

CHAPTER 19: TECHNICAL SPECIFICATION OF POWER LINE CARRIER COMMUNICATION EQUIPMENTS WITH LINE TRAP, 48 V DC PLCC BATTERY, CHARGER

19.1 SCOPE

This specification provides design, manufacture, inspection, testing at manufacturer's works, delivery at site, installation and commissioned of indoor and outdoor Power Line Carrier Communication Equipments as specified herein for. The specification shall be complete for speech communication in dialling mode and/or through 4 wire Express Telephone, data communication and carrier aided protection for 400KV, 220KV & 132KV Transmission Lines. All communication equipment shall be suitable for good quality voice communication among new & existing Sub- Stations, reliable tele-protection and also data communication from RTU and SAS (via GATEWAY) to SLDC, Kahilipara.

19.2. SERVICE CONDITIONS

19.2.1 The materials supplied shall be suitable for operation under the climatic and other conditions mentioned in chapter 2.

19.2.2 Power Line Carrier Communication will have the following minimum components. However, for more efficient performance of the system the bidder can provide additional item at no extra cost.

- a) Capacitor Voltage Transformer (CVT)
- b) Wave Trap
- c) PLCC Terminal
- d) Line Matching Unit/ Line Matching and Distribution unit
- e) Tele Protection Coupler
- f) Battery and Battery charger
- g) EPAX System and Telephone System
- h) HF Coaxial cable

19.3 STANDARDS :

The equipment shall conform to the following latest Edition of the Indian Standards as amended up to date and as per latest relevant I.E.Cs. :

The details are given below :

1. IEC 353 for line trap
2. IS 8792 for line trap
3. I.E.C. 481 for coupling devices
4. I.E.C. 495 for power line carrier terminals
5. I.S. 8997 for coupling devices
6. I.S. 3156 for CVT
7. I.E.C. 358 for C.C. & CVT

8. I.S. 9348 for coupling capacitor
9. I.S. 11967 for Co-axial Cable
10. I.E.C. for Planning of SSB PLCC system
11. I.E.C. for Surge Arrestors
12. I.E.C. 96 for HF Cable
13. I.E.C834-I Part-I for Performance and Testing of Tele protection equipment
14. I.S. 9428 for Characteristic values of Inputs and outputs of single side band PLC terminals
15. I.S. 9528 for frequency planning of power line carrier equipment

19.4 TECHNICAL SPECIFICATION OF LINE TRAP

This specification provides for design, engineering, manufacture, stage testing, inspection and testing before dispatch, packing and delivery at destination of Line Trap along with all accessories specified herein. The line trap to be inserted into high voltage A.C transmission lines to prevent undue loss of carrier signal power, typical in the range 30KHz to 500KHz, under all power system conditions and to minimize interference from carrier signaling systems on adjacent transmission lines.

19.4.1 STANDARDS:

Unless otherwise specified elsewhere in this specification, the rating as well as performance and testing of the line trap shall conform but not limited to the latest revisions and amendments available at the time of placement of order of all the relevant standards as listed hereunder.

Sl No	Standard No.	Title
1	IEC 60353 Second edition, 1989-90	Line Trap for AC Power System
2	IS : 8792-1978	LINE TRAPS FOR AC POWER SPECIFICATION SYSTEMS -(First Revision)
3	IS : 8793-1978	LINE TRAPS FOR AC POWER SPECIFICATION SYSTEMS METHODS OF TESTS -(First Revision)
4	IS-9859 (PART-I)-1981	CODE OF PRACTICE FOR INSTALLATION AND MAINTENANCE OF OUTDOOR POWER LINE CARRIER EQUIPMENT PART I LINE TRAPS (Incorporating Amendment No. 1)
5	IEC 99	Lightning Arresters
6	IEC 99 - 1(1970)	Part-1 , Non-Linear resistor type arresters for

		AC systems
7	IEC 60099-4/2006	Metal-oxide surge arresters without gaps for a.c. systems
8	IS : 5561-1970	Terminal Clamp / Connector

19.4.2 PRINCIPAL TECHNICAL PARAMETERS FOR LINE TRAP:

The Line Trap covered in this specification shall meet the technical requirements listed hereunder. Line traps of different voltage rating shall conform to the following technical particulars:-

TABLE- I

SI No	Technical Parameters	VOLTAGE LEVEL		
		400KV	132 kV	220 kV
I	II	III	IV	V
2	Type of mounting	Pedestal	Suspension /Pedestal	Pedestal
3	Suitable for system Frequency	50 Hz	50 Hz	50 Hz
4	Nominal System Voltage	400KV	132 KV	220 KV
5	Highest System Voltage	420KV	145 KV	245 KV
6	Rated Continuous Current	3150A	800 A	1250 A
7	Rated Short time current for 3 second	63KA	40 kA	50 KA
8	Asymmetrical peak value of the first half wave of the rated short time current	127.5 KA	51 KAp	102 KAp
9	Rated inductance	1 mH	0.5 mH	0.5 mH
10	Type of Tuning	Broad Band	Broad Band	Broad Band
11	Blocking Band frequency range	90-150Khz 150-500Khz	90-150Khz 150-500Khz	90-150Khz 150-500Khz

12	Minimum Guaranteed resistive component of impedance in Blocking Frequency range	500 Ohm	570 ohm	570 ohm
13	Protective device	a) Non-linear resistive type Gapped lightning arresters for a.c. system	a) Non-linear resistive type Gapped lightning arresters for a.c. system	a) Non-linear resistive type Gapped lightning arresters for a.c. system
14	Nominal discharge current of protective device	10KA. However, Coordination shall be done by taking 20KA 8/20 micro-sec discharge in to consideration.	10 KA	10 KA
15	Rated voltage of protective device	> 15.72 KV rms	4.5 KV	9 KV
16	Minimum value of power frequency spark over voltage (Dry and wet) of protective device	> 23.58 KV rms	6.75 KV rms	13.5 KV rms
17	Visual corona extinction voltage	320 KV rms	97 KV rms	156 KV rms
18	Radio Influence Voltage (RIV)	< 500 micro Volt @ 280KV.	< 500 micro volt	< 500 microvolt
19	Attenuation in tuned frequency band	> 7.5 dB	>7.5 dB	>7.5 dB
20	Maximum tapping loss over blocking band I & II stated bove above	2.6 dB	2.6 dB	2.6 dB
21	Maximum tapping loss based on blocking resistance	2.6 dB	2.6 dB	2.6 dB
22	Insulation class	Class F Insulation	Class F	Class F
23	Maximum working stress	Twice the weight of wave trap + 500Kgs.	Twice the weight of wave trap +	Twice the weight of wave trap +

			500 Kgs	500 Kgs
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19.4.3 GENERAL TECHNICAL REQUIREMENTS:

A line trap, consisting of a main coil in the form of an inductor, a tuning device and a protective device, is intended for insertion in a high voltage power transmission line between the point of connection of carrier frequency signals and adjacent power system elements such as busbar, transformers etc. The tuning device connected across the main coil ensures, with proper adjustment, that the line trap presents relatively high impedance at one or more carrier frequencies or carrier frequency bands, whereas the impedance of the line trap at power frequencies is negligible. A line trap may also be used to limit the loss of carrier-frequency at a power system tee point.

19.4.3.1 Main Coil:

An inductor carries the power frequency current of the high voltage transmission line. Wave trap shall consist of a main coil designed to carry continuously the rated current at the maximum ambient temperature and at full operating line voltage. It shall be supplemented with a protective device and a tuning device.

19.2.3.1.2 Tuning Device:

Line traps are to be tuned for a carrier frequency band, which will depend upon the operation carrier frequency pair chosen for transmission lines in question. The resistive component of impedance of the wave trap within its band shall not be less than 570 ohms. The wave traps should be provided with suitable barriers to prevent the entry of birds into the same.

19.4.3.2 Protective Device:

The device connected across the main coil and tuning device which prevents the line trap from being damaged by transient over voltages which may occur across it. The protective device shall be so designed and arranged that neither a significant alteration in its protective function nor physical damage shall result either from the temperature rise or magnetic field of the main coil at continuous rated current, rated short-time current or from emergency overload current. It shall neither enter into operation as a result of the power frequency voltage developed across the line trap by rated short time current nor shall it remain in operation after a response to a transient over voltage which is immediately followed by the power frequency voltage developed across the line trap by rated short-time current.

The protective device shall be shunt connected to the main coil and the tuning device.

For proper coordination with the lightning arrester installed in the substations and generating stations, the wave traps shall be provided with protective device with nominal discharge current of 10 KA.

19.4.4 DESIGN REQUIREMENTS:

Ability to withstand rated short-time current: The line trap so designed shall be capable to withstand the mechanical forces produce by asymmetrical peak value of the short-time current.

19.4.5 Insulation level:

The insulation level for the insulation between the terminals of a line trap is governed by the rated voltage of the protective device. The insulation of the main coil and the tuning device shall be adequately rated for:-

a) The voltage developed across the line trap at the rated power frequency by the rated short-time current. The rated voltage of the protective device shall be higher than this voltage developed across the line trap.

b) the front of wave impulse spark over voltage or the residual voltage caused by the nominal discharge current of the protective device, which ever is higher.

