Technical Specification
for Communication Equipment

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Modifications from last revision Rev-05 to Rev-06

a) SBOM & HBOM: Software Bill of Material (SBOM) and Hardware Bill of Materials (HBOM) has been added as per CERT-In guidelines.

b) Capacity: STM-64 has been added for future packages requirements of higher capacity requirement.

c) License: A clause has been added mandating requirement of perpetual license.

d) IP: IP allocation guidelines have been added to ensure uniformity and compliance.

e) RBAC access for equipment has been added.

f) Concreting throughout the floor inside shelter boundary has been provisioned based on site input.

g) Technical requirement of installation material such as GI pipe, elbow and conduits has been kept in line In line with technical specification of Substation except for nominal bore dia of 32mm instead of 25mm and conformity of specification IS 1239 OR BS 1378.

h) Type test validity requirement is added as per "Guideline for the Type Tests for Major Equipment in Power Plant" issued by CEA and clause for non-submission of type test report of DG set is kept in line with engineering substation technical specification if DG set make is available in compendium of vendor.

i) Approval for nomenclature for naming in SDH and its services have been added.

1. TELECOMMUNICATION SYSTEMS

1.1 General

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

(1) Fiber Optic Transmission System (FOTS)
(2) DDF and Cabling
(3) Craft Terminal based Network Management System (NMS)
(4) Repeater Shelter
(5) FO Approach Cable
(6) FODP

The equipment supplied shall support existing communication network for Power system operational requirements.

1.2 Security

The security related requirements of the equipment shall be as per CEA (Cyber Security in Power Sector) Guidelines, 2021 and all similar security requirements as amended by CEA on time-to-time basis shall be followed/complied by the vendor at no additional cost to Employer till the implementation of the project.

The manufacturer shall allow the Employer and/or its designated agencies to inspect the hardware, software, design, development, manufacturing, facility and supply chain and subject all software to a security /threat check any time during the supplies of equipment

The contractor shall ensure that the supplied equipment have been got tested as per relevant contemporary Indian or International Security Standards e.g. IT and IT related elements against ISO/IEC 15408 standards, for Information Security Management System against ISO 27001/2, Power Control Systems – Security Requirements against IS 16335, Cyber Security for Industrial Control Systems against IEC 62443-4 etc. from an authorized and certified agency/lab. These mentioned standards shall be current with all amendments, if any and in case any standard is superseded, the new standard shall be applicable.

The Contractor shall ensure that all the Communicable Intelligent Equipment are sourced from the list of the "Trusted Sources" as and when drawn by MoP/CEA. In case, for any Communicable Intelligent Devices, if no Trusted Source has been identified, the Contractor in compliance with the provisions made in MoP order dated 2.07.2020 and any other relevant MoP order shall get the product cyber tested for any kind of embedded malware/Trojan/cyber threat and for adherence to Indian Standards at the designated lab.

In case of any deliberate attempt to make a security breach at the time of procurement or at a later stage after deployment/installation of the equipment or during maintenance, liability may be dealt as per guidelines of CEA/Ministry of Power or any other Government department.

1.3 SBOM& HBOM

The Contractor shall submit the inventory list in line with "Technical Guidelines on

SOFTWARE BILL OF MATERIALS (SBOM) and Hardware Bill of Materials (HBOM)" issued by CERT-In guidelines for approval.

TechnicalGuidelines-on-SBOM,QBOM&CBOM,AIBOM_and_HBOM_ver2.0.pdf

2. FUNCTIONAL REQUIREMENT

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

(a) High speed E1 channel support
(b) 64kbps & nx64kbps data channel support as required
(c) Low speed (300 -1200 bps) data channel support as required
(d) Voice (2 wires, 4 wires) channel support and integration with Employer's/RLDC's EPABX system. The details of EPABX System shall be provided during detailed engineering.
(e) Data transport supporting Network Management channels
(f) The connectivity envisaged between Substation and Control Centre over TCP-IP using Ethernet interface for various services of data and voice such as for PMUs, RTUs, VOIP etc.

2.1 Fibre Optic Transmission System

2.1.1 General Network Characteristics

The SDH node shall be used for interconnection of terminal Substation to the fibre optic network and shall be based on the Synchronous Digital Hierarchy (SDH) having bit rate of STM-4/16/64 as specified in BPS. The contractor shall follow numbering plan for the proposed voice communication system.

The transmission equipment to be supplied shall be a complete SDH node (adddrop multiplexer) providing all the features e.g. protection and performance monitoring.This will be used for delivering E1 as per ITU-T G.703 and Giga/fast Ethernet services except repeater stations. In case other interface such as Asynchronous Subchannel data card (RS232/V.24/V.28), Synchronous data card (V.36/X.21), 2 wire voice channel card or 4 wire (E&M) voice channel card as required, shall be supplied either in the same equipment or as independent PDH equipment.

The Contractor shall supply the equipment as per the technical specification. The deliverables shall include all installation materials necessary for successful installation and commissioning of the equipment viz. AC & DC power supply cabling, Krone type/75Ω BNC type Digital Distribution Frame (DDF) in enclosure, optical patch cords for FODP-to-equipment and equipment-to-equipment connection, optical attenuator (5dB/10dB), flexible conduits etc. as per site requirement. Additionally one (1) pair of optical patch cord per SDH node will be supplied as spare. User Manual, System Guide shall be delivered with each equipment. The Contractor shall provide all required minor civil works necessary for full connectivity as required.

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

Equipment Redundancy Requirements Summary

Fiber Optic transmission Equipment :	
Power Supply & Converters ----------	1:1 APS or distributed power supply
Common Control* Cards ----------	1:1 APS
*** = Common control cards which are essentially required for operation of the equipment.**	

The offered equipment shall support automatic switchover function between the redundant modules and all required modules and hardware to support the automatic switch over shall be provided by the Contractor.

At any digital signal level, reapplication of a lost signal shall result in automatic resynchronization and full restoration to normal operation without manual intervention. All alarms incident to the signal failure, shall be automatically cleared at the equipment, rack and monitoring levels and normal operation indications restored and reported if applicable.

The offered transmission equipment (SDH node) shall support fibre optic links upto 250 Km for STM-4, upto 225 Km for STM-16 and upto 175 Km for STM-64 without any repeater station in between. If required, wavelength translator/ optical amplifier shall be provided by the contractor.

2.1.2 Features of Transmission Equipment

- Aggregate interface shall be STM-4/16/64, with MSP protected directions (as required in BPS). If bidder is offering equipment with multifunction cards such as cross-connect or control card with optical interface/SFP or tributary interface, such type of multifunction card shall be considered as Common control card and shall be the part of base equipment. In case optical interface/SFP is embedded with control card, the adequate number of optical interface/SFPs shall be offered to meet the redundancy requirements of the specifications. Further, main and protection channel shall be terminated on separate cards. Aggregate interface of STM-4/16/64 shall have FC/PC. In case other than FC-PC connector is provided in the equipment, suitable patch cord with matching connector are to be provided to connect with FODP.
- All software and hardware shall support IPv4 and IPv6 simultaneously (dual stack).
- SDH equipment shall support dual power feed with redundancies for Power supply unit and Control unit in each rack.
- Minimum 16 nos. x 2 Mbit/s per card, 120Ω/75Ω tributary interface compliant to ITU-T G.703, G.704 with suitable connector.
- Ethernet interface shall have minimum 8 nos. per card of RJ-45 port for ingress and egress of Ethernet data (Ethernet over SDH) at 10/100/1000 Base-T speeds/standards (ITU-T G.7041GFP capsulation). Ethernet shall support LCAS feature. It shall support full throughput upto 1000 Mbps on Ethernet port by virtual concatenation of requisite no. of VC-12.There shall be the provision of “Auto Negotiation” and “Flow control” Enabling/disabling through NMS of the system. Also there shall be provision of configuring the equipment for unrestricted nxVC12 bandwidth (upto 1000Mbps). The Ethernet interface shall support VLAN (IEEE 802.IP/Q), spanning tree (IEEE 802.ID) quality of service. The protection scheme for Ethernet traffic should be ERPS based.

- Services channel shall be provided as a function of the SDH equipment and shall be equipped with Service Channel Muldems that shall provide at a minimum: One voice channel (order wire) with analog interface (0.3 to 3.4 kHz) and one data channel. There shall be a facility to extend the line system order-wire to any other system or exchange lines.
- ADM configuration for traffic protection by using SNCP & MSP.
- Synchronization: The substation GPS can be used for extending synchronization to equipment. Alternately existing network Master Clock can be used for synchronization.
- ISM (In Service Monitoring) circuitry shall be provided as a function of the SDH equipment. Local visual alarm indicators shall be provided on the equipment, as a rack summary alarm panel. Alarms shall be as per ITU-T Standards G.774, G.783 and G.784.
- Downloading of software shall be possible from remote.
- Shall have Embedded Communication Channel (ECC), ports (Ethernet/RS232) for craft terminal and management interface and shall support DCC pass through.
- DCN implementation through protected VC12. Support DCN grooming in VC12.
- Pre-connectorised Optical patch cords shall be of G.625D fibre. The Patch cord return loss shall be equal to or better than 40 dB and insertion loss equal to or less than 0.5 dB. Fiber jumpers shall be of sufficient lengths as to provide at least 0.5m of service loop.
- Manageable by Craft Terminal programme. It shall support performance monitoring, remote software upgrade, configuration management from remote as well as local craft terminal. The craft terminal shall have minimumconfiguration of 2.4 GHz, 8 GB RAM, 256 MB Video Graphics Memory, ,320 GB Hard Disk Drive, keyboard, mouse/trackball etc., serial/USB (2.0) ports to accommodate printers, IEEE 802.11a/b/g wireless LAN, Bluetooth,and a battery back-up of at least 3 hours. VDUs shall be 15" TFT active matrix color LED with a minimum resolution of 1024 X 768.
- Local Craft Terminal will be provided with requisite software for performing all element level management functions viz. configuration management, fault management, performance management etc.
- Shall be operated with -48 V DC Power Supply. DC power interface shall be suitable to work on a nominal voltage of -48V ± 20%.Compact design suitable for installation in 19” rack.
- The bidder shall be required to provide only Optical Interface/SFP to be installed in the existing/third party SDH equipment at few locations if any. The bidder has to ensure compatibility of the supplied Optical Interface/SFP for the same.
- Licences

  All interfaces and features specified in the Technical Specifications of the respective products shall be equipped with perpetual licenses (Not a subscription model).

- IP Address

  The Successful Bidder shall be responsible for configuring and assigning IP addresses to all supplied equipment in accordance with the IP addressing scheme provided by the Employer. The Contractor must ensure that all devices are assigned IP addresses as per that scheme, verify connectivity, and document the assigned IPs in the final network configuration report.

