

KARNATAKA POWER TRANSMISSION CORPORATION LIMITED



## TENDER DOCUMENT

**For Site Survey, Design, Engineering, supply, wiring, Installation, integration, testing and commissioning of Remote Terminal Units, DCU, UPS and cables at KPTCL stations.**

# KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

## Remote Terminal Unit - Specifications-Revision 1

		<b>Details</b>
		Complete SCOPE of the Project in Chronological Order
<b>A</b>		<b>Technical Specification of Remote Terminal Unit (RTU)</b>
<b>PART-I</b>		<b>RTU's General Requirement</b>
1.01		Scope
1.02		Type of RTU
1.03		Coverage
1.04		Purpose
1.05		I/O Ports
	1.05.1	Analog Inputs
	1.05.2	D/I
	1.05.3	D/O
1.06		Communication Port
1.07		Protocol
1.08		Suitability
1.09		Site Survey
1.1		Functional Requirements
1.11		Programmable Logic Capability
1.12		Communication Interface
1.13		Algorithm
1.14		Cards
1.15		Intelligence level
1.16		Expandability
1.17		Communication Media
1.18		Slave Mode
1.19		Scan Groups
1.2		Exception Reporting
1.21		Time Synchronization
1.22		Power Supply
1.23		P/S Protection
1.24		Power Failure

## KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

1.25		Grounding and Protection against EPR
1.26		Redundancy
1.27		Multi Drop
1.28		DDTA (Data Delivery Time Analysis)
1.29		RTU Hang
1.3		Security
1.31		RTU Address
1.32		I/O Requirements
	1.32.01	Analog Input
	1.32.02	A/D Converter
	1.32.03	Digital Inputs
	1.32.04	Status Input Requirements
	1.32.05	Single Contact Digital Status input (SS)
	1.32.06	Double Contact Digital Status input points (DS)
	1.32.07	Three State Status
	1.32.08	S.o.E
	1.32.09	Binary Coded Decimal Input (BCD)
	1.32.10	Binary Word Input
	1.32.11	Digital Outputs (D/O)
	1.32.12	Two State DCO
	1.32.13	Two State Momentary Control Relay
	1.32.14	Latching Contact Output
	1.32.15	Control Security
	1.32.16	Rise/Lower Pulse Outputs
	1.32.17	Digital Word Output
1.33		Maintenance Port
1.34		Support Facilities
1.35		Remote Downloading to RTU
1.36		Maintenance Support
1.37		Interface Cabinets
1.38		Enclosures
1.39		Interconnections
1.4		Terminal Blocks
1.41		Assembly
1.42		MCCB
1.43		Noise Level

# KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

1.44		Environmental
1.45		Critical Up time
1.46		Reserve
1.47		Maintainability
1.48		Life Span
1.49		MTBF
1.5		MTTR
1.51		Royalty
1.52		RTU S/W
1.53		OS
1.54		Initialization/Restart
1.55		Monitoring
1.56		Compiler
1.57		Diagnostics
1.58		Interposing Relay/Opto Couplers/Opto Isolators
1.59		DC transducer
<b>PART-II</b>		<b>Cables</b>
2.01		Scope
2.02		Current Cables
2.03		Voltage Cables
2.04		Signal Cables
2.05		Control Cables
2.06		Supply of Cables
<b>PART-III</b>		<b>RTU Installations</b>
3		General
3.01		Power Supply
3.02		LT-AC Panel
3.03		Positioning
3.04		Wiring
3.05		RTU Ground
3.06		Wiring Diagrams
3.07		Circuit Diagram
3.08		Terminal Block
3.09		Interface to Communication Equipments

# KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

3.1		RTU Wiring
3.11		Inspection
3.12		Scheme diagram
<b>B</b>		<b>Technical Specifications for 2kVA Online UPS for SCADA in KPTCL Stations</b>
<b>PART-I</b>		<b>UPS General Requirement</b>
	1.01	Scope
	1.02	Supply Voltage for UPS
	1.03	Operating Frequency
	1.04	Rectifier Module
	1.05	Inverter Specification
	1.06	Protection
	1.07	Output Indications
	1.08	Alarms
	1.09	Panel Meters
	1.1	Bypass Arrangement
<b>PART-II</b>		<b>Isolation Transformer</b>
	2.01	Scope
	2.02	Electrical Specification
<b>PART-III</b>		<b>Batteries</b>
	3.01	Scope
	3.02	Battery Sets
	3.03	LT - A/C
	3.04	Location
	3.05	Cables
	3.06	Battery Stand
	3.07	Accessories
	3.08	Charging and Discharging
	3.09	Commissioning

## KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

C		Technical specification for Data Concentrator Unit (DCU) for DLMS (Device Language Message Specification) meters
	1.00	Scope
	1.01	Concept
	1.02	General Specification
	1.03	Operational Requirement
	1.04	Communication
	1.05	Hardware Specifications
	1.06	Software Specification at Control Centers
	1.07	Operating Temperature
	1.08	Power Requirements
	1.09	Security
	2.00	Environmental & Safety Standards

**Complete SCOPE of the Project in Chronological Order**

This section deals with the Complete Scope of the Project in Chronological Order cover all 100 Stations in KPTCL as per annexure 2 for both Data Acquisition and Supervisory Control

**1) Supply**

- 1.1 Supply of RTU as per specification enclosed.
- 1.2 Supply of DCU as per specification enclosed.
- 1.3 Supply of UPS as per specification enclosed.
- 1.4 Supply of Cables as per specification enclosed.

**2) Services**

- 1.1 RTU & DCU commissioning and testing
- 1.2 UPS commissioning and testing
- 1.3 Integration of RTU, DCU and UPS with field equipments.

## **A. Technical specification of Remote Terminal Unit (RTU)**

PART-A	RTU's General Requirement	Page No-52
PART- B	Cables	Page No-95
PART-C	Installation of RTUs	Page No-99



**Part-A RTUs-General Requirement**

**1.01 Scope:** This specification covers the details of Design, Engineering, Manufacturing, Testing, Supply, delivery and commissioning and up link of Remote Terminal Units along with suitable test software and accessories for telemetry of real time electrical data from various Sub-Stations located in the state of Karnataka.

**1.02 Type of RTU:** The RTU with 128 status input,80 number output,24 numbers analog input and eight numbers of configurable Modbus,61850 , DLMS and IEC-60870-5-103 port and Two number Ethernet port for conventional stations shall be designed for both TCP/IP Interface. Wherever Numeric Relays or IEDs are installed, these RTUs shall be able to acquire all the possible measurands directly on IEC-60870-5-103 / IEC- 61850.

RTU should meet cyber security standards of IEC-60870-5-7 including IEC 62351.

**1.03 Coverage:** It is proposed to install RTUs in the Stations of KPTCL.

- 1.04 Purpose:** Main Purpose of installing RTUs in all the Stations is to achieve following functions **which will be reporting to the existing Main Control Centre, SLDC, Anand Rao Circle, Bangalore and Back Up Control Centre, Nelamangala on IEC 60870-5-104 Protocol and SCADA/EMS system is of M/s ABB Make,**
- a.** Data Acquisition
  - b.** Supervisory Control
  - c.** Programming Logic Control
- and** **d.** HMI : **RTU shall have built in software for supporting HMI.**

**1.05 I/O Ports:**

RTU shall support the following I/O points.

**1.05.1 Analog Inputs:**

- a)** Through MFT: 30 Numbers of Multi Functional Transducer (MFT) of 0.2S accuracy class, 3-Ph-4W and output of the MFT shall be communicating to RTU in Modbus protocol each providing electrical measurands of the bay as mentioned in the Section 1.32.01.**Irrespective of the number of Bays at site, 30 number of MFTs should be supplied with each RTU. Maximum 8 numbers of MFTs in a loop on RS-485 port can be connected.**
- b)** A/I (Through Transducer): 24 inputs with minimum of 2 AI cards which can take International Standard input from conventional Transducers.

**1.05. 2. D/I:** 128 number of inputs.

Configurable for SPI/DPI and Number of inputs should not be more than 16 inputs per card. Misc system status points as mentioned in Clause 1.24 shall not be counted under this.

**1.05.3. D/O:** 80 number of control outputs. Configurable for

SCO/DCO and Number of outputs should not be more than 16 outputs per card.

**1.06 Communication Port:**

a) In addition to the above, each RTU shall be equipped with configurable Com Ports to acquire Data from MFTs directly on RS-485 Interface on MODBUS protocol, IEC-60870-5-103, IEC-61850, DLMS and should have minimum Eight Number of ports configurable for Modbus application, IEC-60870-5-103 and IEC-61850.

b) For Remote communication four number of Ethernet ports to communicate to different master control centres configurable to minimum of twelve masters on IEC-60870-5-104.

**1.07 Protocol:** RTUs shall be designed to support the Protocols as detailed below

1) IEC-60870-5-104, having TCP/IP Interface for remote

Communication.

2) IEC-61850 and IEC-60870-5-103 for Intelligent

Electronic Devices (IED ) Communication with RTU.

3) MODBUS protocol for MFT communication.

4) DLMS protocol for Energy Meter Communication.

KPTCL would like to employ IEC-60870-5-104 Protocol to support Web-Based kind of Architecture to monitor/Edit/Configuration of RTU with Three level Password Protection namely view, edit and control. Any change in the requirement at the time of integration is the bidder responsibility.

**1.08 Suitability:** RTUs shall be suitable for Real Time application for SCADA. They shall have Microprocessor/PLC based function control logic. RTU shall assemble response messages in accordance with received messages from Host and send them to Host on query.

