circuit and open circuit protection. The transducers shall comply the following requirements, in addition to the requirement of IEC 60688, without damage to the transducer.

Voltage:

Voltage test and other safety requirement compliance as specified in IEC 60688 or 60687and IEC 414.

a. Impulse Withstand:
i. IEC 60688 or 60687 compliance is required.

b. Electromagnetic Compatibility:
i. IEC 60688 or 60687 and IEC 801-3, level 1 compliance is required.

c. Permanent Overload Protection:
i. IEC 60688 or 60687 compliance is required.

d. Temporary Overload Protection:
i. IEC 60688 or 60687 compliance is required.

e. High Frequency Disturbance:
(i)IEC 60688 or 60687 compliance is required.

The transducers shall comply with the following general characteristics:

(a) Shock Resistance:
Minimum severity 50 A, IEC 68-2-27 requirements

(b) Vibration Strength:
Minimum severity 55/05, IEC 68-2-6 requirements.

(c) Input Circuit Consumption:
Less than or equal to 0.2 VA for voltage and 0.6VA for current circuits.

(d) Reference Conditions For Accuracy Class:
IEC 60688 or 60687compliance is required.

(e) Temperature Rise:
IEC 60688 or 60687 compliance is required.

(f) Operating Temperature:0 ^{o} C to + 60 ^{o} C (-5 ^{o} C to + 55 ^{o} C for project area with snowfall history)

A.1 DC Transducer

The DC transducer (DCT) is of two types.

(i) Voltage
(ii) Current

The DC Transducer are required to measure battery charger current & voltage shall be suitable for 20% continuous over load and shall be able to withstanding 20 times the normal current rating for a period of one second. The DCT shall be able to accept the input up to 120% of the nominal voltage. The DCT shall have low VA burden. DCT shall be mounted in the interface cabinet to be supplied by the contractor. The input range for current & voltage are site specific &shall be finalised at the time of detailed engineering. Output of the device shall preferably be 4-20ma or MODBUS in order to optimize the BOQ. The accuracy of transducer shall be ±0.5%.

A.2Multi Function Transducers (MFTs)

The contractor shall provide the multi function transducers for acquiring the real time analog inputs through 3 phase 3 wire CT/PTs circuits/ 3 phases 4 wire CT/PTs circuits (Based on the field requirement). Based on the CT/PT secondary rating, the multi function transducer shall be designed for nominal 110 V (Ph-Ph voltage) and 1A/5A (per phase current). The MFT shall be suitable for 20% continuous over load and shall be able to withstanding 20 times the normal current rating for a period of one second. The MFT shall be able to accept the input voltages up to 120% of the nominal voltage. The MFT shall have low VA burden. MFTs shall be mounted in the interface cabinet to be supplied by the contractor/RMU as feasible.

Multi function transducers shall provide at least phase voltage, phase current active/reactive power, import & export energy (active & reactive) ,Pf , frequency with class 0.5 accuracy or better.

The parameters to be acquired from multifunction transducers shall be selectable. MFT shall provide the 15 minute values (configurable 15 minute/1 hour) of Active Energy Import, Active Energy Export, Reactive Energy Import and Reactive Energy Export.

Multi function transducers shall accept nominal 24V DC as auxiliary power supply.Multi function transducer shall be provided with RS485 interface to communicate with RTU over Modbus protocol in multi-drop mode.

The MFTs shall be suitable for mounting on DIN rails. The MFT terminals shall accept up to two 2.5 mm2 for PT/CT circuit terminations.

The MFT shall be programmable with password protection thru suitable facia mounted key pad arrangement so that the configuration parameters such as CT /PT ratio , integration time of energy , reset, communication parameters setting (Address, baud , parity) can be set up at site also. The device shall have LCD displays to visualize all parameters being monitored configurable at site for CT/PT ratio etc.

Each FRTU shall have two MFTs for monitoring load current and other parameters in each of the breaker unit of the 4-Way RMUs.

A.3 Transducer make- Risabh or equivalent

B. FRTU Modem

Prerequisite

- **Modem Vendor should have supplied a minimum of 100 Modems for similar application over the past 3 Years. Necessary certificate from the Utiliser shall be submitted.**
- **Modem should be CE certified**

General Specification

1.1 4G with 3G fallback

1.2 2 Ethernet ports – 10/100Mbps

1.3 1 RS 232/Ethernet port for maintenance/configuration

1.4 Dual SIM

1.5 Minimum 5 LEDS showing clear status of

1.5.1 Power

1.5.2 GSM Signal

1.5.3 SIM card in used

1.5.4 Registration

1.5.5 Cellular Activity

1.6 64 MB RAM

1.7 32 MB Flash

1.8 Linux Operating System

1.9 2 Digital Inputs for sending SMS

1.10 Power Input : 8V to 32V DC

1.11 Operating temperature -20 to +60 degrees

2.0 Communication Mode

2.1 4G with 3G failover

2.2 SMS alerts generated from FRTU

2.3 Multiple sources via Ethernet WAN, Cellular

2.4 Failover between sources of communication

2.5 Support of fast failover

2.6 Compliant to IPV4 and support for IPV6

2.7 Port blocking, port access and port forwarding

2.8 Static Routes support

3.0 Security

3.1 Secure VPN client – PPTP, Open VPN, L2TP, IPSec

3.1.1 IPSec should support IKEV1 and IKEv2

3.2 Selectable Encryption schemes

3.3 Support Certificate uploads

3.4 Traffic shaping / filtering in firewall

3.5 SYNC flood protection

3.6 Stateful Packet Inspection

3.7 Ability to lock the Modem to a SCADA IP

4.0 Management

4.1 Web interface configuration

4.2 Remote download of firmware over the Air

4.3 Remote download of application patch over the Air

4.4 Configurable logging and event reporting

4.5 Remote configuration via HTTPS, Secure SSH shell

5.0 Reliability

5.1 Intelligent Network Watchdog to monitor Data connection stability

5.2 Hardware Watchdog

However, entire responsibility to configure and establish the communication link with SCADA Control Centre lies with FRTU Vendor.

6.0 Make

- **Preferably Fargo**