

220KV GIS and Pothead yard of 240 MW Heo Hydro Electric Project, Arunachal Pradesh.		Technical Specification
		Volume II Section-I
		Sub Sec. 3 PLCC System

Volume-II

Section I Sub-Section 3

PLCC System

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1. POWER LINE CARRIER COMMUNICATION SYSTEMS

1.1. Scope

This specification covers the design, manufacturing, testing at manufacturer's works, ex-works supply, loading at manufacturer's works, insurance, transportation, and destination store delivery, erection, testing and commissioning of the PLCC (Power Line Carrier Communication) equipment along with cubicles for housing and all other accessories, at site. All the required accessories, documents & equipment whether specified herein or not shall be in the scope of the Bidder.

The scope shall also include supply of special tools & plants required for the erection, testing and commissioning of the PLCC equipment along with the supply of mandatory spares required for maintenance of the PLCC equipment. The manufacturer shall also recommend the additional spares required for efficient and trouble-free operation of the PLCC equipment.

Bidders shall also provide optional quote for the type tests, which may be performed at the discretion of the Employer.

The scope of supply is as follow:

- Coaxial cables between the Line Matching Units and the Line Traps;
- Line Matching Units and coupling devices;
- Power Line Carrier Terminal.

1.2. Design Criteria

1.2.1. Coordination with Existing Equipment

The Line traps, coupling devices and PLCC equipment shall be installed at the HEO HEP Pothead yard end of the transmission line. Line traps and Coupling devices shall be mounted in the Pothead yard and PLCC terminal equipment shall be installed in the control-room.

The Bidder shall be responsible for coordinating the equipment supplied by him with the already existing carrier equipment at Receiving end / Pooling sub-station. Bidder shall also be responsible for collecting all the necessary information / data from Receiving end / Pooling sub-stations / from concerned authority for the installation of the equipment.

1.2.2. Frequency Planning

The multipurpose single side band (SSB) PLC systems shall be arranged for a 4 kHz nominal carrier frequency band in the carrier frequency range (40 kHz to 500 kHz). The available AF bandwidth shall be 300Hz to 2400Hz for speech and 2.16 kHz to 3.4 kHz for protection signal.

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Bidders may plan for a minimum speech signal to noise ratio of 25 dB under adverse weather conditions without companders, and for the frequency shift keyed (FSK) signaling channels, up to 1200 Baud, the minimum S/N ratio shall be 15 dB. A safety margin of 9 dB shall be taken over and above these SNR values in order to cater for variations in line attenuation from the computed value as in-hand reserve. The r.m.s corona noise power levels for 4kHz bandwidth shall be within –20 dBm to –10 dBm. The Bidder shall indicate the noise power in the 4 kHz bandwidth and submit the SNR calculations for speech and protection channel at the proposed frequencies. An additional minus two and a half dB may be assumed for psophometric factor. As far as coupling loss (phase to phase) is concerned, the Bidders may assume the same as 5dB at one coupling end for evaluating SNR. Sample calculations for SNR requirements and power allocation over different channels must be furnished along with the bid conforming to IEC- 663 (1980). Maximum permissible line attenuation shall be clearly brought out in these calculations. Maximum additional loss caused by coupling circuit shall be taken as 3dB and modal conversion loss shall be within 0.5dB to 1.0 dB for calculation of line attenuation. Further, Bidder shall submit details of frequency planning done (including computer studies carried out and facilities available) for PLCC links on EHV lines in the past. Bidder must enclose one copy of computer study result done in the past along with the bid.

Frequency and output power of PLCC terminals for protection shall be planned such that the protection signal is received with full reliability even when one of the phase is earthed or is on open circuit on the line side causing an additional maximum loss of 6dB.

Bidder shall be fully responsible for the co-ordination required with concerned statutory authority for finalising the frequency plan.

PLCC system must not cause interference to priority radio communication services within the frequency bands laid down by the International Telecommunication Union for Radio Regulations/ National Statutory authority. The frequency plan will be referred to wireless adviser for clearance and in case any change in the Bidder's recommended carrier frequency and power output is proposed by these authorities, the Bidder shall have to modify his proposal accordingly. Change of power output shall, however, not involve repeater stations.

1.2.3. Proposed Arrangement

The power line carrier communication equipment required by the Employer is to provide primarily efficient, secure, and reliable information link for carrier aided distance protection and direct tripping of remote-end breaker and also for speech communication between generating end and other end sub-stations. It shall include separate carrier terminals of multipurpose type for speech and protection purposes. Provision for superimposing telex and data signals shall be made

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on speech terminals. All carrier terminals including those for protection shall be suitable for point to point speech communication also.

For security reasons each transmission line is proposed to be protected by Main-I and Main-II protections as given below. SEL 321 relay shall be used for line protection and it combines the features for both main as well as back up protection.

The requirement of carrier information on each link covered under this specification is as below:

- One protection channel for Main-I and another channel for Main-II distance protection schemes.
- One speech channel with a facility to superimpose telex and data signals.
- One main and one back-up protection channel for direct circuit breaker inter tripping for 220 kV lines.