- The communication equipment shall support multiple users and access levels at least the following for CLI/NBI access
  (i) Administrator: Configuration/troubleshooting
  (ii) Read only access : Only see the equipment status
  (iii) Operator- Can create configuration but cannot delete

2.1.2.1 Network Monitoring (Craft Terminal based)

- Manageable by Craft Terminal programme. It shall support performance monitoring, remote software upgrade, configuration management from remote as well as local craft terminal. The craft terminal shall have minimum configuration of 2.4 GHz, 8 GB RAM, 256 MB Video Graphics Memory, 320 GB Hard Disk Drive, keyboard, mouse/trackball etc., serial/USB (2.0) ports to accommodate printers, IEEE 802.11a/b/g wireless LAN, Bluetooth, and a battery back-up of at least 3 hours. VDUs shall be 15" TFT active matrix color LED with a minimum resolution of 1024 X 768. However, the configuration shall be finalized during detailed engineering as per the latest industrial standards.
- Local Craft Terminal will be provided with requisite software for performing all element level management functions viz. configuration management, fault management, performance management etc.
- Bidder shall provide the telecom equipment which can be integrated with the existing NMS server/s of the respective RLDC/ SLDC. The details of existing NMS server/s shall be provided during detailed engineering or to be ascertained by Bidder conducted during site survey.

2.1.3 Optical Link Budget Calculations

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

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

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

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

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

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

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

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

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

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

The Successful Bidders shall determine the total link loss based on the above parameters

and shall submit the system design (including link budget calculations) for each fibre optic link during detailed engineering.

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

2.1.4 Technical Requirement of Repeater Shelter

The detailed requirements for Repeater Shelter are attached at '**Annexure – II**'.

2.2 Fibre Optic Approach Cable

For purposes of this specification, a fibre optic approach cable is defined as the Armoured underground fibre optic cable required to connect Overhead Fibre Optic Cable (OPGW) between the final in line splice enclosure on the gantry / tower forming the termination of the fibre cable on the power line and the Fibre Optic Distribution Panel (FODP) installed within the building. The estimated fibre optic approach cabling length requirements are indicated in the appendices. However, the Contractor shall supply & install the optical fibre approach cable as required based on detailed site survey to be carried out by the Contractor during the project execution and the Contract price shall be adjusted accordingly. Approach Cable shall consist G.652D DWSM Fibers.

2.2.1 Basic Construction

The cable shall be suitable for direct burial, laying in trenches, G.I. Pipes PVC/Hume ducts, laying under false flooring and on indoor or outdoor cable raceways.

The Approach Cable shall be a UV resistant, rodent proof, armoured cable with metallic type of armouring. The outer cable jacket for approach cable shall consist of carbon black polyethylene resin to prevent damage from exposure to ultra-violet light, weathering and high levels of pollution. The jacket shall conform to ASTM D1248 for density.

2.2.2 Optical, Electrical and Mechanical Requirements

Approach cable shall contain fibres with identical optical/ physical characteristics as those in the OPGW cables. The cable core shall comprise of tensile strength member(s), fibre support/bedding structure, core wrap/bedding, and an overall impervious jacket.

2.2.3 Installation of Approach Cable

The existing cable trenches/ cable raceways proposed to be used shall be identified in the survey report. The Contractor shall make its best effort to route the cable through the existing available cable trenches. Where suitable existing cable trenches are not available, suitable alternatives shall be provided after Employer approval.

Suitable provisions shall be made by the Contractor to ensure adequate safety earthing and insulated protection for the approach cable.

The required GI pipe (light grade) of suitable size (minimum 32mm), conforming

to IS 1239 or BS 1378, along with required bends, joints, conduit etc. required for laying and installation of approach cable shall be supplied and installed by the Contractor.

2.3 Optical Fibre Termination and Splicing

Optical fibre terminations shall be done in Fibre Optic Distribution Panels (FODP) designed to provide protection for fibre splicing of pre-connectorized pigtails and to accommodate connectorized termination and coupling of the fibre cables. The Contractor shall provide rack /wall mounted Fibre Optic Distribution Panels (FODPs) sized as indicated in the appendices and shall terminate the fibre optic cabling up to the FODPs. The location of FODP rack shall be fixed by the Contractor, with the Employer's approval.

2.3.1 Fibre Optic Distribution Panel

At each location requiring the termination of at least one fibre pair within a cable, all fibres within that cable shall be connectorized and terminated in Fibre Optic Distribution Panels in a manner consistent with the following:

(a) All fibre optic terminations shall be housed using FODPs provisioned with splice organizers and splice trays. All fibres within a cable shall be fusion spliced to pre-connectorized pigtails and fitted to the "Back-side" of the provided fibre optic couplings.

(b) FODPs shall be suitable for use with each of the cable types provided as part of this contract. FODPs shall accommodate pass-through splicing and fibre terminations.

(c) FODPs for indoor use shall be supplied in suitable cabinets/racks with locking arrangement.

(d) The FODP shall be of corrosion resistant, robust construction and shall allow both top or bottom entry for access to the splice trays. Ground lugs shall be provided on all FODPs and the Contractor shall ensure that all FODPs are properly grounded. The FODP shall meet or exceed ingress protection class IP55 specifications.

(e) Flexible protection shall be provided to the patch cord bunches going out from FODP cabinet to other equipment cabinet.

3. ENVIRONMENTAL, EMI, POWER SUPPLY CABLING AND EARTHING REQUIREMENTS

3.1 Environmental Condition

Equipment shall operate in accordance with the Environmental Operating limits as shown in the following Table:

Environmental Operating Limits

Temperature Range: **Specification** **Operation without damage** **Shipping/storage**	(Un Controlled Environment) 0 to 45°C -10 to 55°C -40 to 60°C
Relative Humidity, non-condensing	Upto 90%
Elevation: Operating Non-operating	to 3,000 m to 10,000 m

- Equipment shall be properly shielded against radiated emissions at each location.

- Power Distribution and Protection: Power supplies/converters for communications equipment shall use -48Vdc uninterrupted primary source power. The Employer will furnish only one power source. Contractor shall provide required distribution panels, circuit breakers, appropriate panel disconnects and all cabling, fusing, switching required. Distribution Panel feeders, Panel Disconnects, distribution panels and circuit breakers shall be sized and equipped to support at least 100% expanded load requirements. The Contractor shall also be responsible for Load Balancing.

- Contractor shall provide equipment and rack safety earthing in full compliance with EMI/EMC requirements as per relevant international standards.

- Equipment cabinet (enclosure) shall be designed 19 inch, free standing but shall be mounted on the floor. The dimensions of the cabinet shall be minimum 2200mmx600mmx600mm. All doors and removable panels shall be fitted with long life rubber beading. All panels shall be fabricated from minimum 2.0mm thickness steel sheet. However, for racks with load bearing Aluminium extrusion frame, door panels and side panels may be fabricated from minimum 1.6mm thickness steel sheet and the top & bottom panels shall be fabricated from minimum 2.0mm thickness steel sheet. Equipment cabinet (enclosure) shall be dust and moisture proof as per IP41 specification or better (supporting certificates/documents shall be submitted during detailed engineering).

- The Contractor shall provide all required minor civil works necessary for full connectivity as required in the Contractor's scope of work.

- Any other miscellaneous items which may be required for successful interfacing for establishment of end-to-end communication is deemed to be included in the scope of the Contractor.

4. TESTING

All materials furnished and all work performed under this Contract shall be inspected and tested. The entire cost of testing for factory & site acceptance, routine tests, production tests and other test during manufacture & site activities specified herein shall be treated as included in the quoted unit price of materials, except for the expenses of Inspector/Employer's representative.

Type tests shall not be required to be carried out if supplier has conducted these tests earlier on the same type of equipment and valid type test certificates are available. The

test certificate shall be considered valid if,

i. Tests conducted earlier is either conducted in accredited laboratory (accredited based on ISO/IEC 17025 by the National Accreditation body of the country where laboratory is located) or witnessed by POWERGRID/representative authorized by POWERGRID/representative of Utility /representative of accredited test lab/ representative of The National Accreditation Board for Certification Bodies (NABCB) certified agency.

ii. Type test reports contain valid Calibration reports/certificates of the relevant testing equipment, information pertaining to ratings, the relevant drawings, model number, test circuit, calculations (if any), photos, acceptance criteria/values specified in Technical Specification/ relevant standards (IS/ IEC) and compliance to the same.

And

iii. The Equipment shall be supplied from the same manufacturing works, where from the sample was manufactured and successfully type tested as per relevant standard or at the works of Parent organization in case of technology transfer/ Joint Venture (JV) for the initial period of 03 years from the date of establishment of manufacturing plant for offered equipment provided that the design, material, and manufacturing process of the offered equipment are identical to those of the type-tested sample of the original facility. In such cases, while submitting the Type Test Reports, the Original Equipment Manufacturer (OEM), shall furnish an undertaking with it declaring that there is

a) No change in the Design,

b) No change in the material,

c) No change in manufacturing process, and

d) No amendment/revision in the relevant standard as regard to type test conditions, since the type test

iv. In case of own manufacturing plant at different location within India, the type test of the original manufacturing works shall also be acceptable for the equipment manufactured and supplied from the different location subject to the following conditions:

   a. the relevant standard does not bar the same,
   b. the equipment being manufactured at different locations shall be identical in design, drawings, specifications, ratings to that of the type tested sample in the original facility (where it was manufactured and successfully type tested),
   c. the equipment being manufactured at different locations shall be identical in material & critical components, manufacturing process/ practices, and quality control to that of the type tested sample in the original facility (where it was manufactured and successfully type tested),
   d. Also, while submitting the Type Test Reports, the Original Equipment Manufacturer (OEM), shall furnish an undertaking for above conditions (a), (b) and (c).

"Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification. All equipment being supplied shall conform to type tests as per Annexure-I of technical specification. The test reports submitted shall be of the tests conducted with validity period as per Guideline for the Type Tests for Major Equipments in Power Plant. Type test validity and other requirement for type testing shall be governed from the "Guideline for the Type Tests for Major Equipments in Power Plant".
Link as below
" Final_Type_Test_Guidelines_2026.pdf"
Major item's type test validity is as below.

S.No.	Name of Equipment	Validity of type test

		(in years) from originally scheduled last date of bid submission
1	SDH Equipment	10
2	Fiber Optic cable(Approach Cable)	10
3	Cable (Power, Control)	10
4	Battery, Battery charger	10
5	DG set	10

The type test report for DG Set comprising of diesel engine and alternator are not required to be submitted for the makes listed in Compendium of Vendors of POWERGRID. For the new makes, type test reports of engine and alternator as per relevant standard shall be submitted for purchaser's approval.

In case the test reports are older than the duration specified, the Contractor shall repeat these tests at no extra cost to the purchaser. In the event of any discrepancy in the test reports or any type tests not carried out, same shall be carried out by Contractor without any additional cost implication to the Employer. Type Tests shall be certified or performed by reputed laboratories using material and equipment data sheets and test procedures that have been approved by the Employer.

Equipment to be delivered shall be tested at factory before dispatch as per approved procedure. Factory Acceptance Test shall demonstrate the technical characteristics of the equipment in relation to this specification and approved drawings and documents. The Contractor shall provide procedures for installation and site acceptance test. The site acceptance testing will comprise of end- to-end testing between the terminal stations and RLDC/SLDC and RTAMC/other CC end.

The detailed requirements for Type Test, Factory Acceptance Test and Site Acceptance Test are attached at '**Annexure – I**'.