19.4.6 System Voltage insulation:

The system voltage insulation of a line trap is provided by insulator strings or post insulators. The line trap system voltage insulation shall be consistent with the other equipment in the associated high voltage transmission network.

19.4.7 Tensile strength of suspension system:

The suspension system of a line trap shall be designed for a tensile stress of at least twice the mass of the line trap in kilograms, multiplied by 9.81 to convert to newtons, plus 5000 N.

19.5 ACCESSORIES:

- i) **Bird barriers:** The bird barrier design shall be such that no entrance to the line trap shall admit a sphere having a diameter of 16 mm.
- ii) **Terminal clamp/connectors:** The clamp shall be suitable for AAAC/ACSR Zebra conductor in case of 220 kV system and AAAC/ACSR Panther conductor in case of 132 kV system. The clamp, connectors, nuts, bolts and hardware shall be of nonmagnetic material and shall conform to IS: 5561. The clamp shall be fitted on incoming and outgoing pad of Line Trap. The incoming and outgoing conductor shall be on either side of the clamp fitted with the help of bolts and nuts arrangements. The clamp shall be designed to carry the continuous load of 800 Amp at 132 KV and 1250 Amp at 220 KV and shall withstand a dynamic short circuit current of 31.5 and 40 KA respectively for 1 second. The temperature rise shall not exceed 35°C over 50°C ambient. All the castings shall be free from blowholes, surface blisters, cracks and cavities. All sharp edges shall be blurred, rounded off and buffed. Clamp and connectors shall be designed to avoid corona formation. The visual corona extinction voltage shall not exceed 97 KV (rms.) for 132 kV and 156 kV (rms) for 220 kV. Radio interference voltage for clamp and connectors shall not exceed 500 microvolts at 97 KV (rms.) for 132 kV and 156 kV (rms) for 220 kV. No current carrying parts of the Clamps and connector shall be less than 10 mm of thickness.

iii) 400KV WAVE TRAP

The clamp shall be suitable for 4" IPS AL TUBE and TWIN/QUAD ACSR Moose Conductor. The clamps shall be chosen as per requirement of the substation. The clamp, connectors, nuts, bolts and hardware shall be of non-magnetic material and shall conform to IS: 5561. The clamp shall be fitted on incoming and outgoing pad of Line Trap with four Nos. of Nuts & Bolts. The incoming and outgoing conductor shall be on other side of the clamp fitted with the help of six bolts and nuts arrangements. The clamps shall be suitable for horizontal and vertical take off with conductor diameter 31.77 mm for Twin/Quad ACSR Moose conductor. The clamp shall be designed to carry the continuous load of 3150 Amp at 400KV and shall withstand a

dynamic short circuit current of 50KA for 3 second. The temperature rise shall not exceed 35 °C over 50 °C ambient. All the castings shall be free from blowholes, surface blisters, cracks and cavities. All sharp edges shall be blurred, rounded off and buffed. Clamp and connectors shall be designed so as to avoid corona formation. The visual corona extinction voltage shall not exceed 320 KV (rms.). All nuts and bolts shall be suitably shrouded. Radio interference voltage for clamp and connectors shall not exceed 1000 microvolt at 305 KV (rms.) at 1 MHz. No current carrying parts of the Clamps and connector shall be less than 10mm thickness including drilled Holes.

iv) RATING PLATES:

The main coil, the tuning device and the protective device shall be provided with rating plates of weatherproof material fitted so that they are readily visible. .

v) Line Trap:

The Line Trap shall be supplied with fitted Tuning Pot and Lightning Arrester. All the type test reports as per relevant IS/IEC of the Line Trap offered shall be invariably enclosed with the offer. Offers without Type Test Report shall not be considered. The Line Trap shall be fitted with top and bottom clamp with Connector etc. complete in all respect for connecting line trap to line side and equipment side respectively. The clamp, connector, nut, bolts, etc. which is affected by magnetic field of line trap shall be of nonmagnetic material. All iron parts shall be hot dip galvanized. The arrangement of minimum three nos. of tie rod assembly shall be required to avoid shearing from thread of tie rod assembly.

19.6 DRAWINGS:

The following drawings indicating all the dimensions etc. with complete technical details shall be enclosed together with technical bid :

- (i) General arrangement for Line Trap indicating dimensions, technical parameters, weight etc
- (ii) Suspension / mounting arrangement indicating dimensions
- (iv) Tuning pot ckt arrangement
- (v) Details of terminal clamp/connectors suitable for AAAC/ACSR conductor and quac/twin ACSR Moose conductor
- (viii) Suspension fittings (hardware) for line trap
- (ix) Disc Insulator with general technical specification
- (x) Lightning Arrestor as protective device for Tuning Pot
- (xi) Bird barriers
- (xii) Other accessories of Line Trap
- (xiii) Any other components/drawings not covered

19.7 TECHNICAL SPECIFICATIONS OF LINE MATCHING UNIT/LINE MATCHING DISTRIBUTION UNIT (LMU/LMDU):

19.7.1 GENERAL REQUIREMENT:

The indoor PLCC equipments are connected to line through co-axial cable – outdoor coupling device – Coupling Capacitors for transmission & reception of carrier frequency signals. Coupling devices are connected in between HF terminal of Coupling Capacitor and indoor PLCC terminals through co-axial cable.

The coupling device proposed to be procured shall perform following functions as a composite unit:

1. Compensate the reactive component of coupling capacitor(s) impedance in order to efficiently transmit the carrier signals with the help of tuning device.
2. It shall match the impedance between power line and coaxial cable end.
3. Two numbers 'phase to earth' type coupling filters shall be used to achieve 'phase to phase' / 'Inter-circuit coupling'. Connection between secondaries of the two phase to earth type coupling device shall be through a balancing transformer/hybrid such that reliable communication shall be ensured even when one of the coupled phase is earthed or open circuited on the line side.
4. Galvanic isolation of primary & secondary terminals of coupling device.
5. It shall drain the power frequency current derived from coupling capacitor(s) to earth.
6. It shall arrest the voltage surges received from power line at the terminal of coupling device.
7. It shall provide direct & efficient earthing to primary terminals of the coupling device. The equipments shall be of latest components, technology and highly reliable. The equipments offered must have been type tested.

19.7.2 SCOPE OF SUPPLY:

Line Matching Unit / Line matching Distribution Unit shall be supplied fully wired complete in all respect with all interconnections and coaxial cable termination facilities with UHF glands. The equipment shall be of latest design with modular construction.

19.7.3 SPECIFICATION:

(a) STANDARDS :

The coupling device offered shall confirm to following standards:

1. IS 8997: Specification for coupling devices for PLC system
2. IEC 481: Coupling devices for power line carrier system
3. IS 8998: Methods for tests for coupling devices for PLC System

(b) CONSTRUCTION:

The coupling device offered shall be fully programmable.

The Unit shall be modular in design and should accommodate tunable modules for different use. The bidder will furnish the details of tunable modules, which can be used along with the device. The composite unit shall be housed in waterproof Fibre Box modular construction cabinet with proper ventilation & vermin proofing arrangement. Proper arrangement for mounting the same on G. I. supporting structure shall be made. The equipments shall work

satisfactorily under hot humid & polluted atmospheric conditions. Suitable arrangements shall be provided for the connection of co-axial cables in the coupling device and supply of cable connectors shall be in the scope of supply. Cable glands of good quality suitable for co-axial cables shall be provided.

19.7.4 FEATURES:

1. The coupling device offered shall be suitable for nominal equipment side impedance of 75 ohms unbalanced and 150 ohm balanced as required.
2. The equipment offered shall work satisfactorily for carrier frequency range of 50-500 KHz.
3. The line side impedance shall be 200 Ohms to 400 Ohms for phase to earth couplings and 400 ohms to 600 ohms for phase to phase coupling.
4. The coupling device shall be suitable for use with coupling capacitor of 2200 to 8800 pf and shall be programmable.
5. Insulation withstand voltage shall be 10 kV RMS for one minute.
6. Impulse withstand voltage for high voltage input side to ground shall be 10 kV and co-axial cable input to ground shall be 3 kV.
7. The nominal peak power of the coupling device shall not be less than 1000W.
8. The coupling device shall have inbuilt three element protective device consisting of drainage coil, Lighting Arrestor and Earthing Switch conforming to relevant standards. The same shall be generally meet the following requirements:
 - (a) Drainage Coil: The drainage coil shall effectively ground the 50Hz power frequency current received from coupling capacitor(s) but shall not permit HF signal to ground. The power frequency impedance shall be less than 1.5 ohm and continuous current capacity at power frequency shall be 1.5Amp.
 - (b) Lightning Arrestor: The lighting arrestor shall effectively ground the high voltage surges coming from power line side at the terminal of coupling device. The lighting arrestor shall stand spark over voltage of 3.3 kV.
 - (a) The Earth Switch: The earthing switch shall ground the primary terminal of coupling device when required. The rated current for earthing switch shall not be less than 150 Amp.
9. The interconnections in the coupling device shall be made with special high frequency Liz wires.
10. The impedance matching shall be perfect so that the return loss is minimum.