**1.09 Site Survey:** The Bidders may visit some of the Stations where RTU is already commissioned before submitting the quote.

**1.10 Functional Requirements:** RTUs shall be capable of performing following minimum functions:

- 1) Collect Analog Inputs, Digital Inputs, Pulse Inputs and Misc. Analog Inputs.
- 2) Process and Transmit Analog, Digital and Processed values to Host on query.

- 5) Accept Digital Command from Host,
- 6) Execute Commands.
- 7) Support Data Transmission Baud Rate from 9.6 kBps to 256 kBps.

### **1.11 Programmable Logic Capability:**

The RTU shall support programmable logic capabilities, easy to use editing facilities. These facilities shall allow creation of programmable logic and computational algorithms for the RTU. The programmable logic capability shall enable the RTU to perform control functions such as closed-loop analog control, sequencing for equipment startup and shutdown, automatic failover control, and other such functions typically performed by Programmable Logic Controllers (PLCs).

The programming methods can also comply with IEC 61131-3, the emerging international standard for programmable logic controllers in following program languages:

- Function block diagram (FBD)
- Instruction List (IL)
- Structured Text (ST)
- Ladder Diagram (LD)
- Sequential Function Chart (SFC)

The PLC programs shall run parallel to the tele-control task.

PLC programs shall have access to all process signal values as well as the process signal defined such as invalid, time, etc.. PLC programs running distributed applications shall use the signal defined for secure and safe operation.

PLC shall use available Analog and Digital Inputs and perform user defined functions by using arithmetic, Logical functions, Time Delay and communicate output to RTU for execution. The process time between input and output should meet power system protection requirement.

### **1.12 Communication Interface:**

Each RTU shall be equipped with a minimum of twelve communication ports to support:

- 1) Port-1      Interface to Master through Ethernet
- 2) Port-2      Interface to Master through Ethernet
- 3) Port-3      Interface to Master through Ethernet
- 4) Port-4      Interface to Master through Ethernet
- 5) Port-5      Data Acquisition
- 6) Port-6      Data Acquisition
- 7) Port-7      Data Acquisition
- 8) Port-8      Data Acquisition
- 9) Port-9      Data Acquisition
- 10) Port-10    Data Acquisition
- 11) Port-11    Data Acquisition
- 12) Port-12    Data Acquisition

Port 1-4 shall be for **IEC 60870-5-104** communication.

Port 5-12 shall be configurable ports having facility to configure Modbus, IEC61850 & **IEC 60870-5-103**.

**1.13 Algorithm:** Each RTU shall be designed to function in **Asynch Mode**

Only except for reporting by Exception on disturbance.

**1.14 Cards:** Cards fixed to RTU shall be supplied with following Port Combination:

D/I Cards: in multiples of 16 or 32

D/O Cards: in multiples of 16 or 32

A/I: in multiples of 8 or 16

**1.15 Intelligence level:** Each card shall have separate processor performing duties like Diagnostics, Time stamping, event logging etc., to enhance the intelligence level. This intelligence level goes down if one integral card with I/O port is fixed, as the load on the processor increases. It is intended to ensure that other cards remain intact and if one card goes faulty due to any fault, data from other cards are still transmitted.

**1.16 Expandability:** Each RTU shall be designed for 100% expandability to ensure there is no space constraint for integration of new additional modules.

**1.17 Communication Media:** RTU shall be capable of supporting any of the following transmission media.

- a) OFC
- b) VSATs
- c) PSTN/ISDN
- d) PLCC

e) RF

Note: RTU should be able to work with minimum of two Modes of Communication Media working at different Speeds. It may be required to work with Hybrid of Media also. **However the communication media to the control centre from the RTU is not in the scope of this project.**

**1.18 Slave Mode:** The RTU shall perform as a slave on the communication channel to the Host. All communication shall be initiated by the SCADA system FEP/Master Station. The RTU must notify the master station on an unusual condition in 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.

**1.19 Scan Groups:** RTUs shall be capable of getting assigned A/I, D/I points (Including points reported by exception) through Scan Groups. A scan group shall be specified set of data points within an RTU central data base, which will be communicated to Master station on specific scan request. The Communication protocol message length shall only limit a scan group size. Any RTU input point shall be assignable to any scan group.

The Bidder shall provide a convenient and flexible scheme for assigning points in the RTU to scan groups. He shall also provide all special equipment necessary to configure the RTU and assign points to scan groups.

**1.20 Exception Reporting:**

The RTU communication protocol shall be capable of reporting status changes (COSI) by exception (spontaneous change of status indication). The communication protocol shall also support an update demand scan of all status data by master station regardless of the lack of any changed data.



## KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

The RTU shall continue to indicate exception changes until the master station acknowledge successful receipt of the changed data. The status change indication shall be invariably communicated to the Master station along with the time Stamp.

RTU shall report data to the master station in the following manner with,

- a) Time stamp.
- b) Cyclic, with configurable cycle time.
- c) Spontaneous, with configurable dead band for analog points.

### **1.21 Time Synchronization:**

All RTUs shall be capable of getting Time Synchronized with GPS Clock of Master. The internal RTU time base shall have a stability of 1ppm that is 3.6 mili seconds per hour or better. The RTU time will be set from time synchronization messages received from a Master station. The RTU shall synchronize its internal clock with the Master station..

**1.22 Power Supply:** RTUs shall be capable of performing with both:

- a) 230 V, 50 Hz. Single Phase AC Supply from a UPS

AND

- b) 110/220 V DC from Battery/Charger

The RTU power supply shall supply all necessary power to Support RTU functions. The RTU power supply shall be sized to handle the maximum power requirements for the ultimate number of input and output points. Arrangements shall be made to protect the RTU from Reversed polarity. In case of RTUs operating with DC Source, the RTUs shall operate with station DC voltage without causing ground. The RTU shall not place a ground on the input power. Each RTU shall have the capability of automatic start up and Initialization following restoration of power after an outage without need of master station interaction. All restarts shall be reported to Master.

Bidders may note that DC source will not be available at most of the Stations. It is therefore desirable to design the RTU to work with 230 V, 50 Hz. Single Phase AC Supply from a UPS. Same supply shall be made to available to other auxiliary equipments of RTU like cooling fans, Internal lighting and maintenance outlets etc.,

### **1.23 P/S Protection:**

Over voltage and under voltage protections shall be provided within the power supply to prevent the RTU internal logic from being damaged as a result of 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.

### **1.24 Power Failure:**

The RTU shall have a **system** status point which shall be set if the Power to the RTU's has been cycled (on-off) for any reason (including maintenance).

### **1.25 Grounding and Protection against EPR (Earth Potential Raise):**

The RTU shall also be connected to Earth Mat of the Station using 50 X 6 mm to GI Flat to ensure that RTU raise to the same potential in case of EPR. The Bidder shall ensure Ground Resistance before commissioning the RTU. Each RTU shall be protected by suitable protective equipments for failure against EPR.

**1.26 Redundancy:** . The Bidder has to provide redundancy in RTU for the following,

- a. Redundant Power Supply Card.
- b. Redundant CPU Card.

**1.27 Multi Drop:** RTUs shall have capability to support Multi dropping/Polling.

**1.28 DDTA (Data Delivery Time Analysis):** The Bidder shall furnish data updating from RTU to 104 protocol viewer at Station level.

**1.29 RTU Hang:**

RTU shall be so designed to accept valid queries from Master. It shall not accept any other message, which may render RTU to hang. Each RTU communication message shall include an error code, the use of which shall result in a very low probability of an erroneous message 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 message addressed and received by the RTU. Cyclic error detection codes shall be employed.

**1.30 Security:**

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 supplier shall give full details of the EDC (Error Detection and Correction) code. The protocol security shall use the IEC 870-5 and, as a minimum, frame format class FT 1.2 (T-101 profile) with a

minimum hamming distance of four (4).

**1.31 RTU Address:** RTU addresses shall be programmable within the RTU through Software Configuration means.

**1.32 I/O Requirements:** The Bidder shall provide all hardware necessary to meet the initial point requirements, for A/I, D/I, D/O, Com- Port and relays. They shall have 20% spare points per I/O type. The RTUs shall be physically sized to support the ultimate I/O requirements per RTU. The following RTU Input/output types are described in the following sections:

- a. Analog input
- b. Digital inputs
- c. Digital outputs
- d. Serial I/O port

**1.32.01 Analog Input:**

**a. MFT (Multi Function Transducer):**

MFT are used to acquire Electrical Parameters through MODBUS protocol. The following are the details of MFTs.

- a. Interface: RS-485, in Daisy Chain to RTU Com Port
- b. **Maximum No. of MFTs per RS-485 port in Daisy Chain: 08**
- c. Wiring: Both 3 Ph-4W
- d. Supply: Self Powered.

## KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

- e. Outputs: 13 outputs giving 32 Power Parameters
01. System Volts in kV  
System Current in A  
System MW
  02. System Volts THD %  
System Current THD %
  03. Volts  $L_1$ -N in kV  
Volts  $L_2$ -N in kV  
Volts  $L_3$ -N in kV
  04. Volts  $L_1$ -  $L_2$   
Volts  $L_2$ -  $L_3$   
Volts  $L_3$ -  $L_1$  all are in kV
  05. Volts  $L_1$ - THD %  
Volts  $L_2$ - THD %  
Volts  $L_3$ - THD %
  06. Current  $L_1$   
Current  $L_2$   
Current  $L_3$
  07. Current  $L_1$ -THD %  
Current  $L_2$ -THD %  
Current  $L_3$ -THD %
  08. Neutral Current  
Frequency

Power Factor

09. MW

MVAr

MVA

10. kWh (7 digit Resolution)

11. kVArh (7 Digit Resolution)

12. MW Demand

Current Demand

13. MW Maximum Demand

Current Maximum Demand

14. Primary Current: Max. 9999.5 (360  
MWs) (at 120 % of relevant CT/PT  
inputs) PT Primary Max. 400 kV (at 120 % of  
relevant CT/PT inputs)

15. Demand Integration time:

8, 15, 20 and 30 Mins

16. Resets for: Max Demand and Active  
Energy Registers

17. Pulse output Durations: 60, 100 or  
200 m secs.

## KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

Pulse Rate Divisors: 1, 10, 100, 1000

18. Baud Rate: 2.4, 4.8, 9.6 and 19.2 kbps in RS-485.

19. RS-485 Parity: Odd/Even with No. 1 or 2 Stop Bits.

20. Mod-Bus Address: 1-247

21. PT Input: 57.7 to 346 V (L-N)  
100 to 600 V (L-L).

22. Max Voltage: 120 % of Nominal  
Short Duration: 2 times for 1 sec,  
repeated at 10 times at 10 secs interval

23. PT Primary: 400 kV Max or 360 MWs

24. CT Input: 1A, 5 A

25. CT Ratio: Max. 9999.5/1A or  
9999.5/5 A. Max Current: 120 % of  
nominal. Short Duration: 20 times for 1  
sec, repeated at 5 times at 5 secs, interval

26. Max. Burden :< 0.6 VA

27. Output: RS-485: 2 Wire half Duplex  
Baud Rate: 2.4, 4.8, 9.6 and 19.2 kbps

28. Frequency: 45-66 Hz

29. Measuring Ranges:

Voltage: 120 %

Current: 120 %

Frequency: 45-66 Hz

Power Factor: 0.5 Lag-1-0.8 Lead

THD: 1 to 15<sup>th</sup> Har.

kWh/kVArh: 7 Digit resolution

30. Accuracy:

All parameters to meet 0.2s class of accuracy.

31. Up Date time: 500 m secs.

32. Enclosure:

Body: Poly Carbonate case  
and ABS base Terminals. Shrouded  
screw clamps mounting on DIN rail.

3.3 Dielectric: 2.2 kV RMS at 50 Hz  
withstand for 1 min.

3.4 Operating Temp.: -20<sup>OC</sup> to + 70<sup>OC</sup>  
Relative Humidity: 95 % non condensing



Warm up time: 1 min

Dimensions: 96 h X 96 w X 155.5 mm d

Panel cut out 92 X 92 mm

**b.Through Transducer:** The RTU shall accommodate analog inputs, which are isolated ,Uni-polar,or Bi-polar,2 wire ungrounded differential signal with full resolution as follows:

i. -2.5 to +2.5 mA

ii. 0 to 5 mA

iii. +4 to 20 mA

### **1.32.02 A/D Converter:**

In MFT kind of environment, A to D conversion will happen within MFT. The RTU shall contain analog-to-digital (A/D) conversion equipment operating at analog conversion rates necessary to satisfy the system scan requirements when operating in a polled mode. The A/D converter shall have a digital resolution of at least 12 binary bits plus sign **or anything better can be accommodated**. The overall accuracy of the A/D conversion process shall be better than 0.2 % full scale over the specified operating temperature range of -5 to + 55 °C. However, if only a signal zero integrity checkpoints are provided, then the accuracy shall be better than 0.1 % instead of 0.2 %. The output shall be monotonic (the output shall consistently increase with increasing input and decrease with decreasing input).

An over-range and sign bit shall be generated by the analog input subsystem for reporting to the Control Centre. It is desired to have isolated Analog inputs. The input to the analog-to-digital subsystem shall exhibit

## **KARNATAKA POWER TRANSMISSION CORPORATION LIMITED**

common mode noise rejection characteristics of at least 100 dB from zero to 50 Hz with a 1000 ohms source unbalance. Normal mode noise rejection shall be at least 50 dB at 50 Hz. The overall accuracy tolerance and rejection characteristics shall include the effects of any scaling resistors, amplifiers, and multiplexes used between the input terminals and the final converted value.

The implemented data multiplexing and transducer termination techniques shall not effectively degrade the accuracy and noise immunity characteristics. The Analog-to-digital converter input amplifier shall be protected against permanent change from induced energy surges.

The analog-to-digital converter equipment shall preferably include an integrity check feature with at least three voltage reference checks preferably  $\pm 90$  % of full scale and zero. The overall accuracy and stability of the integrity check reference value shall not exceed 0.05 % of full scale throughout the specified temperature range. The reference voltage points shall not be included in the ultimate point count. The integrity check feature shall be monitored periodically by the Control Centre to assure that the RTU A/D converter is operating satisfactorily. Analog inputs shall be derived from linear transducers (in case of Transducer based Type) to be provided by the Bidder.

Standard Misc. Analog inputs to accept transducer outputs of 0 to  $\pm 10$  mA dc into a load of 0 to 1k ohms or 0 to +10 mA dc into a 0 to 1k ohms, or +4 to +20 mA dc into 0 to 500 ohms shall be used. Scaling resistors and any required signal conditioning shall be provided, and mounted independently of the A/D converter or multiplexer modules such that multiplexer modules and A/D converter modules may be substituted without regard to scaling resistors or signal conditioning components.

### **1.32.03 Digital Inputs:**

The digital status input interface shall be capable of accepting isolated, wet or dry contact status input. The Contractor shall apply necessary sensing voltage, current limiting, and optical isolation and debounce filtering independently for each digital status input. The sensing voltage shall not exceed 48 V DC. The sensing voltage source shall be isolated from that of the RTU's logic power such that any noise or short circuit across the sensing supply's output terminals would not disrupt the RTU operation other than the shorted digital status input.

The RTU shall store all status changes detected for retrieval by the master station, tagged with time of the occurrence. For communication delays or short-term failure of communication with a master station, the RTU shall store a minimum of 300 status change events. The RTU shall report any overflow of this status change buffer to the master station.

Each Digital input module in the RTU shall support at least 16 digital input points. All input circuits of the digital input modules shall be electrically isolated from the external signal. Optical isolation techniques shall be used throughout the RTU for digital input circuit protection.

Driving voltage to auxiliary contacts on breakers and other devices shall be provided from an isolated voltage source within the RTU. This RTU driving voltage shall be derived from RTU auxiliary power source (230 V AC). Circuit protection shall be provided to eliminate the possibility of catastrophic effects of short circuit conditions on device contacts and input circuits within the RTU. The following types of digital inputs shall be supported:

- a) Status Inputs
- b) SOE Inputs
- c) BCD Inputs
- d) Binary Word Inputs
- e) Pulse Accumulator Inputs.

Each D/I Module shall support a minimum of 16 Points.

**1.32.04 Status Input Requirements:** The following status inputs shall be supported:

- a) Single Contact Digital Status input (SS)
- b) Double Contact Digital Status input points (DS)
- c) Three-State Status

**1.32.05 Single Contact Digital Status input (SS)**

SS signal is generally used for isolators. This type of input receives single information, which is true or false (information lacking). Physically true or false corresponds to a potential free contact, which is closed or opened. Generally this type of input is connected to a contact, which remains closed during normal operation, but the reverse case is also possible.

**1.32.06 Double Contact Digital Status input points (DS)**

This type of input receives an information pair, which reflects this status of a device able to position itself on one of two steady statuses, as in a circuit breaker.

Physically the input associated to one DS corresponds to a potential free contact pair and this information pair is complementary (one normally open and one normally closed contact). For instance, opened/closed DS status would correspond to an opened circuit breaker while closed/opened status would correspond to a closed circuit breaker. Breakers with reclosing capability shall be supported with Momentary Change Detection (MCD). As a minimum, MCD shall store a change indication which coupled with the current status of the device will permit reporting of four status changes per MCD point since the last sampling period 2 bit MCD.

Alternate MCD implementations will be considered. It should be either the CD indication with status be returned in the status response message or be reported by exception. The status change sequences, which a two-bit MCD shall detect, are as follows:

- a) Initially closed, trip-close
- b) Initially tripped, close-trip
- c) Initially closed, trip-close, trip

MCD data shall not be deleted unless directed by the Control Centre but shall be overwritten if a second valid MCD occurs before the Control Centre has scanned the RTU.

The RTU shall filter status changes as follows:

- a) Status changes with a duration less than 20 milliseconds shall not be noted as a change.
- b) Status changes with duration of greater than 20 Milliseconds shall be noted as a change.

The filter time shall be adjustable between 4 to 25 ms with an increment of 1 ms via DIP switch (or equivalent). Any Status point may also be designated as SOE. All SOEs shall be time stamped at a resolution of 1ms.

**1.32.07 Three State Status:**

Three-State Status is mainly used for devices that slowly change from one state to other like Isolators. The capability shall be provided to monitor these switches. The status of such devices shall be available through the use of a pair of contacts in the form of **a** contact and **b** contact.

The information regarding a device position or an operation setting depends on the status of two normally complementary signals. In case of status change on one of the contacts, it is necessary to examine the other contact position to know the actual position and status. For a device to change status, both contacts must change state. The change of state shall be time tagged (If status point is designated as SOE) to the nearest millisecond as follows.

