

Appendix - A

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Specifications of FOTE

3.1 Introduction

This section describes the Fibre Optic Communication network configuration and the equipment characteristics for communication system to be installed under the project. The sub-systems addressed within this section are:

- (1) Fibre Optic Transmission System (FOTS)
- (2) Termination Equipment Subsystems
- (3) Network Management System (NMS)
- (4) MDF, DDF and Cabling

The requirements described herein are applicable to and in support of network configurations depicted in Appendix and Network Management System (NMS) for monitoring and control of this communication network. TMN/NMS and NMS have been interchangeably used in this specification.

The security related requirements of the equipment shall be as per DoT (Department of Telecommunication) guidelines and all similar security requirements as amended by DoT on time to time basis shall be followed/complied by the vendor at no additional cost to MPPTCL till the implementation of the project.

3.2 General Network Characteristics

3.2.1 Description

The proposed fibre optic communication network shall support the voice & data communication requirements of RTUs, SCADA/EMS system and other Power system operational requirements. The communication system shall provide data & voice connectivity across the various locations or connectivity of RTUs with Control Centres. The RTUs/PMUs located at various locations will report to Control Center using IEC 60870-5-101 or IEC 60870-5-104 Protocol. The proposed communication system shall provide connectivity of RTUs over TCP/IP protocol using Ethernet interface and few other RTUs over serial interface. The offered communication System shall support the communication requirements of RTUs and the SCADA/EMS system described in point to multi point and/or multipoint to multipoint configurations using Ethernet over SDH

The fibre optic network shall be based on the Synchronous Digital Hierarchy (SDH) having bit rate of STM-4/ STM-16. The network shall consist of overhead fibre optic links with a minimum bit rate of Synchronous Transport Module-4/16. The tentative list of Fiber Optic links to be implemented under this package are given in Appendix-A of this volume. The Contractor can propose a system based on higher bit rate systems, if required, so as to meet the link budget requirements or any other specification requirement. The detailed BOQ is described in Price Schedules.

3.2.2 Functional Requirement

The primary function of the equipment is to provide a highly reliable voice and data communication system for grid operation in support of the SCADA/EMS, RTUs, Teleprotection & PMUs and for new technological requirements of Power System Operation such as Special Protection Scheme, Grid Security Expert System, Load Management, Advanced Protection System & Substation Automation System. A brief summary of the communication system requirements is as follows:

- (a) High speed E1 channel support
- (b) 64kbps & nx64kbps data channel support
- (c) Low speed (300 -1200 bps) data channel support
- (d) Voice (2 wires, 4 wires) channel support and integration with MPPTCL/SLDC EPABX system. The details of EPABX System shall be provided during detailed engineering.

- (e) Data transport supporting Network Management channels
- (f) The connectivity envisaged between Substation and Control Centre over TCP-IP using Ethernet interface for various services of data and voice such as for PMUs, RTUs , VOIP etc..
- (g) Integration with existing fibre optic terminal equipments.

3.2.3 General Systems Requirements

Required characteristics are defined and specified herein at the system level, subsystem level, and equipment level.

3.2.3.1 System Synchronization

All the new equipments under the contract must be synchronize using GPS Clock. In addition to GPS input reference, the synchronization clock must have provision to take INPUT reference coming from other clock. All sync equipments proposed under this contract should meet ITU-T G.811 criterion. The holdover quality of slave clock, if any, shall meet ITU-T G.812 standard requirements.

The Contractor shall provide system wide synchronization fully distributed throughout the telecom network and connected to all equipments new & existing.

3.2.3.2 Equipment Capacities

Equipment supplied shall be sized and equipped with sufficient capacity to support BoQ and configuration requirements as identified in the appendices. Each subsystem supplied shall be sized (to be equipped as specified) to support full subsystem expansion.

Data communications channelization required to support the TMN/NMS subsystems specified in Technical Specifications (TS) are not identified in the appendices. Therefore, the Contractor is required to size and equip the system to include all channelization and channel cards required to support the TMN/NMS function.

3.2.3.3 Redundancy Requirements and Protection Schemes

Equipment redundancy and Automatic Protection Schemes (APS) are specified in the Table 3-1. The failure of one element shall not prevent the use of any other that has not failed.

**Table 3-1
Equipment Redundancy Requirements Summary**

Fiber Optic transmission Equipment :	
(a) SDH equipment	
Power Supply & Converters ----- -----	1:1 APS or distributed power supply 1:1 APS
Common Control* Cards ----- -----	1:1 APS or distributed power supply 1:1 APS
(b) DACS (Cross Connect)	
Power Supply ----- -----	1:1 APS or distributed power supply
Common control* cards----- -----	1:1 APS or distributed power supply
(c) Drop/Insert Multiplexer	

**Table 3-1
Equipment Redundancy Requirements Summary**

<p>Power Supply ----- -----</p> <p>* = Common control cards which are essentially required for operation of the equipment.</p>	
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3.3.1 SDH Equipment

3.3.1.1 Functional Requirement(As per Price Schedule I)

There is a requirement for different types of equipment under this project which are described in this section. The BOQ is provided in the Price Schedules . For the purpose of BOQ, the SDH Equipment is considered to be divided in three parts i.e. Optical interface/SFP, Tributary interfaces (Electrical tributaries such as E1, Fast Ethernet 10/100 Mbps, Gigabit Ethernet interface & Optical tributaries such as Gigabit Ethernet etc.) and Base Equipment (Consisting of Common Cards, Control Cards, Optical base card, Power supply cards, sub-rack, cabinet, other hardware and accessories required for installation of equipment i.e. everything besides optical interface/SFP and tributary cards). All delivered SDH Equipment shall support upgradation to MPLS-TP by changing cards only.

If bidder is offering equipment with multifunction cards such as cross-connect or control card with optical interface/SFP or tributary interface, such type of multifunction card shall be considered as Common control card and shall be the part of base equipment. In case optical interface/SFP is embedded with control card, the adequate number of optical interface/SFPs shall be offered to meet the redundancy requirements of the specifications. Further, main and protection channel shall be terminated on separate cards and there should be no single point of failure.

The equipment shall be configurable either as Terminal Multiplexer (TM) as well as ADM with software settings only.

(i) STM-4 (MADM) with 3 MSP protected direction.

The aggregate interfaces shall be (at least) STM-4 towards at least three protected directions (Protected as specified in this specifications). The equipment shall be equipped with minimum 32 E1 interfaces & Fast Ethernet interface with minimum 8 interfaces as tributaries. In addition, Gigabit Ethernet (Optical) interface shall also be provided. This Gigabit Ethernet (Optical) interface shall be convertible into GBe (electrical)port by an Electrical SFP to be provided for GBe port. It means that two SFPs i.e one optical and one electrical must be considered for the GBe port. The equipment shall provide non blocking cross connect capability of 128 STM-1 (bi-directional) at high order VC-4 level and as well as at low order VC-12 level.

(ii) STM-16 (MADM) with 5 MSP protected direction.

The aggregate interfaces shall be (at least) STM-16 towards at least five protected directions (Protected as specified in this specifications). The equipment shall be equipped with minimum 32E1 interfaces & Fast Ethernet interface with minimum 16 interfaces as tributaries. In addition, Gigabit Ethernet (Optical) interface shall also be provided. This Gigabit Ethernet (Optical) interface shall be convertible into GBe (electrical)port by an Electrical SFP to be provided for GBe port. It means that two SFPs i.e one optical and one electrical must be considered for the GBe port. The

equipment shall provide non blocking cross connect capability of 320 STM-1 (bi-directional) at high order VC-4 level and 320 STM-1 (bi-directional) at low order VC-12 level.

(iii) Optical Interface/SFP to be implemented in the existing SDH equipment

The bidder shall be required to provide only Optical Interface/SFP to be installed in the existing/third party SDH equipment at few locations. The bidder has to ensure compatibility of the supplied Optical Interface/SFP for the same. The details of existing SDH equipment installed in MPPTCL system is given in Appendix:

3.3.1.2 Redundancy and Protection

Two fibre rings shall be implemented wherever the network permits. On linear sections of the network, protected links using 4 fibres shall be implemented. The proposed rings considering present network are indicated in Annexure for reference, however the same may vary during actual implementation.

Service Channel

Service channels shall be provided as a function of the SDH equipment and shall be equipped with Service Channel Modems that shall provide at a minimum: One voice channel (order wire) with analog interface (0.3 to 3.4 kHz)/VOIP and one data channel. There shall be a facility to extend the line system order-wire to any other system or exchange lines.

3.3.1.3 Supervision and Alarms

ISM (In Service Monitoring) circuitry shall be provided as a function of the SDH equipment. Local visual alarm indicators shall be provided on the equipment, as a rack summary alarm panel. Alarms shall be as per ITU-T Standards G.774, G.783 and G.784. Additionally, F2/Q2 interfaces for a local craftsperson terminal interface and remote equipment monitoring is required.

The Equipment shall support collection of at least four (4) external alarms for monitoring and control of station associated devices by the TMN/NMS

3.3.1.4 Synchronisation

The equipment shall provide synchronization as per Table 3-2. One 2 MHz synchronization output from each equipment shall be provided.

3.3.1.5 Electrical and Optical I/O Characteristics and General Parameters

Table 3-2 provides the electrical and optical characteristics as well as other general parameters for SDH equipment.

Table 3-2	
Electrical and Optical I/O Characteristics and General Parameters	
Optical Wavelength NOTE (1)	1310/1550nm
Optical Source NOTE (2)	Laser
Optical Source Lifespan	Better than 5 X10 ⁵ hours
Optical Fibre Type	G.652 D
Optical Connectors	Type FC-PC
Transmission Quality	Per ITU-T G.821, G.823, G.826
Source Primary Power	-48 Vdc
Equipment Specifications	Per ITU-T G.783

Tributary, Electrical Interface	Per ITU-T G.703, 75 Ω
Ethernet Interface	10/100 Mbps, 1000Mbps
SDH Bit Rates	Per ITU-T G.703
Optical Interfaces	Per ITU-T G.957, G.958
Frame and Multiplexing Structure for SDH	Per ITU-T G.707
Synchronization	Per ITU-T G.811, G.812, G.813, G.803
Management Functions	Per ITU-T G.774, G.784
Protection Architectures	Per ITU-T G.841
Built In Testing and Alarms	Per ITU-T G.774, G.783, G.784

NOTE (1) Optical wavelength shall be selected considering the characteristics of the optical fibre and the link budget.

NOTE (2) **Eye Safety for Laser Equipment:** To avoid eye damage, when a receiver detects a line interruption, it is required that the optical power of the laser shall be reduced to safe limits on the transmitter in the opposite direction as per ITU-T G.958.

NOTE (3) In case other than FC-PC connector is provided in the equipment, suitable patch cord with matching connector are to be provided to connect with FODP.

3.3.2 Optical Link Performance Requirements

The optical fibre link performance requirements are specified as follows:

3.3.2.1 Link Budget Calculations

The fibre optic link budget calculations shall be calculated based upon the following criteria:

(1) Fibre attenuation: The fibre attenuation shall be taken to be the guaranteed maximum fibre attenuation i.e. 0.21 dB/Km @1550nm and 0.35 dB/km @1310nm.