19.7.5 TYPE TESTS:

Valid Type Test reports not more than 5-Year-old performed for following tests along with all test result sheets & reference documents shall be submitted with the offer here under.

- Composite Loss
- Return Loss
- Distortion & Intermodulation

- Lightning Impulse Voltage Withstand
- Power frequency Voltage Withstand
- Drain Coil
- Environmental test
- Degree of protection : IP 55
- Earth switch

19.7.6 TECHNICAL PARTICULARS FOR MODULAR COUPLING DEVICE

TABLE-II

SI No	Description	COUPLIND DEVICE
1	Carrier Frequency Range	78-500 kHz
2	Maximum temperature limit for satisfactory operation of coupling device mounted outdoor	50° C or better.
3	Composite loss	≤ 1 dB
4	Return loss	≥ 12 dB
5	Nominal line side impedance	240/320 ohms (Phase to earth)
6	Nominal carrier equipment side impedance	75ohms unbalanced and 150 ohm balanced, 75ohms unbalanced and 150 ohm balanced (switchable)
7	Nominal Peak Envelop power with Distortion and Inter-modulation Products 80 dB Down)	1000 watts for frequency ≥ 100 kHz
8	Power frequency Impedance between primary terminal and Earth Terminals of Coupling Device	Less than 20 ohm
9	Maximum number of PLC terminals that can be connected in parallel	
	(a) 20 W (P.E.P.) PLC Terminals	(a) 8 to 12 nos.
	(b) 40 W (P.E.P.) PLC Terminals	(b) 6 to 8 nos.

	(c) 100 W (P.E.P.) PLC Terminals	(c) 4 to 6 nos.
10	1 Minute Power Frequency Insulation level between Primary and Secondary Terminals of Coupling Device	10 KV rms
11	Impulse (1.2/50 micro-sec) withstand level between Primary and Secondary Terminals of Coupling Device	10 kV peak
12	Drainage Coil :	
13	(a) Inductance	0.2 to 0.7 mH
	(b) Continuous power frequency current	≤ 1.5 Arms
	(c) Short time rating for 0.2 sec	≤ 50 A
14	Lighting Arrestor :	
15	(a) Type of construction	Non linear resistor type with spark gap
	(b) Rated Voltage	660 V
	(c) Rated discharge current	5 KA _{peak}
	(d) Maximum permissible short time current	30 kA peak
	(e) Impulse spark over voltage (max)	3300 V _{peak}
16	Earthing Switch	
	(a) Rated Current	250 A _{rms} , or better
	(b) Rated Voltage	10kV
	(c) Short time current	16 kA, 1 sec

Technical Specifications Digital Power Line Carrier Equipment

19.8.1 General

Power Line Carrier (PLC) System will primarily be used for tele-protection, voice & data communication. The new Power Line Carrier (PLC) circuits in conjunction with existing OPTICAL communication network shall connect the new SAS networks (IEC61850) of existing and new 132KV/220 KV/400KV substations of AEGCL via GATEWAY as per

IEC60870-5-101 and IEC60870-5-104 to the nearest Wideband nodes connected to SLDC, Kahilipara for data communication. Digital PLCC (twin channel, 8kHz bandwidth) equipment shall be procured under this project. DPLC shall be applied in analog mode via FSK channels or in digital mode via the implemented data pump to transmit SAS information. For 400kV Lines, bidder shall quote two PLCC Panels for each line where one panel will be for transmission of Speech + Data and the other panel will be for dedicated carrier inter tripping scheme.

19.8.2 The PLC equipment shall comply with the standard IEC 60495, second edition, 1993.

19.8.3 For safety, the equipment shall conform to IEC 60950-1, 2005.

19.8.4 For EMC and EMI, the equipment shall comply with IEC 61000-6-2(Immunity) and IEC610006-6-4 (Emission). In particular, it shall comply with IEC 60255-5, IEC 61000-4-2/-3/-4/-5/-6/-8/-12/-16/-17/-18, IEC 60255-22-1, EN 55022 / CISPR22.

19.8.5 The system shall be of modular design and allow for easy upgrading.

19.7.6 The PLC equipment shall not use fans or similar for artificial cooling under normal operating conditions.

19.7.7 Carrier frequency section

19.7.7.1 The PLC equipment shall support DPLC (Digital PLC) and APLC (Analog PLC) mode of operation in the same platform, software programmable via PC/Notebook.

19.7.7.2 Modulation shall be SSB (Single-Side-Band) for APLC operation MCM(Multi-Carrier- Modulation) with Trellis Coding for DPLC mode operation.

19.7.7.3 Modulation and coding shall be implemented as software functions in DSP (Digital Signal Processor) technology.

19.7.7.4 Transmission mode shall be 2-wire frequency duplex.

19.7.7.5 The nominal carrier frequency shall be programmable from 40 kHz to 500 kHz minimum, preferably however up to 1000 KHz for nominal band widths ≥ 4 kHz.

19.7.7.6 The carrier frequency stability over the stated temperature operating range shall be equal or better than ± 1 ppm.

19.7.7.7 The nominal bandwidth BN for transmitting or receiving shall be programmable from 4 kHz to 32 kHz in steps of 4 kHz, and to 2 kHz or 2.5 kHz (for single purpose tele protection).

19.7.7.8 Transmit (Tx) and receive (Rx) bands shall be configurable for adjacent or non- adjacent operation.

19.7.7.9 Transmit output power shall be user-programmable through software up to 100 W or more (Peak Envelop Power) to maintain healthy link for line length of at least 250 km. The output power shall be reducible in steps of 1 dB via user interface program (HMI).

19.7.7.10 The nominal output impedance shall be 75 Ohm unbalanced or 150 Ohm balanced as an option.

19.7.7.11 The return loss in the transmit band shall be ≥ 10 dB, according to IEC 60495.

19.7.7.12 The tapping loss shall be ≤ 10 dB, according to IEC 60495.

19.7.7.13 The receiver selectivity shall be > 65 dB at 300 Hz from the band edges.

19.7.7.14 The AGC range of the receiver shall be 40 dB minimum or better to maintain healthy link for line length of at least 250 km.

19.7.7.15 The supplied PLCC Equipment should be in successful operation for at least 3 years for a line length of Minimum 250 km at 400kV or above voltage level. The bidder shall submit the relevant Performance Certificate from STU/CTU at the time of Bidding.

19.8 System Operation

19.8.1 The PLC shall be programmable via PC with HMI/GUI (Graphical User Interface) based on MS-Windows.

19.8.2 The PLC system shall facilitate the programming and monitoring of the remote terminal from the local terminal using the standard GUI/HMI (Human-Machine-Interface).

19.8.3 An EMS (Element Management Service) shall be incorporated in the HMI for monitoring and programming of the PLC terminals in the network. The EMS shall allow remote cyclic alarm polling of all the PLC terminals in a network.

19.8.4 Supervision of a PLC network shall optionally be possible using SNMP (Simple Network Management Protocol), serving communication network management systems with alarm and equipment information.

19.8.5 Remote access to the equipment over IP networks shall make use of the SSL/TLS protocol for secure communication. Equipment internal user authentication and logging of security relevant data shall be supported.

19.8.6 Command and alarm events as well as special system events (e.g. equipment reset) shall be stored by an internal event-recorder in a non-volatile memory. At least 1000 command events and another 1'000 alarm/system events shall be recordable. The latest 1000 events of each type must always be available, even in case of a memory overflow.

19.8.7 A clock synchronizing input shall be provided, to synchronize the internal real time clock with the external Station GPS signal. The DPC Panel should have interface for sync with the station GPS Clock. Furthermore, the Bidder shall ensure that the remote end stations, to be connected via PLCC Link, have the necessary equipment and interfaces for synchronizing the internal real time clock of DPC panel with the station GPS and shall ensure the same by providing any additional equipment (if required) without any cost implication to AEGCL. The Bidder may carry out the necessary survey for the same before the submission of the BID.

19.8.8 Back-up batteries for preserving the data (configuration, event recorder, etc.) during loss of supply are not accepted.

19.8.9 The Workstation or PC/Notebook shall be connectable via a serial RS-232 port (converter shall be provided for serial to USB) or via Ethernet/IP port(s). The bidder should provide serial to USB converter for each supplied PLCC Panel as a mandatory accessory.