The RTU shall detect the time (to the nearest millisecond) that contacts **a** and **b** change state. The time tag for these changes shall be the time when the change in the second of the two contacts is detected.

If the state changes for the two contacts are not completed at the time the RTU is polled, the response shall announce the "in transit" state. The contact statuses are as follows:

State	a	b
CLOSED*	CLOSED	OPEN
OPEN*	OPEN	CLOSED
IN TRANSIT	OPEN	OPEN

## KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

ERROR	CLOSED	CLOSED
-------	--------	--------

\* It shall also be possibly to define these two states in the opposite sense. The Bidder shall provide two sets of screw terminals for each input point. One terminal from each set shall be electrically connected and labeled as common.

### 1.32.08 S.o.E:

The RTU shall support Sequence of Events (SoE) inputs. A single point may be both status and SoE. SoE shall be time-stamped to a resolution of 1 millisecond within the RTU. The RTU shall allow SoE to be activated and deactivated on an RTU basis or on a point basis using a command message. The RTU shall set a flag in the return message of any communication from the Control Centre indicating there is SoE data. A flag shall also be set to indicate to the Control Centre that the buffer is 80 % full. The buffer size shall be no less than three (3) times the buffer required for total SoE in the RTU.

The Control Centre shall request SoE data. SoE data shall not be deleted unless directed to do so by the Control Centre. SoE data, if not specifically deleted, shall be overwritten when the buffer is full with the oldest data being overwritten. The RTU shall have a retransmit capability of all SoE data currently in memory if it is commanded. The event shall contain the point ID, the point current state and the time of the state change. SoE shall have electronic filtering on each point to discriminate false indications. The time tag shall be the time of the first valid detected closure.

### 1.32.09 Binary Coded Decimal Input (BCD)

The RTU shall be capable of accepting Binary Coded Decimal (BCD) digital

inputs (minimum of four digits per input). The RTU shall convert the four-digit BCD value to a binary value for transmission to the Control Centre. A BCD input shall use one address.

**1.32.10 Binary Word Input:**

The RTU shall be capable of accepting a binary input up to 16 parallel bits long. A binary input shall use one address.

**1.32.11 Digital Outputs (D/O):**

- a) Multiples to support in multiples of 16
- b) Isolation Galvanic and Optical Isolation
- c) Input Voltage 250 V AC/DC, 110 V DC or 48 V DC
- d) Current Rating > 1Amp
- e) Protection Transient Protection
- f) Relay actuators shall be provided
- g) Contactor rating (For tripping CBs) min 10 Amp.

The following digital output types shall be supported:

- a) Two-State Digital Control Output (DC)
- b) Raise/lower Control Output
- c) Digital Word Output.

Whenever there is control executed from RTU it should give indication in annunciation panel as LED and an audio alarm till its acknowledged. This also can be provided by LCD display min of 6x4 inches with facility to retrieve and reset. Shall be provided which gives indication for breaker operations executed from RTU. **The number of digital outputs in RTU panel should match with the indication in the annunciation panel.**



#### **1.32.12 Two State DCO:**

The RTU shall be capable of giving out two-state supervisory controls. The RTU shall be designed such that only one output can be activated at a time. Select-Before-Operate (SBO) methodology shall be used. The maximum time the RTU waits between receipt of a control select command and the activate command shall be selectable between 1 and 20 seconds in 1 second increments. The factory setting for the time between the select and operate command shall be 5 seconds.

The RTU shall provide the power to operate Contactors of interposing relays, provided externally. The Bidder shall provide Interposing Relays of suitable VA ratings and assemble them in a suitable enclosure. The Bidders may quote for any of the following types of relays.

- a) Momentary Contact Outputs
- B) Latching Contact output

#### **1.32.13 Two State Momentary Control Relay:**

There shall be two relays per point. One relay shall be for the trip or open command. The other shall be for the close command. Each low power output relay shall have at least two normally open and two normally closed contacts. Each relay shall be activated for a defined time. The closure time shall be selectable per point from 0.1 to 2 seconds in increments of 0.1 seconds. The factory setting time shall be 0.5 seconds.

#### **1.32.14 Latching Contact Output:**

Each latching control output shall have, as a minimum, two normally open and two normally closed contacts that shall remain in a given state until a following

command changes the contact state. Example: Providing Interlock for local/remote Operations.

#### **1.32.15 Control Security:**

Operation of control outputs shall use a true select-check-before-execute command sequence between the RTU and the SCADA system master station. The sequence shall include, as a minimum, the following functional capabilities.

- a) Operator Selects a point for operation on his MMI
- b) This point gets checked with Data Base in the Host
- c) Host asks for confirmation of the Point ID
- d) Operator Confirms Point ID
- e) Host checks with the Breaker Status
- f) And then asks for Authority
- g) Operator Confirms authority
- h) Host checks with the Authority to open/close
- i) Host asks operator to give execute command
- j) Operator executes command
- k) The master station shall transmit a control selection

message addressing the proper RTU and control

points within RTU, and indicate the control action

desired (such as open/close).

- l) The RTU shall initialize its control logic, reassemble the control selection message received in (k) above, and re-transmit the reassembled message to the master station. The RTU's point selection logic indicating the point and control function selected shall generate the information in the message sent to

the master station. It shall not be a simple repeat of the master station's messages transmission.

- m) The master station will verify the returned message with the message sent in (k) above and, if valid, shall issue an execute control message to the RTU.
- n) The RTU shall only operate the control point selected after the check -before-execute sequence (as mentioned above) has been performed without error or interruption by any other messages. The RTU shall reset its control logic upon error in the sequence or if the execute message is not received within a set time (user adjustable from 2-20 seconds) after the command message is received at the RTU.
- o) COSI is sent to Host.

#### **1.32.16 Rise/Lower Pulse Outputs:**

Raise/lower control output shall be provided to control transformer tap changer positions, generator unit controllers and other similar devices. Raise/lower control output shall operate interactively with the Operator. The Operator shall select a pre-defined raise or lower contact closure, each time the command is executed for the selected point. The Operator shall either release the point from control when finished or a Control Centre Man-Machine Interface timeout shall release the point if there is no activity for a defined timeout period.

The RTU shall be designed such that only one Jog Control point

can be active at a time. During the time Raise/lower Control is active, normal scanning shall be permitted. It is desirable to have an accelerated scan on the associated analog point, if it exists, so that the Operator can see the results of the Raise/lower Control actions. The contact closure times shall be adjustable per point between 0.1 and 4 Secs. in 0.1 second increments. The factory setting time shall be 0.5 seconds. The relay contacts shall be rated as specified for the two-state digital outputs.

#### **1.32.17 Digital Word Output:**

The RTU shall support an eight (8)-bit digital word output. The output shall be through low power signal relays. Each digital word output shall represent one (1) output address. The output word shall be permanent until changed, like in Tap Changing Operation.

#### **1.33 Maintenance Port:**

The RTUs shall be provided with all support hardware and software to allow maintenance access to the RTU database, configuration and functional operation through a Lap Top. The maintenance access shall be used by the Customer to define the structure of RTU configuration and to maintain the operation of the RTU.

#### **1.34 Support Facilities:**

The Bidder shall quote for support Hardware & software. The support facilities shall include but not be limited to the spare parts, portable RTU maintenance terminal, maintenance manuals, and any other supports facilities as they are applicable to the Bidder's RTU design.

#### **1.35 Remote Downloading to RTU:**

The RTU shall be designed to accept Remote software down

loading from Hub with respect to RTU Configuration, Version Revisions, etc., The detailed Algorithm connected with this Remote Down Loading shall be supplied to the Employer as a document.

**1.36 Maintenance Support:**

The Bidder shall guarantee to provide spare parts, repairing of individual faulty modules, or RTU and software support for RTUs for a minimum period of 10 years from the date of installation.

If Bidder is not a producer of the RTU, he shall give a commitment of the OEM to this effect.

**1.37 Interface Cabinets:**

The interface cabinets between the RTU and the field equipment shall be provided. The interface cabinet shall house all transducers, MFTs, interposing relays/opto Couplers, Contact Multipliers and interface terminal blocks. The interface cabinet shall be mounted adjacent to the RTU cabinet. All RTU signals shall be connected to the transducers, MFTs, interposing relays, and field signals in the interface cabinets. Care shall be taken to see that CT wires are not extended beyond limits to this Cabinet where Transducers/AI Devices are housed. The Bidder shall submit a cabinet design to the Customer for approval. The cabinet shall be logically partitioned to have transducers, MFTs in one section, interposing relays in another and interface connections to the RTU in another section. All components shall be installed complete with internal wiring prior to shipment. The entire cabinet shall be of good Gauge made of Steel and lockable. If multiple locks are provided, the same key shall open any lock.

The interface cabinet shall house various pieces of equipment that are needed to interface to the RTU. It shall be of modular type. The equipment shall be rail-

mounted type. The connections shall be on the front end for incoming and outgoing circuits and on the rear end for internal connections different sub-assemblies of the interface cabinet.

Pre wired and standardized designs for the interface cabinet to be developed. The interface components for each typical bay shall comprise typical modules and sub-assemblies logically sorted by type of interface. For example, interface component associated to a double bus bar type feeder shall consists of a module for the circuit breaker position indication, a module for the associated bus bar isolators position indication, a module associated to power measurements and a module associated to position control.

Each module or sub-assembly shall be provided with all testing (switching, disconnecting and inserting) facilities, allowing easy maintenance. Wire ways not more than 50% full for maximum RTU configuration, shall be provided to route the necessary connectors from the Customer's choice of top or bottom access to the I/O terminations. For wire way-sizing purposes, the RTU supplier shall assure that each point uses an independent cable.