Standard Procedure for Type test, Factory acceptance test and Site acceptance test are attached at '**Annexure-I (A)**' (Test shall be applicable as per offered items)

5. TRAINING

The Contractor will provide a training of suitable duration on supplied SDH equipment for Employer's personnel to provide working knowledge of the equipment, operation and diagnostic tools, supervision and monitoring using local craft terminal. The training may be provided by the Contractor or its sub-vendor at the site itself, preferably prior to installation, and will include training materials, presentation equipment, and all associated expenses.

No separate charges for training shall be payable to the Contractor.

6. SUPPORT SERVICES

Throughout design, implementation, factory testing, and field installation and testing, the Contractor shall supply consulting assistance, as required by the Employer for site preparation, field installation, and other areas where technical support may be required.

The Contractor shall be responsible for minor facility renovation, and maintenance of

the supplied system up to and including successful completion of the Site Acceptance Test.

After final acceptance of the communications equipment, the Contractor shall offer continuing technical support and spare parts for the communication equipment for a minimum period of 15 years from operational acceptance by the employer or 7 years after the declaration of withdrawal of equipment from production whichever is earlier. However, the termination of production shall not occur prior to Operational Acceptance of the system by the Employer. Some locations have existing SDH & MUX equipment. The traffic may be switched over to new fibre optic communication equipment in phase manner. The Contractor shall review the Employer existing equipment make, integration & switch over recommendation and prepare a detailed field implementation plan.

6.1 Technical Support

Consultation with Contractor's technical support personnel and trained field service personnel shall be readily available on a short-term/long-term basis to assist the Employer personnel in maintaining, expanding, and enhancing the telecommunication network upon expiration of the warranty period.

6.2 Contractor’s Future Hardware/Software Changes

The Employer shall be informed of all alterations or improvements to the hardware supplied under this Specification. The Employer shall be placed on the Contractor's mailing list to receive announcements of the discovery, documentation, and solution of hardware/software problems as well as other improvements that could be made to supplied equipment. The service shall begin at the time of contract award, and shall continue for a minimum period of 15 years from operational acceptance by the employer or 7 years after the declaration of withdrawal of equipment from production whichever is earlier. The Contractor shall also include a subscription to the hardware subcontractors' change notification service from the time of contract award through the warranty period, with an Employer renewable option for extended periods.

6.3 Mandatory Spare Parts

The Contractor shall be required to supply minimum spares for each subsystem as in BPS. The subsystem set of spare parts is defined to include all equipment modules, subunits and parts required to effect replacement, repair and restoration to full operational status of a defined unit of a subsystem (i.e. SDH equipment).

6.4 Warranty Period

The one-year period commencing immediately after the operational acceptance is called the Warranty Period/Defect liability Period. In addition to the responsibilities covered under Vol-I Condition of Contracts during Defect Liability Period, the Contractor shall also be responsible for maintenance of the Fibre Optic Transmission System etc. supplied under this Package.

6.5 Miscellaneous Supplies

The Contractor shall provide all required consumable and non-consumable supplies necessary to support all installation and test activities through final operational

acceptance. However, if there are any problems in the SAT and additional consumables are required, the same shall also be supplied by the Contractor at no additional cost.

7. DOCUMENTATION

The Contractor shall submit following documents during detailed engineering:

(a) Data Requirement sheets
(b) Link Budget calculations
(c) MQP, FQP, if applicable
(d) Bill of Quantity including mandatory spares
(e) Previous Type test reports
(f) Factory Test report
(g) Manuals for each equipment
(h) Schematic drawing
(i) Numbering, Marking, labelling documents
(j) Synchronization plan
(k) Test schedule
(l) Training manual
(m) Configuration diagram
(n) Transportation & handling Procedure
(o) Installation Manuals
(p) Maintenance Manual
(q) Nomenclature: The contractor is responsible to follow standard naming in SDH and its services. Same shall be finalized during detailed engineering.

Annexure - I

Testing Requirement of Communication Equipment

1.1 List of type test to be conducted on Telecom equipment

The type tests for Telecom Equipment with all types of cards are described below:

1.1.1 Temperature and Humidity Tests

The tests listed below are defined in IEC Publication 60068.

(a) Low Temperature Test: Operation to Specifications

Low temperature tests shall be conducted as defined in IEC Publication 60068-2-1, test method Ad, with the following specifications:

(1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for sixteen (16) hours. Its performance is checked during the test.

(2) Degree of Severity: Test shall be done at 0°C

(3) Acceptance Criteria: No degradation of performance during and after the test.

(b) Low Temperature Test : Operation without Damage

Low temperature tests shall be conducted as defined in IEC Publication 60068-2-1, test method Ad, with the following specifications:

(1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 72 hours. Its performance is checked during the test and after the test as soon as the thermal equilibrium is reached at the room temperature (*Post-test*).

(2) Degree of Severity: Test shall be done at -10° C

(3) Acceptance Criteria: Degradation of performance is allowable during the test, however there shall be no degradation of performance in the *post-test*.

(c) Dry Heat Test: Operation to Specifications

Dry heat test shall be done as defined in IEC Publication 60068-2-2, test method Bd, with the following specifications:

(1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test.

(2) Degree of Severity: operation to specification range.

(3) Acceptance Criteria: No degradation of performance during and after the test.

(d) Dry Heat Test: Operation without Damage

Dry heat tests shall be done as defined in IEC Publication 60068-2-2, test method Bd, with the following specifications:

(1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 96 hours. Its performance is checked during the test and after the test as soon as the thermal equilibrium is reached at the room temperature (*Post-test*).

(2) Degree of Severity: Test shall be done at 55ºC.

(3) Acceptance Criteria: Degradation of performance is allowable during the test, however there shall be no degradation of performance in the *post-test*.

(e) Damp Heat Test

Damp heat testing reveals aging with respect to the humidity level and applies basically to electronic equipment. This test shall be done as defined in IEC Publication 60068-2-3 with the following specifications:

(1) Test Duration: The equipment is started up as soon as thermal equilibrium has been reached and operated for 10 days. Its performance is checked during the test.

(2) Degree of Severity: Test shall be done at (40 ± 2) °C & (93 ± 3) % RH

(3) Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

(f) Temperature Variation Test

Temperature variation testing shall be as per IEC Publication 60068-2-14 (Gradual Variations, Method Nb). The equipment shall be powered on and various parameters shall be monitored continuously during the test period.

(1) Number of cycles required is five (5)

(2) The degree of severity: temperature TL:0°C, TH: (Operation to specification range)

(3) Cycle duration for each temperature is three (3) hours.

(4) Ramp : 1 ºC/minute.

(5) Acceptance Criteria: The equipment shall meet the specified requirement and there shall not be any degradation in BER.

1.1.2 Power Supply and EMI/EMC tests

The test procedure and acceptance criteria shall be as defined in IEC 60870-2-1.

(a) Immunity Tests

The list of Immunity tests are specified below in Table 1:

Table 1: Recommended Immunity Tests

S. No.	Immunity Test	AC Power Supply	DC Power Supply	Control & Signal	Telecom Line	Para-metres
1	Voltage Fluctuations	Yes	Yes	N/A	N/A	Table 11 of IEC 60870-2-1: 1995 - Level : 1
2	Voltage dips and Interruptions	Yes	Yes	N/A	N/A	
3	1.2/50 - 8/20 µs surges	Yes	Yes	Yes	N/A	Table 12 of IEC 60870-2-1: 1995 - Level : 1
4	Fast transient bursts	Yes	Yes	Yes	Yes	Table 12 of IEC 60870-2-1: 1995 - Level : 4
5	Damped oscillatory waves	Yes	Yes	Yes	Yes	Table 12 of IEC 60870-2-1: 1995 - Level : 1
6	Electrostatic discharge	Yes				Table 13 of IEC 60870-2-1: 1995 - Level : 4
7	Radiated electromagnetic field	Yes				Table 15 of IEC 60870-2-1: 1995 - Level : 4
-End of Table-						

(b) Emission Tests

The list of Emission tests are specified below in Table 2

Table 2: Recommended Emission Tests

S. NO.	Emission test	AC Power Supply	DC Power Supply	Control & Signal	Telecom Line	Para-metres
						Table 17 of IEC 60870-2-1: 1995 - Class : B
1	RF disturbance voltages CISPR 22	Yes	Yes	N/A	N/A	
2	RF disturbance currents CISPR 22	N/A	N/A	N/A	Yes	
3	RF radiated fields CISPR 22	Yes				
-End Of Table-						

(c) Insulation Withstand Voltages

As per section 6 of IEC 870-2-1. Recommended class: VW1 of Table 18.

1.1.3 Mechanical Tests

(a) Mechanical Vibration Test

The procedure for this test is described in IEC Publication 60068-2-6. The testing procedure shall be carried out in the sequence 8.1 + 8.2.1 + 8.1 as described in document 60068-2-6. For the vibration response investigation (clause 8.1 of 60068-2-6), the test shall be carried out over a sweep cycle under the same conditions as for the endurance test (described later), but the vibration amplitude and the sweep rate may be decreased below these conditions so that the determination of the response characteristics can be obtained.

The endurance tests conditions are selected according to the vibration withstand requirements.

Transportation tests shall be performed with the equipment packed according to the Contractor's specifications.

(b) Shock Test

The procedure of this test is defined in IEC Publication 60068-2-27 (each test) with a semi-sinusoidal shape (clause 3.1.1.2).

The recommended severity shall be A = 294 m/s^2, D = 18 ms. Three shocks per axis per direction shall be applied to the equipment packed according to the Contractor's specifications.

Or Free Fall Test

This test could be performed as an alternative to the shock or Bump test. The procedure is defined in IEC publication 60068-2-32. The equipment shall be packed according to the Contractor's specifications. The drop height shall be defined in accordance with IEC 68-2-32. The surface of the packing case which comes into contact with the ground is the surface on which the packing case normally rests; if the packing does not have any features (inscription, special shape, etc.) identifying this surface, the test is carried out successively on all the surfaces of the packing.

Or Bump Test

This test could be performed as an alternative to Shock test or Free Fall test. The procedure is defined in IEC 60068-2-29.

1.2 Type tests for Optical Fibres

The type tests listed below in Table 3 shall be conducted on DWSM fibres to be supplied as part of Approach cable. The tests specific to the cable type are listed in subsequent sections.