(2) Splice loss: Minimum 0.05 dB per splice. One splice shall be considered for every 3 kms.

(3) Connector losses: Losses due to connectors shall be considered to be minimum 1.0 dB per link.

(4) Equipment Parameters: The equipment parameters to be considered for link budget calculations shall be the guaranteed "End of Life (EOL)" parameters. In case, the End of Life parameters are not specified for the SDH equipment, an End of Life Margin of at least 2 dB shall be considered and a similar margin shall be considered for optical amplifiers.

(5) Optical path Penalty: An optical path penalty of at least 1 dB shall be considered to account for total degradations due to reflections, inter symbol interference, mode partition noise and laser chirp.

(6) Maintenance Margin: A maintenance margin of at least 2.5 dB/100Km shall be kept towards cabling, repair splicing, cable ageing and temperature variations etc.

(7) Other losses: Other losses, if any required specifically for system to be supplied shall also be suitably considered.

(8) Dispersion: The fibre dispersion shall be taken to be the guaranteed maximum dispersion i.e. 18 ps/nm.Km @1550 nm & 3.5 ps/nm.km @ 1310 nm for DWDM fibres.

(9) Bit Error Rate: The link budget calculations shall be done for a BER of 10^{-10} .

The bidders shall determine the total link loss based on the above parameters and shall submit the system design (including link budget calculations) for each category of fibre optic link during detailed engineering.

For finalising the FOTS system design & BOQ, above methodology shall be adopted taking into account fibre attenuation, dispersion and splice loss determined during the detailed engineering. Accordingly, additions and deletions from the contract shall be carried out based on unit rates indicated in the contract.

3.3.2.2 Link Performance

The Link performance for ES, SES and BER for the fibre optic links shall correspond to National Network as defined in ITU-T G.826.

3.3.2.3 FODP to SDH Equipment

The Contractor shall be responsible for connectivity between the FODP and the SDH equipment. The Contractor shall provide FCPC coupled patch cords. The location of FODP shall be finalized during detailed engineering.

The patch-cord length between the FODP & equipment rack shall be suitably protected from rodents, abrasion, crush or mechanical damage.

3.4 Termination Equipment Subsystem

The Termination Equipment Subsystem is defined to include the equipment that interfaces (adapts) the subscriber (user) to the Fibre Optic Transmission System (FOTS). Functional descriptions of these equipments are as follows:

3.4.1 Functional Description

The transmission network node provides subscriber interface to the transmission network and/or switching/routing. For clarity, the basic functions accomplished at the network nodal points, are described briefly as follows:

Multiplexer shall be used to accomplish subscriber connectivity to the Digital Communication Network. Subscriber Line Units shall provide analog to digital and direct digital conversion to 64 Kbps digital channel. In the CEPT standard hierarchy, thirty (30) such 64 Kbps digital channels shall be Time Division Multiplexed (TDM) resulting in a single 2.048 Mbps (E-1) digital bit stream.

Digital Drop-Insert and Branching Equipment shall be used to digitally interface a small number of channels at spur locations without requiring successive D/A and A/D conversions of the throughput channels.

Digital Cross connect Equipment (DACS) shall be used to provide software controlled dynamic routing/rerouting of the primary (E-1) bit stream as well as the 30 channels of the E1 bit stream.

The proposed Drop insert multiplexer should have DACS capacity.

The equipment shall also have an interface for external 2048 kHz synchronisation signal according to ITU-T Recommendation G.703.

3.4.2 First Order Multiplexing

The Contractor shall be required to provide E-1 Drop & Insert Multiplexer and E-1 Channel Bank primary multiplexing in compliance with the electrical input-output characteristics provided in Table 3-3.

3.4.2.1 Drop & Insert Multiplexer Functionality

Drop & Insert multiplexer functionality as detailed hereunder are required to be complied for which bidder may offer separate/integrated multiplexer.

Drop & Insert multiplexer in conformance with CEPT E-1 characteristics shall be required at locations where the subscriber requirement is minimal. The drop and insertion of up to thirty 64 Kbps channels supporting subscriber line units (SLU) shall be required at intermediate locations. The Drop & Insert Muxes supplied shall be performance and card compatible with the Channel Bank Equipment provided so that all Subscriber Line Interface cards are interchangeable. The Drop insert multiplexer should have DACS capacity.

Table
CEPT E-1 Standard First Order Multiplexing
Electrical Input/Output Characteristics

Applicable Standards:	CEPT per CCITT Recommendation G.702, G.703, G.711 and G.712
Number of Tributaries:	30 X 64 Kbps
Alternative Sub-rate Tributaries:	n X 64 Kbps V.36 64Kb/s V.11/V.36
Output Aggregate Rate:	2.048 Mb/s ± 50 ppm
Interface Code:	HDB3
Impedance:	75 ohm unbalanced/120 ohm balanced
Peak Level @ 120 ohm:	3.0 volts ± 10%
Peak Level @ 75 ohm:	2.37 volts ± 10%
Maximum Insertion Loss:	6 dB
Signal Waveform:	Per CCITT G.703
Frame Structure:	Per CCITT G.742
Jitter Performance:	Per CCITT G.823
Power Supply Voltage:	-48 Vdc ±20%

3.4.2.2 Subscriber Line Units\Subscriber Line Interface Cards

The terms Subscriber Line Interface Cards and Subscriber Line Units have been used interchangeably throughout the specification. Multiple configurations of SLUs shall be required to provide subscriber to primary multiplexer Bank interfacing for a variety of voice and data communications.

The SLU interface requirements are discussed in the following subparagraphs:

(A) Voice Channels

The voice channel requirement is for (I) 4-Wire E&M trunking in support of EPABX trunks & PLC VF and (II) 2-Wire telephonic interfaces. 2 wire SLUs shall be DTMF/TP optioned for 2-wire loop start or 2-wire GND start. The voice cards shall utilize ITU.T A - law companded PCM G.711, 64 kbits/s encoding. The voice card requirements are indicated in the BoQ.

(B) Sub-Channel Data Multiplexing

For this Project, the RTU data interface to the wideband telecommunications network node shall be defined at the DTE level at low-speed rates of 300, 600 and 1200 baud. The port shall be compatible with RS232C interface. The Contractor shall be required to furnish 64 Kbps SLU asynchronous data multiplexing for at least 4 selectable low speed DTE interfaces whenever multiple asynchronous data circuits are required.

(D) Integrated Module to transmit Protection Commands

This module shall support the following features related to the protection commands:

1. Transmit 8 protection commands for point to point communication Commands shall be programmable for permissive or direct trip functions.
2. Accept protection command signals in the range of 24VDC ... 250VDC (site programmable) directly from station battery without involving any intermediate converter.
3. All inputs and outputs shall independent and be isolated and with EMC immunity for harsh environment.
4. Security and Dependability shall be selectable and programmable.
5. It should support point to point commands and shall also be able to transfer commands to realize AND-and OR-combinations between commands

(E) C37.94 Optical Interfaces for connecting to Digital Protection Couplers / to provide Distance Teleprotection

There is a requirement to connect the Digital Protection Couplers with communication equipment to provide Distance Protection / Teleprotection using C37.94 channels. 2-port Optical C37.94 Interface card is envisaged in this project .

TECHNICAL SPECIFICATION

STANDALONE DIGITAL TELEPROTECTION EQUIPMENT

S. No	Parameter	Guaranteed Value Required
	Feature	shall employ latest digital signal processing technology
1	Teleprotection Network Interface	E1, 2.048Mbps, G.703 interface option for transmission over E1, 2.048Mbps electrical links, compatible to fiber optic equipments.
2	Command Interface - Binary	8 Commands; with trip counters event registers in each equipment and suitable for transmission on E1 electrical interface . 110VDC; 250VDC - User Selectable Command Voltage
3	Number of Input Commands	8
4	Number of Output Commands	8
5	Protection Schemes	Direct Transfer Tripping Permissive Tripping Blocking / Unblocking Tripping
6	Total time - including Command Transfer Time and Relay operating time in E1 2.048Mbps, G.703 mode	< 10 ms.
7	Supported Command Voltages	User Selectable 110VDC / 250VDC
8	1+1 Redundant Power Supply	Dual DC Power Inputs: -48 VDC
9	User settable clock synchronization / timing mode	User Configurable or NTP / IRIG-B input port for time synchronization
10	User Selectable / Automatic Periodical Link Test	Yes
11	Link Performance Alarms	Yes
12	System Performance Alarms	Yes
13	Alarms Logging	Yes
14	Event (Command and Switching) Logging	Yes
15	External Alarm Relay	Yes (User configurable 8 external alarms with Display counter unit)
16	SNMP	SNMPv2 for remote monitoring
17	Remote Access - Telnet and GUI	10/100BaseT Ethernet Interface for remote access over an IP network
18	Password Protection	Encrypted Password Protection
19	Network Management System Support	SNMP Traps and NMS for real time remote monitoring and management over an IP network

S. No	Parameter	Guaranteed Value Required	
20	Network Management System (NMS) Capacity	To monitor up to 500 units from a central site	
21	Should provide SNMP monitoring	Yes	
22	Should provide external alarm provision	Yes (User configurable 8 external alarm outputs with Display counter unit)	
23	Nominal DC input voltage	-48DC	
24	Range of Input voltage	48V DC, range 40V DC ~ 60V DC	
25	Input Voltage Reversal Protection	Yes	
26	Over Current Protection	Yes	
27	Short Circuit Protection	Yes	
28	Power Consumption (maximum) under full load	Maximum 35 watts (with trip counter)	
	Type test Requirement		
29	Reliability (Dependability, PMC: Probability of Missing a Command) of a command sent in BER between 10 ⁻³ and 10 ⁻⁶ must be < 1%	IEC60834-1 conditions	Complied as per IEC 60834-1
30	Security (Security, PUC: Probability of an Unwanted Command) of a command doesn't sent in condition of BER=0,5, must be <<10 ⁻¹⁰	IEC60834-1 conditions	Complied as per IEC 60834-1
31	Electromagnetic compatibility		Complied as per IEC 60834-1, IEC 60870-2-1, IEC 60068-2.
32	Interface to Protection relays (Input); Rated Voltage Maximum current rating Other Parameters	Volts (DC) Amps (DC) IEC standards	290V DC 5mA IEC-255-0-20 / VDE 0435, 0631, 0700, 40013847
33	Interface to Protection relays (Output); Rated Voltage Maximum current rating Other Parameters	Volts (DC) Amps (DC) IEC standards	290V DC 5A IEC-255-0-20 / VDE 0435, 0631, 0700, 40013847

S. No	Parameter	Guaranteed Value Required	
34	Alarm Contact relays; Rated Voltage Maximum current rating Other Parameters	Volts (DC) Amps (DC) IEC standards	290V DC 5A IEC-255-0-20 / VDE 0435, 0631, 0700, 40013847
35	Contact input/output Hi-pot dielectric		2.5kV RMS
36	Operational Temperature	-10° C to 55° C	
37	Storage Temperature	-25° C to 70° C	
38	Humidity	95% R.H. (non-condensing)	
39	Altitude	Upto 9,000 feet	
40	Others	<p>1.Digital Tele-protection equipment shall be provided with visual trip counters event registers to register events which can be down loaded in to pc or laptop.</p> <p>2.High security and dependability shall be ensured by the contractor. probability of false tripping and failure to trip shall be minimum. curves / figures indicating above-mentioned measures shall be submitted with the tender proposal. if not, otherwise stated routine and type tests of the protection signalling equipment shall consider the IEC recommendations and suggestions of the latest revision.</p> <p>3.Principle of operation during normal operation protection signaling equipment shall transmit a secured guard code. In case protection signaling equipment receives one or more command it should interrupts the guard code and shall transmit the command code in sequence. the receiver recognizes the command code and absence of the guard code and generates the command.</p> <p>4.auto loop test facility shall be provided.</p> <p>5. redundant power supply unit</p> <p>6.all I/Os electrically isolated</p> <p>7.full duplex operation</p>	

3.4.3 Digital Access Cross connect System

Seperate DACS is not envisaged in this project and it is presumed that the following DACS Functionality if required at any site shall be fulfilled by SDH/PDH Equipment delivered under this project;

The Contractor shall be required to provide Digital Access Cross connect Systems (DACS) capable of switching 16 or more E-1 lines in compliance with the electrical input-output characteristics provided in Table 3-4. DACS shall be fully compatible with CEPT E-1 tributary standards.