### **1.38 Enclosures:**

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. Racks shall be of standard Make. Freestanding indoor enclosures shall be provided for indoor RTUs. The dimensions of the enclosures shall be so designed to house all the equipments inside and provide ease of operation to operator. To give a smooth appearance, the door surfaces shall be flush with the face of the cabinet. A metal pocket attached to the inside of the front door shall be provided to hold RTU Documentation. The enclosure shall be built up as a 48.26 cm (19-inch-Standard) rack-mounted system with hinged

units provided as necessary. The front door shall have a key lockable handle.

All RTUs supplied shall have a common key to all doors. The enclosure shall be indoor, dust proof with rodent protection and meet ISO-IP 41 class specifications. Indoor enclosures shall have both top and bottom cable access with removable dust covers for all access holes. The enclosure shall have a baked enamel finish with two coats of finish paint applied over a primer.

All RTUs shall be protected against the electromagnetic, electrostatic, and induced transient voltages and currents that are often present in substations and power stations. Within the enclosure, hot-spot temperatures shall not exceed the recommended operation temperatures of the components. Suitable exhaust fans shall be provided to remove excess heat from the Cabinet. Equipment shall be sufficiently sturdy to withstand handling during shipment, placement, and start-up without damage. The shipment configuration shall adequately protect equipment from scraping, banging, or any other damage. The Bidder shall assume responsibility for the correction of all such damage upon receipt of the equipment at the Customer's receiving site.

During the period prior to permanent installation, both indoor and outdoor enclosures shall be stable with doors open. The auxiliary stabilizers may be provided, if needed. No equipment shall be mounted on the cabinet doors. All indoor RTU cabinet doors shall be removable without tools and shall have three point latches. Required supports, tie downs, etc., required, shall be provided for handling Cabinet. Each enclosure shall be furnished with four removable lifting eyes and predrilled holes for bolt-down installation. Suitable grounding braid shall be provided and shall electrically connect all moving parts (doors, swing racks, etc.) and all the cabinets of a multi-cabinet RTU together. Front and rear doors shall be used on each freestanding enclosure. Swing rack(s) supported by heavy gauge hinges may be provided so that only front access shall be required for routine maintenance and troubleshooting.

Each RTU shall be equipped with a fused convenience power

outlet inside the enclosure to power test instruments. The convenience outlet shall be consistent with standard Indian power service. Convenience outlets shall be equipped with Ground Fault Interrupters. An overhead lamp at the top of the enclosure shall be provided.

Each RTU shall have one bolted clamp type cable of stranded copper conductors for grounding cable connection. All internal RTU metal

Components such as mounting rails and chassis shall be firmly grounded to the RTU cabinet by use of grounding devices, such as star washers and grounding straps. Multiple cabinet RTUs shall be bonded together.

Analog and digital inputs shall include shields on each pair of Cable. Signal and safety ground networks within the enclosure shall be provided. The safety ground shall be isolated from the signal ground and shall be connected to Customer's Ground Mat. Ground wire of the ac power input shall always be used. The signal ground shall terminate at a separate stud connection sized for a lugged 16-mm<sup>2</sup>-ground wire. Each ground network shall be copper bus bar, braid, or cable. Use of the enclosure frame, skins, or chassis mounting hardware for the ground network is not acceptable.

All materials shall be the best commercial grade used in the manufacture of RTU equipment. All wire and cable connection and terminators shall be permanently labelled for identification. All connection points for external cables and wires shall be easily accessible for connection/disconnection. They shall be permanently labelled. All components and equipment shall be of current production from component manufacturers. To facilitate expansions and maintenance, modularity shall be employed throughout the hardware equipments. All wiring shall be neatly laced or clamped. Materials that are susceptible to corrosion shall not be used.

### **1.39 Interconnections:**



## KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

Cables required between component units of the RTU, RTU to interface cabinet should be supplied and installed by the Bidder and shall be shown on the drawings. Plug type connectors with captive fasteners or compression type connectors shall be used for internal connections. The connectors shall be polarized to prevent improper assembly. Each end of interconnection cables shall be identified by a marker, which includes the cable number and the identifying numbers and location of each of the cable's terminations.

Bidder shall supply wiring diagrams for RTU along with the offer. Wiring within enclosures shall be neatly arranged and shall not be directly fastened to the enclosure frame. All wiring shall use copper conductors and have flame retardant insulation. Conductor in multi conductor cable shall be individually colour coded. Metal clamps must have insulating insert between the clamps and wiring. Wiring between stationary and movable components, such as wiring across door hinges or to components mounted on extension slides, shall allow for full movement of the components without binding or chafing of the wiring.

Adequate space for the hardware shall be provided for routing of the field wiring within the enclosures. The following techniques, material, and practices shall be followed in the internal wiring of RTUs:-

Terminations: All connections for interconnecting wiring integral to the supplier's equipment shall be of a durable and reliable type.

Signal separation: All wire that carry out low level signals shall be adequately protected and separated from power wiring.

Pin and socket identification: Each pin and associated socket connection

shall be clearly identified by a coding scheme that is uniform within each subsystem.

**Connector Alignment:** Plugs and receptacles shall have keys, aligning pins, or other devices to indicate and ensure proper insertion of connectors.

**Mating to adjacent Connectors:** Plugs and matching receptacles shall be physically positioned or constructed to preclude improper matching with adjacent plugs or connectors.

**Plug and Receptacle Accessibility:** All plugs and receptacles shall be mounted and positioned for ease of replacement or repair.

**Cable Harnesses:** Whenever possible, wire shall be bundled into harnesses formed by plastic or nylon cable ties.

**Cable Routing:** Cable shall be routed so that wires or insulation cannot be over flexed, pinched, or damaged by doors, drawers, disassembly, or by other operation required for installation, testing and maintenance.

**Cable Accessibility:** Cable and wiring shall be easily accessible by maintenance personnel.

**. Cable Bending:** Cable shall be connected or disconnected easily without bending or crimping.

## KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

**Cable mounting:** Cable or wiring shall be mounted on stationary panel where Stress points shall not occur on connectors. Cable glands shall be provided wherever required.

**Cable protection:** Grommets or other protective devices shall be used to protect cables or wires that are routed through panel holes or over sharp edged surface.

**Card Edge Connectors:** All printed circuit card edge connectors shall have gold plated contact surfaces and shall have positive contact wiping action.

**1.40 Terminal Blocks:** For interfacing of 3 Phase CT in-out and 3 Phase-4 Wire for PT Terminal blocks disconnecting type of Terminal Block to be provided as per the KPTCL approved make. The cable for CT connection shall be of 4.0 sq. mm size and for all other inputs (PT/status/signals/analog, digital outputs) shall be of 2.5 sq. mm.

**1.41 Assembly:** Each assembly of printed circuit cards shall be clearly marked with the manufacturer's part number and serial number. All electronics parts (such as capacitors, resistors, and integrated circuits) shall be marked either with the characteristics of the part or with an industry standard part number. Where custom parts are provided (such as read only memories) the part shall be marked such as to specifically identify the part when similar parts may exist. All printed circuit card cages and all slots within the cages shall be clearly labeled. Printed circuit cards shall be

## **KARNATAKA POWER TRANSMISSION CORPORATION LIMITED**

keyed for proper insertion. It is desirable that printed circuit card be keyed to prevent insertion into incorrect location. Following assembly requirements shall be followed.

**Component mounting:** Mounting of components shall be on plug in printed circuit cards of epoxy glass or equivalent quality. Cards and their associate slots shall be plainly identified so that they can be readily associated with information on drawings and supplier furnished manual.

**Plug in Assemblies:** Plug in assemblies and sub assemblies shall be employed whenever possible, using as few mounting screws as possible consistent with stress and vibration requirements.

**Guide pins:** Guide pins or other devices shall be provided for alignments of sub units during connecting and disconnecting so that pin and socket connectors are protected.

**Sub-Unit Replacement:** Replacement of one modular sub unit shall not require removal of other modular sub units.

**Mounting hardware:** Fasteners for modular sub units shall require no specialized tools, mounting hardware shall be interchangeable.

**Grounding:** Each cabinet provided under this specification shall

be grounded to Station Earth mat/Electronic Earth.

**Equipment Assembly:** Equipment shall be assembled to allow for easy access without disassembly of components contained within enclosures. Slide out or hinged mountings shall be employed where enclosures would otherwise prevent access to equipment. Equipment shall be mounted so as to provide easy access to test points, fuses, switches and all items requiring replacement adjustment or calibrations.

**Wire ways:** Wire ways and I/O cabling shall not interfere with removal, repair or adjustment of RTU power supplies, circuit cards and terminations.

**Components:** Components shall be selected which have quality levels that conform to standard engineering and industry requirements for comparable equipment. Solid state and other electronic components shall be applied within their specified operating ranges. No components, which have been selected for special characteristics from a group of the supplier's standard product, shall be used unless specifically authorized by the purchaser. All discrete components, including semiconductors, resistors, capacitors, fuses and lamps, shall be selected in accordance with standard commercial and industrial quality assurance methods.

**1.42 MCCB:** All miniature circuit protection breakers shall be of

the manually operated, moulded case type, and shall provide thermal over current and instantaneous short circuit, protection.

**1.43 Noise Level:** The audible noise generated by the RTU equipment shall not exceed 40 db at a distance of one meter from the enclosure.

