ODISHA TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

DIGITAL POWER LINE CARRIER EQUIPMENT, TELEPROTECTION COUPLER & REMOTE TERMINAL UNIT (RTU)

CONTENTS

TECHNICAL SPECIFICATION OF DIGITAL POWER LINE CARRIER EQUIPMENT

General

- The PLC equipment shall comply to the standard IEC60495, second edition, 1993.
- For safety, the equipment shall conform to IEC60950-1.
- For EMC and EMI, the equipment shall comply with IEC60255-5,
- IEC61000-4-4/-5/-6/-12/-16, IEC60255-22-1.
- The system shall be of modular design and allow for easy upgrading.
- The PLC equipment shall not use fans or similar for artificial cooling under normal operating condition.

Carrier frequency section.

- The PLC equipment shall support DPLC (Digital PLC) and APLC (Analogue PLC) mode of operation in the same platform, software programmable via PC/Notebook.
- Modulation shall be SSB (Single-Side-Band) for APLC operation, and MCM (Multi-Carrier-Modulation) for DPLC mode of operation. Modulation and coding shall be implemented as software functions in DSP (Digital Signal Processing) technology.
- Transmission mode shall be 2-wire frequency duplex. The nominal carrier frequency shall be programmable from 40 to 500 kHz Minimum preferably however up to 1000 kHz.
- The carrier frequency stability over the stated temperature operating range shall be equal or better than +/- 1ppm.
- The nominal bandwidth BN for transmitting or receiving shall be programmable preferably from 4 kHz to 16 kHz in steps of 4 kHz. Transmit (Tx) and receive (Rx) bands shall be configurable for adjacent or non-adjacent operation.
- Transmit output power shall be the user-programmable for 10,20 or 40W PEP (Peak Envelope Power). 80W PEP transmit power shall be available as an option. The nominal output impendence shall be programmable as 75 or 125 Ohms, unbalanced, or 150 Ohms balance as an option.
- The return loss in transmitter band shall be > 10 dB
- The tapping loss shall be <= 1.5 dB, according to IEC60495.
- The receiver selectivity shall be ≥ 65 dB at 300 Hz from the band edges.
- The AGC range of the receiver shall be 40 dB minimum.

System operation.

- The PLC shall be programmable via PC with HMI/GUI (Graphical User Interface) based on MS-Windows.
- The PLC system shall facilitate the programming and monitoring of the remote terminal from the local terminal using the standard GUI/HMI (Human-Machine-Interface)
- An EMS (Element Management System) shall be incorporated in the HMI for monitoring and programming of the PLC terminals in the network. The EMS shall allow cyclic alarm polling of all the PLC terminals in a network.
- The DPLC shall have the facility to store minimum 256 events and alarm by an internal event recorder in a non-volatile memory.
- The DPLC must have built in test equipments functionality for PLC commissioning and monitoring eg. Received level, AGC, SNR, spectrum analyzer for RX band and test tone generation etc.

Speech and Audio Frequency (AF) signal transmission.

- The PLC shall be configurable for providing up to 3 analogue AF (audio frequency) channels with 4 kHz gross bandwidth each.
- The useful frequency band shall range from 300 Hz to 3720 Hz for each AF channel. In case of multi channel all the channels should operate simultaneously without interference on each other.
- For each channel, a speech low-pass filter shall be configurable with a programmable upper cut-off frequency of 2 kHz to 3.4 kHz in steps of 200 Hz Speech interfaces shall be configurable as 4-wire E&M, 2-wire FXO or 2- wire FXS.
- It shall be possible to configure 3 analogue speech channels in 8 kHz or in 12 kHz RF-transmission bandwidth.
- Inter-channel cross talk shall be compliant to IEC60495.
- A compandor according to ITU-T G.162 shall be configurable via HMI for each speech channel. Control inputs shall be provided for compandor switching (on/off) by the PABX.
- The frequency band above speech shall be available for the transmission of narrowband modem signals from internal or external modems. The level range of the AF-input-output ports shall be in accordance with IEC60495.
- Digital transmit filters, programmable with respect to bandwidth and center-frequency in steps of 60 Hz, shall be available for each AF channel for the local extraction, insertion and transit-connection of selected Tele-operation frequency bands.
- An equalizer shall be available for each AF channel for equalizing amplitude response distortions of up to +/-12 dB. The equalizer shall be configurable for equalizing group delay distortions. The frequency response before and after equalization shall be displayed in graphical form by means of the GUI (HMI) Equalization of the channel frequency response in both directions shall be possible from one (either) end.
- The PLC shall have local and remote loop back features.