19.8.10 With the Ethernet/IP interface option it shall be possible to access the PLC terminal via LAN intranet.

19.8.11 The PLCC/ DPC should be integrated with an external counter for display of any executed inter tripping commands.

19.8.12 The PLCC Panel supplied should be equipped with redundant power supply and CPU Card.

19.4.9 Speech and Audio Frequency (AF) signal transmission

- 19.4.9.1 The PLC shall be configurable for providing up to 3 analog AF (audio-frequency) channels with 4 kHz gross bandwidth each.
- 19.4.9.2 The useful frequency band shall range from 300 Hz to 3720 Hz for each AF channel.
- 19.4.9.3 For each channel, a speech low-pass filter shall be configurable with a programmable upper cut-off frequency, ranging from 2 kHz to 3.4 kHz in steps of 200 Hz.
- 19.4.9.4 Speech interfaces shall be configurable as 4-wire E&M, 2-wire FXO and 2-wire FXS.
- 19.4.9.5 It shall be possible to configure 3 analog speech channels in 8 kHz or in 12 kHz RF-transmission bandwidth.
- 19.4.9.6 Inter-channel crosstalk shall be compliant with IEC 60495.
- 19.4.9.7 A compandor according to ITU-T G.162 shall be configurable via HMI for each speech channel. Control inputs shall be provided for compandor switching (on/off) by the PABX.
- 19.4.9.8 The frequency band above speech shall be available for the transmission of narrowband modem signals from internal or external modems.
- 19.4.9.9 The level range of the AF-input/output ports shall be in accordance with IEC 60495.
- 19.4.9.10 Digital transit filters, programmable with respect to bandwidth and center-frequency in steps of 60 Hz, shall be available for each AF channel for the local extraction, insertion and transit-connection of selected teleoperation frequency bands.
- 19.4.9.11 An equalizer shall be available for each AF channel for equalizing amplitude response distortions of up to +/- 12 dB.
- 19.4.9.12 The equalizer shall also be configurable for equalizing group delay distortions of up to 2 ms.
- 19.4.9.13 The frequency response before and after equalization shall be displayed in graphical form by means of the GUI (HMI).
- 19.4.9.14 Equalization of the channel frequency response in both directions shall be possible from one (either) end.
- 19.4.9.15 Integrated Digital Compressed Voice shall be available as an option. Up to 16 digital compressed speech channels shall be supported per PLC link.
- 19.4.9.16 The data rate required for one compressed speech channel shall be less than 7 kbit/s.
- 19.4.9.17 In a substation, selected compressed voice channels shall be through connectable on a digital basis to other PLC terminals/links.

19.4.10 Narrowband Data Transmission

- 19.4.10.1 The PLC shall provide - as software options – up to four integrated modems for narrowband data transmission.
- 19.4.10.2 Transmission speed, channel center-frequencies and the spectral bandwidth shall be programmable in steps for commonly used data rates, ranging from 100 bit/s to 9600 bit/s in bandwidth of 240 Hz to 3400 Hz respectively.
- 19.4.10.3 The narrowband modems shall be designed for low delay and short recovery times following a link disturbance.
- 19.4.10.4 Adaptive equalizers, individually configurable for each narrowband modem, shall ensure optimum performance over time, by compensating changing channel characteristics. In a 4 kHz channel, it shall be possible to transmit up to 4 x 2400 bit/s, or 2 x 4800 bit/s, or 1 x 9600 bit/s.
- 19.4.10.5 Data transmission above 2 kHz band-limited speech shall be possible at 2 x 2400 bit/s or 1 x 4800 bit/s.

19.4.11.0 Broadband Data Transmission

19.4.11.1 The PLC shall provide – as software option – an integrated modem for broadband / high speed data transmission. Transmission speed and spectral bandwidth shall be programmable via PC/Notebook.

19.4.11.2 The speed and transmission bandwidth shall be programmable for up to 32 kbit/s in 4 kHz spectral bandwidth, up to 128 kbit/s in 16 kHz bandwidth and up to 256 kbit/s in 32 kHz bandwidth.

19.4.11.3 The data rates shall be selectable in steps, compliant with commonly used standardized data rates.

19.4.11.4 The system shall support automatic transmission speed adaptation in five user-defined steps, self-adapting to the prevailing line condition (noise and interference).

19.4.11.5 The broadband modem shall provide a facility for automatic detection and suppression of narrowband interferers.

19.4.11.6 Special operating modes shall allow transferring analog speech (with an upper cut-off frequency of 2 kHz) and a broadband modem (operated in the frequency band above 2 kHz) in channels with nominal bandwidth BN of 4 kHz and 8 kHz. The data rate of the broadband modem using the remaining 2 kHz bandwidth shall be at least 9.6 kbit/s, the data rate of the broadband modem using the remaining 6 kHz bandwidth shall be up to 48 kbit/s.

19.4.12.0 Data Multiplexing

19.4.12.1 The PLC equipment shall provide an internal multiplexer for the time-division multiplexing of up to 6 serial data channels and/or Ethernet/IP traffic.

19.4.12.2 Data ports shall be compliant with V.24/V.28, RS-232 and/or V.11/X.21/X.24.

19.4.12.3 The internal multiplexer shall provide data flow control for the asynchronous ports and speed adaptation for the synchronous ports according to the prevailing aggregate data rate and HV power line condition.

19.4.12.4 All data ports shall be electrically isolated from ground and against each other.

19.4.12.5 Point-point and point-multipoint operation with channel-sharing shall be possible, for polling SCADA protocols.

19.4.12.6 Three Ethernet/IP ports - electrical 10/100 Mbit/s, auto sensing - shall be available as an option. Preferably, a fourth port with exchangeable SFP transceivers for optical connection shall be provided.

19.4.12.7 The Ethernet/IP ports can be used for equipment programming & monitoring and/or for Ethernet/IP traffic switching/routing via the PLC link. No external device(s) shall be required for the latter purpose.

19.4.12.8 IP header compression shall be configurable in order to minimize bandwidth.

19.4.12.9 In switching mode, VLAN support shall be configurable (ID & priority). In routing mode, ≥ 10 IP routes and port-based priority shall be configurable.

19.4.12.10 The bandwidth of the Ethernet/IP service via the PLC link shall follow the automatic speed adaptation of the broadband modem.

19.4.12.11 SALIENT FEATURES OF DIGITAL PLCC

The salient features for the Digital PLCC are detailed out as follows

A. HIGH FREQUENCY CHARACTERISTICS

1. Frequency Range	40-500 KHz as per IEC 60495
2. Center Frequency Programmable	In steps of 1 Hz
3. Nominal Impedance as an option)	75 ohm unbalanced (150 ohm balanced
4. Return Loss in the transmitted band	≥10 dB according to IEC 60495
5. Tapping loss	≤ 1.5 dB according to IEC 60495
6. Image rejection	≥75 dB

B. TRANSMITER / RECEIVER

1. Nominal transmit output power (PEP)	upto 100W or better
2. Nominal Bandwidth	4- 32 kHz (each direction)
2. Output Level Adjustment (HMI))	In steps of 1 dB (via user interface program
3. Receiver Sensitivity	-30 dBm
4. Receiver Selectivity	As per IEC-60495
5. AGC Range (Automatic Gain Control)	40 dB dynamic range or better
6. Minimum Signal to Noise Ratio	20dB(QAM16/TCM32)/24dB(QAM64/TCM128)

C.GENERAL CHARACTERISTICS

1. Application mixed	Universally applicable in analog, digital, or operation.
2. Modulation	Single Side Band with Suppressed carrier SSB) Multi-Carrier (OFDM) modulation with Trellis Coding and forward error correction. Single step frequency conversion with Direct Digital Synthesis (DDS).
3. Gross Bit rate	32 kbps in 4 kHz, 128 kbps in 16 kHz up to 256 kbps in 32 kHz bandwidth
4. Test Facilities	Inbuilt accessible via HMI
5. Standards compliance	IEC 60495, IEC 60834-1, IEC 60950-1, IEC 61000-6-2, IEC 61000-6-4

D. USER INTERFACES

1. Data Interfaces and bit rates supported	RS- 232 (up to 19.2 kbps)/V.24
--	--------------------------------

Ethernet, V.11

- | | |
|-------------------------------|----------------------------------|
| 2. Voice interfaces supported | 2W/4W E&M, FXO and FXS, Hotline |
| 3. Speech level adjustment | Transmit level (-20 to + 5 dBm) |
| | Receive level (-20 to + 8 dbm) |

E. OTHER CHARACTERISTICS

- | | |
|---------------------------------------|---|
| 1. Alarms | Supported on panel |
| 2. Operating Temperature and humidity | 0 to +45 deg C, 90% humidity |
| 3. Power supply voltage | 48 VDC +20/- 15% |
| 4. Maximum power consumption
Ohm | 135 W or better for normal operation @ 75 |

19.5.0 TECHNICAL SPECIFICATION OF TELE-PROTECTION COUPLER

- 19.5.1 The Digital protection signalling equipment is required to transfer the trip commands from one end of the line to the other end in the shortest possible time with adequate security and dependability. It shall also monitor the healthiness of the link from one end to the other and give alarms in case of any abnormality. The protection signalling equipment shall have a proven operating record in similar application over EHV systems and shall operate on 48V DC (+15%, -10%).

It shall provide suitable interfaces for protective relays, which operate at 220/110V DC. Power supply points shall be immune to electromagnetic interface.

19.5.2 Principle Of Operation

During normal operation, protection signalling equipment shall transmit a guard signal/code. In case Protection signalling equipment is actuated by protective relays for transmission of commands, it shall interrupt the guard signal/code and shall transmit the command code to the remote end. The receiver shall recognize the command code and absence of the guard code and will generate the command to the protective relays.

All signal processing i.e. generation of tripping signal and the evaluation of the signals being received shall be performed completely digital using Digital Signal Processing techniques.

19.5.3 Loop Testing

An automatic loop testing routine shall check the tele protection channel.

It shall also be possible to initiate a loop test manually at any station by pressing a button on the front of the equipment.

Internal test routine shall continuously monitor the availability of the protection signalling equipment.

Proper tripping signal shall always take the priority over the test procedure.