Table 3
Type Tests For Optical Fibres

S. No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation	As per Standard	IEC 60793-1-40 Or EIA/TIA 455-78A
2	Attenuation Variation with Wavelength	As per Standard	IEC 60793-1-40 Or EIA/TIA 455-78A
3	Attenuation at Water Peak	As per Standard	IEC 60793-1-40 Or EIA/TIA 455-78A
4	Temp. Cycling (Temp dependence of Attenuation)		IEC 60793-1-52 Or EIA/TIA 455-3A, 2 cycles
5	Attenuation With Bending (Bend Performance)		IEC 60793-1-47 Or EIA/TIA 455-62A
6	Mode Field dia.		IEC 60793-1-45 Or EIA/TIA 455-164A/167A/174
7	Chromatic Dispersion		IEC 60793-1-42 Or EIA/TIA 455-168A/169A/175A
8	Cladding Diameter		IEC 60793-1-20 Or EIA/TIA 455-176
9	Point Discontinuities of attenuation		IEC 60793-1-40 Or EIA/TIA 455-59
10	Core -Clad concentricity error		IEC 60793-1-20 Or EIA/TIA 455-176
11	Fibre Tensile Proof Testing		IEC 60793-1-30 Or EIA/TIA 455-31B
-End Of table-			

1.3 Type tests for Fibre Optic Approach Cable

The type tests to be conducted on the Fibre Optic Approach cable are listed in Table 4: Type Tests for Fibre Optic Approach Cable. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table 4:
Type Tests Fibre Optic Approach Cable

S.NO.	Test Name	Test Procedure
1	Water Ingress Test	(IEC 60794-1-F5 / EIA 455-82B) Test duration : 24 hours
2	Seepage of filling compound	(EIA 455-81A) Preconditioning : 72 hours, Test duration : 24 hours.
3	Crush Test	(IEC 60794-1-E3/ EIA 455-41)
4	Impact Test	(IEC-60794-1-E4/ EIA 455-25A)
5	Stress strain Test	(EIA 455-33A)
6	Cable Cut-off wavelength Test	(EIA 455-170)
7	Temperature Cycling Test	(IEC60794-1-F1/EIA-455-3A) – 2 cycles
-End Of Table-		

1.4 Factory Acceptance Test Requirement

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Factory acceptance testing shall be carried out on Approach Cable, FODP, Craft terminal, SDH Equipments, associated line & tributary cards, and all other items for which price has been identified separately in the Bid Price Schedules.

Material shall not be shipped to the Employer until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the Employer, and the Employer has issued CIP Clearance/Interim Inspection Report. Successful completion of the factory tests and the Employer approval to ship, shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the Employer's authorised representatives unless waiver for witnessing by Employer’s representatives is intimated to the contractor.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation by the Employer.

The factory acceptance test shall demonstrate the technical characteristics of the equipment in relation to this specifications and approved drawings and documents. List of factory acceptance tests for Fibre Optic Transmission system, Approach cable, Craft terminal, and FODP are given in specified Tables in this section. This list of factory acceptance tests shall be supplemented by the Contractor's standard FAT testing program. The factory acceptance tests for the other items shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's / supplier's) standard FAT testing

program. In general the FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces, alarms and diagnostics etc.

During FAT stage, the employer has to verify all type test reports/certificates including Communication Protocol and security conformance tests of the devices offered for FAT as part of essential cyber security tests. The equipment/system besides for functionality shall also be tested in the factory for vulnerabilities, design flaws, parts being counterfeit or tainted, so as to minimize problems during on-site testing and installation. Cyber security conformance testing are to be carried out in the designated lab as identified by GoI/MoP.

The following auditor report and audit recommendations are to be verified during FAT.

1. Vulnerability assessment
2. Risk assessment
    a. Network architecture validation with respect to design documents.
    b. Penetration testing
    c. System Hardening test

1.4.1 Sampling for FAT

From each batch of equipment presented by the Contractor for Factory acceptance testing, the Employer shall select random sample(s) to be tested for acceptance. Unless otherwise agreed, all required FAT tests in the approved FAT procedures, shall be performed on all samples. The Sampling rate for the Factory acceptance tests shall be minimum 10% of the batch size (minimum 1) for all items. The physical verification shall be carried out on 100% of the offered quantities as per the approved FAT procedure. In case any of the selected samples fail, the failed sample is rejected and additional 20% samples shall be selected randomly and tested. In case any sample from the additional 20% also fails the entire batch may be rejected. In case a number of equipments are required for demonstration of the performance of any equipment during FAT, the sample size shall be taken as that number of equipments which are necessary to demonstrate the performance, irrespective of the percentage.

The Sampling rate for the Factory acceptance tests shall be 10% of the batch size (minimum 2) for FO cable drums, FODPs, and other similar items.

Since FAT testing provides a measure of assurance that the Quality Control objectives are being met during all phases of production, the Employer reserves the right to require the Contractor to investigate and report on the cause of FAT failures and to suspend further testing/ approvals until such a report is made and remedial actions taken, as applicable.

1.4.2 Production Testing

Production testing shall mean those tests which are to be carried out during the process of production by the Contractor to ensure the desired quality of end product to be supplied by him. The production tests to be carried out at each stage of production shall be based on the Contractor's standard quality assurance procedures. The production tests to be carried out shall be listed in the Manufacturing Quality Plan (MQP), alongwith information such as sampling frequency, applicable standards, acceptance criteria etc.

The production tests would normally not be witnessed by the Employer. However, the Employer reserves the right to do so or inspect the production testing records in accordance with Inspection rights specified for this contract.

Table 5:
Factory Acceptance Testing for Fibre Optic Transmission System

Item:	Description:
1.	Physical inspection for conformance to DRS, BOQ, drawings and appearance of equipment
2.	Optical output power
3.	Transmitter lightwave spectral analysis
4.	Low receive level threshold
5.	Generation of bit error rate curve
6.	Measurement of analog and digital service channel parameters as well as service channel functionality
7.	Performance of supervision, alarm, Craftsperson interface, diagnostics, loop backs etc.
8.	Electrical interface tests which include: output and input jitter, bit error rate, pulse shape, cable compensation, and line rate tolerance for multiplexers
9.	At a minimum tests on Ethernet interface shall include demonstration of ping test, throughput test, Latency test, Packet Loss test as per RFC 2544
11.	Simulation of failure conditions and failover of each redundant unit.
12.	VLAN (Layer-2 switching) feature testing configuration.
13.	Protection scheme for Ethernet Traffic (ERPS)
14.	Test of spare card slots
15.	Checks of power supply/converter voltage margins

Table 5:
Factory Acceptance Testing for Fibre Optic Transmission System

16.	Random inspections to verify the accuracy of documentation
17.	Test of spare parts/modules/cards as per applicable tests
18.	Comprehensive Cyber Security Tests in compliance to latest cyber security guidelines issued by CEA/MoP or any other govt department.

Table 6 **FAT on NMS (Craft Terminal)**	
1	Physical inspection of NMS hardware (Craft Terminal) for conformance to approved BoQ, DRS & drawing
2	Testing of NMS to demonstrate proper operation of all functions: Configuration Management, Performance Management, Fault Management and Security Management.

Table 7 **Factory Acceptance Tests On Approach Cable**
Factory Acceptance Test
Attenuation Co-efficient at 1310 nm and 1550 nm
Point discontinuities of attenuation
Visual Material verification and dimensional checks as per approved DRS/Drawings

Table 8 **Factory Acceptance Test**
Visual check of Quantities and Specific Component Number for each component of FODP and dimensional checks against the approved drawings.

1.5 Site Acceptance Tests

All equipment shall be tested on site under the conditions in which it will normally operate.

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. At a minimum Site Acceptance Testing requirement for Telecom equipment, NMS etc. is outlined in following section. This testing shall be supplemented by the Contractor's standard installation testing program, which shall be in accordance with his quality plan(s) for Telecom equipment installation.

During the course of installation, the Employer shall have full access for inspection and verification of the progress of the work and for checking workmanship and accuracy, as may be required. On completion of the work prior to commissioning, all equipment shall be tested to the satisfaction of the Employer to demonstrate that it is entirely suitable for commercial operation.

1.5.1 Phases for Site Acceptance Testing

The SAT shall be completed in following phases:

1.5.1.1 Installation Testing

The field installation test shall be performed for all equipment at each location. If any equipment has been damaged or for any reason does not comply with this Specification, the Contractor shall provide and install replacement parts at its own cost and expense.

In the installation test report, the Contractor shall include a list of all hardware or components replaced or changed between the completion of factory tests and the start of field tests and show that documentation and spare parts have been updated.

During Installation testing, the employer has to verify all type test reports/certificates including Communication Protocol and security conformance tests of the devices as part of essential cyber security tests.

The following auditor report and audit recommendations are to be verified during SAT.

1. Vulnerability assessment
2. Risk assessment
    a. Network architecture validation with respect to design documents.
    b. Penetration testing
    c. System Hardening test

The minimal installation testing requirements for fiber optic transmission subsystem are provided in the table below:

Table 9
Fibre Optic Transmission system Installation Testing

Item:	Description:
1.	Physical Inspection for conformance to drawings, rack elevations and appearance of equipment and cabling
2.	Equipment power supply (DC-DC converter) output voltage measurements
3.	Terminal transceiver performance testing (Tx power, Tx spectrum, receive signal strength, connector losses etc.)
4.	Service channel performance
5.	Craftsperson interface, alarm and control functional performance
6.	Rack and local alarms: No alarms shall be present and all alarms shall be demonstrated to be functional
7.	Network management interface and supervision performance
8.	Correct configuration, level setting & adjustments and termination of Input/ output interfaces
9.	Proper establishment of Safety and signalling earthing system and resistance to ground to be checked.
10.	Simulation of failure conditions and failover of protected components.
11.	Comprehensive Cyber Security Tests in compliance to latest cyber security guidelines issued by CEA/MoP or any other govt department.

1.5.1.2 Link Commissioning Tests

The commissioning tests shall verify that communication can be performed over the fiber optic link under test. Delay measurement, Bit Error measurements & service channel performance monitoring shall be made on the fibre optic links to verify compliance with designed link performance.

For Ethernet interface: At a minimum the following test requirements shall be demonstrated as per RFC 2544:

a) Ping test
b) Throughput test
c) Latency test
d) Packet Loss

The links shall be tested for 12 Hour. In case any link does not meet the performance requirements during 12 hour, then the cause of failure shall be investigated and the test shall be repeated after rectifying the defects.

This phase of testing shall be conducted by the Contractor and witnessed by the Employer. Field adjustments shall be made to meet established standard, however if the field adjustments fail to correct the defects the equipments may be returned to the Contractor for replacement at his own expense. In case any adjustments are required to be made during the interval of the test then the test shall be repeated.

1.5.1.3 Integrated Testing

Prior to commencement of integrated testing the overall system shall be configured as required to provide all the data and voice channel required to interconnect to control centres and other nodes in existing system. The integrated testing shall include end-to-end testing of communication.. The intent of integrated testing is to demonstrate that the equipment is operational end to end under actual conditions, that all variances identified during factory and field installation and communications testing have been corrected, and that the communication equipment is compatible with other equipment. The Integrated System Test shall include all fibre optic transmission equipment, the network management subsystem (Craft Terminal) and other components.

At a minimum the following tests shall be included in the integrated testing:

(1) Equipment configuration shall be checked to establish that it supports the channel routing.
(2) End to end testing of all individual voice circuits (VOIP) and to demonstrate proper operation of channels over wideband systems. Operation shall be checked in terms of quality of voice, call initiation and call termination processes.
(3) End-to-end testing of all individual Data Circuits (Ethernet). Operation shall be checked in terms of monitoring of BER/packet loss.
(4) Testing of NMS (Craft Terminal) to demonstrate proper operation of all functions. All the standard features of the NMS (Craft Terminal) shall be demonstrated for proper functioning.
(5) All the standard features of the existing NMS server (at RLDC/ SLDC) shall be demonstrated for proper functioning with respect to supplied communication equipment/ Node.
(6) Demonstration of Protection switching and synchronization of equipment.
(7) Comprehensive Cyber Security Tests in compliance to latest cyber security guidelines issued by CEA/MoP or any other govt department.