Narrow band Data Transmission.

- The PLC shall provide - as software options - integrated modems for Narrow band data transmission.
- Transmission speed, channel centre-frequencies and the spectral bandwidth shall be programmable in steps for commonly used data rates, ranging from 100 bit/s to 2400 bit/s above speech band.
- The narrow band modems shall be designed for low delay and short recovery times following a link disturbance. In a 4 kHz channel, it shall be possible to transmit preferably up to 2 x 2’400 bps.

Broadband Data Transmission.

- The PLC shall provide - as software option - an integrated modem for broadband/high speed data transmission. Transmission speed and spectral bandwidth shall be programmable via PC/Notebook.
- The speed and transmission bandwidth shall be programmable for at least up to 64 kbit/s in 16 kHz bandwidth. The data rates shall be selectable in steps, compliant with commonly used standardized data rates.
- The system shall support automatic transmission speed adaptation in at least 3 user - defined steps, self-adapting to the prevailing line condition (noise and interference).

- The broadband modem shall provide a facility for automatic detection and suppression of narrow band interferers.

Data Multiplexing.

- The PLC equipment shall provide an internal multiplexer for the time- division multiplexing of up to 8 serial data channels that can be allocated individually to the internal modems. Data ports shall be compliant with V.24/V.28, RS-232 and/or V.11/X.21/X.24.
- The internal multiplexer shall provide data flow control for the asynchronous ports and speed adaptation for the synchronous ports according to the prevailing aggregate data rate and HV power line condition.
- All data ports shall be electrically isolated from ground and against each other.
- Point-point and point-multipoint operation with channel-sharing shall be possible.
- An Ethernet port shall be available as an option, for equipment configuration via LAN, or for general IP forwarding.

Integrated Teleprotection.

- Each teleprotection system shall support the transmission of up to 4 independent and simultaneous commands, programmable individually for blocking, permissive- or direct tripping.
- The transmission of the command signals shall be accomplished within the speech bandwidth or within the spectral bandwidth of the broadband modem, i.e. the teleprotection shall not require the allocation of extra/ separate bandwidth.
- During transmission of protection commands, other service like speech and data shall be temporarily interrupted in order to transmit the protection signal at increased power (command signal boosting). The nominal transmission time shall be < 11 ms, < 12 ms, < 13 ms for blocking, permissive and direct tripping respectively. The required SNR for a dependability of < 1E-03 shall be no more than4, 3 and 0dB for blocking, permissive and direct tripping respectively in Tac = 15 ms, 20 ms and 40 ms. The unwanted commands probability (security) shall for any SNR conditions (worst case) be no higher than 1E-04, 1E-06, 1E-09 for blocking, Permissive and direct tripping, respectively. Electrically isolated upto-coupler inputs, solid-state outputs and mechanical relay outputs shall be available as I/O interfaces to the protection relay. Voltage range shall be selectable from 24 VDC to 250 VDC nominal.
- Inputs and outputs shall be freely allocated to the commands or alarms (programmable via HMI) It shall be possible to individually delay or prolongate the input and output command signals via HMI, and to monitor their duration. All transmitted and received commands shall be logged with time stamps of1 ms resolution by the internal event-recorder, and stored in a non-volatile memory for at least 256 events.
- The teleprotection shall provide an integrated cyclic loop test.
- The teleprotection shall be software programmable via PC HMI with GUI For single - purpose teleprotection applications, the nominal transmission.
- Bandwidth of the PLC terminal shall be configurable for 2 kHz in each direction.

General

- Ambient condition 5o to 55oC
- AC Supply 230V AC+10%-15%, 50 Hz

- Battery supply -48V DC±15%

- Alarm relay output Potential Free change over contracts
  System alarm/Cabinet alarm

  Hardware alarm

  Link alarm

  Interface alarm

- Modules of Power supply Single or Doubled (Redundant)

Electromagnetic Compatibility (EMC):

- Emission in accordance with IEC/EN 61000-3-202000 standard, EN 50081-2
- Electrical safety in accordance with IEC/EN 60950-1:2001
- Power frequency magnetic field as per IEC 61000-4-8 level 4 class

Electrostatic Discharge as per IEC 61000-4-2 level 4 class.