The high-speed digital protection signalling equipment shall be designed and provided with following features.

- Shall work in Digital PLCC Terminal.
- Full Duplex operation
- Auto loop facility shall be provided

- Shall be able to transmit upto 4 commands with trip counter

Bidder shall quote for protection signalling equipment suitable for 4 commands with separate trip counters for transmit and receive. Laptop shall be provided for configuration of PLCC/DPC.

High security and dependability shall be ensured by the manufacturer. Probability of false tripping and failure to trip shall be minimum. Statistical curves/figures indicating above mentioned measures shall be submitted along with the bid.

The DPC shall be housed in offered PLCC panel and should be a standalone type.

Reports of the following tests shall be submitted for approval for protection signalling equipment and relays associated with the protection signalling equipment and interface unit with protective relay units, if any.

i) **General equipment interface tests :**

- Insulated voltage withstand tests
- Damped oscillatory waves disturbance test
- Fast transient bursts disturbance test
- Electrostatic discharge disturbance test
- Radiated electromagnetic field test
- RF disturbance emission test

ii) **Specific power supply tests**

- Power supply variations
- Interruptions
- LF disturbance emission
- Reverse polarity

iii) **Tele-protection system performance tests**

- Security
- Dependability
- Jitter
- Recovery time
- Transmission time
- Alarm functions
- Temperature and Humidity tests (As per IEC 68-2)
 - Dry heat test (50°C for 8 hours)

- b. Low temperature test (-5°C for 8 hours)
- c. Damp heat test (40°C/95%RH for 8 hours)

All the above tests at i, ii & iii (except temperature & humidity tests) shall be as per IEC 60834-1 and the **standards mentioned therein**.

iv) Relays

- a) Impulse voltage withstand test as per IEC 60255.
 - b) High frequency disturbance test as per IEC 60255.
- 19.5.4 The bidder shall offer voice frequency transmission equipment, which shall work on frequency shift or coded signal principle for transmission/ reception of protection signals.
- 19.5.5 The teleprotection shall conform to IEC 60834-1, 1999.
- 19.5.6 Each teleprotection system shall support the transmission of up to four independent and simultaneous commands, programmable individually for blocking, permissive tripping or direct tripping (intertripping).
- 19.5.7 The transmission of the command signals shall be accomplished within the speech bandwidth or within the spectral bandwidth of the broadband modem, i.e. the teleprotection shall not require the allocation of extra / separate bandwidth.
- 19.5.8 During transmission of protection commands, other services like speech and data shall be temporarily interrupted in order to transmit the protection signal at increased power (command signal boosting).
- 19.5.9 The nominal transmission time shall be < 11 ms, < 12 ms and < 13 ms for blocking, permissive tripping and direct tripping respectively.
- 19.5.10 The equipment for protection shall have high degree of reliability and speed. It shall be guaranteed to function reliably in the presence of noise impulse caused by isolator or breaker operation. The required SNR shall be less or equal than 6 dB for a dependability of < 1E-03 for blocking and permissive tripping, and for a dependability of < 1E-04 for direct tripping, i.e. the probability of missing a command in a maximum actual transmission time $T_{tr} = 15$ ms, 17 ms and 22 ms respectively.
- 19.5.11 The probability of an unwanted command (security) shall for any SNR condition (worst case) be not higher than 1E-03, 1E-06 and 1E-09 for blocking, permissive tripping and direct tripping respectively.
- 19.5.12 Electrically isolated opto-coupler inputs, solid-state outputs shall be available as I/O interfaces to the protection devices. Voltage range shall be selectable from 24 VDC to 250 VDC nominal.
- 19.5.13 Commands shall be freely allocatable to the inputs and the outputs, alarms shall be freely allocatable to the outputs (programmable via HMI).
- 19.5.14 It shall be possible to individually delay and prolongate the input command signals or to prolongate the output command signals and to monitor their duration (all parameters configurable via HMI).
- 19.5.15 All transmitted and received commands shall be logged with time stamps of 1 ms resolution by the internal event-recorder.
- 19.5.16 The teleprotection shall provide an integrated cyclic loop test.
- 19.5.17 The teleprotection shall be software-programmable via PC HMI with GUI.

19.5.18 For single-purpose teleprotection applications, the nominal transmission bandwidth of the PLC terminal shall be configurable for 2 kHz or 2.5 kHz in each direction. A service phone channel shall optionally be available in this operating mode.

19.5.19 The DPC should have E1 interface so that two channels can be created for transmission of commands, out of which one channel will be through PLCC and the other channel through FOTE. The channel arrangement should be such that if the main channel fails, the DPC should automatically switch to the other channel.

19.5.20 The offered DPC shall be equipped with redundant Power Supply Card and redundant 4 command Relay Interfacing card.

19.5.21: The DPC shall be IEC 61850 compliant Digital Tele- Protection Coupler, have 16 commands with redundant power supply card and CPU along with Analog PLCC Interface Card, E1 interface card and optical interface card to support 150 km for 132kV and 220kV and 240km for 400kV

19.5.19 PRINCIPAL TECHNICAL REQUIREMENTS OF TELE PROTECTION COUPLER

TABLE-III

Application	Transmission of protection commands for line and objects protection via DPLC equipment.
Number of units	Two No, 8 commands (atleast) module to be fitted in offered DPC (Standalone)
Number of commands	16 simultaneous commands per system, simultaneously transmitted. Individually configurable for blocking, permissive or direct tripping. Single purpose teleprotection in the 2 kHz APLC channel: 3 independent commands (as above) and 1 prioritised command (for direct tripping).
Secure against	Noise (continuous or impulsive), speech and sweep tones, DTMF (CCITT 48430 or ITU-T Q.23) in-band signalling
Bandwidth requirement	Nil; command signal transmission in-band (alternate purpose with signal boosting)
Processing of received signal	Adaptive (to prevailing channel condition, always ensuring shortest transmission time)
Guard signal	Pilot signal or own guard signal in speech band
Number and type of inputs Method of tripping Voltage ranges	16 optocoupler per tele protection interface Contact and battery, or dry contact 24 to 250 V DC, selectable in 4 ranges.

Number and type of outputs	16 solid state relays contacts per tele protection interface.		
Tripping voltage	5 to 250 V DC		
Tripping current	≤ 1 A carry / 2 A peak solid state		
	5 A carry / 20 A peak mechanical relay		
HMI configurable	Command and alarm assignment to I/O ports, Command pick-up times, hold times, duration monitoring State of command outputs during link alarm Alarm and unblocking level thresholds		
Test facilities	Manual or periodic loop test every 1,3,6,12,24 hours.		
Event recording	Time-stamped command events, command counters, stored in non-volatile memory. GPS Clock synchronizing input should be available		
Teleprotection performance	Blocking	Permissive tripping	Direct tripping
Overall time for PLC, VFT and transmission path	<20 ms	<20 ms	< 30 ms
Operating time lower than the specified maybe preferred provided they fulfil the requirements of security and reliability as mentioned: False Trip Probability (Noise burst of any amplitude) : 10^{-5} or better Fail to trip probability for S/N 6 dB in 3.1kHz Band (white Noise Measurement) : 10^{-2} or better			

19.6.0 TECHNICAL SPECIFICATION 48V PLCC BATTERY BANK

19.6.1. TYPE AND RATING

i) Stationary type, sealed, valve regulated lead acid battery tank suitable for operation on 48 Volts D.C. system to meet loads like emergency lightning, control and signaling circuits, relays, breaker operations, indicating circuits, etc. shall be required. The stationary battery shall comply with the provisions of IEC 896, Part 2 / ANSI T1.330.

ii) The Ampere-hour capacity of the battery bank at 27°C at 10 hours discharge rate shall be 200 AH.

iii) The nominal voltage of the battery bank shall be 48 Volts D.C.

iv) The number of cells in a complete battery bank set shall be 24 plus 2 spares.

19.6.2 PLATES

Positive plates shall be made of flat pasted type using lead-cadmium antimony alloy for durability, high corrosion resistant, maintenance free, long life both in cyclic as well as in

,float applications. Negative plates shall be heavy duty, durable flat plate using lead calcium alloy pasted box grid. Negative plates shall be designed to match the life of positive plates and combination of negative and positive plates shall ensure long life, durability and trouble-free operation of battery. PLC operated equipment should be deployed for preparation of paste to ensure consistency in paste quality. Conventional / manual type of paste preparation is not allowed.

19.6.3. CONTAINER AND LID

The containers and lids shall be made of a special grade polypropylene copolymer plastic material. They shall be sufficiently robust and not liable to deformation under internal operating pressures and within the temperature range naturally encountered, leak proof, non-absorbent and resistant to the acid with low water vapour permeability.

19.6.4 VENT PLUGS

Each cell shall be equipped with one-way safety valve with opening pressure of 5 ± 1 psi and closing pressure 4 ± 1 psi. The vent plug shall be made with suitable grade of fire retardant plastic material. Each valve opening shall be covered with flame barrier capable in preventing the ingress of flame into the cell interior when the valve opens and hydrogen / oxygen gas mixture is released.