Annexure-I (A)

Standard Procedure for Type Test, FAT and SAT

TYPE TEST PROCEDURE

SDH System

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1. General Test Set-up for BER Testing, Ethernet testing and Alarm Signaling :

Test Set-up with detailed interconnection of cards and description for flow of signals to be provided.

2. List of Test Equipment:

Complete list of test equipment with serial number and validity of calibration to be provided.

3. Acceptance Criteria

The functional acceptance criteria for EUT are defined below:

N= the performance of equipment (EUT) in non-degraded mode (N1, N2 & N3)

N1=BER test

Evaluation criteria N for BER test, the test duration / period, are 15 mins. The pass criteria for "Operation to specification tests is that the number of bit error at the end of specified measurement period shall not exceed the max number of error generated by BER is equal $1X10^{-10}$

N2= Alarm status:

Evaluation criteria N for alarm status. No effect ≥ No change of status in the LCT & alarm contacts.

N3= Ethernet ping test:

Evaluation criteria N for Ethernet ping test. Perform ping test and there shall be no missing of pings during normal operation of ping test.

D= The performance of equipment (EUT) In degraded mode (D1, D2):

D1= BER test:

Evaluation criterion D for minor failure: Temporary degradation (with the equipment or link still in operational status) or loss of functions or performance which is self-recoverable with respect to the loss signal recovery condition.
The allowed number, of error ≤ Error rate up to 10^{-6} error during the BER test.

D2= Alarm Status:

Evaluation criterion D for alarm status => change of alarm status allowed. Appearance of major and minor alarm on alarm contact. The alarms can be affected during the testing period but will be self-recoverable with respect to loss signal recovery condition.

EUT performance check:

Equipment checks are made before, during and after the test as detailed in test procedures.
If functional degradation is allowed during the test then after the test, equipment under test should behave normally (i.e. without degradation with no manual intervention)

4. Temperature and Humidity Tests

Test Number	**4.1**
Tender reference	
Test Name	**Low Temperature test: Operation to Specification**
Standard reference	**IEC 60068-2-1 (2007) Method Ad**
Test setup	As per figure shown in chapter General test setup
Test Procedure	The Climatic chamber shall be operated at Temperature = 0° C. The rate of change of temperature within the chamber shall be 0.5°C per minute. The test duration is 16 hours excluding thermal stabilization. The equipment shall be powered on after 1 hour of thermal stabilization.
Acceptance criteria	No degradation of performance is allowed during the test & after the test. According to evaluation criteria N1, N2 & N3 Section: ***"3.acceptance criteria"***
Observation	During test & After test: Non degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status. N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**4.2**
Tender reference	
Test Name	**Low Temperature test: Operation Without Damage**
Standard reference	**IEC 60068-2-1 (2007) Method Ad**
Test setup	As per figure shown in chapter General test setup
Test Procedure	The Climatic chamber shall be operated at Temperature = -10° C The rate of change of temperature within the chamber shall be 0.5°C per minute. The test duration is 72 hours excluding thermal stabilization. The equipment shall be powered on after 1 hour of thermal stabilization.
Acceptance criteria	Degradation of performance is allowed during the test. According to evaluation criteria D1, D2 & D3 of ***"3.acceptance criteria"***. However there shall be no degradation of performance in the post-test according evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During test : Degraded mode **For Equipment Under Test (EUT)** D1= BER test D2= Alarm Status D3= Ethernet ping test After the tests :Non-Degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**4.3**
Tender reference	
Test Name	**Dry Heat Test : Operation to Specification**
Standard reference	**IEC 60068-2-2 (2007) Method Bd**
Test setup	As per figure shown in chapter General test setup
Test Procedure	The Climatic chamber shall be operated at Temperature = 45° C. The rate of change of temperature within the chamber shall be 0.5°C per minute. The test duration is 96 hours excluding thermal stabilization. The equipment shall be powered on after 1 hour of thermal stabilization.
Acceptance criteria	No degradation of performance is allowed during the test & after the test. According to evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During the tests & After the test :Non-Degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**4.4**
Tender reference	
Test Name	**Dry Heat test: Operation Without Damage**
Standard reference	**IEC 60068-2-2 (2007) Method Bd**
Test setup	As per figure shown in chapter General test setup
Test Procedure	The Climatic chamber shall be operated at Temperature = 55° C. The rate of change of temperature within the chamber shall be 0.5°C per minute. The test duration is 96 hours excluding thermal stabilization. The equipment shall be powered on after 1 hour of thermal stabilization.
Acceptance criteria	Degradation of performance is allowed during the test. According to evaluation criteria D1, D2 & D3 of ***"3.acceptance criteria"*** However there shall be no degradation of performance in the post-test according evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During test : Degraded mode **For Equipment Under Test (EUT)** D1= BER test D2= Alarm Status D3= Ethernet ping test After the tests :Non-Degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**4.5**
Tender reference	
Test Name	**Damp Heat Test**
Standard reference	**IEC 60068-2-3**
Test setup	As per figure shown in chapter General test setup
Test Procedure	The Climatic chamber shall be operated at Temperature = (40 ± 2) °C Humidity = (93 ± 3) % RH The rate of change of temperature within the chamber shall be 0.5°C per minute. The test duration is 240 hours excluding thermal stabilization. The equipment shall be powered on after 1 hour of thermal stabilization.
Acceptance criteria	No degradation of performance is allowed during the test & after the test. According to evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During the test & after the test :Non-Degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**4.6**
Tender reference	
Test Name	**Temperature Variation Test**
Standard reference	**IEC 60068-2-14 (2009) Method Nb**
Test setup	As per figure shown in chapter General test setup
Test Procedure	The Climatic chamber shall be operated at Low temperature 0° C and at 45° C. The cycle test duration will be 3 hours for each temperature. The ramp is defined as 1°C/minute. The Number of cycle is 5. The equipment shall be powered on.
Acceptance criteria	Equipment performance is checked during the test & after the test and no degradation of performance is allowed during the test. The evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During the test & after the test :Non-Degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

5. Power supply & EMI/EMC Test

5.1 Immunity Tests

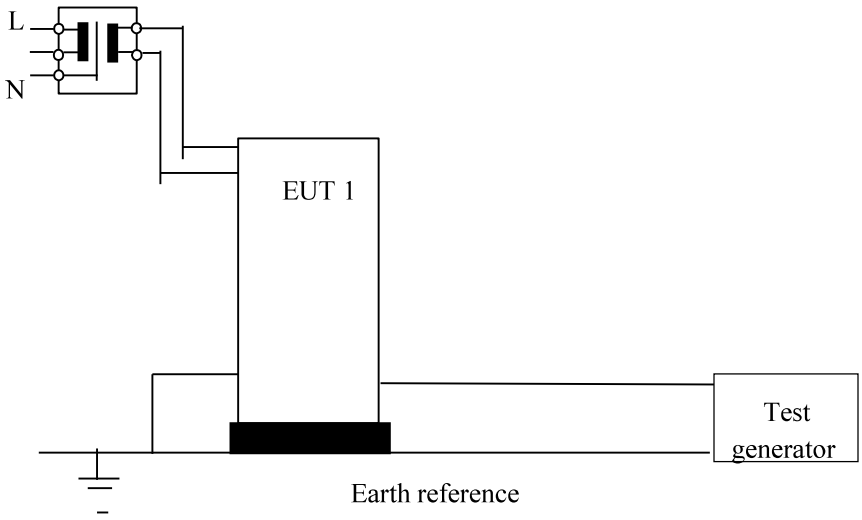
The list of Immunity tests are specified below:

Sr. No	Immunity test	AC Power Supply	DC Power Supply	Control & Signal	Telecom Lines	Parameters
1	Voltage Fluctuation	Yes	Yes	N/A	N/A	IEC 60870-2-1:1995, Table 11 Level:1
2	Voltage dips & Interruptions	Yes	Yes	N/A	N/A	
3	1.2/50-8/20us surge	Yes	Yes	Yes	N/A	IEC 60870-2-1:1995, Table 12 Level 1
4	Fast transient Burst	Yes	Yes	Yes	Yes	IEC 60870-2-1:1995, Table 12 Level 4
5	Damped Oscillator waves	Yes	Yes	Yes	Yes	IEC 60870-2-1:1995, Table 12 Level 1
6	Electrostatic Discharge	N/A	Yes			IEC 60870-2-1:1995, Table 13 Level 4
7	Radiated Electromagnetic field	N/A	Yes			IEC 60870-2-1:1995, Table 15 Level 3

Test Number	**5.1.1**
Tender reference	
Test Name	**Voltage fluctuations**
Standard reference	**Table 11 of IEC 60870-2-1(1995) Level 1**
Test setup	As per figure shown in chapter General test setup
Test Procedure	This test is applicable on DC power supply port. The three condition (Un, Un+10% and Un-10%) will be conducted. Un= (-48 VDC) U=±8% during 2.5±0.5 sec Global cycle : 10s for one cycle Test of sequence of three constructive cycles (Zero second delay between each cycle).
Acceptance criteria	No degradation of performance is allowed during and after the test. According to evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During test & after the test non degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**5.1.2-a**
Tender reference	
Test Name	**Voltage Dips**
Standard reference	**Table 11 of IEC 60870-2-1(1995) Level 1/ IEC61000-4-11**
Test setup	As per figure shown in chapter General test setup
Test Procedure	This test is applicable on DC power supply port. The three condition (Un, Un+10% and Un-10%) will be conducted. Un= (-48 VDC) U=30% reduction: U= 14.4 for Un =-48V U=15.8 for Un =-48V+10% U=13.0Vfor Un=-48V-10% Duration of dips: ±0.5s One sequence of three dips with an interval of ten seconds.
Acceptance criteria	Transient disturbance, Degradation of performance is allowed during the test according the evaluation criteria D1, D2 & D3 as of chapter ***"3.acceptance criteria"*** However there shall be no degradation of performance in the post test according the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During the test : Degraded mode **For Equipment Under Test (EUT)** D1= BER test D2= Alarm Status D3= Ethernet ping test After the tests :Non-Degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**5.1.2-b**
Tender reference	
Test Name	**Voltage Interruption**
Standard reference	**Table 11 of IEC 60870-2-1(1995) Level 1 and IEC 61000-4-11**
Test setup	As per figure shown in chapter General test setup
Test Procedure	This test is applicable on DC power supply port. The three condition (Un, Un+10% and Un-10%) will be conducted. Un= (-48 VDC) U=100% reduction: U= 45.6 for Un =-48V U=50.2 for Un =-48V+10% U=41.0V for Un=-48V-10% Duration of interruptions: 10ms One sequence of three interruptions with an interval of ten seconds.
Acceptance criteria	Transient disturbance, Degradation of performance is allowed during the test according the evaluation criteria D1, D2 & D3 as of chapter ***"3.acceptance criteria"*** However there shall be no degradation of performance in the post test according the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During the test : Degraded mode **For Equipment Under Test (EUT)** D1= BER test D2= Alarm Status D3= Ethernet ping test After the tests :Non-Degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**5.1.3**
Tender reference	
Test Name	**1.2/50 - 8/20 us Surge**
Standard reference	**Table 12 of IEC 60870-2-1(1995) Level 1/IEC 61000-4-5**
Test setup	As per figure shown in chapter General test setup
Test Procedure	This test is applicable on - DC power supply port. - control and signal lines -indoor telecommunication lines. Wave : 1.2/50us – 8/20 us Level : 0.5KV common mode 0.25KV differential mode* (not applicable to balanced signal lines) 5 positive pulses and 5 negative pulses separated by 1 min are tested. Safety Insulation  Positive polarity and negative polarity are tested, 5 positive pulse and 5 negative pulse separated by 1 min. The differential mode will not be applied on shielded lines.