DACSs shall be provided at locations specified in the appendices and shall be used to establish and reconfigure cross-connections at the tributary level of up to 480 x 64Kb/s channels. DACS E-1 line interface shall be fully capable of accessing each E-1 line.

Within the context of this specification, sizing of DACS system is defined as 4 x n where n is the maximum size of the port switching matrix. Thus a DACS sized as 8 x 16 means that 8 E1 ports are interfaced over a 16 port (E1) matrix.

A DACS system shall consist of the switch matrix, all routing logic and timing circuitry for internally sourced, line derived or externally supplied network timing and full software support.

The DACSs to be provided under this contract shall consist of at least a 16 port switching matrix, with 16 ports equipped, i.e. 16 X 16 size. The DACS shall also be able to switch the signalling of the voice channels along with the voice channels. The DACS shall not use, decrease or block the specified capacity of the switching matrix while switching the signalling. The DACS shall support the Channel Associated Signalling (CAS) and Common Channel Signalling (CCS) both as per ITU-T G. 704.

The DACS shall provide user friendly control and management software. The user shall be able to operate the DACS locally through craft terminal, via an RS-232 interface or remotely under TMN/NMS supervisory control.

**Table
CEPT E-1 Digital Access Cross Connect System
Required Operating Characteristics**

E-1 Trunk Capacity:	Minimum 16-Port Switch Matrix Minimum 4-Port I/O per card
Tributary Capacity:	30 X 64 Kbps
Compatibility:	CEPT E-1, CEPT E-1 tributary channel
Frame Delay:	Minimum < 1 frame Maximum < 2 frames
E-1 Port Interface: Interface Code: Impedance: Peak Level @ 75 ohm: Maximum Insertion Loss:	2.048 Mb/s ± 50 ppm HDB3 75 ohm unbalanced/120 ohm balanced 2.37 volts ± 10% 6 db
Signal Waveform: Frame Structure: Jitter Performance:	Per CCITT G.703 Per CCITT G.742 Per CCITT G.823
Synchronisation:	Internal, external source and

Table
CEPT E-1 Digital Access Cross Connect System
Required Operating Characteristics

	synchronized on incoming E-1
Routing: Routing Table Capacity:	Fully non-blocking tributary to/from E-1 channel Minimum of 9 routing tables for reconfiguration
Supervisory Ports: Supervisory Port Interface: Interface:	Serial Com Ports RS-232 Standard ASCII ANSI compatible terminal
Supervisory Channel:	Asynchronous data rates, software selectable: speed of 110-9600 bps, odd or even parity 7 or 8 bits.
Power Supply Voltage:	-48 VDC \pm 20%

3.4.3.1 Required DACS Applications

The DACS provided shall be fully capable of implementing standard applications such as "Groom and Fill", Drop & Insert/Bypass, Broadcast and Alternative Routing.

3.4.3.2 Menus and Reports

DACSs throughout the network shall be required to function as fully integrated subsystems of the Telecommunications Management Network (TMN/NMS).

The DACS software shall provide menu driven management of DACS and shall provide at least the following:

- (I) Active Configuration: The user shall be able to modify the current active configuration.
- (II) Configuration : The configurations other than the active one shall be listed, edited, viewed, renamed, deleted and activated . Actions shall be allowed manually, upon a carrier failure or specified alarm condition, remotely or on a scheduled basis.
- (III) Reports : The user shall have selection of pre formatted specific reports and "Report Options" to be used to select where the next reports will be sent.
- (IV) Administration: This shall provide the user, options to control, view and maintain various logs and the DACS software.
- (V) Alarms: This shall display Alarm Status on all active ports and shall have an alert mechanism that readily identifies an alarm event to the user through TMN/NMS (locally as well as remotely). The alarms shall have different colours based on the importance of the alarm.

3.3 MDF, DDF and Cabling

For the purposes of the specification, the contractor shall provide cabling, wiring, DDF

patching facilities and MDFs interfacing to the wideband telecommunications system. Equipment and material components for MDF, DDF and cabling are also part of this procurement. It shall be the Contractor's responsibility to provide all cable support required for full supplied equipment interconnection with the MDF and shall be in accordance with communications industry standard practices and the requirements mentioned in the technical specifications.

3.5.1 MDF and DDF Patching Facilities

The Contractor shall supply and install all cabling, wiring, connectors, cross connects, Digital Distribution Frames (DDF) and Main Distribution Frames (MDF) associated with the installation and interconnection of equipments procured under this package as follows:

- (i) DDF for termination of new SDH equipment E-1 ports
- (ii) Cabling (including connectors) for E1 level connections from DDF to existing SDH equipments, DDF to Existing & new PDH equipments. To the extent possible, existing cable at site shall be used.
- (iii) All Ethernet ports shall be terminated with RJ-45 connector. Provision for 100% expansion with connector for terminating additional Ethernet ports shall be provided.
- (iv) MDF for data connectivity DB25 termination and for voice Krone type termination or equivalent shall be provided.
- (v) Cabling and connectors required to enable subscriber-to-subscriber circuits over the telecom network. The Line side of the MDF shall be cabled to the Primary Multiplex and the equipment side shall be cabled to the MDF of the assigned subscriber (PLCC, PABX, Telephone at wideband locations etc).
- (vi) Any other cables, connections etc required for a fully functional, integrated telecom system.

The connections amongst various equipments such as FOTS, termination equipment and subscriber MDFs etc shall always be routed through DDF and MDF to provide maintenance access.

3.5.2 Digital Distribution Frame Functional Requirements

The Contractor shall provide DDF for Digital Signal Cross connect (DSX) Broadband-quality (better than 20 MHz) patching facilities configured "normally-thru" with Equipment, Line and Monitor Patch Jacks. DDFs shall provide the following basic functions:

- (i) "Normally thru" circuit routing
- (ii) Circuit rerouting via patch cord assemblies
- (iii) Circuit disconnect and termination

All DDFs shall be sized and equipped to support the offered configuration of the provided equipment. Independent Transmit and Receive patch jack assemblies (line and equipment) shall provide for separate transmit and receive single-plug patching. Transmit and receive patch jack assemblies shall be located side-by-side such that dual-plug patch cord assemblies may be used to route both transmit and receive for the same circuit.

3.5.3 Main Distribution Frames

The Contractor shall make provision for cross connection of subscriber services to the

subscribers utilizing DB25 for data/ Krone type for voice or equivalent and shall provide full connectivity up to and terminated on the equipment side of the appropriate DDFs and line side of MDFs. The Contractor shall terminate on the equipment side of patching facilities provided by other contracts and shall provide DSX type patching facilities supporting aggregate bit streams (i.e. dataplexers and E-1 Channel Banks). Separate Patch panels or MDFs shall be provided for Data and Voice. All cross connects shall be accomplished utilizing one, two or three pair patch cords. Patch plugs are permissible for direct one-to-one circuit "cut-thru".

3.4 Patch Cords

The Contractor has to supply FCPC coupled Patch cords as required . The Patch cord return loss shall be equal to or better than 40 dB and insertion loss equal to or less than 0.5 dB. Fiber jumpers shall be of sufficient lengths as to provide at least 0.5m of service loop when connected for their intended purpose. In addition to FC-PC coupled Patch cords required for commissioning of the project, the contractor shall also require to provide two nos. FC-PC coupled Patch cords per wide band node as spare.

3.5 Telecommunication Management Network / Network Management System(Data Sheet for NMS and Craft Terminal to be enclosed)

The Contractor shall provide two nos. Telecommunications Management Network System/Network Management System (TMN/NMS) for operational support to the FOTS and associated Termination equipment subsystems. One TMN/NMS will work as Main other as backup. The location of the Main and Backup TMN/NMS shall be at Jabalpur and Indore respectively. These TMN/NMS shall provide the capability to monitor, reconfigure, and control elements of the telecommunications network from the centralized locations and at each node of the network where equipment is located. This TMN/NMS system shall assist MPPTCL/in the operations and maintenance of the wideband communication resources of the including detection of degraded circuits, system performance, the diagnosis of problems, the implementation of remedial actions and the allocation or reallocation of telecommunications resources and addition/deletion of network elements.

The design of the TMN/NMS shall be such that a single TMN/NMS shall be capable for all the NEs (Network Elements) i.e. SDH equipment, Mux, Drop-Insert, DACS etc.

In case a single TMN/NMS cannot be provided for all the NEs, the contractor may supply separate TMN/NMSs. Each of the offered TMN/NMS shall meet the requirements indicated in this section. The bidder shall provide details of the offered TMN/NMS in the bid. The NMS offered shall at least be capable for monitoring(alarms and network viewing) of existing system nodes

3.6 Communication Channel Requirement and Integration

The Contractor shall provide all required interface cards / devices, LAN, routers/bridges, channel routing, cabling, wiring etc. and interfacing required for full TMN/NMS data transport.

The TMN/NMS data transport shall utilize the wideband communications transmission system service channel in the overhead whenever possible. This will provide inherent critical path protection

Should the configuration requirements dictate multiple TMN/NMS station processors, the TMN/NMS Master Station shall require bidirectional data transport with its station processor(s). This communications interfacing shall be via critically protected data channels. It shall be the Contractor's responsibility to provide for and equip all necessary critically protected TMN/NMS data channel support.

In case supervisory channels are not available, the Contractor shall provide suitable interfaces in their supplied equipment for transport of TMN/NMS data. The Contractor

shall also be responsible for providing suitable channels with appropriate interfaces to transport the TMN/NMS data.

The NMS information of new PDH & SDH system shall be transported through the existing communication network, wherever required, up to the NMS location. The NMS information of the new SDH & PDH system being procured under the package shall be transported through the existing communication network using 64 kbps/2Mbps (G.703) interfaces. Any hardware required for above interfacing shall be provided by the Contractor.

The bidders shall describe in the proposal the TMN/NMS data transport proposed to be used by the bidder in detail including capacity requirements and various components/equipment proposed to be used.

3.7.1 Applicable Standards

The TMN/NMS design concept, functional and informational architecture and physical architecture, shall be in compliance with ITU-T Recommendation M.3010.