19.6.5. SEPARATORS

Separator shall be made of spun glass, micro porous matrix and shall be resistant to Sulphuric Acid. It shall be capable of keeping the entire electrolyte and shall be electrically insulated. Sufficient separator overlap and PVC shield protection to top and bottom edges of the plates is to be provided to prevent short circuit formation between the edges of adjacent plates.

19.6.6 CONNECTORS

The connectors shall be lead coated copper of suitable size to join the cells. The connectors shall be suitably designed and coated to withstand corrosion due to sulphuric acid. The coating should be adequate and tenacious. All the copper inter cell connectors shall be provided with heat shrinkable sleeves except at the connecting points.

19.6.7. ELECTROLYTE

The electrolyte shall be prepared from the battery grade Sulphuric Acid conforming to ISS: 266. The batteries shall be supplied in factory filled and charged condition.

19.6.8 WATER

Water required for preparation of electrolyte shall conform to IS: 1069.

19.6.9. PLATE CONNECTION

Lugs of plates of like polarity shall be connected by lead burning to a horizontal strap having an upstanding terminal post adopted for connection to external circuit. Strap and post shall be cast with lead alloy. The positive and negative terminal posts shall be clearly marked for unmistakable identification.

19.6.10 BOLTS AND NUTS

Nuts and Bolts for connecting the cells shall be of superior grade passivated Stainless steel.

19.6.11 TERMINALS

Terminals shall be of integral lead terminal with solid copper core with M6 threading for fastening. The junction between terminal posts and cover and between the cover and container shall be hermetically sealed.

19.6.12. BATTERY RACKS

Batteries shall be installed on MS racks to be supplied by the Contractor to fit in the battery room. Racks/Trays shall be powder coated with anti-corrosive paint. Rack shall accommodate 55 cells plus 2 spares. Racks/Tray shall be suitably treated before painting for protection against fungus growth and other harmful effects due to tropical environment. The colour of the supporting racks shall conform to RAL 7032 shade.

19.6.13 CAPACITY REQUIREMENTS:

When the battery is discharged at 10 hour rate, it shall deliver 80% of Rated Capacity (corrected at 27°C) before any of the cells in the battery bank reaches 1.85 V/cell. The battery shall be capable of being recharged from the fully exhausted condition (1.75 V/cell) within 10hrs upto 90% state of charge. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life.

The capacity (corrected at 27°C) shall also not be less than Rated capacity & not more than 120% of Rated capacity before any cell in the battery bank reaches 1.75 V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at a rate of 1/10th of the Rated Capacity:

- (a) After SIX hours of discharge: 1.92V/cell
- (b) After EIGHT hours of discharge: 1.85V/cell
- (c) After TEN hours of discharge: 1.75V/cell

Loss in capacity during storage at an average ambient temperature of 35°C for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within 0.05V of the average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt-hour efficiency shall be better than 80%. However, the battery to be manufactured and to be delivered at site in such a way that load can be connected with the battery within 15 days from the date of installation. Date of initial charging is to be mentioned on the battery.

19.6.14 ASSOCIATED EQUIPMENTS & ACCESSORIES (For each set of battery) :

- a) Best quality metallic stand/frame as per Clause 9.12.
- b) Stand insulators +5% extra
- c) Inter row connectors :Appropriate quantity
- d) Inter tier connectors
- e) Centre-zero (3-0-3) volts DC Voltmeter : 1 No
- f) Torque wrench/ Spanners : 1 No
- g) Connection hardwares, such as strips, bolts, nuts(with 5% extra)
- h) Cable clamps with hardware

- i) Cell numbering tags with fixing arrangement
- j) Two sets of special tools and tackles for connecting terminals of the battery
- k) Any other accessories not specified but required for satisfactory operation.

19.6.15 TYPE TEST OF BATTERY:

The Bidder/ Supplier shall supply type tested battery as per IS 15549:2004/ IEC 60896-21 & 22 over the range of at least one capacity per design. The Bidder/ Supplier shall submit necessary evidences enclosed along with tender documents.

SI No	DESCRIPTION
1	Gas Emission
2	High Current Tolerance
3	Short Circuit Current & DC Internal resistance
4	Protection against Internal Ignition from External Spark source
5	Protection against Ground Short Propensity
6	Content & Durability of required marking
7	Material Identification
8	Valve Operation
9	Flammability Rating of Material
10	Intercell Connector Performance
11	Discharge Capacity
12	Charge Retention during Storage
13	Float Service with Daily Discharge for reliable mains power
14	Recharge behavior
15	Service Life at an operating temperature of 40°C for brief duration exposure time
16	Impact of Stress Temperature of 60°C for brief duration exposure time with 3hrs discharge test
17	Abusive Over Discharge
18	Thermal Runaway Sensitivity
19	Low Temperature Sensitivity
20	Dimensional Sensitivity at Elevated Internal Pressure & Temperature
21	Stability against Mechanical abuse of units during installati

19.6.16 Routine Test:

- (i) Physical Examination Test
- (ii) Visual Inspection
- (iii) Dimensions, Mass & Layout
- (iv) Marking & Packing

19.6.17 ACCEPTANCE TEST OF BATTERY

- (i) Polarity Marking
- (ii) Verification of Dimensions
- (iii) Open Circuit Voltage of each Cell & Total Open Circuit voltage of the battery bank
- (iv) Test of AH Capacity

19.6.18 LIST OF FACTORY & SITE TESTS FOR BATTERY

Sr. No.	TEST	FACTORY TESTS	SITE TESTS
1	Physical Verification	YES	YES
2	Capacity Test on the cell at 1/10th of Rated Capacity, corrected at 27°C	YES	
3	8hrs Charge & 15mins Discharge Test at Full Rated Load	YES	

19.7.0 48V BATTERY CHARGER

19.7.1 General:

This section covers the general requirement of 48 V DC SMPS Based Power Plants, based on High Frequency Switch Mode Techniques using switching frequencies of 20KHz and above for use in AEGCL.

19.7.2 SMPS Based Power Plants is intended to be used in **Auto Dual Float Rectifier cum Boost Charger (FR-BC)** mode as a regulated DC Power Source.

19.7.3 Power System Configuration: The configuration of 48 V DC Power Plants with FR-FC & FRBC Modules shall be as under:

SI No	Basic SMR Module	Configuration	Permissible Ultimate Capacity
1	25 A FR-FC	(n+1)	75 Amp
2	50 A FR-FC	(n+1)	150 Amp
3	25 A FR-BC	(n+2)	75 Amp
4	50 A FR-BC	(n+2)	150 Amp

The FR-FC or FR-BC modules shall be housed in (n+1) or (n+2) parallel configuration in a single rack where 'n' is the actual required number of FR-FC, FR-BC modules for meeting the particular load requirement.

AEGCL shall indicate the Type, Number and Configuration of SMR Modules, depending upon the load requirement.

19.7.3.1. The Battery Charger of 48V/25A (Ultimate capacity 150A) or 48/50A (Ultimate capacity 150A) N+1 configuration shall be of SMPS type and shall be chosen as per load demand of communication equipments of the substations. The system shall consist of DSA and Float Rectifier –cum-Charger (FR/FC) in a steel rack in a modular type. It should have menu driven microprocessor control technique for DSA as well as module for control, monitoring and alarm to achieve better reliability of the system.

19.7.3.2: The Battery Charger shall have Dual Source AC Input (AC Input 1 and AC Input 2) with individual MCCB and shall be provided with Auto Changeover arrangement.

19.7.3.3: The Battery Charger shall have an IP Rating of IP42 or better. The Charger shall be type tested for IP42 or better rating.

19.7.4 Rack Configuration :

Rack is composed of following units accommodated in sub racks

- a) Dual Float Rectifier cum Boost Charger (FR-BC) Modules
- b) Distribution-Switching-Control-Alarm Arrangement (DSCA)
- c) The number and rating of FR-FC, FR-BC Modules shall be provided as per purchaser's requirement. The Distribution-Switching-Control-Alarm Arrangement (DSCA) shall be provided for the Ultimate Expandable Capacity. All factory wirings for the rack shall be for the Ultimate Expandable Capacity so that only plugging-in of FR-FC or FR-BC module shall enhance the DC Power output.

19.7.5 Parts & Components

19.7.5.1 The Parts & Components including Fuses and Circuit Breakers for manufacturing of the SMPS Based Power Plants shall be of Industrial Grade. These Parts & Components shall be procured from reputed manufacturers to ensure prompt and continuous service and delivery of spare parts.

19.7.5.2 Power Transformers and Chokes shall use Class B or Higher Grade of insulation. The Transformers and Chokes shall be wound with copper wire provided with adequate insulation.

19.7.5.3 Component mounting and fixing methods shall be secured.

19.7.6. Wiring:

19.7.6.1 All insulated conductors except those within the confines of a printed circuit board assembly shall be of the rating enough to withstand the maximum current voltage during fault and overload.

19.7.6.2 All wiring shall be neatly secured in position and adequately supported. Where wires pass through any part of Metal Panel or Cover, the hole through which they pass shall be suitably bushed with rubber grommet.

19.7.7 Bus Bars:

19.7.7.1 Bus bars shall be of high conductivity electrolytic copper strips capable to withstand 1.5 times the maximum load current. The Bus bar shall be capable to carry current density of 2 Amps/mm² but shall not be less than 25mmx5mm in any case. The size of bus

bars chosen for battery and load path shall be capable to take care of the current of maximum power plant capacity for which it is designed.