The equipment for protection signals shall have high degree of reliability and speed. It shall be guaranteed to function reliably in the presence of noise impulse caused by disconnector or breaker operation. It shall also be possible to effect direct tripping of breaker at one end when the other end breaker opens out either manually or by relays such as bus fault relay etc.

The time intervals between receipt of a trip command on the transmit side, its transmission over the carrier link, reception at the far end and giving command to the trip relays at the distant end shall not exceed 20msec. for permissive inter-tripping and 30 ms. for direct inter-tripping even for the longest line section. The above timings are inclusive of operating time for auxiliary relays and interposing relays. if any included in the PLCC equipment.

The requirement of protection signaling channel is such that security against incorrect signals being received shall be at least two to three orders higher than reliability against a signal not being received.

The planning of frequencies for the PLCC terminals shall be done considering the existing PLCC network as well as full communication channel requirement detailed above so that there is no problem of frequency allocation at a later date when the subsequent section communication requirements come up.

For reasons of safety and reliability, phase to phase coupling shall be employed. Bidders must furnish detailed write-up on methods of coupling and recommend suitable coupling mode for 220 kV double circuit line along-with the bids. Coupling mode shall, however, be fully confirmed by Bidder after conducting detailed computer study taking into account the transpositions of 220 kV lines for optimum coupling mode over these line sections. The coupling arrangement shall be fully optimised by the Bidder after conducting detailed study of every line section individually,

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taking into account the temperature variations, transpositions, earth resistivity, conductor configuration, carrier channels requirements, security and reliability criteria and other relevant details. The line attenuation shall be calculated for complete range of frequencies. The earth resistivity data, existing frequency networks and other relevant details of each line will be furnished to the Bidder for carrying out the computer studies and frequency planning. The Bidder shall complete the computer studies wherever required and submit the frequency plan and optimum coupling details within a period of one month from the date of receipt of above data. The cost of doing the computer studies wherever required shall be included in the lump sum bid price and details of computer study charges shall be indicated. Bidder must indicate the links on which computer study is required.

The parameters of the equipment quoted shall be such that the mode of wave propagation on 220 kV power line shall not impose any limitation on the efficient and reliable performance of information link from protection or communication point of view. The Bidder shall have to check and prove through the results of his computer studies that attenuation in the EHV line is within limits and the offered equipment will perform satisfactorily.

The Bidder shall submit curves illustrating 'incorrect tripping' and "failure to trip" probability plotted against corona noise level, in the presence of impulse noise due to switching of disconnectors, and circuit breaker etc. Details of field tests and laboratory tests for successful operation of his equipment, under such adverse conditions shall be furnished by the Bidder. These are to be related to end-to-end signaling and shall take into account the type of communication link e.g. account shall be taken of transpositions in the phase to phase coupled high tension line. Details of field tests and laboratory tests for successful operation of the equipment under the above circumstances shall be submitted by the Bidder illustrating the above parameters.

1.3. Coupling Device

1.3.1.Details of Coupling Devices

The coupling devices shall be interposed between the capacitor voltage transformer and coaxial line to the PLCC transmitter/receiver and in conjunction with the capacitor voltage transformer shall ensure:

- Efficient transmission of carrier frequency signals between the carrier frequency connection and the power line;
- Safety of personnel and protection of the low voltage parts and installation, against the effects of power frequency voltage and transient over voltages;
- The coupling device, in conjunction with the CVT shall form an electric filter of band pass

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type;

- It shall match characteristic impedance of high tension line to impedance of the carrier frequency connection. Impedance matching between power line and the carrier frequency connection may be done by a transformer. The details must be submitted along-with the bids;
- Galvanic isolation between primary and secondary terminals of the coupling device shall be performed by the above mentioned transformer;
- Power frequency currents derived by the CVT may be drained to the earth by a separate inductance termed drain coil of suitable rating. The drain coil winding shall offer a maximum guarantee of continuity of connection to the earth terminal and withstand over voltages which may occur on the power line, taking into effect of the main arrester;
- Voltage surges coming from the power line at the terminals of the coupling device shall be limited by a non-linear surge arrester of suitable rating in the primary side. The input circuit of power line carrier equipment shall always have protective devices in the form of zener diodes and surge suppressors;
- The surge arrester shall have power frequency spark over voltage co-ordinated with the equipment ahead of it;
- For direct and efficient earthing of its primary terminals, the coupling device shall be equipped with an earthing switch. This switch shall be available for earthing of CVT high-tension terminals, when the coupling filter units are removed from circuit for maintenance/ replacement. The design shall take due regard of requirements for safety in accordance with the Indian Electricity Rules;
- A surge arrester shall be connected as directly as possible between the primary and earth terminals and shall be capable of protecting the coupling device and the carrier frequency connection.

In case of phase to earth coupling only one coupling capacitor and one line trap is required at each coupling point so this system offers economies in coupling equipment but it normally results in higher attenuation than phase-phase coupling and less security in the event of earth fault on the coupled phase. In case of phase-phase coupling two coupling capacitors and two line traps are required at each coupling point so the cost of coupling equipment will be approximately twice than that of phase-earth coupling but this type of coupling offers a number of important advantages, including lower attenuation, greater security against communication failure due to line faults and less interference both radiated and picked up.