TECHNICAL SPECIFICATION OF TELEPROTECTION COUPLER

1. SCOPE:

The specification covers the design, manufacture, testing before despatch, delivery at store and wherever necessary erection / supervision, testing at site and setting to service of the AF coupler at various GRID Sub-Station and Generating Station.

2. BASIC REQUIREMENTS:

a) All the works shall confirm to the IEC recommendation 834-1.

b) All the materials and equipments offered under this specification shall comply to Indian standards.

c) the tenderer shall submit separately a list of spares recommended by him for 10 years of operation along with item-wise prices. Supply of such spares during useful life of the equipment shall be guaranteed.

d) Following drawings shall be supplied with tender:

i) Drawing showing outline of complete AF channel and AF coupler equipment.

ii) Drawing showing out section view of the equipment.

iii) Drawing showing mounting details of all the equipments.

iv) Drawing showing the provision of accessories, descriptive literature explaining the basic Principle of operation of the equipments.

v) Two sets of instruction / operating manual containing circuit diagram, instruction for erection and commissioning of the equipments, testing schedule, fault tracing procedure shall be supplied along with each equipment.

3. TECHICAL PARTICULARS:

a) The protection equipment should be plug in type and compatible to be fitted with the carrier sets already in operation under OPTCL.

b) Tenderer shall offer protection equipment transmitting command within the speech band of the power line carrier set. The time interval that lapses between the instant command that is received from protection relay at the transmitting side and the time this command is passed on to the protection relay at the distant side shall not be more than 10ms.

c) The equipment shall be suitable for use in conjunction with distance protection system.

d) The equipment shall be suitable for operation in tropical climate.

e) The equipment shall consist of two tier bolted together one tie would contain the electronic part transmitter and receiver, while the other tier would house the test and interconnection unit. On the front side socket shall be provided to carry out test measurements.

f) Equipment should provide full duplex transmission of two non- coded permissive or blocking commands plus two coded prioritized direct tripping commands for the protection of single and double lines including breaker failure protection.

g) The equipment should be so designed that it should prevent the Circuit breakers from false tripping. The equipment should be Insensitive to corona noise, created by operation of circuit breakers, isolators, switches and electrical surges.

h) The equipment should be fully microprocessor based.

i) The equipment should use pilot signal of PLC as guard signal and frequency command signal within the speech band.

j) The equipment should provide separate frequencies corresponding to the individual commands or command combination in the PLC speech frequency band.

k) In the command state the equipment should cutoff the guard signal and transmit the command signal within the speech band. At the same time the speech and the data signal on the same channel should be interrupted during the short time of commands transmission.

l) The output relay of the receiver should operate only when receiver recognizes the missing of guard signal and simultaneously presence of a valid command signal.

m) The duration of command transfer should not exceed two seconds otherwise the receiver should give alarm.

n) The equipment should have provision for a cyclic and manual in-service loop test.

o) The equipment should have facility for counting the tripping of breaker.

4. BASIC TECHNICAL DATA:

Blocking Permissive tripping Direct tripping

a)	Nominal Transmmission timeT0		≤10ms	≤12ms	≤13ms
	Security(Puc)		<1E -04	<1E -06	< 1E -09
	Dependability(SNR/Tac)		>6dB/15 ms	>3dB/19ms	
	>0dB/38ms				
b)	Number of commands		: 4		
c)	Commands duration	:	2 seconds		
d)	S / N Ratio for reliable				
	command reception	:	6 dB		
e)	Primary supply		Internal from the operating carrier set.		
f)	Insulation		: According to IEC 834-1,IEC-495.		
g)	Ambient condition		: Adjustable between 0 to 9 dB.		
h)	Guard channel frequency		: 3600 (pilot of carrier set)		
i)	Trip / Test signal frequency	:	Within the speech band 300 to 2000		
Hz.					
j)	Secure against		: continuous or impulsive, speech and sweep tones DTMF in-band signaling		
k)	Bandwidth requirement		: NIL ,PLC pilot signal or own guard		
signal					
	Guard Signal		above speech band of 2000HZ		
l)	Command input		: Minimum 2 nos upto coupler type per interface module		
m)	Methods of tripping		: contact or battery , or dry contact		
n)	Voltage ranges		: 220 VDC		

TECHNICAL SPECIFICATIONS REMOTE TERMINAL UNIT (RTU)

RTU shall be capable of providing all functions specified herein with the addition of the necessary hardware and software modules in the field when required by owner.