19.7.7.2 Bus-bar Riser height wherever applicable shall be 250mm for both load and battery.

19.7.7.3 Earthing: All non-current carrying metal parts shall be bonded together and earthed. An earth terminal suitable for taking minimum 4 mm dia wire and with suitable marking shall be provided.

19.7.8 The SMPS Based Power Plants shall be designed & manufactured for continuous operation at rated load in the ambient temperature range of 0°C to 55°C.

19.7.9 Insulation Resistance and Voltage Proof

19.7.9.1 The insulation resistance of a fully wired FR-FC and FR-BC Modules when tested with a 500V DC Megger shall be as given below:

- a) AC input and Earth - Greater than 2 Mega Ohm
- b) DC Output and Earth - Greater than 1 Mega Ohm
- c) AC input and DC output - Greater than 5 Mega Ohm.

19.7.10 Lightning Protection :

The SMPS Based Power Plants shall have modular type Type I/Class B and Type II/Class C type surge protection in TT configuration of wiring. Both the Type I/Class B and Type II/Class C arrestors should be from the same manufacture and shall be mounted as per the specific installation recommendations of the manufacturer to achieve perfect coordination.

19.7.11 Radio Frequency Interference Suppression: The module shall be designed to minimize the level of electromagnetic interference (EMI), both conducted and radiated, detected in its vicinity and generated by Switch Mode Power Conversion Equipment operating within the rack.

19.7.12 Name plate :

A name plat etched/engraved/anodized or any other better arrangement ensuring better life expectancy shall be suitably fixed on each rack/module and contain following information.

1. Specification Number
2. Type of Unit
3. Manufacturer's name and identification
4. Model No.
5. Unit Serial No.
6. Input Voltage and phase
7. Output Voltage and current
8. Year of manufacture
9. Suitable for battery capacity

19.7.13 AC input supply: The Power Plant using FR-FC or FR-BC modules of 25 Amps shall operate from single phase AC input and FR-FC or FR-BC modules of 50A capacity may operate from single phase or 3 phase 4 wire AC input. The nominal input frequency is 50Hz which may vary from 48-52Hz. The input voltage range shall be as given below:

a) Single Phase (nominal 230V) :

For Power Plant to be used at stations having reasonable power supply regulation, incoming power supply range shall be from 165 V AC to 260 V AC.

b) Three Phase/4 Wire 400V+10%/ - 15% (Nominal 400V)

19.7.14 There shall be an automatic arrangement for shutting off the FR-FC or FR-BC Modules wherever the input voltage is beyond the specified operating limits with suitable alarm indication. It shall resume normal working automatically when the input is restored within the working limits. Hysteresis within specified working limits shall not cause shutting down of the FR-FC or FR-BC Modules. A tolerance of $\pm 5V$ may be acceptable for protection & alarm operation. All the FR-FC or FR-BC Modules shall switch OFF simultaneously.

19.7.15 FR-FC or FR-BC Modules working from 3 phase/4 wire input shall work satisfactorily for unbalance of $\pm 10\%$ of nominal input. The module shall be isolated (if required for the protection of the unit) in the event of unbalance beyond 10% and shall restore when the input is within limits.

19.7.16 The SMPS battery charger shall be capable of continuous operation with float voltage 2.23 to 2.25 Volt per cell and 2.3 Volt per cell for charge voltage while supplying the constant DC load.

19.7.17 The SMPS battery charger shall have constant voltage characteristics throughout the range (from zero to full load) at floating value of the voltage so as to keep the VRLA batteries fully charged but without harmful overcharge.

19.7.18. The float cum boost charger works on 415 V AC, 50 Hz supply (or 230 V AC, 50 Hz supply). The battery charger should be capable of delivering the full rated load at the specified voltage at the output terminals. The set output voltage is maintained for AC input variation of + 10% and load variation from 0-100% of rated full load.

19.7.19 The charger voltage in float mode of operation is normally be set at 54 V DC and the same shall be adjustable between 48 and 54 V DC through variable potentiometer. When the charger is selected to boost mode, it should supply charging at the rated current maximum. This shall be adjusted from 20% to 100% of rated current through potentiometer.

19.7.20 All these circuits are housed in freestanding cabinet of folded sheet steel (thickness of sheet steel should not be less than 2.5mm) construction finished in stove enamel light gray colour conforming to shade of 631 of IS: 5. The cabinet is provided with front and back doors for easy accessibility. All meters, meter selector switches, control switches and LCD display (Microprocessor unit) etc are to be provided on the front panel. The AC input and DC output MCCB'S and control switches are provided on middle inside of the breaker panel. The cable terminations are provided on front side of the cubicles.

19.7.21 PARTICULARS FOR 48 VDC

Type FLOAT CUM BOOST CHARGER

Hot swappable rectifier modules 25A/48V, N+1 configuration.

TABLE-IV (a)

SL NO	DESCRIPTION	PARAMETERS
1	RATING	48 V (Capacity shall be as per Battery Sizing Calculation) Dual float cum boost charger (suitable for MF-VRLA battery).
AC INPUTS		
2	VOLTAGE	415 V AC+ 10% (230V AC +10%)
3	PHASE	3 phase, 3 wire (single phase)
4	FREQUENCY	50 Hz+5% (50Hz+2Hz)
5	POWER FACTOR	(Better than 0.7 lagging)
DC OUTPUT		
6	FLOAT VOLTAGE	48 V- 54 V DC
7	BOOST VOLTAGE	48 V-55.2 V DC
8	OUTPUT CURRENT	35A
9	VOLTAGE REGULATION	Better than + 1% of set value
10	RIPPLE	Less than 1% r m s
11	EFFICIENCY	(Better than 90%)
12	SYSTEM OUTPUT VOLTAGE	55.2V DC+1%(at load terminal)

METERS: The microprocessor-based controller should have metering facilities namely (a) Load Voltage (b) Load Current, (c) Battery Voltage (d) Battery Current (e) Battery Temperature, (f) Voltage and current of individual module.

TABLE-IV (b)

PROTECTION			
Over voltage trip at the output	:	Over voltage cutback	56.5+ 0.5 V DC
DC under voltage at battery input	:		42+ 0.5 V(1.75 V X 24)
Fuse at AC input	:	Fast acting semiconductor fuse	Fast acting semiconductor fuse
Fuse at DC out put to load	:	MCCB	Fast acting semiconductor fuse
Reverse polarity at battery input	:	Protected	Protected
Out put current limiting	:		Battery charging current limit

AC input MCCB	:	Required	Required
Blocking diode	:	Required	Required
Charger over load	:	Required	Required
<u>INDICATION</u>			
AC input ON	:	Required	
DC output ON	:	Required	
Float ON	:	Required	
Boost ON	:	Required	

AC under voltage	:	Required
AC over voltage	:	Required
DC over load	:	Required
DC over voltage	:	Required
Short circuit	:	Required
Reverse polarity	:	Required
Mains fail		Required
Charger fuse fail		Required
Battery over voltage		Required

TABLE-IV (c)

<u>CONTROLS AND SWITCHES</u>	
AC input MCCB	ON/OFF switch at input
DC output MCCB	Three-way switch to select auto / manual float / manual boost operation
Auto/manual float/boost mode selector switch	Two-way switch to read charger output current or battery charge / discharge current
Auto /manual voltage regulator selector switch	Single turn potentiometer for float voltage adjust

Float and boost voltage variable potentiometer	Single tern potentiometer for boost voltage adjust
Manual voltage adjust variable potentiometer	Single tern potentiometer for charger total current adjust
Battery current adjust potentiometer	Single tern potentiometer for battery current adjust
Heaters power supply switch	
Socket power supply switch	
ADDITIONAL FEATURES	
Soft start on DC side	Auto float / boost operation

19.8.0. TECHNICAL SPECIFICATION OF PAX SYSTEM

19.8.1. The offered exchange shall be the latest state of-art digital 32-bit microprocessor based suitable for direct connection to PLCC terminals, Optic Fibre, Digital Microwave, VSAT, etc, without the need for any four wire interconnection device. The design shall employ stored program technique and utilizes the principles of Time Division Multiplexing / PCM technology.

19.8.2 The offered EPAX directly interface with the Power Line Carrier Communication terminals with E & M signalling. The EPAX shall also support the CO trunk. The software of the EPAX should support both the E & M and CO trunks and should have the facility to be interconnected to P & T trunks for CO Access.

19.8.3 The EPAX should support single, two- or three-digit numbering scheme. The exchange should support a minimum of 16 out pulsing digits and a maximum of 20 out pulsing digits at time from a normal telephone. The exchange should be fully Non-blocking.

19.8.4 The duplication of both CPU and PSU is to be provided as in-built features in the offered exchange.

19.8.5 The EPAX should support a maximum configuration of 250 Ports. The EPAX shall have universal ports wherein any type of line card or trunk card of the EPAX can be inserted into any slots. Also, the number of trunks can be either E & M or CO or a combination of both. The offered exchange shall work purely as a PLCC switch or a combination of PLCC & CO or a network switch or a combination of PLCC, CO, Fibre and digital microwave.