1.3.2.Characteristics & Parameters

Coupling device shall conform to IEC 481 and shall have the following carrier frequency

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characteristics as applicable to a phase to earth type coupling device:

- Nominal line side impedance of coupling device shall be 240 ohms;
- Nominal equipment side impedance shall be 75 ohms (unbalanced);
- Composite loss not more than 2 dB;
- Return loss not less than 12 dB;
- Bandwidth shall suit the frequency plan between 40 and 500 kHz;
- Nominal peak envelope power should not be less than 650 Watt. Average continuous power shall be specified by the Bidder;
- The level of individual distortion and intermodulation products arising within coupling device shall be at least 80 dB below the level corresponding to the peak envelop power;
- Continuous current carrying capacity of drain coil shall be 1A (rms) and short time current rating shall be 50A (rms) for 0.2 sec.;
- The impedance at power frequency between the primary terminal and the earth terminal shall be less than 20 Ohm;
- The rated current of earthing switch shall not be less than 200A.

The power frequency spark-over voltage of surge arrester shall be of the order of 2 kV rms and it shall be able to sustain an impulse discharge current of wave 8/20 μ s of at least 5 kA.

For isolation between primary and secondary terminals of the coupling device, the power frequency voltage tests shall be applied using a voltage of 5 kV rms for 1 minute and the coupling device shall be so designed as to withstand a 1.2/50 micro-sec impulse voltage of 10 kV (peak).

The interconnections in the coupling device shall be made with special high frequency Liz wires.

The impedance matching shall be prefect so that the return loss is minimum.

1.3.3.Rating Plate

The coupling device shall be provided with a rating plate of weather-proof material and shall meet the requirements. The inscription shall be indelibly marked. The rating plate shall give the following data:

- Manufacturer's name;
- Type;
- Manufacturer's serial number;
- Nominal peak envelop power;
- Capacitance of coupling capacitor to which the carrier frequency requirements of the coupling device are referred;

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- Nominal line side and equipment side impedance;
- Available bandwidth or carrier frequency working range.

If any additional data are required that shall also be provided.

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 Fiber 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 equipment 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.

1.3.4.Mounting Arrangements & Connections

The coupling device shall be suitable for outdoor mounting. Temperature of metallic equipment mounted outdoor is expected to rise up to 65 °C during the maximum ambient temperature of 40 °C specified. The equipment offered by the Bidder shall operate satisfactorily under these conditions.

All the elements of coupling device shall be fitted on a base plate having pad locking arrangements. The Bidder shall submit detailed drawing indicating interconnection and all other details for approval of the Employer during detail engineering.

The high-tension terminal of coupling device shall be connected to high frequency terminal of the CVT by means of 6mm sq. copper wire with suitable lugs & taped with 12 kV insulation by the Bidder.

Coupling device shall have at least two terminals for carrier equipment connection. Bidder shall confirm that such a parallel connection to coupling device directly will not result in any additional attenuation.

1.3.5.Coupling Device Tests

A. Type Test

The coupling device including the drainage coil, surge arrester and earthing switch shall conform to the following type tests as per IEC-481 / IS: 8998.

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- Composite loss;
- Return loss;
- Distortion and intermodulation test;
- Impulse voltage test;
- Power frequency voltage tests;
- Tests on the drain coil or matching transformer winding;
- Measurement of impedance at power frequency;
- Current carrying capacity at power frequency;
- Tests on arresters- According to IEC publication 99-1.

B. Routine Test

Routine tests shall include but not be limited to the following:

- Composite loss and return loss tests on coupling device;
- Turns ratio test and insulation tests on the balancing transformer;
- Milli volt drop test, power frequency voltage test and mechanical operation test on earthing switch;
- Power frequency spark over test for surge arrester as per relevant IS / IEC.

Bidder shall furnish along with his bid copies of all type and routine test conducted earlier on similar coupling device in accordance with relevant standards.

1.4. High Frequency Cable

1.4.1. Description of Cable

High frequency cable shall connect the coupling device installed in the Pothead yard to the PLCC terminal installed indoor. The high frequency cable to be offered by the Bidder shall be suitable for being laid directly in trenches or in ducts.

The cable shall be steel armoured and its outer covering shall be protected against attack by termites. Bidder shall offer his comments on method employed by him for earthing of screen and submit full justification for the same with due regard to safety requirements.

1.4.2. Cable Parameters

Impedance of the cable shall be such as to match the impedance of the PLC terminal on one side and to that of the coupling device on the other side over the entire carrier frequency range of 40-500 kHz.

Loop resistance of cable shall not exceed 30 ohm per Km at 20°C.

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The cable shall be designed to withstand test voltage of 4 kV conductor and outer sheath for one minute.

Bidder shall specify attenuation per Km of the cable at various carrier frequencies in the range of 30 to 500 kHz. The typical attenuation figures for high frequency cable shall be in the range of 1 to 5 dB/km in the frequency range of 40-500 kHz.

1.4.3. Testing, Inspection & Test Certificates

The high frequency cable shall conform to type tests and be subjected as per IEC: 96-2 / BS: 2316 / IS: 5802.

The Bidder shall submit along with the bid, copies of type tests performance reports of the cable being offered.

1.4.4. Laying

All HF cables within the scope of this specification shall be laid and terminated out by the Bidder as per relevant IS standard.