**1.44 Environmental:** The RTU will be installed in Power Station or Sub-Station control room without temperature or humidity control. The RTU shall be capable of operating in ambient temperature from -5 to + 55°C and relative humidities from 5 to 95% non-condensing.

**1.45 Critical Up time:** RTU should be designed to have critical up time of 99.9 %.

**1.46 Reserve:** Each RTU shall provide a 20 % reserve capacity for connecting other points. This means that one additional card in each category should be fixed to

provide for this Reserve capacity. However, each RTU shall be designed to provide 100 % expandability, in the same Chassis.

**1.47 Maintainability:** The RTU design shall facilitate isolation and corrections of all failures. The following features, which promote rapid problem isolation and replacement of failed components, shall be provided.

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 failure.

**1.48 Life Span:** Each RTU shall have life of 20 years from the date of fixing. Bidder shall give **after Sales Product support for a minimum of 10 Years.**

**1.49 MTBF:** RTU shall provide an MTBF (Mean Time Before Failure) of 5 years.

- 1.50 MTTR:** The Bidder shall undertake to provide MTTR (Min. Time to Repair) of not more than 6 hrs, for effecting repairs on RTU, beyond which time, the Downtime penalty is applicable.
- 1.51 Royalty:** The Bidder shall submit a certificate that the Customer shall not be liable to pay any royalty on account of using the RTU with any compatible system or installing any other protocol in the RTU not specifically supplied by the Bidder.
- 1.52 RTU S/W:** All S/W in RTU shall be implemented according to established design and coding Standards. The S/W shall be designed to accommodate growth within the RTU without requiring software or data base regeneration. The S/W delivered shall be latest and any version revision shall be supplied free of cost and RTU shall be capable of taking such upgrades. The RTU shall have Micro Processor based control logic residing in EEPROM.
- 1.53 OS:** The Operating System shall be non-proprietary,



capable of performing distributed applications. It shall support multi tasking and multi programming. The minimum real time facilities to be provided shall include process, job, database, memory management, process synchronizing, message services for communication between jobs and device and interrupt handling.

**1.54 Initialization/Restart:** S/W shall provide automatic restart of the RTU upon power restoration, memory parity errors, hardware failures and upon manual request. The S/W shall initialize the RTU and begin execution of RTU functions without intervention by the Master. All restarts must be reported to Master.

**1.55 Monitoring:** RTU S/W shall monitor operations of the RTU and report H/W errors.

**1.56 Compiler:** The Bidder shall supply a data base compiler to build up data base of RTUs and configure RTUs.

**1.57 Diagnostics:** The Diagnostic S/W shall monitor and test the various components of an RTU. It shall provide for user interaction and printouts.

**1.58 Interposing Relay/Opto Couplers/Opto Isolators:**

The status inputs from field equipments i.e. circuit breakers and isolator on/off signals shall be connected to the Interposing relay or opto isolator modules with 220 V DC/110V DC signal through NO/NC contact. These signals are to be galvanically isolated from the RTU circuit which the interposing relay or opto isolator modules mounted in interface cabinet shall act as a buffer stage. The output of the interposing relay or opto isolator shall be 48 V DC (RTU operating Voltage)

The interposing or opto isolator unit shall meet the following requirements:

- a) Auxiliary Power 48V DC
- b) Input signal from field 220 or 110 V DC
- c) Input impedance More than 50 kilo-Ohms
- d) Output signal to the RTU 48 V DC Digital input module

**1.59 DC transducer:** Transducer should have the following specification,

1. Type: DC
2. Operating range (Input): 80-260 V DC
3. Dual Output (isolated): 4-20 mA
4. Accuracy: 0.5%
5. Aux supply input: 48-230 V DC
6. Response time: 500 msec

7. Span/Zero Adjustment

8. Quantity: Two

The Transducer should be housed in RTU making provision of Terminal Blocks' for connecting Input and Output.

### **Part-B Cables**

#### **Cables:**

**2.01 Scope:** This section of specification describes requirements of Cables, associated with RTUs. The cables required for wiring, the field devices to RTU, Interface cabinet or to the transducers shall meet the following requirement. The required quantity is to be assessed by the Bidder.

#### **2.02 Current Cables:**

The Current cables shall have the following characteristics:

- a) Copper Core meeting IEC-228, Class II requirements
- b) Minimum core cross-section of 4.0 Sq. mm, Multi Strand 7 core
- c) Rated voltage  $U_0/U$  of 0.6/1.0 kV
- d) Fire suppression PVC insulation and external sheathing equal to IEC 540.
- e) Shielding, longitudinally laid with overlap
- f) Dielectric withstand 2.5 kV at 50Hz for 5 minute
- g) Core temperature limit  $75^{\circ}\text{C}$  at normal operation and  $160^{\circ}\text{C}$  during short circuit.
- h) External marking with manufactures name, type, core quantity, cross section and year of manufacture

### **2.03 Voltage Cables:**

The Voltage cables shall have the following characteristics:

- a) Copper Core meeting IEC-228, Class II requirements
- b) Minimum core cross-section of 2.5 Sq. mm, Multi Strand 4 core
- c) Rated voltage  $U_0/U$  of 0.6/1.0 kV
- d) Fire suppression PVC insulation and external sheathing equal to IEC 540
- e) Shielding, longitudinally laid with overlap
- f) Dielectric withstand 2.5 kV at 50Hz for 5 minute
- g) Core temperature limit  $75^{\circ}\text{C}$  at normal operation

and 160<sup>0C</sup> during short circuit.

h) External marking with manufactures name, type, core quantity, cross section and year of manufacture

#### **2.04 Signal Cables:**

The Armoured Signal cables shall have the following characteristics:

- a) Copper Core meeting IEC-228, Class II requirements.
- b) Minimum core diameter of 0.5 Sq. mm 10 core.
- c) Rated voltage U<sub>0</sub>/U of 0.6/1.0 kV
- d) Fire suppression PVC insulation and external sheathing equal to IEC 540.
- e) Shielding, longitudinally laid with overlap
- f) Dielectric withstand 2.5 kV at 50Hz for 5 minute
- g) Core temperature limit 75<sup>0C</sup> at normal operation and 160<sup>0C</sup> during short circuit.
- h) External marking with manufactures name, type, core quantity, cross section and year of manufacture

These cables should be prefabricated cables with end connectors and shall form integral part of interface cabinet.

#### **2.05 Control Cables:**

The Control cables shall have the following characteristics:

- a) Copper Core meeting IEC-228, Class II requirements.
- b) Minimum core cross-section of 1.5 Sq. mm, Multi Strand 10core.
- c) Rated voltage  $U_0/U$  of 0.6/1.0 kV
- d) Fire suppression PVC insulation and external sheathing equal to IEC 540
- e) Shielding, longitudinally laid with overlap
- f) Dielectric withstand 2.5 kV at 50Hz for 5 minute
- g) Core temperature limit  $75^{\circ}\text{C}$  at normal operation and  $160^{\circ}\text{C}$  during short circuit.
- h) External marking with manufactures name, type, core quantity, cross section and year of manufacture

## **2.06 Supply of Cables:**

- a) 4sqmm 3core for AC input to UPS: 10mtrs
- b) 32sqmm multistrand cable for Battery: 15 mtrs x 2 runs
- c) 4sqmm 3core for AC output from UPS to RTU: 5 mtrs
- d) CT termination 4sqmm cable: 40mtrs/station/colour
- e) PT termination 2.5sqmm cable: 40mtrs/station/colour

f) Signal cable 0.5sqmm 10 core: 500mtrs/station

g) Control cable 1.5sqmm 10 core: 160mtrs/station

### **PART-C Installation of RTUs**

**3.00 General:** The Bidder shall be responsible for the complete commissioning of RTU and interface cabinets.

**3.01 Power Supply:** P/S from UPS should be taken to RTU and IF Units as the case may be.

**3.02 LT-AC Panel:** The Bidder shall provide LT AC Distribution Board with 2 MCCBs and 3 Nos. 3 pin outlets with fuses.

MCCB # 1: AC input to UPS

MCCB # 2: Stabilized AC output from UPS

**3.03 Positioning:** Main RTU shall be installed in consultation with the Customer. Positioning of other equipments shall be as under:

- a) Base RTU in Control Room.
- b) MFTs may be fixed to individual C&R Panels itself to avoid drawing CT, PT cables for a long distance.
- c) Interface Cabinets near Main RTU and shall house Relays, Opto Couplers, other Transducers, etc.,

**3.04 Wiring:**

- a) Connection of all input and output signals shall be to interfaced with the substation power system equipment.
- b) Installation/fixing of all transducers/signal-conditioning modules shall be wired in the Interface Cabinet.
- c) Internal wiring of interface cabinet and RTU shall meet the specified requirement and standards. It shall be the responsibility of the Bidder to supply and install the interposing relay/opto- isolators in the interface cabinet.
- d) Proper sizing and installation of grounding to the



RTUs and interface cabinets shall be effected.

**3.05 RTU Ground:** The RTU cabinet shall be properly grounded to the Substation Earth mat. The Bidder shall follow the Grounding methodology

**3.06 Wiring Diagrams:** The Bidder shall give the Wiring Diagrams of RTU and IF Cabinets, IF Units, as the case may be, for approval by the Customer, in addition to GA drawing.