19.8.6 The offered switch shall have an integrated E1 type card wherein a direct 2 MB stream can be connected to the switch.

19.8.7 The switch shall have ISDN compatibility for interfacing with PSTN and other public ISDN exchanges. A valid TEC certification for ISDN compatibility to be enclosed without the same the bid is liable for rejection.

19.8.8 The switch shall be equipped with voice guidance feature to navigate the subscriber in using the major features of the exchange. Data transmission through MODEM pooling shall be available in the exchange. The EPAX shall support exclusive Load Despatch Express type communication network with all to one and one to All type of trunk access. This feature shall be in addition to the normal All to All type. The exchange offered needs to be

type tested for EMC specifications in line with IEC recommendations 495 for PLCC equipment. A valid certification for EMC compliance from any government laboratory within three years as on date of bid opening needs to be enclosed with the bid. The EPAX must have been EMI / EMC tested for the following as per IEC 495 to suit the stringent conditions in the Sub-station environment.

- a. Impulse Voltage withstand test (IEC 255-4).
- b. High Frequency disturbance susceptibility test (IEC 255-22-1).
- c. Electrical Fast Transient Susceptibility Test (IEC 801-4).
- d. Electrostatic discharge susceptibility test (IEC 801-2). Radiated susceptibility (IEC 801-3).

19.8.9. The Bidders shall offer suitable telephone equipment for automatic dialling which must work in full coordination with the already provided telephone equipment in the existing PLC system.

19.8.10 The bidder shall offer the latest state-of-art digital based Microprocessor EPAX suitable for direct connection to the PLCC terminals without the need of any four wire-interconnecting device (EFGS/EMFGS). The EPAX shall employ stored programme technique and utilize Time Division Multiplexing.

19.8.11. The EPAX shall be suitable for internal communication between the local subscribers as well as for selective communication over tie lines.

The special features of the offered EPAX shall be as follows:

- i) EPAX is of latest microprocessor-based design, which employs Pulse Code Modulation/Time Division Multiplexing principle.

The following are the advantages over space division/reed relay switching:

- a) Fully solid-state circuitry and hence high reliability in operation.
- b) Fast response
- c) Low operation and maintenance cost
- d) High traffic handling capacity - Fully Non-blocking type
- e) Compact size
- f) Noise free operation
- ii) Self checking diagnostics facility as a built-in feature of the EPAX. In view of this, the maintenance of the EPAX is extremely simple.
- iii) The design of the software structure should be very flexible. Using any standard telephone instrument, the following programming shall be done at site:
 - Modification of local subscriber number
 - Modification of subscriber priority
 - Modification of subscriber facilities like Access to Tie lines and Follow Me
 - Modification of Tie line number
 - Modification of Tie line groups

- Modification of Exchange number
- Allocation of Alternate route
- Transit call barring

The above programming facility at site should not require any additional test equipment.

iv) Built-in main distribution frame with Protective Devices such as surge arresters and fuses for all limbs of subscriber lines and tie lines to protect the sophisticated electronic circuitry of the exchange from damage due to external surges/spikes.

v) The EPAX is suitable for easy expansion if required at a later date.

As per your requirement, supply of EPAXs equipped with 16,32,64 subscriber lines and 8,16,32 tie lines (PLCC directions). The ultimate capacity of the EPAX shall be 250 ports for flexible usage of either the subscriber lines or trunk lines.

19.8.13. The line interface circuit module shall serve as an interface between the subscriber line and the exchange whereas the trunk interface circuit module shall serve as an interface between the tie line and the exchange. However, the EPAX shall be possible to expand either the number of subscriber lines or tie lines if required, at a later date, in view of the modular construction adopted. The EPAX shall have a 32-bit microprocessor and programmable at site. The software shall support both E&M signalling and CO trunks. The EPAX shall be provided with universal ports wherein the Subscriber line card and CO trunk card can be inserted into any slots. . If the ultimate capacity of the trunks has been used and on a later date the board intends to increase the trunk capacity the same can be done by decreasing the subscriber lines and thereby increasing the trunks. Vice versa for subscriber lines if the ultimate capacity is reached by reducing the trunks the subscriber lines can be increased.

19.8.14 The duplication of both the CPU and PSU is to be provided as an in-built feature in the offered EPAX. The EPAX shall support the digital telephone with display on a single pair of cable. The offered EPAX shall be provided with a voice guidance card, which helps the subscriber in using, the all the features of the exchange viz. call back etc. The EPAX shall be fully automatic and should function without the help of an operator. The details of site programming facility shall be provided in detail.

19.8.15. The EPAX shall have the following facilities:

- a) Follow me
- b) Priority interrupt/Conference
- c) Automatic alternate route selection
- d) Ring when free
- e) Line Lock out
- f) Either party release
- g) Real time clock
- h) Audible and visual alarm on all fault conditions.

19.8.16. The EPAX shall be self-contained and provide its own ringing current and tones.

19.8.17. Visual display with LED's shall be available on each line and trunk card to display call status. Visual and audible alarms shall be provided on all fault conditions based on the self-diagnostic routines.

19.8.18. The EPAX is to be housed in dust proof steel cabinet.

19.8.19. The EPAX works on 48V DC +15% -10% supply. The loop resistance for subscriber lines is 1000 ohm maximum and for Tie lines 1500 ohm maximum.

19.8.20. The offered EPAX shall support the system software to work as an exclusive PLCC exchange or a combination of PLCC and CO trunks or as a network exchange on E&M. It is very important to note that these three combinations shall be available on the system software so that the purchaser can switch to the exact application at the time of commissioning. The offered EPAX shall work in conjunction with the existing EPAXs of other makes in the grid.

19.8.21. The offered EPAX shall have ISDN compatibility for the CO trunks. The system software shall be posted on flash memory as per the latest International standards for fast and reliable operations. The EPAX shall also support a minimum dialling of 16 digits at a time and a maximum of 20 digits. The EPAX shall have compatibility with E1 trunks for expansion in later stage. It should have the software in-built for through connectivity from E1 trunk to PLCC trunks.

19.8.22. The EPAX should be provided with universal ports for peripheral cards so that any combination of subscribers and trunks can be selected by the user by inserting suitable interface cards.

19.8.23. The EPAX must have been EMI/ EMC tested for the following as per IEC 495 to suit the stringent conditions in the Sub-station environment.

- 1.Impulse Voltage withstand test. (IEC 255-4)
2. High Frequency disturbance susceptibility test (IEC 255-22-1)
- 3.Electrical Fast Transient Susceptibility Test (IEC 801-4)
- 4.Electrostatic discharge susceptibility test (IEC 801-2)
- 5.Radiated susceptibility. (IEC 801-3).

19.9.0 TECHNICAL SPECIFICATION OF HIGH FREQUENCY COAXIAL CABLE

19.9.1 The high frequency coaxial cable shall be required to connect the line matching unit / line matching distribution unit installed in the switchyard of the substation to the carrier equipment installed in the carrier rooms.

19.9.2. The high frequency cable to be offered by the bidders shall be suitable for being laid directly to the ground or in trench or ducts.

19.9.3. The cable shall be PVC sheathed and steel armoured. The capacitance of the cable shall be low so as to minimise attenuation of the signal within carrier frequency range. The impedance of the cable shall be so as to match the output impedance of the PLC terminals and secondary impedance of the coupling units. The cable shall be installed to withstand a test voltage of 4 KV.

19.9.4 Bidders shall specify attenuation per Km. of high frequency coaxial cable at various frequencies in the range of 80 to 450 KHz.

19.9.5. High frequency cable shall be supplied on drums containing lengths of minimum 500 metres.

TABLE-V

SI No	Description	Particulars
1	COAXIAL CABLE	1/1.22mm HF Coaxial Cable having annealed plain tinned copper wire centre conductor, Semi-Air spaced dielectric of composite helical thread of polythene in a polythene tube and annealed plain tinned copper wire braided, Melinex tapped, extruded, special PVC sheathed, black steel wire Braid armoured and characteristic impedance of 75 ohms.
2	Centre Conductor	Tinned copper wire of 1.22 mm dia.
3	Cable Core and Air	Centre Conductor wrapped with Spaced Centre Conductor wrapped with Spaced Radial thickness:1.00 mm. Diameter over Pe tube: 5.20 mm.
4	Outer conductor	Braid of tinned copper (Electrolytic grade/wire of 0.20mm dia with 90% coverage.
5	Barrier	PVC/MYLAR Tape.
6	Inner Jacket	Special cable grade PVC Radial thickness 0.70 mm.
7	Bedding	PVC Tape.
8	Armouring	0.4mm GI wire, 70% coverage.
9	Overall jacket	PVC.
10	Electrical data:	
11	Max Conductor resistance @ 20%	15.7 Ohms/KM
12	Dielectric strength(Core to shield)	4KV RMS for 1 minute
13	Nominal impedance	75 ohm
14	Nominal capacitance at 1Khz	53 pf/meter
15	Mx. Attenuator frequency (KHZ)	(KHZ) db/km 10 0.80 60 1.40

		300 3.30
		500 4.70
16	Min.Bending radius	15 Cm