1.4.5. Drum Length

The cables shall be supplied wound on drums containing lengths not less 500 metres each.

1.4.6. Packing

The cable shall be wound on a wooden drum of suitable size and packed as per IS: 10418. Wood preservative shall be applied to the entire drum. Packing shall be sturdy to protect the cable from any injury during transportation, handling and storage. The ends of the cable shall be sealed by means of non-hygroscopic sealing material.

The cable shall carry the following information stenciled on the drum:

Manufacturer's name, brand name or trade-mark;

- Reference of IS Standard;
- Type of cable;
- Number of cores;
- Nominal X-sectional area of conductor;
- Cable Code;
- Length of the cable on the drum;
- Number of lengths on the drum (if more than one);
- Direction of rotation of drum (by means of an arrow);
- Approximate gross mass;

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- Running end of cable;
- Country of manufacture;
- Year of manufacture.

1.4.7. Marking

The cable (drum) may also be marked with the Standard Mark.

1.5. Terminal Equipment

1.5.1. Details of Terminal Equipment

The information link shall be provided for speech, protection, telex and data services. PLCC terminals shall be fully co-ordinated to match with the specific requirements of high speed of operation, security, reliability and efficient operation of protection channel along with the carrier terminals, Bidder shall ensure the complete and fool-proof co-ordination of the PLCC and protection equipment. It shall therefore be necessary to have these combinations as one unit without any mismatch or necessity of any intermediate coordination unit.

PLCC terminal shall use Amplitude Modulation and shall have single side band transmission mode. These shall be equipped for programmable frequency duplex working and shall be fully transistorised.

For a single channel PLCC equipment effective line attenuation shall be 35 to 40 dB whereas maximum line attenuation shall be 60 dB.

All the PLC terminals shall be of multipurpose type. The Bidder shall confirm that the total transmission time for tele protection shall not exceed 20ms for permissive and 30ms for direct tripping signals. Speech and tele protection channels shall independently fulfil the SNR requirements out of the power allocated to its channel from the total power of the PLCC terminals.

Detailed calculation for SNR requirement and power allocation over different channels should be furnished along with the bid.

Multiplexing equipment, VFTs and converters etc. for data are not included in the scope of present specification and shall be procured separately. The successful Bidder shall, however, be required to co-ordinate his carrier equipment with these equipment for successful operation of the system.

In the input circuit of the PLCC terminal protective devices shall be provided in the form of zener diodes or surge suppressors in order to eliminate any surge transfer through the coupling device or the surge induced in the connecting path of H.F. cable.

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To improve voice transmission characteristics for the system compressors and expanders shall be provided. The companders shall have at least 2: 1 compression ratio with a corresponding expansion ratio of 1: 2. The operating range of compander shall be compatible with the audio power levels specified for 4 wire operation. The improvement gained by companders shall however not be taken into account for power allocation and shall be in-hand reserve.

The Bidder shall clearly indicate in his offer the methods adopted to ensure that sudden changes in the input level of the receiver shall not cause false tripping. The receiver design shall also provide protection against false tripping from random noise.

Fail-safe devices shall be provided, so that a mal-function in one unit or sub- assembly cannot cause damage elsewhere in the system. All plug-in equipment shall be fitted with features to prevent improper insertion. The electrical cables shall not be routed across sharp edges or near sources of high temperature. The adjustments, which are susceptible to mis-adjustment from accidental contact / vibration, shall be equipped with suitable locking devices.

The terminals shall be provided with built-in indicating instrument to facilitate checking of important voltages and current values and signal levels in different parts of the PLCC terminals. Protection fuses shall be provided in all-important circuits and fuses shall be so mounted as allow their easy inspection and replacement. All test points shall be easily accessible.

The carrier set shall be provided with suitable supervision and alarm facilities. Individual parts of the carrier set should be accessible from front, making it possible to place the carrier cabinets side-by-side.

The cabinets shall be properly cleaned and spray painted with two coats of synthetic enamel paint. Exterior of the cabinets shall be painted with smoke-glossy finish. Interior of the cabinets shall be painted with white enamel paint with glossy finish. All the panels shall be properly earthed to the Employer's earthing grid by the Bidder. Bidder shall submit detailed drawings for earthing connections.

All the panels shall be protected against moisture ingress and corrosion during storage. Panels shall be properly dried before they are installed and energised. Bidder shall indicate measures adopted to prevent ingress of moisture during operation.

All cabinets having PLCC terminals shall be provided with lamps of sufficient wattage for interior illumination with switch.

A name plate shall be provided on the front door of each cabinet indicating channel function, transmitter frequency and direction etc.

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1.5.2.Design Criteria

The PLCC set shall be designed to give guaranteed performance from 0 deg. C to 40 degrees C ambient temperature. The thermal capability of the equipment shall be so designed that the equipment remains operational successfully up to 60 degrees C ambient temperature. Any ventilation fans provided for circulation of air inside the cabinets shall conform to relevant Indian Standards.

1.5.3.Parameters

Characteristic input and output parameters of the single side band PLCC terminals shall be as per IEC-495, unless otherwise specified.