**3.07 Circuit Diagram:** The Bidder shall supply 2 Sets of Circuit Diagrams for all Modules used in their RTUs, along with the Wiring and GA Drawings, while seeking Drawing approval. **The Bidder may note that the Drawings would not be approved, unless, Circuit Diagrams are submitted.**

**3.08 Terminal Block:** For interfacing 3 Ph CT and 3 Ph-4 Wire PT of disconnecting type of Terminal Blocks shall be provided to all C&R Panel's .Termination Blocks shall be properly wired in RTU, Interface Cabinet, etc, Terminal Blocks to be provided should be of

KPTCL approved make.

### **3.09 Interface to Communication Equipments:**

There shall be provision for connecting RTUs to Communication equipments like VSAT and OFC through CAT-6 cable.

### **3.10 RTU Wiring:**

Bidder shall acquire data from all the lines from 110 kV/66kV to 11 kV, as the case may be, in all the proposed locations. In these locations, wiring for data acquisition and supervisory control shall be done for all the points. Cables for 11kV MFTs should be provided in switchgear panel & MFT communication to be extended to RTU. For higher voltage classes C&R panel, MFTs to be fixed in RTU panel & CT/PT termination to be done using suitable cables from C&R panel. Cables & Wires required for all the cabling like MFT, Status, Control, Energy meter etc. are to be provided as per PART -B of the specs.

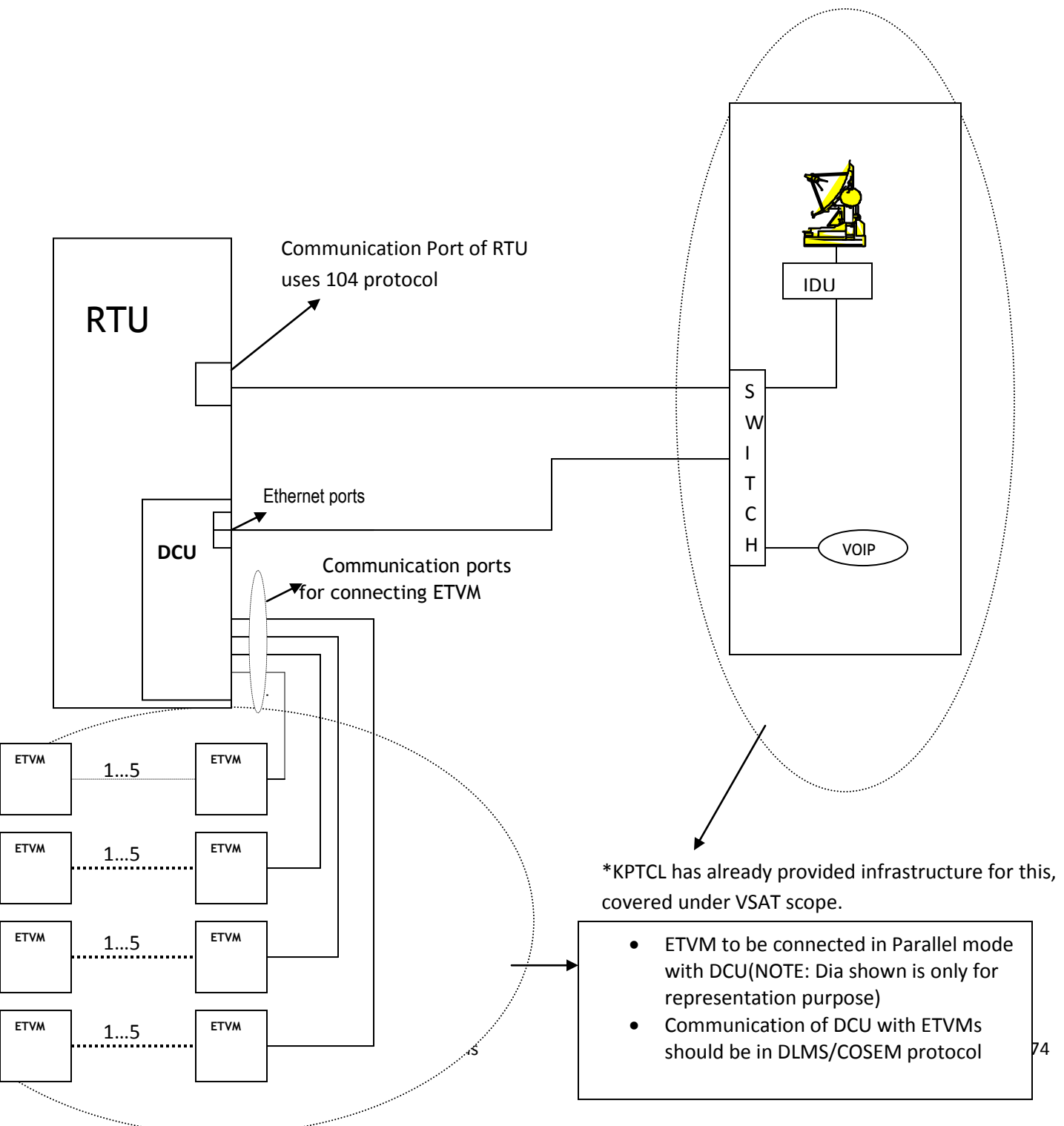
### **3.11 Inspection:**

It is noted that FAT on RTU shall be arranged by the Bidder at OEM's spot and all strategic tests shall be witnessed there, in detail by KPTCL representatives.

### 3.12 Scheme diagram:

RTU, DCU connectivity with ETVMs and Outdoor Unit in KPTCL Stations as shown below

## RTU, DCU connectivity with ETVMs and Outdoor Unit in KPTCL Stations



## **B. Technical Specifications for 2kVA Online UPS for SCADA in KPTCL Stations**

PART- A	UPS General Requirement	Page No-105
PART- B	Isolation Transformer	Page No-109
PART- C	Batteries	Page No-110

**Part-A UPS-General Requirement**

**1.0 Scope:** An UPS should provide power to RTU continuously even during failure of main supply with pure sinusoidal wave and should cater need of communication equipments, SCADA equipments and any other peripheral interface equipment related to SCADA.

**1.01 Supply Voltage for UPS:**

Input Voltage	: 230 V AC Single Phase 50 Hz.
Voltage Range	: 170 to 290 V

**1.02 Operating Frequency:**

Frequency	: 50 Hz.
Frequency Stability	: +/-3 Hz.

**1.03 Rectifier Module:**

Float Voltage	: Charger controls with constant current till it charges batteries to 100% and then it must keep constant voltage .
---------------	---

**1.04 Inverter Specification:**

Rating	: 2 kVA
Load Power Factor	: 0.8 Lag to Unity
Output Voltage	: Single Phase 230 V AC

## KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

Algorithm	: Adoptive Pulse Width Modulation
Output Stability	: +/- 1%
Output Frequency	: 50 Hz.
Wave form	: Pure Sinusoidal
Harmonic Distortion	: 3 % RMS Max.
Crest Factor	: Up to 3.1
Transient Response	: Less than 2 Cycles
Duty Cycle	: Continuous
Efficiency	: > 90 %
Over Load	: 125 % for 10 Minutes min. : 150 % for 10 Secs. min. : 175 % for 100 m secs. min.
Cooling	: Forced Air
Operating Temperature	: 0 to 60 <sup>0</sup> C

1.05 **Protection:** UPS should be capable of providing protection to for connected devices against surge voltages coming from source or due to EPR. In addition UPS to provide protection for following system anomalies

- a. Output Short Circuit
- b. Battery Tripping
- c. Inverter Overload
- d. Over Charging of batteries
- e. Input Under/**Over** Voltage
- f. Output Under/Over Voltage

**g. Battery Under Voltage**

1.06 **Output Indications:** UPS to have display to show mimic Diagram and Status indication for the following:

- a. Mains On/Off
- b. Charger On/Off
- c. Battery On/Off
- d. Inverter On/Off
- e. Battery Low
- f. Over Charge
- g. Input Under/Over Voltage
- h. Input Phase Failure
- i. Inverter Over Load

1.07 **Alarms:** Alarms to indicate following abnormalities shall be provided for

- a. Battery Low
- b. Mains failure
- c. Inverter failure
- d. Rectifier failure
- e. Bypass operated

**1.08 Panel Meters:** UPS should have built in Panel Meters for measurement bypass of the following

- a. Input Voltage
- b. Output Voltage
- c. Output Current
- d. Battery Voltage
- e. Battery Current with direction

**1.09 By Pass Arrangement** : Directional Static Switch to bypass AC after input transformer when UPS fail



**Part-B Isolation Transformer**

**2.0 Scope:** Isolation Transformer should be housed in UPS to provide isolation between input and output with a two winding transformer of ratio 1:1.

**2.01 Electrical Specification:**

- |                         |                           |
|-------------------------|---------------------------|
| 1. Power Rating         | : 2 kVA                   |
| 2. Type                 | : Dry type                |
| 3. Cooling              | : Air Natural             |
| 4. Winding              | : Copper                  |
| 5. Input Supply         | : 230V AC, 1 phase, 50 Hz |
| 6. Output               | : 230V AC, 1 phase, 50 Hz |
| 7. Transformation Ratio | : Provided on input side  |
|                         | a. 1:1                    |
|                         | b. 0.85:1                 |
| 8. Protection           | : MCB                     |

**Part-C Batteries**

**3.0 Scope:** 8 numbers of Tubular Lead Acid Batteries of 100 Ah Capacity to meet 4 Hours backup with 2 kVA load at UPF, Each Battery shall be 12 V.