3.7.2 TMN/NMS Architecture

The TMN/NMS shall provide

- (a) Collection of Management data from all Network Elements (NEs) supplied under this package. The minimum monitoring and control requirements for the communication equipment shall be as defined in this section.
- (b) Processing of above management data by using processor(s) located at Control Centre and additional intermediate station processor(s), wherever required.
- (c) Monitoring and control of the NEs as defined below:
 - i) The Control Centre for all the network elements being procured under this package (including local operator console) shall support management of all equipments supplied under this package. At minimum functions of Network management layer (NML) and Element management layer (EML) as defined in CCITT M3010.
 - ii) Monitoring and control of NEs using Craft Terminals as defined in this Section.
- (d) Supervisory monitoring and control of the following station associated devices:
 - I) Intrusion Detection Alarms
 - II) Power Failure
 - III) Fire and Smoke Detection
 - IV) Environmental Control (Temperature, Humidity etc.)
- (e) Communication channel support for TMN/NMS System as specified

The supplied TMN/NMS system shall be capable of handling all management functions for at least 150% of the final network elements. The NMS location indicated here are tentative and the same shall be finalized during detailed engineering. TMN/NMS system should not be dependent on each other for their working.

The TMN/NMS system hardware shall be so designed that failure of single processor/component (router, switch, converter etc.) shall not inhibit any of the functionality of the TMN/NMS system. The Contractor shall submit for MPPTCL's approval the TMN/NMS architecture describing in detail the following subsystems/features:

- (a) Database used in TMN/NMS
 - (b) Master Processor, server/workstation, LAN, Peripherals and hardware
 - (c) Software and operating system
 - (d) Local Consoles/remote consoles
 - (e) Craft Terminals
 - (f) Data communication between NEs, Remote/Local Consoles and TMN/NMS Processor(s)
 - (g) Routers/Bridges
 - (h) Expansion Capabilities
- f) The offered TMN/NMS system shall be capable of integration to other supplier's Network Management System (NMS) upwardly through SNMP/CORBA - TMF418 complaint North bound interface. The interface shall accommodate all required functionalities to implement (Operation Support System)OSS but not limited to the following:
- i) Real time forwarding and synchronization
 - ii) Provisioning of circuits
 - iii) Upload of network topology
 - iv) Monitoring of events for topology and circuit changes
 - v) Alarm handling

The details shall be finalised and discussed during detailed engineering and the Contractor shall be obliged to provide/share all necessary information and co-ordinate with the implementation vendor of (Operation Support System)OSS.

3.7.3 Management Functions

The TMN/NMS shall support following Management functions:

3.7.3.1 Configuration Management

Configuration management is concerned with management, display, and control of the network configuration. Minimum specific requirements that shall be satisfied include the following:

- a. Provide tools to establish and maintain the backbone topology and configuration information and provide graphical maps depicting the configurations.
- b. Gather descriptive information about the current configuration of the equipment, provide operator displays, and prepare reports.
- c. Provide tools for planning, establishing, and changing the static equipment configuration. Provide for changes to the equipment configuration in response to

equipment failures, planned upgrades, and operator requests to take equipment offline for testing.

- d. Provide verification testing to support new equipment installation.

3.7.3.2 Fault Management

Fault management is concerned with detecting, diagnosing, bypassing, directing service restoration, and reporting on all the backbone network equipment, systems, and links. Minimum specific requirements that shall be satisfied include the following:

- a. Display equipment status in a consistent fashion regardless of the source of the data on a graphical topological, map-type display. Status shall be displayed through the use of colours on links and nodes as well as through text.
- b. Obtain status and detect faults through periodic polling, processing of unsolicited alarms and error events, and periodic testing for connectivity.
- c. Maintain an alarm summary of unacknowledged alarm events on the management station display and maintain a log of all received alarms. The operator shall be able to acknowledge and clear alarms individually and as a group. The use of alarm correlation techniques is encouraged to minimize the proliferation of alarms caused by a single, common event. All alarms shall be configurable as critical alarms, major alarms and minor alarms with different colours.
- d. Provide the capability to diagnose and isolate failures through analysis of error and event reports and through the use of both on-line and off-line diagnostic tests and display of monitored data.
- e. The criteria for fail over shall be configurable as automatic fail over to redundant equipment wherever possible and through operator-initiated actions where automatic fail over is not possible. The status of fail over shall be reported to the NMS.
- e. Track network equipment failure history.

3.7.3.3 Performance Management

Performance management is concerned with evaluation of the use of network equipments and their capability to meet performance objectives. Minimum specific requirements that shall be satisfied include the following:

- a. Provide support for an operator to initiate, collect, and terminate performance metrics under both normal and degraded conditions. For example, BER of each link, together with other data measured at each node, shall be available on operator request (atleast for SDH).
- b. Monitor point to point & end to end signal quality and history. Provide operator controls to monitor performance of specified events, measures, and resources (atleast for SDH). Specifically provide displays to permit the operator to:
 - 1. Select/deselect network equipments, events, and threshold parameters to monitor
 - 2. Set monitoring start time and duration or end time
 - 3. Set monitoring sampling frequency
 - 4. Set/change threshold values on selected performance parameters
 - 5. Generate alarm events when thresholds are exceeded.

6. Set multiple thresholds on certain performance parameters. Alarm categories include as a minimum a warning and a failure.
7. Calculate selected statistical data to measure performance on selected equipment based on both current and historical performance data maintained in performance logs. Performance data provided is limited to what is available from the equipment Contractors.
8. Provide graphical displays of point to point and end to end current performance parameter values. Provide tabular displays of current, peak, and average values for performance parameters.
9. Generate reports on a daily, weekly, monthly, and yearly basis containing system statistics.

3.7.3.4 Security Management

The TMN/NMS shall be provided with security features to limit access to monitoring and control capabilities to only authorized personnel. One access level of System Administrator and at least two levels of operator access shall be provided - read (view) only, and write (configure). The system administrator shall be able to create, define and modify operators with different access levels, network domains and perform all kind of maintenance and up gradation of the TMN/NMS system. With "read only" access level, network parameters should only be viewed. Access to database maintenance, command control and test functions shall be available with "write " access level. Means shall be provided to ensure only one authorized user has write capability for a selected domain of the network. It shall be possible to define multiple domains for purposes of monitoring and control.

Human error and conflict detection are also required. Such errors and access violations shall be reported to the offending user as error messages and warnings.

3.7 Craft Terminal

Each equipment (SDH equipment, Mux, Drop/Insert and DACS etc.) on the fibre optic communication network shall include provision for connecting a portable personal computer (PC) to be known as craft terminal to support local commissioning and maintenance activities. Through the use of this PC and local displays/controls, the operator shall be able to:

- a. Change the configuration of the station & the connected NEs.
- b. Perform tests
- c. Get detailed fault information

The craft terminal shall be connected to the interface available in the communication equipment. Portable (laptop) computers (Craft terminals), each complete with necessary system and application software to support the functions listed above, shall be supplied to the MPPTCL as per BOQ.

3.10.1 Master Processor, Server, Workstation and Craft Terminal

The server/workstation and craft terminal shall have suitable processor(s) which shall be sufficient to meet all the functional requirement and expansion capabilities stipulated in this specification. Only reputed make like Dell, IBM, HP, Compaq make shall be supplied. The minimum configuration is required as given below:

(a) Hardware requirement of NMS :

Sr.No	Description	Characteristics
1	Features	Fast response times with the latest quad core Intel Xeon E3 1200 V6 family as well as flexible dual core processor options including Intel Pentium, Intel Core i3 or Intel Celeron.
2	Processor	Intel Xeon E3 1200 V6, 3.0 GHz, 8 M cache, 4C/4T, turbo (80W), Quad core processor.
3	Processor sockets	1 No. installed processor
4	CPU/Clock speed	3.0 GHz or above
5	RAM	DDR4 16 GB expandable upto 64 GB. Available two sockets for expansion.
6	Hard Disk	2*1TB (1+1 redundant), 7.2k rpm, SATA 3 Gbps, 3.5 in hot plug hard drive 13G.
7	Storage drive	DVD R/W Drive
8	Supports	IPV4 & IPV6 and SNMP V1/V2/V3.
9	Interfaces	1 *DB-9 serial port, 1* DB-15 video port, Rear USB: 2*USB 3.0 +4*USB 2.0 , Front USB: 1*USB 2.0 +1*USB 3.0, Ethernet ports; On – Board LOM 1GBE Dual Port
10	Expansion slots	2* PCIe 3.0 Slots
11	RAID Controller	PERC H330 integrated RAID controller
12	User interfaces	19.5 inch with 1600*900 resolution at 60 Hz LED Display monitor supporting 16.7 million colours, 104 USB Keyboard and USB optical mouse, 24 port layer 2 switch.
13	Power Supply	2*495 W (1+1) redundant PSUs Hot swappable
14	Emission classification (EMC)	CECP certified
15	Environmental aspects	Temperature: operating 5 deg. C to 40 deg. C Temperature: Non- operating: - 5 deg. C to -45 deg. C Relative Humidity: Operating upto 90% Relative Humidity: Non - operating upto 90%
16	Physical Specification	5 U rack
17	Other	Appropriate network drive card shall also be provided wherever required. However, the internal hard disk drive for the server shall be redundant and all the data shall be mirrored. Further, the TMN/NMS software shall support data mirroring on redundant disk drives.

(b) Hardware requirement of Craft Terminal :

Sr.No	Description	Characteristics
1	Features	Laptop
2	Processor	Intel core i5 processor (Dual core 2.60 GHz, 3.20 GHz Turbo, 3 MB)
3	Processor sockets	1 No. installed processor
4	CPU/Clock speed	2.60 GHz
5	RAM	4 GB RAM installed.
6	Hard Disk	320 GB 7200 rpm Hard drive
7	Storage drive	DVD R/W Drive
8	Supports	IPV4 & IPV6 and SNMP V1/V2/V3.
9	Graphic Supports	Intel integrated HD Graphics 4600 with Dynamic Video memory of 256 Mb
9	Interfaces	Stereo global headset jack, Memory card reader, Docking connector, VGA, HDMI, USB 3.0 (4) Network connector (RJ-45), SIM card connector.
12	User interfaces	15" FHD ,Anti Glare LED display
13	Power Supply	130 Watt AC Adapter and 6- cell (65 Wh) Lithium Iron battery with Express Charge and upto 10 hours of

		battery life
14	Emission classification (EMC)	Energy star 5.2
15	Environmental aspects	Temperature: operating 5 deg. C to 40 deg. C Temperature: Non- operating: - 5 deg. C to -45 deg. C Relative Humidity: Operating upto 90% Relative Humidity: Non - operating upto 90%

3.10.2 Peripherals and hardware

TMN/NMS system shall be provided with laser printer. The laser printer shall have a minimum print speed of 24 rpm with duplex facility and a minimum resolution of 1200 x 1200 dpi. The laser printer shall have LAN ports for connecting to TMN/NMS system.

The laser printer under this specification shall be black & white and include print enhanced buffering to prevent loss of print data in the event of a print failure.

3.10.3 Local Operator Consoles

The Contractor shall provide operator consoles sized and equipped to support the subsystem(s) furnished and in compliance with the specification. The console shall provide along with the TMN/NMS Server interfacing for the TMN/NMS users to the software operating support systems. At a minimum, a console shall include the hardware similar to a workstation. The Local Operator Console & Server Hardware & Software is part of the set for Network Manager & Element Manager System.