The salient features are detailed out below:

1	Mode of transmission	Amplitude Modulation single side band with suppressed carrier or reduced carrier.
2	Carrier frequency	40 to 500 kHz range.
3	Stability of carrier frequency	Less than $\pm 5\text{Hz}$
4	Nominal carrier	4.0 kHz frequency band in either direction of transmission.
5	Number of VFT channels	5 (minimum) at 50 Baud rate
6	Frequency spacing between channels of several equipment operating in parallel	
a.	Transmitter to its own receiver	0 Hz
b.	Transmitter to adjacent transmitter	$\geq 8\text{kHz}$
c.	Transmitter to adjacent receiver	$\geq 4\text{kHz}$
d.	Receiver to adjacent receiver	0 Hz
7	Nominal impedance	
a.	At carrier frequency interface	75 ohm (unbalanced)
b.	At Voice Frequency inputs and outputs	600 ohm (balanced)
8	Return Loss	Not less than 10 dB (carrier frequency side) Not less than 14 dB (voice frequency side)
9	Power output	40 Watt at HF terminal
10	Frequency difference between a pair of	Frequency difference between VF

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	PLC terminals	signal at the transmitting and receiving ends will not exceed 2 Hz with suppressed carrier; with reduced carrier frequency difference shall be zero. This shall include permissible ambient temperature variation and supply voltage variation of +20% and -15%.
11	Automatic gain control	Audio frequency output level remains within + / -1 dB for a RF input variation of +30 to -30dB.
12	Cross talk attenuation	Not less than 60 dB
13	The overall loss of speech circuit at 4 wire transmit and 4 wire receive of a pair of PLC terminals without compander from the overall loss at 0 dBm0 for any input level between 10 dBm0 and 0 dBm0	Within ± 0.3 dB
14	The level between which limiter action starts for any sine wave signal of frequency between 300 Hz and upper frequency of speech channel	-3 dBm0 and 0 dBm0 (without compander)
15	Intermediate frequency level	40 dBm
16	The weighted telephone noise level measured at the speech output of a pair of PLC terminals without companders.	Shall not exceed -55 dBmop
17	Near end and far end cross talk due to signal channels either individually or collectively in a pair of PLC terminals without companders	Shall not give rise to a weighted disturbance power in the speech circuit of more than -50 dBmop
18	Signal to noise ratio for voice communication without compander	Better than 35 dB
19	Signal to noise ratio for voice communication with compander	Better than 50 dB
20	Supply voltage	48 V DC +20%, -15%. (Positive pole earthed) and peak-to-peak

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	ripple shall be less than 5%.
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1.5.4.Power Supply for PLC Terminals

The PLC terminal shall be suitable for working on 48 V DC supply with +ve pole earthed and with the following supply voltage variation limits:

- Stated performance requirements to be satisfied at 48 V DC +10%, -15%;
- The Bidder shall ensure by providing suitable means such that in the event of any short circuit of the output terminals of power supply unit in the carrier terminals, the unit is switched off without causing any damage to the power supply unit itself. It is necessary to provide protection against any accidents, short circuit, or short circuits due to the failure of some components in the circuitry;
- The terminal shall remain in operation when supply voltage is raised by 20% of its nominal value without any damage or failure to the equipment as per IEC 495- 1993;
- The power consumption of the PLC terminals shall be minimum and shall be commensurate with the output power of the PLC terminals as specified to keep the size of the battery optimum.

1.5.5.Tests

Insulation tests and electromagnetic compatibility according to IEC 495 (1983)

A. Balanced carrier I/O

- | | |
|---|------------------------------|
| 1. Voltage withstand | As per IEC 255-5 |
| 2. Insulation resistance | As per IEC 255-5 |
| 3. Impulse voltage test | As per IEC 255-4, class 3 |
| 4. HF interference test | As per IEC 255-22-1, class 3 |
| 5. Fast electrical transients
/ bursts | As per IEC 801-4,class3 |

B. Audio Frequency I/O:

- | | |
|--|------------------------------|
| 1. Voltage withstand | As per IEC 255-5 |
| 2. Insulation resistance | As per IEC 255-5 |
| 3. Impulse voltage test | As per IEC 255-4, class 3 |
| 4. HF interference test | As per IEC 255-22-1, class 3 |
| 5. Fast electrical transients
/bursts | As per IEC 801-4,class3 |

C. Alarm and signaling contacts:

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|-------------------------------|------------------------------|
| 1. Voltage withstand | As per IEC 255-5 |
| 2. Insulation resistance | As per IEC 255-5 |
| 3. Impulse voltage test | As per IEC 255-4, class 3 |
| 4. HF interference test | As per IEC 255-22-1, class 3 |
| 5. Fast electrical transients | As per IEC 801-4, class 3 |
| /bursts | |

D. AC auxiliary supply I/P:

- | | |
|-------------------------------|------------------------------|
| 1. Voltage withstand | As per IEC 255-5 |
| 2. Insulation resistance | As per IEC 255-5 |
| 3. Impulse voltage test | As per IEC 255-4, class 3 |
| 4. HF interference test | As per IEC 255-22-1, class 3 |
| 5. Fast electrical transients | As per IEC 801-4, class 3 |
| /bursts | |

E. Station battery auxiliary supply I/P

- | | |
|-------------------------------|------------------------------|
| 1. Voltage withstand | As per IEC 255-5 |
| 2. Insulation resistance | As per IEC 255-5 |
| 3. Impulse voltage test | As per IEC 255-4, class 3 |
| 4. HF interference test | As per IEC 255-22-1, class 3 |
| 5. Fast electrical transients | As per IEC 801-4, class 3 |
| /bursts | |

F. Induced electromagnetic fields

IEC 801-3 for equipment in closed cubicles

Bidder shall submit type test & routine test certificates from internationally reputed test authorities for the quoted PLCC terminals in respect of characteristic input and output parameters of the PLCC terminals in accordance with IEC-495 along with the bid.