**3.01: Battery Sets:**

Configuration : 1

Type : Tubular Type Lead Acid Batteries  
Cell Voltage : 12 V x 8 Nos  
DC Voltage : 96 V  
Back up time : 4 hrs.  
Ah Capacity : 100 Ah, Battery should be of high discharge and to give required Ah till end of 4<sup>th</sup> hour.

**3.02 LT-A/C :** The Contractor shall establish for LT AC Board with Industrial Type Sockets as noted below

- for Input
- 1) One 15A MCCB for 230V Single-Phase
  - 2) One 15A MCCB for Output of UPS
  - 3) 5 Nos. Switch Fuse 5 pin power sockets each 16A rating for:
    - a) P/S to RTU
    - b) P/S to Interface Unit
    - c) P/S VSAT IDU
    - d) P/S to Local PC
    - e) One spare

**3.03 Location:** UPS Batteries shall be located in Battery Room on a battery stand and UPS shall be housed close to SCADA equipments.

**3.04 Cables:** 16 Sqmm multistrand Single Core Copper Cable shall be used for DC and 4 sqmm Copper cables for AC.

**3.05 Battery Stand:** Batteries shall be housed on wooden stand, coated with black acid proof oxide paint.

**3.06 Accessories :** All Accessories shall be supplied like 16sqmm flexible cable and tinned copper lugs for batteries, float and breather for battery, etc.

**3.07 Charging and Discharging:** Batteries shall be supplied to Site, shall be subjected for 2 full Charge and Discharge cycles at factory before despatch.

**3.08 Commissioning:** The above UPS is to be transported to site and commissioned at the site at the location identified by the customer.

## C. Technical specification for Data Concentrator Unit (DCU) for DLMS (Device Language Message Specification) meters

**1. Scope:** The Objective of the DCU is to collect the energy data from DLMS meters without any human intervention and send it to the remote control centre over any communication media.

**1.01. Concept:** Data Concentrator Unit (DCU) should be capable of acquiring load survey data and midnight data from multiple DLMS meters. DCU should be compatible with different make DLMS meters present in a sub-station. Data is used to generate various reports for proper load planning and monitoring required for Energy management. Data collected from meters should be stored in DCU, enabling transmission of the acquired data at pre-configured intervals. DCU is to be engineered for use in substations and should meet the requirements of input power and robustness for operation in these environments.

### 1.02. General specification:

- a) The Concentrator shall interface with connected DLMS meters and master control centre using bi-directional communication.
- b) The master control centre should be able to read and configure the concentrator's data and parameter locally as well as remotely.
- c) The concentrator should be able to detect the presence of new meter.
- d) The concentrator should collect its own events/alarms and that of meters which are connected to it.
- e) The concentrator should have the capability to retrieve and retain the required data from/ to the meter at cyclic time interval.
- f) The concentrator should be able to restart locally and remotely.

- g) The concentrator should regularly check communication of the meters and record the status and periodically send the information to central control centre.
- h) Lifespan of the concentrator should be at least 10 years with maximum failure rate annual of 0.5%.
- i) Buffering of data in the event of loss of communication or power interruption.
- j) Create and optimize RS 485 daisy chain multi drop loops by distributing the meters in a substation to available RS485 port in the DCU to ensure reliable communications with energy meter.
- k) DCU must collect events such as tamper, power outages, supply and service violations etc recorded by the meter as per IS 15959 DLMS/COSEM protocol and send these events to the central control center.
- l) DCU must collect power outage time and duration logged by Meter as per IS 15959 DLMS/COSEM protocol and send these reports to the control centre.
- m) I and EMC compliance to standards.(mentioned in 1.09)

### **1.03. Operational requirement:**

- a) Events collected should be made available to master control center either by PUSH or PULL mode.
- b) The events for meters should include meter reading failure, DCU power on/off and etc.
- c) The DCU should gather load survey and midnight data from at least 20 meters and store them locally.
- d) Data to be acquired at every block with interval of every 15 minutes from all meters.
- e) The DCU should have the capability to store data from each meter for up to 45 days.
- f) The Concentrator should maintain time sync with Control Centre.

- g) Minimum of Five fields((Active Energy(Imp),Active Energy(Exp),Reactive Energy(Imp),Reactive Energy(Exp),Frequency, Voltage, Date, Time Block etc. ) for configuration of Energy meter mapping.

**1.04. Communication:**

- a) The concentrator should support different communication type.
- b) While communicating with meters concentrator should be compatible with DLMS / COSEM (Indian edition)
- c) For communication with outside world, DCU should have option on Ethernet to at least two different networks. In KPTCL and ESCOMs substations which are integrated to SCADA, VSAT connectivity shall be utilized. In cases where the sub-station is not integrated to VSAT Network, other modes of communication shall be provided end to end by KPTCL/ESCOM's.
- d) The DCU shall have visual indications (LEDs) for:
  - i. Network status
  - ii. Media Connectivity
  - iii. Power ON
- e) The concentrator system should support IPv4 and upgradeable to IPv6.

**1.05. Hardware Specifications:**

- a) The DCU should have 4 serial ports and two Ethernet ports.
- b) The DCU should operate from 90V – 270V AC/DC. The DCU should be DIN Rail mountable.
- c) The serial ports should be software configurable for RS485 mode
- d) The serial port when configured for RS485 port it should support 4 to 5 meters
- e) All serial port line should have 15kV ESD protection and surge protection.

- f) The serial ports should be isolated port from power supply and other serial ports(triple Isolation)
- g) The isolation voltage should be minimum of 2KV
- h) The baud rate of serial port should be programmable from 9600bps to 38400bps.
- i) Status indication for each serial port.
- j) The Ethernet port should support 10/100Mbps.
- k) The Ethernet port should support Auto MDI/MDIX.
- l) The Ethernet port should have link and speed indication.

#### **1.06 Software Specifications at Control Centre:**

- a) Centralized Software at the Control Centre which communicates with all DCUs and downloads all meter data (Load Survey data, Midnight Reading and tampered data).
- b) Web based Remote maintenance to address DCU and Meter management is required.
- c) DCUs present on the VSAT network are identifiable by unique IP.
- d) The software shall have the capability to schedule data retrieval from each of the DCUs either based on fixed time or based on time intervals (e.g. every 6 or 8 hours). Multiple DCUs can be scheduled at the same-time.
- e) If and when a new DCU is connected into the network, then all the previous days data should be retrieved for all meters connected to the DCU.
- f) **On-Demand Basis:** The software should provide the capability to retrieve data from one or more DCU i.e. should support the demand for specific data retrieval as demanded by the Control Centre end. Suitable User Interface and DCU back-end firmware is required to facilitate this.
- g) Dashboard showing the connectivity status of all DCUs and Energy Meter is required. User should be alerted for 'Non-communicating' DCUs. 'Non-communicating' DCUs are those DCUs for which connection for data retrieval could not be established.

- h) Format of data acquired from DCU should be in presentable format, preferable \*.csv/xml format.
- i) While downloading the data from the DCU's, current progress and status of the process should be available to the user.
- j) Application software for downloading DCU data and Monitoring of DCU's and Energy Meter **is required at Control centre end.**
- k) Microsoft office latest for report generation **at control centre end.**

**1.06. Operating Temperature:**

- a) Specified Operating Ranges from -5 to 60°C.
- b) Range for storage : 0 to 85°C
- c) Range for transport without any failure : 0 to 85°C
- d) Ambient Relative Humidity: 5 to 95% (non-condensing)

**1.07. Power Requirements:**

- a) Input Voltage: 90V to 270V AC/DC
- b) Power Connector: Terminal block

**1.08. Security:**

- a) Concentrator should encrypt data collected by different meters at collection end and decrypt the data received at Control Centre.
- b) At least AES128 method should be used in all information exchanges in private network & in LAN.
- c) At least ECC192 method should be used in all information exchanges in public network, between concentrator and central system directly.



### **1.09. Environmental & Safety Standards**

**DCU should meet the following EMI/EMC, Environmental and Safety Standards**

- a) CISPR 11, 1990 – Radio Frequency Interference - Radiated Emission Test
- b) CISPR 11, 1990 – Radio Frequency Interference - Conducted Emission Test
- c) EN 61000-4-2 – Electrostatic Discharge Immunity Test - Level 3,
- d) EN 61000-4-3 – Radio Frequency Interference - Immunity Test Level 3,
- e) EN 61000-4-4 – Electrical Fast Transient Immunity Test - Level 4,
- f) EN 61000-4-5 – Surge Immunity Test - Level 3,
- g) EN 61000-4-6 – Conducted Susceptibility (Immunity) Test - Level 3,
- h) EN 61000-4-8 – Magnetic Field Immunity Test - Level 1,
- i) IEC 60068-2-27 Shock Test
- j) IEC 60068-2-6 Sinusoidal Vibration Test
- k) IEC 60028-2-1 – Temperature effect test – Cold Test - Ad
- l) IEC 60028-2-2 – Temperature effect test – Dry heat Test – Bd
- m) IEC 60028-2-3 – Relative Humidity Test
- n) IEC 60028-2-14 – Change of Temperature Test
- o) EN 61010-1 Dielectric Test
- p) EN 61010-1 Insulation Resistance Test

### **1.10. Installation of DCU**

- a) DCU should be housed inside the RTU.
- b) Wiring connection of Meters with DCU and DCU connection with existing Communication Network of VSAT is to be done.
- c) Soft integration of DCU with Energy Meters and DCU configuration is to be done.
- d) Centralized Software for downloading of Energy Meter data from DCU as mentioned in clause 1.06(h) is to be done at the existing Server at Control Centre.