The RTU shall be used for real time supervision and control of substation/power plant through owner's regional SCADA systems. LDEM shall be used for local data acquisition, monitoring and control.

1.0 The RTUs shall be capable of performing the following functions:

(a) Designed around an open ended distributed processing configuration consisting of main processor, peripheral I/O modules, termination panels, power supplies & communication equipment/interface.

(b) Collecting, processing and transmitting status changes, accumulated values and analog values.

(c) Time resolution for time tagged events 1 ms

(d) Receiving and processing digital and analog commands from the master station(s).

(e) Accepting polling messages from the master station(s)

(f) Supporting data transmission rates from 100 to 9600 bits per second.

(g) Supporting minimum four communication ports on outgoing side to interact with multiple Masters on con-current protocols.

(h) Supporting up to 32 IEDs on a RS 485/RS232 port for communicating with

61850 compliant systems.

(i) Support Multi-tasking, to enable RTU to concurrently scan input status, whilst executing application program or reporting functions.

(j) The microprocessor-based common logic should have Compact Flash RAM for storage of configuration files and shall support WEB server diagnosis.

(k) Function of switching of channels if dual data communication channel is available.

(l) Supports multiple concurrent protocols including IEC 60870-5- 101 without using any protocol converter as far as practicable. .

The protocol for communication between RTU & Numerical relays shall be IEC 60870-5-103.

(n) Support Multi-tasking, to enable RTU to concurrently scan input status, whilst executing application program or reporting functions.

(o) Modbus protocol support.

(p) PSU of RTU should have capability to drive 2 nos of FSK modem attached with RTU

1.1 Main Processor.

- Advanced 32-bit microprocessor with minimum 40 MHz Processing capabilities.
- Programmable RS-232 Serial ports.
- Communication between Main Processor and I/O Modules shall be on high speed Communication ports of 256 Kbps.
- Three nos. programmable RS 232 serial ports for simultaneous communication with a host of intelligent IEDs at speed of 38.4 Kbps.
- 9600 baud RS 232 maintenance port.
- Optional math co-processor
- Necessary communication module and power supply module shall be provided as part of system requirement.
- I/O Module (Digital and Analogue) shall be provided.
- The Memory capacity of processor shall be with minimum of 2 MB Flash memory adequate enough for satisfactory function of system request.
- The input voltage to the RTU power supply will be provided through 48 VDC /110VDC.

- Self diagnostic shall test memory checksums, RAM test, Configuration verification, Interrupt controller verification, Serial port test, Watchdog and power monitor, Peripheral communication checks, Error logg etc.

1.2 I/O Modules.

The I/O MODULES shall be with separate 16 bit microprocessor based, intelligent, modular unit, capable of data acquisition, control and local data processing.

Each I/O MODULE must be capable of standalone operation for data acquisition and processing so that when it is used in a non-fault tolerant configuration, it will continue its data acquisition, processing and programmable logic functions and subsequently update the Station Level Processor following elimination of the fault.

1.3 **Communication Interface**

The RTUs shall have the capability to support simultaneous communications with multiple independent master stations, a local user maintenance interface and a local logger (printer). Each RTU shall be able to support a minimum of four communication ports. Three of these ports shall be capable of supporting communications to peripheral devices such as multiple SCADA master stations, solid-state meters, microprocessor based relays and remote/local PCs; and the fourth port to be a dedicated maintenance port. The RTU shall simultaneously respond to independent scans and commands from master stations, local logger and local user maintenance interface using a centralized controller and database. The RTU shall support the use of a different communication data exchange rate (bits per second), scanning cycle, and/or communication protocol to each master station. Also, each master station's data scan and control commands may be different for different data points within the RTU's database.

1.3.1 Modems

The FSK modem shall not require manual equalization and shall include self test features such as manual mark/space keying, along loop back and digital loop-back. The modems shall provide for convenient adjustment of output level and receive sensitivity. The configuration of tones and speed shall be programmable and maintained in non-volatile memory in the modem.