Also each transmitter and receiver shall be given a routine factory test to establish that it has been properly assembled and adjusted for normal operation as per Indian Standards.

1.5.6. Heat Soak Test

All the solid-state equipment / system panels shall be subjected to the Heat Soak Test as per the following procedure:

All solid-state equipment shall be burn-in tested for minimum of 120 hours continuously under operating condition. During the last 48 hours of testing, the ambient temperature of the test chamber shall be 40°C. Each PLCC panel shall be complete with all associated sub-systems and

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the same shall be in operation during the above test. During the last 48 hours of the above test, the temperature inside the panel shall be monitored with all the doors closed. The temperature of the panel interior shall not exceed 65°C.

The Bidder shall give details of his manufacturing, testing procedures and the facilities and methods to perform above mentioned tests.

1.5.7. Mountings

PLCC terminals shall be housed in floor mounting sheet metal cabinets, suitable for mounting on concrete plinth as well as channel frame by means of nuts and bolts or welding.

1.6. Other Facilities / Equipment

1.6.1. Speech Communication Facility

PLCC equipment offered shall provide reliable telephone communication between the end stations of transmission line. The equipment shall be suitable for providing the following facilities:

The equipment shall contain all normal facilities like ring back tone, dial tone, engage tone & priority tone, and suitable pulses to establish and disconnect communication between subscribers.

The equipment shall be provided with necessary alarm circuits and fuses etc. The equipment shall be of 4 kHz bandwidth on either direction and be suitable for providing superimposed data and teleprinter facilities at a later date without major modifications and high cost. The Bidder shall clearly indicate in his bid the provision made in his proposal for future development and the extent to which such additional facilities can be added at a later date.

The system shall be completely automatic with definite number allocated for each telephone. The numbering scheme for telephones, exchange and tie lines shall be developed by the Bidder and indicated in the bid. Final numbering scheme shall be fully co-ordinated with the existing / proposed future systems by the Bidder.

Arrangement for over-riding facilities shall be provided by means of priority keys wherever specified. The over-riding facility shall enable cutting-in ongoing calls with the priority key and ask the concerned parties to finish their conversation. The wanted number should then get automatically connected without having to redial the number.

All the carrier telephone conversations shall be secret and it should not be possible for anybody to over hear the conversation going on between any two parties excepting those provided with over-riding facilities.

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The necessary cables for connecting all the telephone instruments ordered for at each sub-station (including wiring and terminations) shall be provided by the Bidder. These telephone instruments shall be located within control room building at respective substation.

All the relays etc. used in the equipment shall be of robust design to cope with the duty imposed on them. Electronic components used in the equipment shall be of long life type and as far as possible a few types only shall be used.

The cabinets housing the equipment for EPAX, four wire E / M interface & remote subscriber units (four wire) shall have mounting arrangement similar to that for PLCC terminals. These cabinets shall also be painted.

All the terminals for speech shall be supplied fully wired for addition of VFTs and transit filters in future.

Equipment for speech communication must be fully compatible with Employer's existing equipment. Any interfaces required for proper matching and connection with the Employer's existing equipment shall be provided by the Bidder.

Terminals for protection shall be suitable for between two ends of each transmission line or on tandem operation basis with back to back connection at the intermediate stations.

Each PLCC terminal for speech as well as protection purposes shall be provided with a plug-in type service telephone and buzzer. Further, 4 wire remote telephone instruments (parallel to service telephone) shall also be provided on one PLCC terminal for protection for each link. These instruments shall be located in respective powerhouse control room to enable the operator to make emergency calls on point-to-point basis. Each such instrument shall be equipped with a buzzer and 'press-to-call' key and shall not require any additional power supply units.

1.6.2. Electronic Private Automatic Exchange (EPAX)

The 25 / 12 lines Electronic Private Automatic Exchange (EPAX) having following functional requirements / specification shall be offered.

The EPAX must be microprocessor controlled and shall be of digital type.

The offered EPAX directly interface with the Power Line Carrier Communication terminals with E & M signaling. 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

EPAX shall be suitable for operation with the power line carrier equipment without any intermediate switching equipment such as four wire group selector etc.

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The equipment shall contain all normal features like ring back tone, dial tone, engage tone etc.

The equipment shall be provided with necessary alarm circuits to give audio / visual alarms for failure of important function / fuses. Visual indicators indicating status of subscriber and trunks etc. shall be provided.

Subscriber circuits shall be protected by means of suitable protective devices against external induction, short circuits, high voltage surges etc. The equipment shall be suitable for working on 48 V DC +10% and –15% supply with positive terminal connected to earth.