Acceptance criteria	Transient disturbance, Degradation of performance is allowed during the test according the evaluation criteria D1 & D2 of ***"3.acceptance criteria"*** However there shall be no degradation of performance in the post test according to the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During the test : Degraded mode **For Equipment Under Test (EUT)** D1= BER test D2= Alarm Status After the tests :Non-Degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**5.1.4**
Tender reference	
Test Name	**Fast transient bursts**
Standard reference	**Table 12 of IEC 60870-2-1(1995) Level 4 / IEC 61000-4-4**
Test setup	As per figure shown in chapter General test setup
Test Procedure	This test is applicable on - DC power supply port. - control and signal lines -indoor telecommunication lines. Level : - DC Power Line : 4KV in common mode - Control & signal lines, telecom lines : 2KV in common mode Frequency repetition : 5KHz Positive polarity & Negative polarity are tested. The test on the DC power line is realized with coupling/decoupling network. The test on the control & signal line, telecom lines is realized with a coupling clamp.
Acceptance criteria	Transient disturbance, Degradation of performance is allowed during the test according the evaluation criteria D1 & D2 as of chapter ***"3.acceptance criteria"*** However there shall be no degradation of performance in the post test according the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During the test : Degraded mode **For Equipment Under Test (EUT)** D1= BER test D2= Alarm Status After the tests :Non-Degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**5.1.5**
Tender reference	
Test Name	**Damped Oscillatory Wave**
Standard reference	**Table 12 of IEC 60870-2-1 (1995) Level: 1 / IEC 61000-4-18**
Test setup	As per figure shown in chapter General test setup
Test Procedure	This test is applicable on - the DC power supply - control & signal lines - Telecommunication lines. Test level: - 0.5KV: common mode voltage - 0.25KV: differential mode voltage Period injection: 1µs (damped oscillatory frequency is 1MHz) Duration of test is at least 2s on each line under test. The minimum time interval between two successive tests is 10sec. acc. IEC 61000-4-1 chapter 8. Injection with the generator connected to a coupling /decoupling network, for shielded lines coupling directly onto the screen. DC power supply: positive pole is earthed on sub rack, therefore only common test line to earth is applied. Control & Signal lines and telecommunication lines: All are balanced lines, therefore acc. IEC 60870-2-1 the differential mode test is not applicable.
Acceptance criteria	Transient disturbance. Degradation of performance is allowed during the test according the evaluation criteria D1 & D2 as of chapter ***"3.acceptance criteria"***. However there shall be no degradation of performance in the post test according the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	<u>During the test : Degraded mode</u> **<u>For Equipment Under Test (EUT)</u>** D1= BER test D2= Alarm Status <u>After the tests :Non-Degraded mode</u> **<u>For Equipment Under Test (EUT)</u>** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**5.1.6**
Tender reference	
Test Name	**Electrostatic Discharges**
Standard reference	**Table 13 of IEC 60870-2-1 (1995) Level: 4 /IEC61000-4-2**
Test setup	As per figure shown in chapter General test setup
Test Procedure	Contact discharge on vertical coupling plane and accessible metallic parts of the sub rack. Level: 8KV According to IEC 61000-4-2 all the intermediate levels (1 to 3) of 2KV, 4KV and 6KV are tested before the level 4 given by IEC 60870-2-1. Positive polarity and negative polarity are tested. Time between pulses is 1s. Ten discharges of each polarity are applied on each point tested. Note: The IEC 60870-2-1 does not specify tests for air discharge.
Acceptance criteria	Transient disturbance. Degradation of performance is allowed during the test according the evaluation criteria D1, D2 & D3 as of ***"3.acceptance criteria"***. However there shall be no degradation of performance in the post test according the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During the test : Degraded mode **For Equipment Under Test (EUT)** D1= BER test D2= Alarm Status D3= Ethernet ping test After the tests :Non-Degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**5.1.7**
Tender reference	
Test Name	**Radiated Electro Magnetic Field**
Standard reference	**Table 15 of IEC 60870-2-1 (1995) Level: 3 /IEC61000-4-3**
Test setup	As per figure shown in chapter General test setup
Test Procedure	Test field strength: 10 V/m (un modulated signal) Modulation Frequency: 1KHz Modulation Depth: 80% Frequency Range: 80 MHz to 1000 MHz Step Size: 1% Both polarizations are tested. Distance between the equipment under test and the antenna: 1 meter. Four sided of the rack are tested.
Acceptance criteria	No degradation of performance is allowed during the test & after the test. The performance is checked only during the test according the evaluation criteria N1, N2 & N3 ***"3.acceptance criteria"***
Observation	During test & after the test non degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

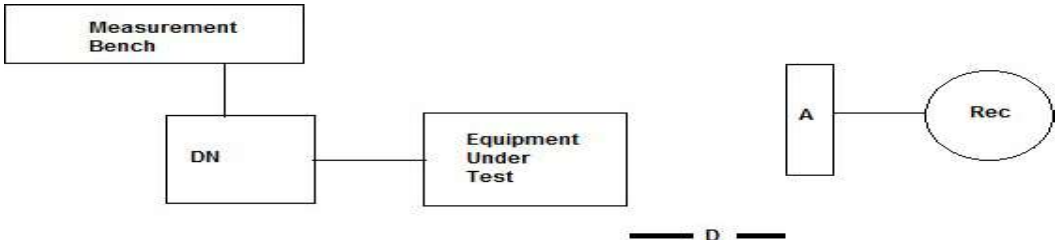
5.2 Emission Tests

The list of Emission tests are specified below:

Sr. No	Emission Test	AC Power Supply	DC Power Supply	Control & Signal	Telecom Line	Parameters
1	RF disturbance voltage CISPR 22	Yes	Yes	N/A	N/A	Table 17 of IEC 60870-2-1: 1995 - Class **: B**
2	RF disturbance currents CISPR 22	N/A	N/A	N/A	Yes	
3	RF radiated field CISPR 22	Yes				

Test Number	**5.2.1**
Tender reference	
Test Name	**RF disturbance voltages**
Standard reference	**CISPR 22 Table 17 of IEC 60870-2-1 (1995) Class: B**
Test setup	As per figure shown in chapter General test setup
Test Procedure	RF disturbance conducted voltages at the main ports. The voltage measurements are done with a receiver connected to a line impedance stabilization network [LISN]. The receiver has a peak average and quasi-peak detector. The test configuration for conducted measurements is floor standing equipment. Frequency range: 0.15 to 30 MHz Measurement unit: LISN Limits: Class B Frequency Range (MHz) — Quasi-peak Limits (dBµV) (Class B) 0.15 to 0.5 — 66 to 56* 0.5 to 5 — 56 5 to 30 — 60 *The limit have a linear decrease with a logarithm frequency variation
Acceptance Criteria	The level must be lower or equal to the limits specified in the test procedure. It is an EMC measurement, so the performance is checked only after the test according the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During test non degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer — For POWERGRID

Test Number	**5.2.2**
Tender reference	
Test Name	**RF disturbance currents**
Standard reference	**CISPR 22 Table 17 of IEC 60870-2-1 (1995) Class: B**
Test setup	As per figure shown in chapter General test setup
Test Procedure	RF disturbance current at the telecommunication ports. The measurements are done a/c to CISPR 22 C.1.2 with a receiver connected to a current probe. The receiver has a peak average and quasi-peak detector. A decoupling network (Ferrite) is placed on the cable of the telecommunication line connected to the bench. The test configuration for conducted measurements is floor standing equipment. In semi-anechoic Faraday room or ambient ground floor. Frequency range: 0.15 to 30 MHz Measurement unit: LISN Limits: Class B Frequency Range (MHz) — Quasi-peak Limits (dBμV) (Class B) 0.15 to 0.5 — 40 to 30* 5 to 30 — 30 *The limit have a linear decrease with a logarithm frequency variation The measurement shall be done with a peak detector. -if the disturbance levels are under the limits, the EUT (Equipment Under Test) is Declared in compliance with the specifications -if some disturbance levels are over the limits, detector QP (Quasi-Peak) is used to verify the compliance with the specification in the frequency range over the limit.
Acceptance Criteria	The level must be lower or equal to the limits specified in the test procedure. It is an EMC measurement, so the performance is checked only after the test according the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	During test non degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer — For POWERGRID

Test Number	**5.2.3**
Tender reference	
Test Name	**RF Radiated Fields**
Standard reference	**Table 17 of IEC 60870-2-1 (1995) Class B and CISPR 22 (2008)**
Test setup	As per figure shown in chapter General test setup
Test Procedure	The measurements are done with a receiver connected to an antenna. The receiver has peak and quasi peak detectors. Decoupling networks (DN: Ferrite) are placed on the cables connected to the bench.  The distance (D) between the EUT and the antenna is 3m. Only the EUT and the antenna are in the semi-anechoic chamber. Frequency range: 30 to 1000MHz Measurements at 3 meters. Antenna: Broadband antenna (30 to 1000MHz) Polarization: Both polarizations are measured Turntable: 360^0 Antenna mast: 1 to 4 meters above the ground plane Semi-anechoic Faraday room Frequency Range (MHz) Quasi-peak Limits (dBuV/m) (Vertical & Horizontal polarization) (Class B) 30 to 230 40 230 to 1000 47 Note: For reason of ambient noise at 10m in open area test site, the measurements will be done in a semi-anechoic Faraday room at 3m: according to chapter 10.2.1 of CISPR 22 IEC: 1997. According to CISPR 22, "An inversely proportionality factor of 20 dB/decade should be used to normalize the measured data to the specified distance for determining compliance." So it's necessary to add 10dB to the limits at 10meters indicted in the CISPR-22.
Acceptance Criteria	The level must be lower or equal to the limits specified in the test procedure. It is an EMC measurement, so the performance is checked only after the test according the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	<u>During test non degraded mode</u> **<u>For Equipment Under Test (EUT)</u>** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