3.10.4 Power Supplies

The TMN/NMS system shall use 220 volts 50 Hz A.C or -48 volt D.C \pm 20% variation as available at site for its operation as available at site.

3.11 General Software/Firmware Requirements

Due to various alternative design approaches, it is neither intended nor possible to specify all software and firmware characteristics. It is the intent herein to provide design boundaries and guidelines that help to ensure a demonstrated, integrated program package that is maintainable and meets both hardware systems requirements and the customer's operational requirements.

3.11.1 Operating System Software

Operating system software shall be provided to control the execution of system programs, application programs, management devices, to allocate system resources, and manage communications among the system processors. The contractor shall make no modifications to the OEM's operating system, except as provided as USER installation parameters.

3.11.2 Applications Software

All applications software shall be written in a high-level programming language unless developed using industry proven application programs and development tools provided with the system. The contractor shall make no modifications to the applications program except as provided as USER development tools.

3.11.3 Software Utilities

A utility shall be provided to convert all reports into standard PC application formats such as excel.

3.11.4 Revisions, Upgrades, Maintainability

All firmware and software delivered under this specification shall be the latest field proven version available at the time of contract approval. Installed demonstration for acceptance shall be required. All firmware provided shall support its fully equipped intended functional requirements without additional rewrite or programming.

All software shall be easily user expandable to accommodate the anticipated system growth, as defined in this specification. Reassembly recompilation or revision upgrades of the software or components of the software, shall not be necessary to accommodate full system expansion.

Software provided shall be compliant with national and international industry standards.

3.11.5 Database(s)

The contractor shall develop all the databases for final wideband network following the global acronyms for all stations. Database(s) to be provided shall contain all structure definitions and data for the integrated functional requirements of TMN/NMS system.

TMN/NMS operator Groups shall share the same virtual database. This means that they shall share the same database and database manager, whether or not physically separate databases are maintained.

3.11.6 Help

All applications shall be supported by USER accessible HELP commands that shall assist the user in the performance of its tasks. HELP commands for an application shall be available to the user from within the active application and shall not interfere with the activities of the application.

Specifications of PMU

1.0 Introduction

The substations /Generating stations normally are provided with CTs on each bay of the switchyard and CVTs/PTs in each transmission line bay and on each bus. Generally CTs have one metering core and four protection cores. The CVTs are provided with three cores for metering/protection. The offered PMUs shall be connected to either of these CT and CVT cores. PMUs shall be suitable for measurement on both the cores (Meter & Protection). Exact core to be connected shall be decided during engineering stage.

1.1 General Requirements

The intent of this section of specification is to describe the technical requirements for supply, installation, testing, commissioning & integration of PMUs. The PMUs to be supplied under this Specification shall be installed at the Substations / Power stations, shall communicate to the existing Phasor Data Concentrator (PDC) installed at SLDC as per IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a-2014 standard or IEC/IEEE 60255-118-1:2018 Standard with all amendments. PMU complying IEC/IEEE 60255-118-1:2018 Standard shall be preferred. *The PMU shall be capable of reporting with its full features to the existing PDC installed at SLDC under the Unified Real Time Dynamic State Monitoring (URTDSM) Project.*

1.2 PMU Requirements

1.2.1 The offered PMUs shall be complete in all respect so that they can be installed at the substation/power plant and can communicate with Phasor Data Concentrator (PDC) installed at SLDC. The necessary cable, connector and installation hardware, as required, shall be supplied by the bidder. Normally PMUs shall be installed near to the control & relay panels and CT/CVT connections to the PMU shall be extended from the control & relay panels.

1.2.2 The PMUs shall communicate with M/s GE make PDC installed at State Load Despatch Centre, MPPTCL, Jabalpur over the communication link provided by MPPTCL. The details of PDC from which these PMUS are required to be integrated are mentioned in enclosed **Annexure-I**. For integration with PDC, PMU shall be provided with minimum One Ethernet port of 10/100 Base Tx and minimum one optical fiber port of 100 Mbps for streaming the data in UDP/IP multicast/unicast or TCP/IP in IEEE C37.118 format. The Ethernet port can be used to connect the PMU directly to the communication equipment in the substation. PMU shall also be capable of reporting data on TCP/IP.

1.2.3 The PMU shall be able to perform synchro-phasor reporting for minimum 2 clients over TCP and/or 2 UDP clients for multicast or unicast. PMU shall be capable of sending data in Multi-cast as well as Uni-cast.

1.2.4 The supplied PMUs shall be suitable to operate on unearthed 220 V DC or 110V DC or 48V DC (+10%, -15%) power supply as available in the substation.

1.2.5 The PMU shall support data 'Reporting Rates' of 25, 50 or above frames per seconds for 50 Hz System. The PMUs with higher reporting rates shall be preferred. The actual rate to be used shall be user selectable. All the PMU hardware and software shall be sized considering 50 frames per second. If the PMU is capable for higher reporting rate, then the PMU hardware and software shall be sized considering the highest reporting rate. Further, the PMU shall be capable of maintaining the accuracy as specified in IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a-2014 standard or IEC/IEEE 60255-118-1:2018 Standard independent of number of Analog Input channels connected to the PMU.

1.2.6 The typical network architecture of PMUs at substation is given at Fig 1 below. The Data Requirement Sheets (DRS) of PMUs and associated items are mentioned at **Annexure-II**.

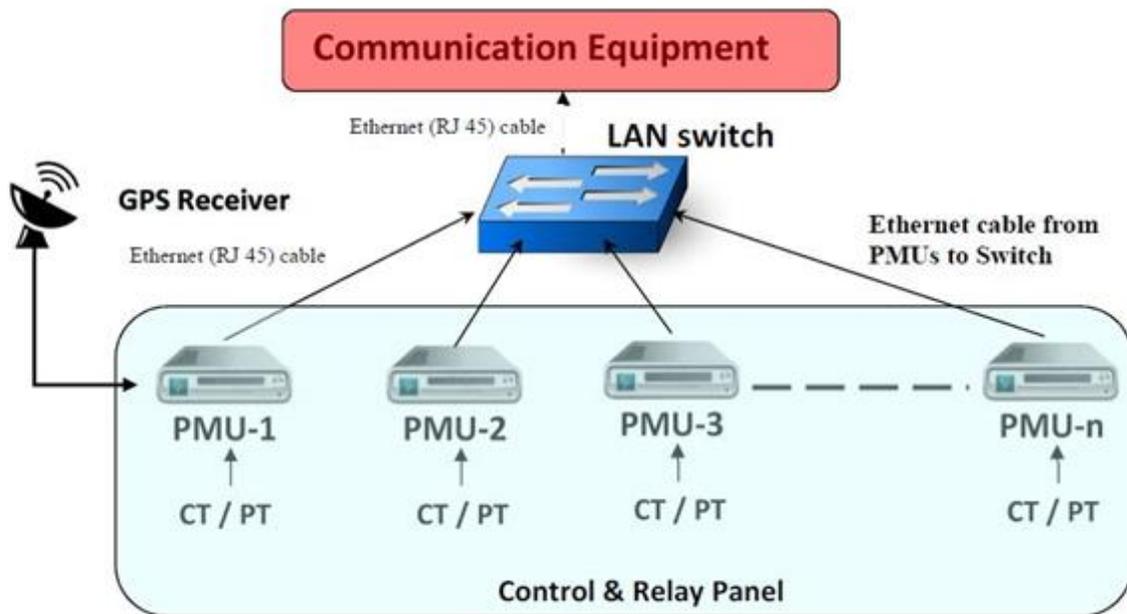


Fig 1 : Typical Network Architecture of PMU installed at Substation Control Room

1.2.7 PMUs shall be provided to measure Voltage and Current Phasors of feeders and transformers specified in the BoQ. PMU shall also measure status of master protection and circuit breakers for feeders and transformers as per SLD. The PMUs shall be able to measure/calculate following:

- 3-phase voltage Phasors (Magnitude and angle),
- 3-phase current Phasors,(Magnitude and angle),
- Positive sequence voltage,(Magnitude and angle),
- Positive sequence current,(Magnitude and angle),
- Breaker Status
- Main Protection Status
- Frequency,
- Rate of Change of Frequency (ROCOF) -df/dt

- Analog Values (MW & MVAR)

Provision shall be made for user selection of measured value.

1.2.8 A time synchronization system (GPS receiver) shall be provided with PMU. The PMU shall have internal clock, which shall be synchronized with GPS clock. Upon loss of signal from the GPS source, the PMU shall detect a loss-of-signal and generate an alarm which will be transferred to PDC. Upon loss of signal, the PMU time facility shall revert to an internal time base. The internal clock shall have minimum stability of 1 ppm.

The PMU with supplied GPS shall keep the total vector error (TVE), the frequency error (FE), and the Rate of Change of Frequency (ROCOF) within the limits specified as per IEEE C37.118 standard & further amendments.

1.2.9 The PMUs shall have continuous self-monitoring ,diagnostic feature and capable to identify & communicate problems and shall generate alarm in case of any abnormality which shall be displayed locally as well as shall be transferred to the PDC. The indication shall be available for each module on the front panel of the PMU.

1.2.10 The PMU shall support Configuration frame 2 & Configuration frame 3.

1.2.14 Remote configuration facility shall be provided in PMU and the supplier shall supply the necessary hardware/software required for remote configuration of PMU in the existing PDC installed at SLDC. **The supplied software shall have the capacity to provide remote configuration of PMUs, through same data channel through which the PMUs are reporting to GE PDC.**

1.2.15 Each Phasor calculation shall be done independently; it should not be depending on first or any other channel either of voltage or current channel of PMU.

1.2.16 PMU shall support multiple data stream i.e. a PMU shall be capable to transmit its data in separate data streams (more than one). Each stream shall be configurable independently based on the following:-

- Contents
- Sampling rate
- Class of service (P or M)
- Communication mode (TCP/UDP)
- Different destinations with separate IDCODE.

1.2.20 The PMUs shall measure the electrical parameters in the power system frequency band of 48-52 Hz with the accuracy as per standard IEEE C37.118.1-2011, C37.118.1a-2014 with all amendments; however, data from PMU shall be available below 48 Hz frequency and above 52 Hz bidder has to assure this feature. The PMU design shall ensure that the impact of frequency fluctuation on accuracy is within permissible limit as per prevailing standards.