The modem shall meet the following requirement :

a) Use CCITT standards including V.24,V.28.V.52 and V.54

b) Communicate data rates of 100,200,300,600 and 1200 bits per second.

c) Use CCITT V.23,R35,R.37,R.38a and R.38b standard tones for the selected RTU data rate.

d) Use frequency shift keying (FSK) modulations.

e) Use both 2 wire and 4 wire communication lines .

f) Receive level adjustable from 0 to –40 dBm @ 600ohms

g) Transmit level adjustable from 0 to -24 dBm @ 600 ohms

h) Have a minimum sensitivity of -48dBm.

1.3.2 Master Station Communication interface

RTUs shall provide multiple communication ports for possible con-current communication to SCADA system/master stations.

1.3.3 Local User Maintenance computer Interface

The RTUs shall include the interface to support the portable local computer configuration and maintenance/test terminal. The interface shall provide easy access to allow purchaser to use the maintenance terminal at the RTUs installed at the site.

1.4 Master Station Communication Protocol

Shall provide a communication protocol for communicating with master stations using the IEC 60870-5-101 communication standard. The communication protocol shall support all the requirements of this standard. The communication protocol shall be nonproprietary and the contractor shall provide complete description and documentation of the protocol to purchaser for future implementation of additional RTUs due to expansion of power system from supplier at the master stations. The RTU shall also be capable of supporting other communication protocols that may be required to communicate with additional master stations in the future.

1.5 Communication Channel Control

The RTU shall perform as a slave on the communication channel to SCADA systems. The SCADA system master stations shall initiate all communication. Where the RTU must notify the master stations of an unusual condition at the RTU (such as a power fail/restoration or RTU malfunction) or must initiate the transfer of changed data, the notification shall be accomplished within the framework of the periodic data acquisition exchanges.

1.6 Exception Reporting

The RTU communication protocol shall report changes by exception. The communication protocol shall also support an update demand scan of all status data by master stations regardless of the lack of any change in data. The reply to an exception scan request for status points shall consist of an indication of the presence or absence of a change of the status indication points in the RTU. A master station will then request the input of the changed points. The RTU shall continue to indicate exception changes until the master station acknowledges successful receipt of the changed data. The RTU shall report the current state of all status indication points to the master station in response to an update scan even if data has not changed.

1.7 Message security (to be defined in the protocol)

Each RTU communication message shall include an error code, the use of which shall result in a very low probability of an erroneous information frame (data) being accepted as valid. The error code shall be determined and appended to the message for all messages transmitted by the RTU and verified by the RTU for all messages addressed and received by the RTU. Cyclic error detection codes such as Cyclic Redundancy Check (CRC) are required.

High data integrity and consistency is required of the RTU protocols. The protocols used shall provide an adequately low Residual Error Rate (RER), depending on the Bit Error Rate (BER) of the line in use. The minimum required RER is as specified in IEC 870-5-101 protocols with the T-101 profile. This requires the following integrity: BER RER10-5 10-14 10-4 10-10 10-3 10-6.The implemented protocol shall ensure satisfactory performance at Bit Error Rate of 1x10-4

1.8 Analog Inputs

Each analog input shall be furnished with signal conditioning to provide a nominal full-scale voltage to the analog-to-digital (A/D) converter.

The A/D converter and associated signal conditioning shall meet the following minimum characteristics over a 0 Deg C and plus (+) 60 Deg temperature range:

A. Automatic self-calibration

B. Full scale accuracy of ±0.1%

C. Linearity of 0.05 per cent full scale

D. Fourteen bit binary resolution or better; plus one sign bit.

The RTU must scan all analog inputs at a rate of at least once per second and support analog dead-band reporting limits.

Unless otherwise specified, transducers will be provided and installed external to the RTU by the Customer. The transducers are "self-powered" off the sensors. Analog Input Types

The RTU must support the following analog input types: ±10 VDC, 0 to 1 mA, -1 mA to 1 mA, 0 to 5 VDC, 4 to 20 mA, 0 to ±5 mA, 0 to 5 mA, and others as requested.

For all 0 to 5 mA transducer inputs, the RTU analog sense must be set up to over range 0 to 6 mA. At 6 mA, the transducer outputs are still linear. The RTU analog inputs must be set to over range 120% on all Customer field analog inputs.