5.3 Insulation Withstand Voltages

As per section 6 of IEC 60870-2-1. Recommended Class: VW1 of Table 18

Test Number	**5.3.1**
Tender reference	
Test Name	**Insulation withstand voltage isolation test & 1.2/50 µsec impulse voltage**
Standard reference	**IEC 60870-2-1 (1995) VWI of Table 18**
Test setup	As per figure shown in chapter General test setup
Test Procedure	This test is specified on DC power supply, control and signal ports and Telecommunication port as per table of 8 insulation with stand voltages class: VWI for DC power supply below 60V The test to applied are : a) Power supply with stand voltage : 0.5 KVrms b) Impulse: 1KV Peak for 1.2/50us impulse voltage; 5 pulse with negative polarity and 5 pulse with alternating polarity.
Acceptance criteria	During the test, the equipment is powered off. After the test, the equipment is required to function correctly in non- degraded mode according the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	After the test: Non degraded mode **For Equipment Under Test** **(EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

6. Mechanical Test

Test Number	**6.1**
Tender reference	
Test Name	**Mechanical Vibration Test**
Standard reference	**IEC Publication 60068-2-6**
Test setup	As per figure shown in General test setup
Test Procedure	6.1.1 5 to 9 Hz 0.3mm 9 to 200 Hz 1m/s^2 1 sweep cycle per all the three axis 6.1.2 5 to 9 Hz 3.5mm 9 to 200 Hz 10m/s^2 200 to 500 Hz 15m/s^2 5 sweep cycle per all the three axis 6.1.3 5 to 9 Hz 0.3mm 9 to 200 Hz 1m/s^2 1 sweep cycle per all the three axis Before commencing the vibration test, the EUT is switched on and functional test shall be done for 15 min period. During the test the equipment is powered off and packed. Vibration test will be conducted in the sequence 8.1, 8.2.1 and 8.1. After Completion of vibration test, EUT shall be unpacked and functional test shall be done for 15 min period.
Acceptance criteria	After the test, the equipment is required to function correctly in non- degraded mode according the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	After the test: Non degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**6.2**
Tender reference	
Test Name	**Shock test**
Standard reference	**IEC Publication 60068-2-27**
Test setup	As per figure shown in General test setup
Test Procedure	Acceleration amplitude 294 m/s^2. Duration: 18 ms Direction: Three Axis Number of shocks: 3 in each direction Direction of Shocks: 6 direction Total Number of shocks: 18
Acceptance criteria	After the test, the equipment is required to function correctly in non- degraded mode according the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	After the test: Non degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

Test Number	**6.3**
Tender reference	
Test Name	**Free Fall**
Standard reference	**IEC Publication 60068-2-31**
Test setup	As per figure shown in chapter General test setup
Test Procedure	The free fall test is applicable to specimens which during transportation, handling or repair work are liable to be dropped from their means of transport or from a work surface. Height of Fall — Specimen Mass In integral transport cases 250mm — <=75 Kg
Acceptance criteria	After the test, the equipment is required to function correctly in non- degraded mode according the evaluation criteria N1, N2 & N3 of ***"3.acceptance criteria"***
Observation	After the test: Non degraded mode **For Equipment Under Test (EUT)** N1= BER test N2= Alarm status N3= Ethernet ping test
Result	Pass [ ] Fail [ ] Not Applicable [ ] Remark [ ]
Remark	
Date Name Signature	For Laboratory representative/Manufacturer For POWERGRID

FACTORY ACCEPTANCE TEST PROCEDURE FOR OPTICAL FIBRE (ITU-T G.652D) APPLICABLE STANDARD EIA/TIA 455

Sl. No.	Test Name	Test Procedure	Acceptance Criteria
1	Attenuation Coefficient	EIA/TIA 455-78A	≤0.35dB/km (1310nm) ≤0.21dB/km (1550nm)
2	Point Discontinuities of Attenuation	EIA/TIA 455-59	≤0.1 dB
3	Attenuation at Water Peak	EIA/TIA-455-78A	≤0.34dB/km at 1383nm
4	Chromatic Dispersion	EIA/TIA 455 -168A/169A /175A	≤18 ps/(nm·km) at 1550nm
			≤3.5 ps/(nm·km) from 1288 nm to 1339nm
			≤5.3 ps/ (nm·km) from 1271nm to 1360nm
			Zero Dispersion wavelength: 1300nm – 1324nm; Zero Dispersion slope: ≤ 0.092 ps/nm^2.km
5	Core - Clad Concentricity Error	EIA/TIA 455- 176	≤0.5 µm
6	Cladding Diameter	EIA/TIA 455-176	125 ± 0.7 µm
7	Fibre Tensile Proof Testing	EIA/TIA 455-31B	≥1.0%, 1 sec. ≥ 0.69 Gpa (100kpsi)

Note: The test report of the above tests for the fibres are to be carried out by the Fibre Manufacturer and used in the Approach cable shall be shown to the inspector during Approach cable FAT and shall be submitted along with the Approach cable FAT reports.

FACTORY ACCEPTANCE TEST PROCEDURE
FOR APPROACH CABLES

Sl. No.	Factory Acceptance Test	Sampling plan
1	Attenuation Coefficient at 1310nm,1550nm	10% of offered FO approach cable drums/lot and 100% of fibers in selected FO approach cable drums.(Minimum 2)
2	Point discontinuities	10% of offered FO approach cable drums/lot and 100% of fibers in selected FO approach cable drums. (Minimum 2)
3	Visual material verification and dimensional checks as per approved DRS & drawings	Quantity verification: 100% of offered material.

IEC 60793-1-40, EIA/TIA-455-59 & EIA/T1A-455-61 and ITU-T G.652 D

Test Location :

Manufacturer :

Test Objective : To measure the optical attenuation at wavelengths 1310 nm and 1550 nm & Point discontinuities at both wavelength of 1310 nm and 1550nm.

Test Set-ups:

Prepare the sample under test as per the figure showing below the test setup. The test bench is connected with Optical Time Domain Reflectometer (OTDR) to measure the value of attenuation coefficient and Point discontinuities

Test Procedure:

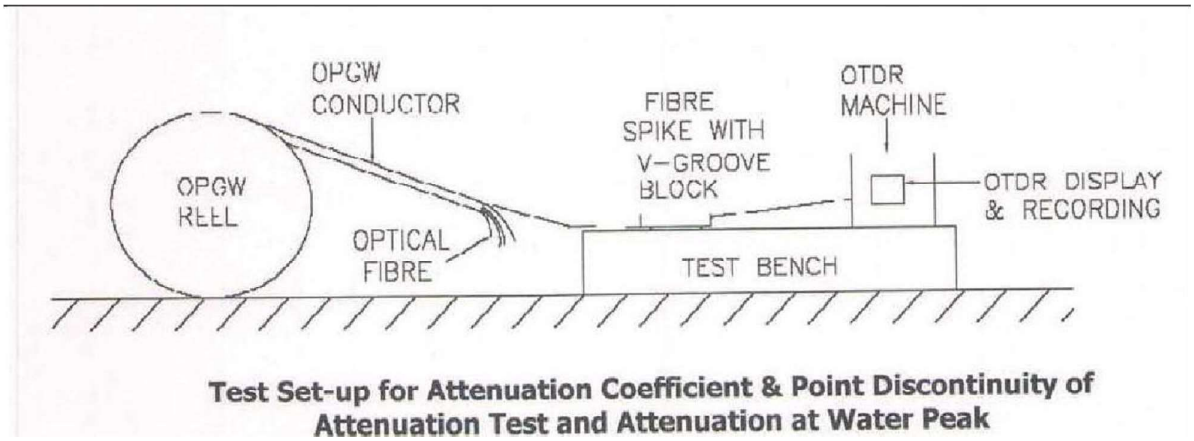
1. Connect the test sample either to the instrument or to one end of end dead-zone fiber (if used). Connect the other end of the dead-zone fiber (if used) to the instrument.
2. If the accurate locations of point defects are to be recorded, the effective group delay index of the test sample is required. If this value is not known, use FOTP-60 (Method A) to determine it.
3. Enter OTDR parameters such as source wavelength, pulse duration, length range, and signal averaging into the instrument, along with the test sample effective group index. The values of some of these parameters may be present in the instrument.
4. Adjust the instrument to display a backscatter signal from the test sample. It may be advantageous to begin with coarse vertical and horizontal scaling to maximize the length displayed. An example is given in Figure.
5. Examine the OTDR signal along the test sample for point defects. If increased resolution is needed, adjust the graphical display, if possible, to expand the section of interest to larger scale (exercising care to assure that proper reading of the true signal can still be distinguished from the noise points).
6. To determine that a point defect (rather than an attenuation non-uniformity situation) exist observe the area in question using two different pulse durations. If the shape of the loss or gain changes with the pulse duration, the anomaly is a point defect. If the shape does not change, the anomaly shall be considered to be attenuation non-uniformity to be measured by FOTP-61.
7. Report any point defect deviations which exceed the values specified in the Detail Specification. Describe the nature of these faults (e.g. apparent loss or gain, reflection, duration, etc.) as required by the Detail Specification.

7.1 Determine the defect location, if required, by placing a cursor at the beginning (or at another point specified by the OTDR manufacturer) of a power rise or drop, this may be difficult to do at a drop. Obtain the distance coordinate via the alphanumeric display. 7.2 Obtain the apparent loss or gain of the defect, if required, by the method described by the OTDR manufacturer .Some instruments required placement of a pair of cursors on each side of the defect. The two best-fit straight lines (from a two-point or least-squares fit for each) are extrapolated to the defect location .If available, the linear fit method should be

chosen. The vertical separation of the lines gives the apparent loss or gain .Note any reflection peak.

7.3 When possible, repeat the test for a single launched into the test sample in the opposite direction. A more accurate loss estimate (and the elimination of apparent gain) is made by averaging readings taken directionally at the same wavelength .This eliminates the effect of any backscatter different for the fiber sections on both side of the defect.

7.4 Repeat the test at another wavelength.



Test Set-up for Attenuation Coefficient & Point Discontinuity of Attenuation Test and Attenuation at Water Peak

Acceptance Criteria:

For Attenuation

Wavelength	Attenuation
1310 nm	< 0.35 dB/Km
1550 nm	<0.21 dB/Km

For Point Discontinuity: Attenuation of fiber shall be uniform throughout its length such that there are no point discontinuity in excess of 0.1dB.