Annexure-1: Details of existing PDC installed at SLDC

Contract Item No as per BOQ		Main and Backup SLDCs : B.4 a, c, d, e
Application		Real Time PDC, Analytics Server and PDS (Part-1)
Sr.No.	Item	Characteristics
1	Manufacturer	CISCO
2	Model	C240-M3
3	Application	Real Time PDC and Analytics
4	Country of Origin	America(North & Latin)/Europe
5	No. of CPU and Cores: 2 x 8 cores	2 x 10C Processor, E5-2670v2, 2.5GHz (2 Socket)
6	Installed 128 GB	8 x 16 GB DDR3 (128 GB), 12 DIMM Slots per Processor Socket total of 24 DIMM Slots
7	Internal Auxillary Memory : 500 Gb Delivered expendable upto 1 TB	2 x 600GB 15K , SAS HDDs. (RAID 1), 16 no. HDD Slots
8	Internal optical drive : DVD (R+W)	DVD +/-RW, SATA, External (HP Make)
9	Input Ports :2 x 1Gbps Ethernet Ports (Minimum)	4 x 1Gb Ethernet Ports
10	Power Supply : Dual AC Power Supply	DualPower Supply, 650W
11	User interface : Through a common TFT monitor , keyboard & mouse connected through KVM Switch in a server rack	Yes
12	Mounting : Rack mountable	Yes, 2U

Annexure-II: Data Requirement Sheets (DRS) of PMU and associated items

1. Phasor Measurement Unit (PMU):

The supplied Phasor Measurement Units (PMUs) shall communicate to the existing Phasor Data Concentrator (PDC) installed at SLDC as per IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a-2014 standard or IEC/IEEE 60255-118-1:2018 Standard with all amendments.

S.No	Description of the Features	Minimum Quantity of the features	Offer by the Bidder
1.	Device	Phasor Measurement Unit (PMU)	
2.	Manufacturer		
3.	Model No.		
4.	Country of origin		
Inputs			
5.	Minimum Analog Channel	PMU shall be able to measure atleast 2 set of 3 phase voltage inputs and 2 set of 3 phase current inputs.	
6.	Minimum Digital Channels	10	
7.	CT core	Capable for Metering & Protection Core	
8.	Auxiliary Power Supply Source	220 V DC or 110V DC or 48V DC (+10%, -15%) power supply source	
9.	Communication ports	One Ethernet port of 10/100 Base Tx and one optical fiber port of 100 Mbps	
10.	Interface ports for Time synchronization	IRIG-B interface port for either a standard or high-accuracy demodulated IRIG-B time-synchronization input signal or Ethernet port on IEEE 1588v2.0 (PTP)	
11.	Communication Protocols	UDP/IP multicast/unicast & TCP/IP	
Measurement Output			
12.	Performance Class	M class & P Class It should be user selectable.	
13.	Test Compliance as per IEEE 37.118 or IEC/IEEE 60255-118-1:2018 Standard	Bidder to fill the values as per test conducted in the lab for each individual values both in steady state and Dynamic State as per IEEE C37.118 Standard OR IEC/IEEE 60255-118-1:2018 Standard	
14.	Environmental Condition During testing	Bidder to fill the environmental condition during testing for each test.	
15.	Reporting rates (Frame per second)	25, 50 or above frames per seconds for 50 Hz System. The actual rate to be used shall be user selectable. All the PMU hardware and software shall be sized considering 50 frames per second. If the PMU is capable for higher reporting rate, then the PMU hardware and	

Technical Specifications for Installation of Phasor Measurement Unit (PMU)

		software shall be sized considering the highest reporting rate.	
16	Configuration Frame	PMU shall support Configuration Frame -2 & Configuration Frame-3	
17	Minimum reporting clients	Minimum 2 clients over TCP and/or 2 UDP clients	
18	Active & Reactive Power	3 Phase active and reactive power measurement/computation for a feeder should be possible in PMU.	
19	Total Vector Error	Less than 1 %	
Other features			
21.	HMI facility	Yes with display in PMU showing real time measured values & configuration changes possible through HMI.	
22.	Remote configuration Change	The supplied software shall have the capability to provide remote configuration of PMUs, through same data channel through which the PMUS are reporting to GE PDC.	
23	Configuration tool	Yes	
24	PMU integration with PDC	The PMU shall be capable of reporting with its full features to the existing GE PDC installed at SLDC under the URTDSM Project. It is the responsibility of the bidder to coordinate with GE for successful integration of PMUs with GE make PDC. In case of any integration issues, the same is required to be sorted out by the bidder.	
25	Station Name, Phasor Name, Analog name, Digital Name	These should be user configurable in PMU.	
26	PMU integration with existing GPS	The PMU shall be capable of integration with the existing GPS installed under the URTDSM Project with all the accuracy requirements as per the IEEE Standards.	
27	PMU integration with existing Layer-3 LAN Switch	The PMU shall be capable of integration with the existing Layer-3 LAN Switch installed under the URTDSM Project with all the accuracy requirements as per the IEEE Standards.	
28	Disturbance Recorder	Disturbance Recorder with disturbance report feature that record upto 12 analog channels & 32 digital channels.	
29	Event Recorder	Upto 512 event records	

Technical Specifications for Installation of Phasor Measurement Unit (PMU)

30	Test reports for measurement compliance	The Bidder shall submit the test reports for measurement compliance for both class of measurements along with the Bid.	
31	Cyber Security	<ul style="list-style-type: none"> • The Access of PMU must be through password and with log of same shall be maintained. • The system shall not be affected by any outside programs like spam, malware etc. • The system must be designed on standard IEEE C37.118.2011-1, C37.118.1a-2014, C37.118.2011-2 with all amendments & IEEE Guide line of PMU. • Any configuration change must be through access right and log of the same must be maintained, all logs of event shall report to existing PDC installed at SLDC. 	
32	IPv6 Compliance	IPv4 to IPv6 conversion in case of future requirement.	
33	Self-monitoring, diagnostic feature and alarm to PDC.	The PMUs shall have continuous self-monitoring ,diagnostic feature and capable to identify & communicate problems and shall generate alarm in case of any abnormality which shall be displayed locally as well as shall be transferred to the PDC. The indication shall be available for each module on the front panel of the PMU.	
34	Multiple data streams configurable independently.	<p>PMU shall support multiple data stream i.e. a PMU shall be capable to transmit its data in separate data streams (more than one). Each stream shall be configurable independently based on the following:-</p> <ul style="list-style-type: none"> • Contents • Sampling rate • Class of service (P or M) • Communication mode (TCP/UDP) • Different destinations with separate IDCODE. 	
Environmental condition			
1	Temperature	-10 to 50 degree Celsius	
2.	Humidity	10% to 95%	

Specifications of RTU

TECHNICAL SPECIFICATION FOR REMOTE TERMINAL UNIT

1.0 Scope of Supply:

The contractor shall provide the complete RTUs, interface cabinets, transducers, Multi Function meters, cabling, installation and implementation and associated support requirements defined in this Specification.

2.0 Overview of the Scheme:

The brief description of scheme for Real Time Data Communication System from Remote Sub-stations to SCADA is as under.

2.1 The system will meet the following requirements of MPPTCL.

Collect parameters from 400KV, 220KV, 132KV substations-upto 33kV voltage level as below: Parameters to be monitored:

Parameters	Transformer/ Reactor	Feeders	Capacitor Bank	Station Transformer
Voltage	√	√	√	√
Current	√	√	√	√
Frequency	√	√	√	√
Active & Reactive power	√	√	√	√
Import & Export Energy (active/ reactive)	√	√	√	√
Power Factor	√	√	√	√
Oil temperature	√	-	-	-
Winding Temperature	√	-	-	-
Low oil level	√	-	-	-
PRV Trip	√	-	-	-
Buchholz alarm	√	-	-	-
Buchholz trip	√	-	-	-
OSR Trip	√	-	-	-
Tap Position Indicator	√ (NA for Reactor)	-	-	-
Healthiness of FIRE Prevention System (Applicable for 400KV & major 220 KV class Transformers/R eactors only as	√	-	-	-

Parameters	Transformer/ Reactor	Feeders	Capacitor Bank	Station Transformer
per Annexure-IV)				
Master Trip Relay Operation	√	√	√	-
Under frequency relay	-	√ (33kV feeders)	-	-
Low SF6	√	√	√	-

2.2 Provide LDMS SCADA with log sheet printing (A3) printer specification and it can generate minimum report with the facility to export into excel as specified below and the software shall be capable to generate more reports as per purchaser requirement as per site conditions:

Sl. No.	Name of reports
I	20Hrs Voltage data
ii	Daily bus balance
iii	Daily energy register
iv	Daily Operating data
v	EHV of feeders
vi	Monthly bus balance
vii	Monthly voltage data
viii	More than 10 tripping
ix	Tripping
x	Voltage profile
xi	Voltage variation
xii	X-mer load monthly
xiii	Daily log sheet

2.3 Transmit the parameters to Control Centres i.e. SLDC& Sub-SLDCs via PLCC/ OPGW and MPPTCL SCADA at Jabalpur and at Indore and Bhopal via GPRS.

3.0 TECHNICAL SPECIFICATION OF RTU:

3.1 RTU Functions:

All functional capability described herein shall be provided, are even if a function is not initially implemented. The term master station is used to denote the SCADA systems. As a minimum, the RTUs shall be capable of performing the following functions:

- (a) Collecting and processing the digital status inputs, analog inputs, accumulated values and transmitting to master station(s).
- (b) Receiving and processing digital & analog control commands from the master station(s).

- (c) Accepting polling messages from at least three master station(s) simultaneously using separate logical databases for each master station.
- (d) Communication simultaneously on all Communication ports and using multiple concurrent protocols, including the IEC 60870-5-101, 60870-5-104 & MODBUS/103 protocol.
- (e) Data transmission rates from 300 to 9600 baud for serial ports (for both IEC 60870-5-101 & MODBUS/103) and 10/100 Mbps for TCP/IP Ethernet ports.
- (f) RTU shall be compatible with protocol 61850 for communication with IEDs.
- (g) RTU shall have the capability of automatic start-up and initialization following restoration of power after an outage without need of manual intervention. All restarts shall be reported to the connected master station(s).
- (h) RTU shall support time synchronization through messages received from master station using IEC 60870-5-101 & IEC 60870-5-104 protocol.
- (i) RTU shall support downloading of RTU database from the master station using the IEC 60870-5-101 and IEC 60870-5-104 protocol.
- (j) RTU shall support SOE (Sequence of events) feature.
- (k) Acting as a data concentrator for acquiring data from Slave RTUs and exercising supervisory control on slave RTUs using IEC 60870-5-101 and IEC 60870-5-104 protocol.
- (l) RTU shall be capable of reporting to multiple control centres on different protocol just by modification in RTU configuration. All software required for multiple protocol support on different ports shall be available and installed, so that same may be configured whenever required.

3.2 Communication ports:

The RTUs shall support simultaneous communications with multiple independent master stations (SCADA system), maintenance and configuration terminal (Laptop PC), a local logger (printer), Multi-function transducers and Local Data Monitoring System (LDMS)/Logger.

The RTUs shall have communication ports as follows:

- a) Two nos. programmable Ethernet ports for connectivity to Master Station on IEC 60870-5-104 and two nos. ports for communication of relays on IEC 61850. Further minimum four additional programmable Ethernet ports will be provided for future use or alternatively a Ethernet gateway shall be provide, i.e. minimum 8 Ethernet ports.
- b) Two RS232 ports –for communication with master stations on IEC 60870-5-101.
- c) One port for the RTU maintenance and configuration terminal.
- d) One port for Local Data Monitoring System (LDMS) and local logger (printer).

- e) Required number (minimum eight) of RS 485 ports for polling Multi-function transducers using MODBUS/103 protocol in multi-drop (party line) mode.

It shall be possible to increase the number of communication ports in the RTU by addition of cards, if required in future. The RTU shall respond to independent scans and commands from Master Station, LDMS and Configuration & Maintenance Terminal simultaneously. The RTU shall support the use of a different communication data exchange rate (bits per second) and scanning cycle on each port.