The equipment shall be completely automatic with definite numbers allocated for each subscriber, tie lines etc.

It shall be possible to integrate the new equipment with the existing system. It will be the responsibility of the bidder to collect the requisite data and make necessary provision in the exchange.

The number of interconnecting link and the number of subscribers that can converse at a time shall be indicated in the offer.

The PAX shall operate satisfactorily up to 1000 ohms loop resistance of subscriber line.

The equipment shall be suitable for working with the existing PAX, FGS, SETR etc. installed at the opposite station.

The telephone exchange shall be housed in a cabinet whose thickness of metal sheet and colour are similar to those specified for housing carrier equipment. But access shall be provided both at the front and also at the rear.

The equipment shall be capable of operating at the ambient temperature and humidity conditions prevailing at the site.

The equipment shall be equipped with a test telephone unit for service calls direct from the PLC equipment with the opposite station.

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).

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1.6.3. Tele protection Equipment (Protection Coupler)

The Digital protection signaling 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.

The Bidder shall offer voice frequency transmission equipment which shall work on frequency shift or coded signal principle for transmission / reception of protection signals as single purpose channel. The equipment shall be suitable for connection to the power line carrier terminal.

An amplitude modulated (on-off) carrier shall be used for line protection and the frequency shift carrier for breaker failure protection and transferred trip relaying. Because impulse noise, bad weather and line faults can be critical to high speed relaying conservative design shall be followed so as to allow greater margins and signal to noise ratios.

The voice frequency transmission equipment shall not only be insensitive to corona noise but shall also remain unaffected by impulse type noise which are generated by electrical discharge and by the opening and closing of circuit breakers, disconnector Switches, earthing switches etc. The equipment shall also be made immune to a field strength of 10V/m expected to be caused by portable radio transmitters in the range of 20-1000 MHz. In his offer, Bidder shall clearly explain as to what measures have been taken to make the equipment insensitive to corona noise, white noise and to impulse noise of an amplitude larger than the wanted signal and submit full field test and laboratory test reports. The guarantee on design data shall not be acceptable.

The Bidder shall ensure equipment shall be unaffected by spurious tripping signals. The Bidder shall submit proof as to how this is achieved satisfactorily.

The equipment shall be suitable for transmission of direct and permissive trip signal as well as blocking signals for protective gear of power system. The equipment shall be operated in the audio frequency range in speech band or above speech band as superimposed channel in 4 kHz band of SSB carrier. The equipment shall operate with full duplex frequency shift mode of operation. The protection signaling equipment shall be of solid-state design, modular in construction and have a proven operating record in similar application over EHV systems. Details regarding application of the equipment over 220kV systems shall be submitted along with the bid.

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Each protection signaling equipment shall provide:

- Transmission facilities for minimum two protection signals;
- Reception facilities for minimum two protection signals.

The equipment shall be designed for remote tripping / blocking on permissive basis and direct tripping for reactor fault and others. The nominal transmission time including PLCC equipment delay and relay operating times for blocking shall be less than 18 msec, for permissive tripping it shall be less than 20msec and for direct tripping it shall be less than 30ms. The command and prolongation time shall be less than 2.5 sec.

Guard signal frequency (pilot frequency) shall be 3780 Hz standard or any other pilot frequency specified by the manufacturer if the GTP. However the guard signal level to the level of interfering signal shall be at least -6 dB, 0 dB, +6 dB.

Operating time lower than specified above may be preferred provided they fulfil the requirements of security and reliability as mentioned below:

- False -trip probability 10-5 (Noise burst of any amplitude)
- Fail to trip probability 10-2 for SIN 6 dB in 3.1 KHz Band
(White Noise Measurement)

It may be emphasised that specified time, as mentioned above is composed of the following:

- Back-to-back signal delay in frequency shift or coded signals protection equipment;
- Back-to-back delay in PLCC terminal;
- Delay in transmission line;
- Operation time of interposing relay, if any, in frequency shift or coding equipment.

The following transfer criteria shall be provided by the equipment:

a) Transmit side

One number potential free NO (normally open) contact of protective relays (To be supplied by the Employer) of under noted rating for each of the following functions:

- Permissive trip command
- Direct trip command

Contact Rating :

Maximum voltage : 660 Volts

Maximum current rating : 10 amps

b) Receive Side

Voice frequency transmission equipment for network protection shall be provided with one

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potential free NO (normally open) contact of the under noted rating for each of the following functions:

- i Permissive trip command
- ii Direct trip command

Contact Rating:

Rated voltage	: 220 V DC
Rated current	: 10 A DC
Other Parameters	: As per IEC-255-0-20

c) Alarm

In addition, the voice frequency protection terminal shall provide at least one number potential free change over contact of the following rating for alarm purposes.

- i Rated voltage : 110 volts
- ii DC Rated current : 10 A DC
- iii Other Parameters : As per IEC-255-0-20

Frequency shift or coded signal protection equipment shall have at least two channels. In order to ensure full availability of PLCC protection channel, arrangement of parallel circuiting of these two channels, as main and standby channels shall be made. This arrangement is generally shown in relevant specification drawing. Each arrangement shall be developed by the successful Bidder in co-ordination with protective relay Bidder. The parallel wiring should however retain the concept of two protection channels of each type of protection with each backing up the other 100% during normal operation and also permit testing without affecting the other. The Bidder shall submit drawings showing inter-connection between PLCC and protection panels for approval by the Employer.