Individually shielded twisted pairs of wires with an overall shield may be used by the Customer for connections between the transducers and the analog inputs at the RTUs. The system shall have high noise immunity from stray circulating currents in the cable shield.

Common-mode noise rejection: 90 dB minimum, 0 to 60 Hz

Normal-mode noise rejection: 60 dB minimums at 60 Hz.

Adjacent channel voltage isolation: withstand the common-mode voltages of any two channels on the same analog input module differing at least 35 volts AC or peak AC.

Programmable Input Ranges Programmable gain instrument amplifier permits programming of voltage input ranges. Ranges are stored in NVRAM on a per point basis. (+/- 1, +/-5, +/- 10 V

scale)

Variable scan rate Programmable scan rate of 16.7 to 20 ms (50/60 Hz) on a per module basis **A/D Conversion** to provide excellent normal mode rejection characteristics while maintaining good

The RTU shall accommodate Analog input current from transducers, which are isolated, unipolar or bipolar, 2-wire ungrounded differential signals with full resolution.

The Analog input accuracy shall be 99.8% or better at 250 C ambient temperature. Mean accuracy shall drift no more than 0.002% per 0 C within the temperature range of –5 to +55 0

C. Determination of accuracy shall be made while the Analog multiplexer is operating at rated speed.

The Analog-to-digital converter shall have a minimum resolution of + 2048 counts (sign plus 11 data bits).Each input shall have protection and filtering to provide protection against voltage spikes and residual current at 50 Hz, 0.1 ma (peak-to-peak). Overload of up to 50% of the input shall not sustain any failures to the input.

The RTU shall make all appropriate signal level conversion and conditioning to allow full utilization of Analog inputs and meaningful reasonability checking. Including signal conditioning components, the input impedance shall not be greater than 250 Ω. Input scaling shall allow for 20% over range.

1.9 Digital Status Inputs

The digital status input interface shall be capable of accepting isolated wet or dry contact status inputs.

The Contractor shall supply necessary sensing voltage, current limiting, optical isolation, and debounce filtering independently for each digital status input. The Contractor supplied sensing volt shall not exceed 48 VDC. The sensing voltage source shall be isolated from that of the RTUs logic power such that any noise or a short circuit across the sensing supply's output terminals would not disrupt the RTU operation other than the shorted digital status input.1 ms resolution for time tagged messages is required for fault analysis

The RTU shall store all status changes for retrieval by the master stations. For communication delays or short-term failure of communication with a master station, the RTU shall store a minimum of 2000 status of change events. The RTU shall report any overflow of this status-changed buffer to the master stations.

It shall be possible to configure each status input for one of the following functions:

Single status input

Change of state

Sequence of event (SOE) time tagging with resolution of ±1 ms.

The SOE buffer capability to store 1024 events.

5. Alarm input

6. Tap position indication using 4-bit BCD coding

7. Trip/block protection signaling.

8. Hysteresis to prevent false state changes due to noise or other conditions.

1.10 Two-State Devices

All switching devices (breakers) shall be supported by a dual-contact status indication. Breakers with re-closing capability shall also be supported with momentary change detection (MCD). All other status indications shall be two-stage single-contact inputs without MCD. Single-contact two-state status point inputs will be from a single normally open (NO) or normally closed (NC) contact. Dual-contact two-state status point inputs will be from two complementary contacts (one NO and one NC). 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.

1.11 Momentary Change Detection

Two-state status input points with momentary change detection shall be used by purchaser for points where multiple operations (changes of state) can occur between RTU scans (e.g. breakers with re-closing devices that operate faster than the scan rate). 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). 1.12.1 Power Supply Protection

Over voltage and under voltage protection shall be provided within the RTU power supply to prevent the RTU internal logic from being damaged as a result of a component failure in the power supply and to prevent the RTU internal logic from becoming unstable and causing mal-operation as a result of voltage fluctuations.

1.12 Noise Level The audible nose generated by the RTU equipment shall not exceed 50 dbA : one meter from the enclosure.

1.13 Environmental Requirements

The RTUs will be installed in control buildings without temperature or humidity control. The RTUs shall be capable of operating in ambient temperatures from –5 to + 55^0 C and relative humidity from 5 to 95%, non-condensing with rate of temperature change of 200 C/hour.