4.0 Modems:

Each RTU shall be equipped with following modem:-

4.0.1 GPRS Modems:

RTU shall be equipped with dual SIM Type with 4G support GPRS/GSM modem along with data enabled SIM at RTU end with minimum two numbers of variable / adjustable IP address. **The GPRS/ GSM modems shall meet the following requirements:**

GSM/ GPRS Section:

- (i) Operate in Dual Band EGSM 900/1800MHz.
- (ii) Compliant with ETSI GSM Phase 2 Standard.
- (iii) Class4 (2W) @ 900 MHz
- (iv) Class 1 (1W) @1800 MHz

RF section:

Provided a SMA interface on the modem to which a fixed Dual Band 5 db gain Antenna can be connected.

4.0.2 PLCC Modems:

Two no. Modems one for remote end and one no. for control centre complete in all respects including power supply unit & rack shall be supplied. The PLCC Modems shall meet the following requirements:

- a. The Modem should be programmable for SCADA or power utility communication network.
- b. Multi-standard support (programmable): ITU R.35, R.37, R.38A, R.38B, V.21, V.23, V.29, Bell 103 and 202.
- c. Use frequency shift keying (FSK) modulation.
- d. Communicate at data rates of 300, 600 and 1200 bps.
- e. Use PLCC bandwidth upto 4khz and shall accommodate multiple data channels over and above voice channels.
- f. Use both 2-wire and 4-wire communication lines.
- g. Receive level adjustable from 0 to -36 dBm programmable by 1 dB step @ 600 ohms.

- h. Transmit level adjustable from 0 to -32 dBm programmable by 1 dB step @ 600 ohms or high impedance with return loss less than 0.2.
- i. Have a minimum sensitivity of -48 dBm.
- j. Shall operate on 48 VDC power supply.
- k. Compatible with IEC 101
- l. Isolation: Transformer upto 1500V.
- m. It must support the FSK communication of 300/600/1200bps (Selectable).
- n. It must support all kinds of communication protocol of compatible power carrier Polling, CCITT (V23, V21, V24, V28), and all kinds of whole sessions and upper audio protocol.

4.1 Local Data Monitoring System (LDMS) Interface:

The RTUs shall include the interface for communication with the LDMS system. The LDMS shall be used for local data acquisition, monitoring and control of substation parameters through RTU. The scope of LDMS shall include installation and integration of LDMS software on a Personal computer.

The LDMS shall be a mini SCADA system providing MMI capability for use in the sub-station control room building. The LDMS software shall include following functions:

- I. Data acquisition for analog, digital and pulse accumulator type data
- II. Data processing – Conversion to engineering units, limit monitoring, data validity test, calculated data.
- III. Calculated data (such as maximum, minimum, average values with associated time-stamping etc.) of all the station parameters.
- IV. Time Synchronization
- V. Sequence of Events Processing
- VI. Supervisory control
- VII. Alarm, tagging, trending, quality codes etc.
- VIII. Single Line Diagrams, Trends, daily, weekly, monthly reports etc. shall be prepared and integrated on LDMS system. The LDMS shall also have capability to generate additional displays, single line diagrams, reports, and trends.

The LDMS shall store all real-time telemetered & calculated data every 5 minutes (adjustable to 15,30,45,60 minutes). The software and hardware shall be sized for storage of all above data at every 5 minutes for at least six months duration. All alarms, events, SOE etc. shall also be stored on regular basis. It shall be possible to define daily, weekly, monthly Substation reports on LDMS. It shall be possible to generate reports highlighting the maximum, minimum, average with associated time-stamping etc. of all the station parameters. The historical data stored on the storage medium shall be in standard format and necessary tools for its export to standard spreadsheet programs (Excel) shall be provided.

The LDMS shall update analog data from RTU every ten seconds (programmable) and status data by exception. The SOE status data shall be recorded with resolution of 10 ms timestamp. The LDMS system should have the provision of manual entry.

The Latest Desktop Computer System (min core i7, RAM 8GB) along with LDMS software, A3 size Printer & UPS of reputed make and Application & Operating Software with antivirus of minimum 3 years of license key shall be supplied.

The LDMS shall support for following existing ADMS scheme: The complete system comprising of RTU and LDMS SCADA software should support existing ADMS scheme and should be able to differentiate between normal tripping and ADMS tripping and shall be capable to generate ADMS alarms both at EHV substations and control centres. The details of scheme for generation of alarm at EHV substations on LDMS is given in **Appendix-I**.

UPS:

Sl. No.	Particulars	Specification
1	Make/Type	Reputed
2	Capacity (VA)	1000 VA
3	Capacity (W)	800 W
4	AC Input Voltage range	Single phase 240V with -15% to +10% variation
5	Input Frequency	50 Hz \pm 3Hz
6	UPS power factor	0.9 or better
7	AC output voltage	230V AC \pm 2%, Single Phase
8	Output frequency	50 Hz \pm 1%
9	Waveform	Sinusoidal
10	Indications	Visual- Mains On, Battery Low Audible- Battery Low

USB Speaker:

Sl. No.	Particulars	Specification
1	Make	Reputed
2	Type	USB powered 2 Satellites Speakers

Printer:

Sl. No.	Particulars	Specification
1	Make	Reputed
2	Type	Laser Printers
3	Color output	Black and white
4	Functions	Print only
5	Ports	1 USB device port; 1 Fast Ethernet 10/100
6	Number of print cartridges	1 (black)

4.2 Communication interface between RTU & MFTs:

The RTU shall acquire data from the MFTs. The MFTs will act as slave to the RTU. The RTU shall have the ability of issuing retry scan to acquire data from the MFTs in case of communication failure between RTU and MFTs. All data from the devices connected on a single port shall be acquired within 5 seconds.

4.3 Communication Protocol between RTU & IEDs:

The RTU shall use the IEC 61850 protocol for communication with IEDs over Substation LAN. The RTU shall act as a Client and collect data from the IEDs. The RTU shall store the data acquired from the MFTs & IEDs in its database and do processing like change detection/dead band processing on the data for optimizing its transmission to the Master Station (SCADA Control Centre). The processing shall include requirements of mapping of information from the protocol of MFT/IEDs to the protocol requirement for communication with Control Centre.

4.4 Master Station Communication Protocol:

The Contractor shall provide a communication protocol for communicating with SCADA master stations using the IEC 60870-5-101 and IEC 60870-5-104 communication protocol standard. The communication protocol shall support all the requirements of this standard. The communication protocol shall be non-proprietary and the Contractor shall provide complete description and documentation of the protocol to MPPTCL.

The RTU shall perform as a slave to SCADA master station when using the IEC 60870-5-101 protocol. All communication shall be initiated by the SCADA master stations. RTU must notify the master stations of unusual conditions at the RTU (such as a power fail/restoration or RTU malfunction), the transfer of changed data etc. All the notifications shall be accomplished within the framework of the periodic data acquisition exchanges.

The RTU shall process the various messages/commands for communication to the Master station using the following priority.

- a) Control command
- b) Status data by exception
- c) Analog data by exception
- d) Analog data periodic
- e) Status data integrity scan

The communication interface to the master station(s) shall allow scanning and control of defined points within the RTU independently for each master station using a separate logical database in the RTU. It shall be possible to pick points from the RTU database randomly and assign it for reporting to a Master station. Further, 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.

4.5 Reporting of status points:

The RTU communication protocol shall be configured to report digital status changes by exception to master station. Digital status data shall have higher priority than the Analog data. All the digital status data shall also be assigned to scan groups for integrity check by Master stations at every 10 minutes.

RTU shall be capable of accepting isolated dry (potential free) contact status inputs. The RTU shall provide necessary sensing voltage, current, optical isolation and debounce filtering independently for each status input. All status inputs shall be scanned by the RTU from the field at 1 millisecond periodicity.

4.6 Reporting of Analog points:

The analog data shall be reported periodically to update all the values at the master station within 10 to 15 seconds. Analog data shall also be reported by exception if the analog value exceeds its previous value by more than 20% (user configurable) and shall be updated at the control centre within 5 seconds.

4.7 Digital control commands:

The RTU shall follow the select-and-execute sequence for operation of digital control commands from the master station. The RTU shall reset its control logic upon any error in the sequence. The RTU shall provide the capability for a master station to select and change the state of digital output points. Device control will be used by MPPTCL to control power system devices.

4.7.1 Control Outputs interposing Relays (Double Contact Digital Output):

Control output interposing relays shall be supplied by the Contractor for each control output described above. Each control relay shall consist of two isolated single-pole double throw contacts. The output contacts shall be rated 10 Amps at 110V / 220 V DC.

4.7.2 Control Disable:

A manual Local / Remote switch shall be provided for each RTU to disable all control output interposing relays by breaking the power supply connection to the control output interposing relays.

4.8 Analog Inputs:

The RTU shall accommodate analog inputs which are unipolar or bipolar, 2-wire ungrounded differential signals. All analog inputs are of +4 to +20 mA. However, the RTU shall be capable of accepting other standard analog input ranges (0 to 5V, 0-10V, 0 to 10mA).

4.9 RTU Sequence of Events (SOE) Collection:

SOE is the time-stamped digital status data. SOEs will enable MPPTCL's personnel to determine the sequential operation of digital status input devices for their state changes. The RTU shall time-stamp the digital status data with a time resolution of one millisecond. The

RTU shall maintain a SOE buffer within the RTU for communication delays and communication failure. SOE buffer shall be sized to store, as a minimum, of 600 events. The RTU shall transmit the SOE data stored in its buffer to master station.

4.10 Time Facility:

The RTU shall have an internal clock with the stability .The RTU shall be synchronized through synchronization message from master station at every 10 minutes using IEC 60870-5-101 protocol. However, all the RTUs shall have a suitable interface for receiving synchronization signals from a local GPS receiver.

5.0 Portable RTU Configuration & Maintenance Software (PCMS):

A Portable Configuration and maintenance Software shall be supplied which shall provide followings capabilities:

- (a) RTU Data base configuration & Maintenance
- (b) Local Operator Interface & RTU Diagnostics

6.0 Power Supply:

The RTU will be powered from a 48 V DC (+ve earthed) system. The RTU shall not place additional ground on the input power source. The characteristics of the input DC power supply shall be

- (a) Nominal voltage of 48 Vdc with operation between 41 and 60 Vdc.
- (b) Maximum AC component of frequency equal to or greater than 100 Hz and 0.012 times the rated voltage peak-to-peak.
- (c) The RTU shall have adequate protection against reversed polarity, over current and under voltage conditions, to prevent the RTU internal logic from being damaged and becoming unstable causing mal-operation.
- (d) Over voltage and under voltage protection shall be provided within the 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 misoperations as a result of voltage fluctuations.

7.0 RTU Cabinets:

The panels shall meet the following requirements:

- (a) Shall be free-standing, floor mounted and height shall not exceed 2100 mm, depth 560mm. Tenderers may note that the height and depth of RTU panels will have to be maintained as mentioned. As far as width of the RTU panels is concerned the same may be offered based on optimum design to accommodate specified number of circuits as also the various accessories, which are to be mounted on the panels.