It has to be ensured that under no circumstances protection channel should share the power. Each protection channel shall be able to transmit power for which system is designed. For example, a 40 W PLCC terminal shall transmit 40 Watt (max) for protection channel alone in the event of fault. Speech and super-imposed data channels, in the same protection terminal must get disconnected momentarily during the operation of protection channels.

The equipment shall be constructed such that in permissive line protection system, operational reliability of the protection channel may be checked over the carrier link by means of a loop test. It shall be possible to carry out the above test from either end of the carrier link. During healthy condition of the transmission line, the loop test shall not initiate a tripping command. In the event of a system fault, while loop test is in progress, protection signal shall over-ride the test signal.

Loop Testing

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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 signaling equipment.

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

The guard signal being transmitted by tele protection equipment and shall be used to monitor the integrity of tele protection link as to level and signal to noise ratio requirements. The command signal shall be transmitted by the tele protection equipment for direct and permissive tripping and blocking.

The equipment shall be complete with built in counters for counting the number of trip commands sent and number of trip commands received.

The voice frequency transmission equipment shall be suitable for 48 V (+) 15% and (-) 10% DC power supply.

Operating frequency range of the protection coupler shall be subject to mutual agreement between the Employer and the manufacturer. Operating temperature of the tele protection equipment shall be 40 degree C.

The following type / routine tests as per IS: 8686 shall be conducted on the relays associated with PLCC equipment for network protection, voice frequency protection signaling equipment and inter face unit with protective relay units if any:

- Type Tests
 - a) Impulse voltage withstand test as per Clause 6.1 of IS: 8686 (for a test voltage appropriate to Clause III as per Clause 3.2 of IS: 8686).
 - b) High Frequency Disturbance test as per Clause 5.2 of IS: 8686 (for a test voltage appropriate to Clause III as per Clause 3.2 of IS: 8686).
- Routine Tests

The following routine tests shall be performed on all relays:

 - a) Contact insulation resistance test as per Clause 10.5 of IS: 3231
 - b) Insulation withstand capability as per Clause 10.5 of IS: 3231 all AC / DC relays.

Bidder shall quote charges for type tests mentioned above in the relevant schedule.

1.7. Drawings, Data, Manuals and Technical-cum-Performance Data (GTP)

A. Drawings, data and Technical-cum-Performance Data (GTP)

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The following drawings and test reports for each item are to be supplied as part of the contract along with the Bid Document:

- PLCC System Model type & detail;
- Detailed construction drawing of the high frequency cable being offered, with mechanical and electrical parameters.

Any Bid lacking complete information in this respect is likely to be rejected.

B. Drawings, O & M Manuals, etc., and documentation (after award of contract)

After award of contract, the Bidder shall supply five (5) copies of the following drawings; for approval as per agreed time schedule and shall subsequently provide six (6) complete sets of final as-built drawings, and two (2) set of electronic files in a CD:

- Guaranteed Technical Particulars as per Schedule;
- Detailed calculation for the PLCC equipment-power allocation, Line attenuation, Noise level under adverse weather condition, S/N ratio, etc;
- Schematic diagram for the complete system;
- Complete assembly drawings of the equipment, wiring diagram and terminal block diagram, etc;
- Dimensional details of each equipment along-with mounting / erection details;
- Front & Rear view of the Panels with instruments, device and relay positions marked;
- Detailed dimensional drawing of foundation with loadings for different equipment;
- Detailed drawing and design calculation for support structure and their civil foundation with loading;
- Catalogues of equipment being offered;
- Type test certificates of the equipment offered;
- Copies of valid ISI Licenses for the equipment offered;

The Bidder shall submit detailed drawing indicating interconnection of coupling elements and all other details for approval of the Employer during detail engineering. Bidder shall submit dimensional drawings, wiring diagram and terminal connections of carrier equipment with coupling devices and other terminal equipment with the PLC cabinet.

Descriptive literature and data on PLCC, etc., shall also be supplied by the manufacturer along with the instruction manuals

1.8. Spare Parts, Mandatory Testing & Maintenance Equipment

The contractor shall supply testing and maintenance equipment required for the PLCC system as a part

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of equipment supply.

Contractor shall supply separately the price of additional spare parts and special recommended tools. Each item shall be clearly described.

All spare parts shall be identical electrically and mechanically to corresponding parts of the equipment supplied and shall be suitably packed and clearly marked, ready for long term indoor storage.

If dismantling of certain parts requires the use of special tools, Contractor shall supply them with the equipment. Each tool shall be described and its unit price indicated in the Tender.

Employer reserves the right to purchase or not the spare parts and special tools covered in this chapter.

1.8.1.Mandatory Spares list

S.No	Item	Qty.
1	HF Cable, terminal blocks, Fuses and interconnecting cable	15% of each type
2	Cable (HF cable)	150 meter

If any additional spare-parts required for trouble free operation are recommended by bidder, these shall be listed and the unit price shall be quoted in the price schedule. The Employer reserves the right to order any or all of such spares.