

REMOTE TERMINAL UNIT (RTU) SPECIFICATIONS

- 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 50 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 communication line.
 - (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 and have at least 1.5 MB 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) The protocol for communication between RTU & Master sites shall be IEC 60870-5- 101 or DNP3.
 - (m) 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.

1.1 Main Processor.

- 1. Advanced 32-bit microprocessor with 40 MHz Processing capabilities.
- 2. Programmable RS-232 Series ports
- 3. Communication between Main Processor and I/O Modules shall be on high speed Communication ports of 256 Kbps.
- 4. Three nos. programmable RS 232 serial ports for simultaneous communication with a host of intelligent IEDs at speed of 38.4 KBaud.
- 5. 9600 baud RS 232 maintenance port.
- 6. Optional math co-processor
- 7. Necessary communication module and power supply module shall be provided as part of system requirement.
- 9 I/O Module (Digital and Analogue) shall be provided.
- 10. The Memory capacity of processor shall be with 2 MB Flash memory adequate enough for satisfactory function of system request.
- 11. The input voltage to the RTU power supply will be provided through 48 VDC /110VDC.
- 12. Self diagnostic shall Program memory checksums, RAM test, Configuration verification, Interrupt controller verification, Serial port test, Watchdog and power monitor, Peripheral communication checks, Error logger.

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 five 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 Master Station Communication interface

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

1.3.2 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.

1.8 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.

1.9 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 RER

10⁻⁵ 10⁻¹⁴

10⁻⁴ 10⁻¹⁰

10⁻³ 10⁻⁶

The implemented protocol shall ensure satisfactory performance at Bit Error Rate of 1x10⁻⁴

1.10 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 $\pm 0.1\%$

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 25°C ambient temperature. Mean accuracy shall drift no more than 0.002% per °C within the temperature range of -5 to +55 °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.

1.11 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 changed 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:

1. Single status input
2. Change of state
3. Sequence of event (SOE) time tagging with resolution of ±1 ms.
4. The SOE buffer capability to store 1024 events.
5. Three-level programmable software filtering for debounces and chatters

6. Pulse accumulator; one of Form A, B, or C at 50 Hz maximum input rate 16 bit binary counter)
7. Alarm input
8. Tap position indication using 4-bit BCD coding
9. Trip/block protection signaling.
10. Hysteresis to prevent false state changes due to noise or other conditions.

1.11.1 Two-State Devices

All switching devices (breakers) shall be supported by a dual-contact status indication. Breakers with reclosing 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.

1.11.2 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 reclosing 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). The duration used to determine change versus bounce shall be adjustable from 4 to 25 ms in increments of 1 ms.

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.

1.13 Noise Level

The audible noise generated by the RTU equipment shall not exceed 50 dbA one meter from the enclosure.

1.14 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 $+55$ °C and relative humidity from 5 to 95%, non-condensing with rate of temperature change of 20° C/hour.

1.15 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.

1.16 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. Intertask 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.

1.16.1 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.

1.16.2 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.

1.18.3 Initialization/Restart Program

Software shall provide automatic restart of the RTU upon power restoration, memory parity 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.

1.16.4 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.

1.16.5 RTU Configuration Support

A RTU Configuration compiler 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.

1.16.6 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 and 485; Definition, Specification, and Analysis of Systems used for Supervisory Control, Data Acquisition, and Automatic Control.

Note: -

1. Following are the leading preferable manufacturers / suppliers of RTU.
 - M/s. Honeywell Automation India Limited, Pune
 - M/s.ABB Limited,Bangalore
 - M/s.Areva Limited
 - M/s.Chemtrol
2. Detail technical specifications of RTU & its compatibility with the existing SCADA system may be got approved from SLDC.