- (b) Shall have maintenance access to the hardware and wiring through lockable full height doors.
- (c) Shall have the provisions for bottom cable entry
- (d) The safety ground shall be isolated from the signal ground and shall be connected to the ground network. Safety ground shall be a copper bus bar. The contractor shall connect the panel's safety ground to the MPPTCL's grounding network. Signal ground shall be connected to the communication equipment signal ground.
- (e) All panels shall be supplied with 230 Vac, 50 Hz, single-phase switch and 15/5A duplex socket arrangement for maintenance.
- (f) All panels shall be provided with an internal maintenance lamp, space heaters and gaskets.
- (g) All panels shall be indoor, dust-proof with rodent protection, and meet IP41 class of protection.
- (h) There shall be no sharp corners or edges. All edges shall be rounded to prevent injury.
- (i) Document Holder shall be provided inside the cabinet to keep test report, drawing, maintenance register etc.
- (j) All materials used in the enclosures including cable insulation or sheathing, wire troughs, terminal blocks, and enclosure trim shall be made of flame retardant material and shall not produce toxic gasses under fire conditions.
- (k) The structural frame of the panels shall be of cold rolled sheet steel of thickness not less than 3 mm for the weight bearing members of the panels such as base frame, front sheet & door frames and 2mm for sides, door, top and bottom portions.
- (l) All sheet steel work shall be degreased, pickled, phosphated in accordance with IS6005. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. Two coats of synthetic enamel paint (RAL7032 shade) shall be applied both in the exterior and the interior of the panel.

8.0 Wiring/Cabling requirements:

Shielded (screened) cables shall be used for external Cabling from the RTU/ SIC panels. These external cables (except communication cables) shall have the following characteristics:

- a) All cables shall have stranded copper conductor.
- b) Minimum core cross-section of 2.5 sq.mm for PT cables, 4 sq.mm for CT cables and 2.5 sq.mm for Power & Control outputs and 1.5 sq.mm for Digital Status inputs, transducer mA current output
- c) Rated voltage U_0/U of 0.6/1.1KV
- d) External sheathing of cable shall have oxygen index not less than 29 & temperature index not less than 250. Cable sheath shall meet fire resistance test as per IS 1554 Part- I.

- e) Shielding, longitudinally laid with overlap.
- f) Dielectric withstand 2.5 kV at 50 Hz for 5 minutes
- g) External marking with manufacture's name, type, core quantity, cross section and year of manufacture.

The Communication cable shall be of shielded, twisted pairs and of minimum 0.22sq mm size.

9.0 RTU Size and Expandability:

The software and the database shall be sized to accommodate growth within the ultimate sizing parameters as defined in this specification for the RTU without requiring software or database structure regeneration. The RTU shall have additional wired available reserve capacity of twenty percent (20%). This reserve capacity shall be used without any additional hardware such as I/O cards and terminal blocks. The RTUs delivered shall have the capability to accommodate additional I/O modules to expand the overall point count of the RTU by a minimum of fifty percent (50%) i.e 80% more than the actual RTU count defined in the BOQ. The I/O modules here mean Status Input module, Analog input module and the Control output module.

10.0 Transducer/ Multi Function Meter:

10.0.1 Transducers:

The Contractor shall supply transducers for the all the analog points. The Transducer must have following properties.

Analogue outputs

Type 4-20mA or (MODBUS)

Accuracy class .2S

Temperature range

Operating range -5 °C to +55 °C

Functional range -20 °C to +70 °C

The input, output and auxiliary circuits shall be isolated from each other and earth ground. The transducer output shall be ungrounded and shall have short circuit and open circuit protection. The transducers shall comply to IEC 60688, IEC 61000-4-3, Level 1 IEC 61000-4-4, Level 1

10.0.1.1 Transformer Tap Position Transducer Winding Temperature and Oil Temperature:

Dual output signal of 4 to 20 mA DC or with RS 485 port on MODBUS, 0.5% accuracy class as per IEC 688 shall be provided.

10.0.1.2 Battery Voltage Transducer:

Output signal of 4 to 20 mA DC or with RS 485 port on MODBUS
Nominal input (U) 0 to 300 V, Measuring range 0 to 130 % U ,
Maximum overload voltage 1.3 x U continuously, 2 x Un for 1 s with up to 10 repetitions at 10 s intervals

10.0.1.3 Battery Current Transducer:

Output signal of 4 to 20 mA DC or with RS 485 port on MODBUS
DC current Measurement input range 0-20 mA directly, or 0-300 mV through shunt

10.0.2 Multi Function Meter (MFM):

The Contractor shall supply Multi Function Meters (MFM) for measurement of real time analog parameters.

The MFMs shall be supplied with following specifications.

Sl. No.	Parameters	Description
1	Nominal PT Input Voltage	110V ac (Phase to Phase), 50 Hz
2	Nominal CT Input Current	1A per Phase
3	CT/PT Input Configuration	Configurable 3-Phase, 4-Wire (balanced or unbalanced load) / 3-Phase, 3-Wire
4	Measurement Method	Configurable 3-Wattmeter / 2-Wattmeter
5	Auxiliary Power Supply (the Power supply of MFM should be provided with galvanic isolation)	110V DC / 220V DC / 48V DC (+25%, -20%) PT input powered MFMs are not acceptable.
6	Mounting	Panel Mount
7	Communication Port	Optically isolated RS485 interface. MFMs will be connected to RTU in multi-drop mode.
8	Communication Protocol	Modbus/RTU
8	Communication Speed	Minimum 9600 baud
9	Display	Multiple windows of 7-segment bright LED display.
10	Accuracy	0.2s Reliable and sustained accuracy to IEC 60687/ IS 14697, Class 0.2s.

MFMs shall provide at least the following parameters as a minimum.

Sl. No.	Parameters
1	Voltage (each phase to neutral or phase to phase)
2	Current (each phase)
3	Frequency
4	Active & Reactive power
5	Import & Export Energy (active/reactive)
6	Power Factor

The MFM shall comply to the test requirements as per latest IEC/IS standards including IEC 60687/ IEC 60688/ IEC 801-4/ IEC 801-3.

5.2.2 For voltage, current, frequency, power, energy, power factor, MFM on LT side of station transformer with Ring type Current Transformers and MFM shall be provided by the contractor.

11.0 Contact Multiplying Relays (CMRS):

The relays shall be DC operated, self reset type. The rated voltage for relay operation shall be of 80% to 120% for 220V/110V 220V DC / 110V DC depending on the station DC supply.

The relay shall have a minimum of two change over contacts, out of which one shall be used for telemetry purposes.

The relay shall conform to following requirement. Power Frequency withstand voltage of 2kV for 1 minute as per IEC 255-5. Insulation Resistance of 100M ohms for a voltage equal to 500V DC.

12.0 Software requirement:

The software provided to support the functions of the RTUs shall meet the characteristics described in this section. The term "software" is used throughout this Specification to mean either software or software implemented in firmware.

12.0.1 Design Characteristics:

All software shall be implemented according to the Contractor's established design and coding standards. MPPTCL reserves the right to reject any software that does not conform to these standards. Complete and comprehensive documentation shall be provided for all software.

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.

12.0.2 Operating System:

The Contractor shall use a non-proprietary operating system capable of managing the distributed applications of the RTU. If a proprietary system is offered then contractor shall provide the corresponding source code. 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.

12.0.3 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.

12.0.4 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.

12.0.5 RTU Configuration Support:

The Contractor shall supply a database compiler which will enable to configure and document each RTU's database. A compiler shall be provided to completely 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.

12.0.6 Diagnostic Software:

The Contractor shall supply diagnostic software which monitors and individually tests each of the components of the distributed RTU. The diagnostics shall provide comprehensive user interaction and printout capabilities.

13.0 Installation Requirements of RTUs:

The contractor shall be responsible for the complete adaptation and installation of the RTUs, interface cabinets, Multi Function Meters, transducers & relays in the MPPTCL substations.

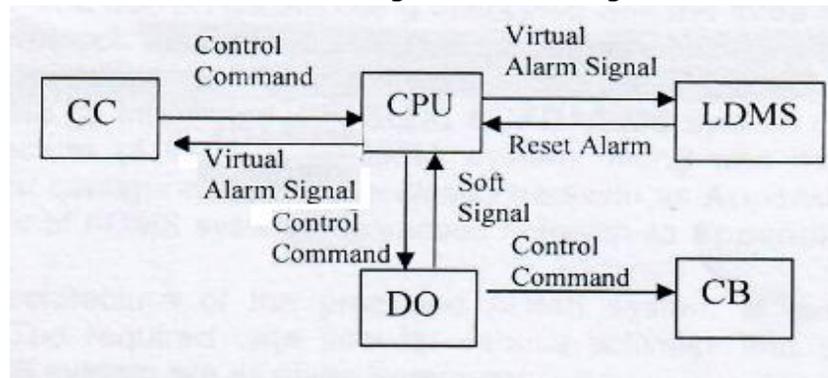
14.0 Guarantee for supply of Spares for 10 Years Operation:

As specified in the bid document, the Contractor has to ensure that the spares required for satisfactory operation of offered goods shall be made available at reasonable cost over a minimum period of 10 years from the date of commissioning of goods.

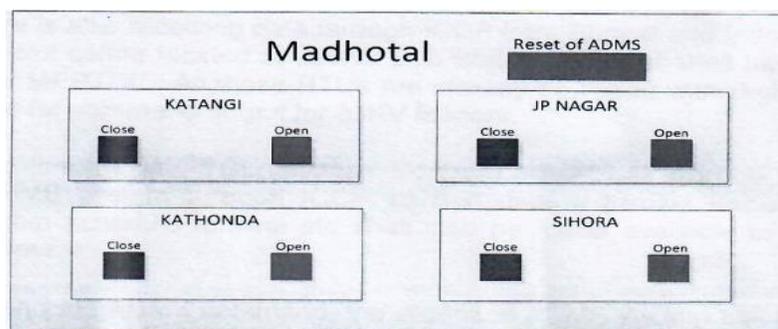
ALARM GENERATION AT EHV SUBSTATION

The details of Scheme for generation of alarm at EHV substations on LDMS is as under:

Upon receiving the Control Command from Control Centre (CC) of MPPTCL SCADA, a Software signal will be generated by relay of Digital Output (DO). The RTU through its CPU shall acquire & monitor the soft signal of relay operation and convert to virtual alarm signals. Afterwards, the virtual alarm signals for all the relays of DO operations will be sent from RTU to LDMS and Control Centre to be displayed in HMI and generate specified alarm sound by speakers attached with LDMS. It is the explicit separation of ADMS control command from normal control for operators at EHV Substations. Moreover, one virtual control for reset of all virtual alarms will be designed and displayed in HMI of LDMS when the alarm sound occurs. The operator will be informed by the sound activated and shall reset all virtual alarm through HMI. The logic is as under:-



There are two status of virtual alarm signal which is open/close for each 33KV feeder and each DO card consists of 8 relays for 4 feeders. A diagram of ADMS alarm will be displayed at HMI of LDMS as under:-



Each 33KV feeder has two status points to be displayed in this diagram which represent the control command from CC is open/close. It will blink and generate the alarm sound at HMI of LDMS. Similarly, the button of reset of all virtual alarms for the particular substation will be designed in HMI by control command. It is to be noted that the ADMS HRC fuses are required to be installed in existing C & R panel.