1.14 Maintainability

The RTU design shall facilitate isolation and correction of all failures. The features which promote rapid problem detection, isolation and replacement of failed components, shall be provided as following:

(a) Self-diagnostic capabilities within each RTU, which can be initiated at the RTU site.

(b) On-line error detection capabilities within the RTU and detailed reporting to the connected master stations of detected errors.

(c) Local indication of major RTU failures.

1.15 RTU SOFTWARE REQUIREMENTS

The software provided to support the functions of the RTUs should meet the characteristics described in this section.

Real-Time Executive Software

A real-time operating system shall come with the firmware, characterized by:

A. Integrated, multi-tasking with structured efficient supervisory layer

B. Priority scheduling of processes in coordination with other tasks; user applications partitioned into sets of processes

C. Inter task communication and synchronization

D. Dynamic memory allocation

E. Real-time clock to maintain calendar and time, and perform RTU timing functions.

F. Efficient real-time responsiveness.

G. During initialization, memory self-diagnostics shall occur and then initialize the system hardware and various I/O devices.

H. Device drivers will be required for:

- Managing input and output through the serial communication ports,

- High-speed link to peripheral boards, and external high-speed port, if needed.

I. Interrupt controller and interrupt servicing procedure shall prioritize and process hardware interrupts as they occur.

J. Debugging tools shall allow users, via a PC, to monitor functions, examine memory, perform communication port loop back tests, adjust modem communication port settings, check CPU usage, and process profiling.

1.15.1 Design Characteristics

All software shall be implemented according to established design and coding standards. Purchaser reserves the right to reject any software that does not conform to these standards. Complete and comprehensive documentation shall be provided for all software. The software and the database shall be sized to accommodate growth within the sizing parameters defined for the RTU without requiring software or database regeneration. The design of the software and the database shall not restrict future expansion beyond the sizing parameters. Expansion beyond the original design parameters may require software or database regeneration.

At the time the RTU is accepted, all software delivered must be up to date and in final form, including all standard software changes and field changes initiated by the Contractor or the Contractor's suppliers prior to acceptance. The software documentation must reflect these changes.

1.15.2 Operating System

The Contractor shall use a non-proprietary operating system capable of managing the distributed applications of the RTU. The operating system shall support multi-tasking and multi-programming. The minimum real-time facilities to be provided shall include process, job, database, and memory management, process synchronizing message services for communication between jobs, and device and interrupt handling.

1.15.3 Initialization/Restart Program

Software shall provide automatic restart of the RTU upon power restoration, memory party errors, hardware failures, and upon manual request. The software shall initialize the RTU and begin execution of the RTU functions without intervention by master station. All restarts shall be reported to the connected master stations.

1.15.4 RTU Operations Monitoring

Software shall be provided to continuously monitor operation of the RTU and report RTU hardware errors to the connected master stations. The software shall check for memory, processor, and input/output errors and failures.

1.15.5 RTU Configuration Support

A RTU Configuration complier shall generate or modify the database of the RTUs. The database compiler shall provide error detection services and shall produce a printed listing of the input data and the resulting RTU configuration. It shall be possible to maintain the RTU database locally and from a master station using the web server function.

1.15.6 Diagnostic Software

The Contractor shall supply diagnostic software, which monitors and individually tests each of the components of the RTU demonstrating all the capability of RTU as mentioned in this section. The diagnostics shall provide comprehensive user interaction and printout capabilities.

Reference Standard

Vendor shall ensure that equipment and required practices conform to Quality Assurance Standards ISO 9001.

Adhere to Modem standard BELL CCITT.

The RTU shall not be affected by operation of microwave and mobile radio equipment per RFI/EMI Radiation Specification FCC Part 15. Nor should RTU emit radio interference contrary to Department of Communication (Communication Canada) Standards as pertaining to digital apparatus (ICES-003-1991).

Adhere to Standards for SCADA system ANSI C37.1-1979.

Adheres to Surge Withstand Capability (SWC) ANSI C37.90a-1974/78 and IEEE 472- 1974/78; and SWC Fast Transient ANSI C37 90 1-1989; and IEC -255 - 4.

Adhere to Communication Equipment Interface and handshaking standard EIA RS232, 422 485; Definition, Specification, and Analysis of Systems used for Supervisory Control, Data Acquisition, and Automatic Control.

Tests

The RTU and cabling elements of the RTU procurement shall be tested in two parts i.e. type test and routine test as described below.

TYPE TEST:

A minimum of one of each major complete integrated units shall be fully tested to assume full compliance with the functional and technical requirements of the specification. The type test reports for the RTU shall be submitted by the bidder which shall include the tests listed in Table-1.

TABLE-1 List of Type Tests on RTU

Test No	**Description of the Test**
1	EMI/EMC Immunity tests for RTU
2	Surge immunity test as per IEC 60870-2-1
3	Electrical Fast Transient Burst Test as per IEC-60870-2-1
4	Damped Oscillatory Wave Test as per IEC 60870-2-1
5	Radiated Electromagnetic Filed Test as per IEC 60870-2-1
6	Damped Oscillatory magnetic Field Test as per IEC-60870-2-1
7	Power frequency magnetic field test as per IEC-60870-2-1
Insulating test for RTU	
8	Power frequency voltage withstand test as per IEC 60870-2-1
9	1.2/50 µs Impulse voltage withstand test as per IEC 60870-2-1
10	Insulation resistance test
Environmental Test for RTU	
11	Dry heat test as per IEC60068-2-2
12	Damp heat test as per IEC60068-2-3

Routine Test

Each complete RTU shall undergo testing to demonstrate compliance with specified requirements, standards and functional capabilities including.

Inventory check and inspection for general construction, cabling connections, drawing conformance and labeling.

Tests of proper functioning of hardware and software by a thorough exercise of all RTU functions, both individually and collectively.

Test operation and accuracy of all RTU analog inputs over entire range.

Test operation of all RTU digital input points.

Test operation of all RTU control outputs.

Test SOE and RTU time synchronization and accuracy.

Test RTU power failure and recovery.

Test of communications including all communication ports .modems and local interfaces.

For any variations in the configuration, hardware components used or variations from the type accepted equipment, owner has the right top perform any of the type testing before successful completion of the Routine testing.

Field Performance Tests

The supplier shall be responsible for providing field installation and testing. All hard wares will be installed, configured, interfaces to all field inputs and outputs established. Upon completion, a filed performance test shall be performed to exercise all functions of the RTU . The SCADA database and displays information shall be provided by the bidder. This testing will include , but not be limited to the following tests.

RTU initialization

Proper functioning of hardware and software by exercising of selected RTU functions using the master station.

Test operation of all diagnostic software and confirm issuance of mindful messages for all types of error conditions.

Test time synchronization and accuracy of the RTU from the master station.

Development and integration of database at RTU and LDMS end in line with regional SCADA master database design will be the responsibility of the bidder.

- ✓ RTU database verification including point-to-point operation and scaling accuracy using the master station.
- ✓ Integration of RTU and regional SCADA master.

RTU should have provision for adopting ***multifunction power line transducers*** for measurement of various electrical parameters of 3 phase 3 wire or 4 wire electric power system. . The DC output of multi function transducer should be available through galvanized isolated analog outputs and RS 485,half duplex serial communication port over MODBUS RTU protocol/DNP 3.0

Modular 3 Phase Ct & PT circuit boards monitor the secondaries of sub-station voltage current transformers. These boards send the waveforms to the RTU for digital signal analysis. This is called transducer less technology. It should allow the master station to display any electrical parameters (single phase or 3 phase composite) from any measurement point. These parameters should include :

- Voltage
- MW
- MVAR
- Frequency

Technical Specification of multi function transducer:

Connection	:	3 phase 4 wire
Input value:		
I in	:	1A,5A(User selectable)
V in	:	110V
DC Output	:	4 nos of galvalised isolated 4-20mA DC, 500 or 750 Ohm
Communication port	:	RS 485 Modbus RTU
Type	:	Multi drop capability
Response Time	:	Less than 500 mSec.

Temperature	:	0- 55^0 C
Humidity	:	95% RH non-condensing
Accuracy	:	±0.5 % of Span

Standards and Regulations:

IEC 60688	:	Electrical measuring transducers for converting AC electrical quantities to analog or digital signals
IEC 60687	:	Alternating current static watt-Hour Meters for Active energy