ATTENUATION AND POINT DISCONTINUITY

Ring Mark	Fiber id	At 1310 nm					At 1550 nm			
		Optical Attenuation	Point Discontinuity	Pass or Fail	Remarks	Ring Mark	Optical Attenuation	Point Discontinuity	Pass or Fail	Remarks

Observations, if any:

Test Results:

The attenuation and point discontinuity measured have met/not met the acceptance criteria.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

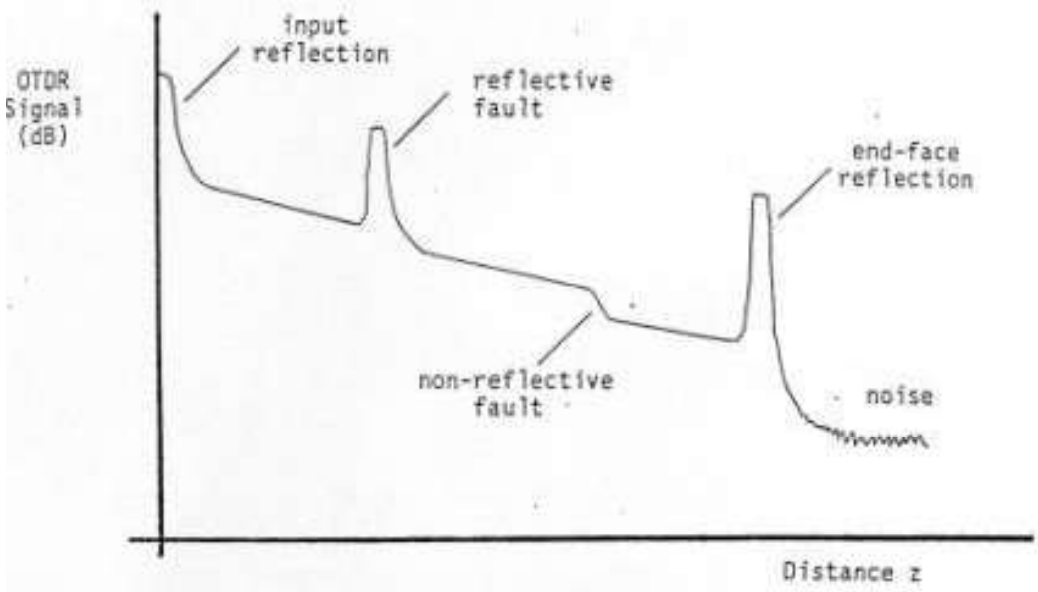


Figure 1. Schematic of an OTDR Trace. Point defects with apparent loss are shown, one reflective and one non-reflective.

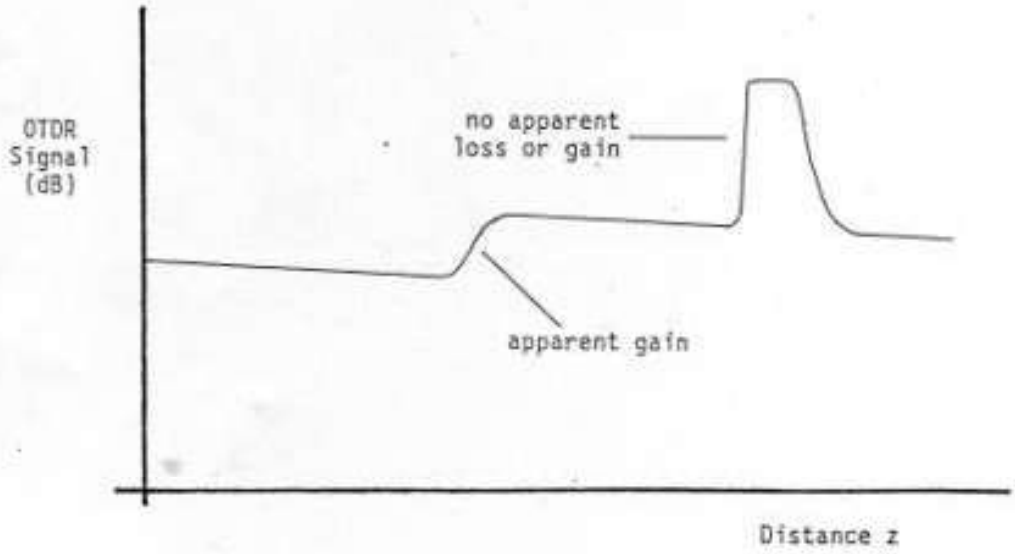


Figure 2. Schematic of an expanded OTDR trace. Two point defects are shown, one with apparent gain, and another with no apparent loss or gain.

2. VISUAL MATERIAL VERIFICATION, CABLE CONSTRUCTION AND DIMENSIONAL CHECKS

Test Standard: IEC 60793 & 60794, EIA/TIA-598

Test Location:

Manufacturer:

Cable Type: Approach Cable.

Reference Doc: Approved DRS & Drawings of Fiber Optical Approach Cable.

Objective: To measure the Visual material verification, Cable construction and dimensional checks for Fiber Optical Approach Cable.

Test Procedure:

The physical/dimensional measurements of the individual parts of the cable shall be taken with suitable measuring device and verified against the approved DRS/Drawings

Drum Checks:

Physical Verification for the 100% offered quantity of the offered reels/drums shall be carried out. 1.

2. 100% physical verification of sealing of cable ends with end caps, check for provision of spare cable caps for each drum.

3. 100% verification of Sealing/Pasting the drum details over the end cap with transparent tape.

4. Verification of drum details properly printed and pasted on each drum suitably as per approved document **Checks on Approach cable:** The below to be verified as per approved DRS/Drawings for both Fiber Optical Approach Cable.

S.NO.	Description	Acceptance Criteria
1.	No. of Fiber	AS per approved DRS& drawings
2.	Buffer Tube Quantity(Nos.)/Diameter	AS per approved DRS& drawings
3.	No. of Fibers per tube(Nos.)	AS per approved DRS& drawings
4.	Filling Material	AS per approved DRS& drawings
5.	Strengthening Member	AS per approved DRS& drawings
6.	Outside Jacket Coating	AS per approved DRS& drawings
7.	Outside Jacket Thickness	AS per approved DRS& drawings
8.	Armoring Tape provided	AS per approved DRS& drawings
9.	Weight(kg/km)	AS per approved DRS& drawings
10.	Overall Diameter	AS per approved DRS& drawings
11.	Identification of colors of fibers/tube	AS per approved DRS& drawings
12.	Other physical/Technical parameters	AS per approved DRS& drawings

Acceptance Criteria: Visual material verification, Cable construction and dimensional checks shall be as per approved DRS /drawings.

Observations, if any:

Test Results: The Fiber Optic Approach cables as teats met tested met the requirement as approved DRS & Drawings.

Test by: **Witnessed by:**

(sign with date) **(sign with date)**

FACTORY ACCEPTANCE TEST PROCEDURE (FAT)

SDH EQUIPMENT along with Optical Amplifier

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TPS-FOTS-001: Review of Calibration or Manufacturing Certificates

Equipment Under Test : **Test Equipment**

Test Parameters : **Review of Calibration or Manufacturing Certificates**

1.0 TEST DESCRIPTION

Prior to the commencement of system testing, the calibration certificates of all the test equipment as listed in the TPS for performing the system factory acceptance testing will be reviewed by inspection team.

2.0 LIST OF TEST EQUIPMENT

Test Equipment	Make	Model No.	Serial No.	Calibration Valid till Date

3.0 TEST RESULT RECORD

Copies of the calibration certificates will be attached along with this test sheet.

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Remarks

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-002: Inventory Verification

Equipment Under Test : **SDH Equipment**

Test Parameters : **Inventory Verification**

TEST DESCRIPTION

The aim of this test is to verify station wise inventory of offered equipment.

2.0 TEST PROCEDURE

1. Check station wise cards/units along with sub rack.
2. Verify it with the quantity of offered equipment as per approved BOM.

3.0 TEST RESULT RECORD

The quantity should be found as per the approved BOM.

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Remarks

_____

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-003: Optical Tx Output Power Measurement

Equipment Under Test : **SDH EQuipment Optical Units**

Test Parameters : **Optical Output Power**

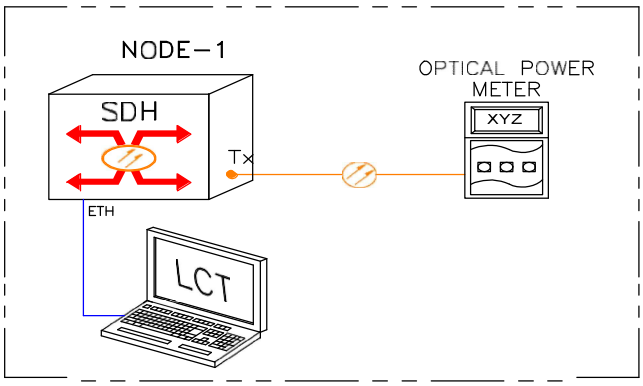
1.0 TEST DESCRIPTION

The purpose of this test is to determine whether the optical interface cards (STM-16 and STM-4) operate at designed level of optical output power range. This test ensures that the laser providing the optical output has adequate optical output power performance in compliance with ITU-T G.957.

2.0 TEST EQUIPMENT

1. Optical Power Meter
2. Local Craft Terminal (LCT)
3. Low loss optical patch cord

3.0 TEST SETUP



4.0 TEST PROCEDURE

1. Choose SDH equipment and plug optical cards of different application code. Use Low loss optical patch cord to connect the output optical port of the tested SDH node with the input port of Optical Power Meter in turn to test the output power.
2. Connect the optical output port of the SDH to the input port of the optical power meter with low loss optical patch cord to test the output power as shown in above figure.
3. Set the optical power meter to the specified wavelength.
4. Measure the output power level in dBm.
5. Record the result showing on the optical power meter.

5.0 TEST RESULT RECORD

*As per approved DRS

No.	Optical interfaces/ Card tested as per approved BOQ	Min (dBm)*	Max (dBm)*	Actual (dBm)

6.0 Acceptance Criteria:

The measured optical output power should be within the limits as per G.957

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Remarks

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-004: Receiver Sensitivity Measurement

Equipment Under Test : **SDH Equipment Optical Units**

Test Parameters : **Receiver Sensitivity Measurement**

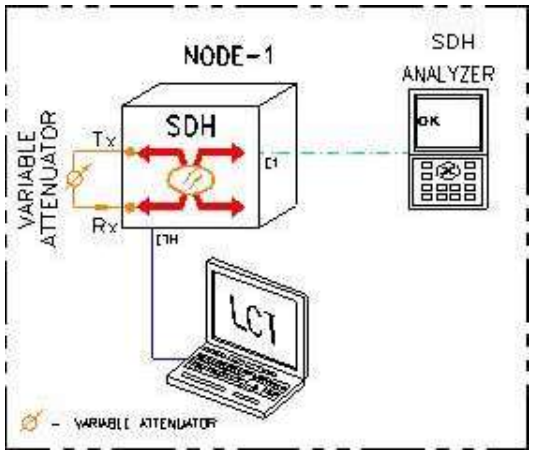
1.0 TEST DESCRIPTION

This test is performed to test the optical card of the SDH unit to ensure the minimum and maximum optical power level (sensitivity) of optical signal that can be detected and correctly re-constructed in compliance with ITU-T G.957.

2.0 TEST EQUIPMENT

4. Optical Power Meter
5. Variable Optical Attenuator (VOA)
6. SDH Analyzer
7. Local Craft Terminal (LCT)
8. Low loss optical patch cord

3.0 TEST SETUP



4.0 TEST PROCEDURE

Receiver Sensitivity

1. Choose the SDH equipment with STM-16 and STM-4 optical interface cards. Use optical patch cords to connect the optical ports to SDH Analyzer and VOA as shown in above figure.
2. Setup the SDH Analyzer for BER testing.
3. Increase the attenuation till any error occurs at the tested optical interface card.
4. Decrease the attenuation gradually, so that the error just goes off.
5. The test should continue for a period of 90 seconds.

6. Disconnect the optical patch cord from the tested port (Rx) and connect to the optical power meter.

7. Record the result showing on the optical power meter, is the receive sensitivity.

5.0 TEST RESULT RECORD

Sr. No.	Node / Station	Slot No./ Port No./Sr.No.	Module Type	Receiver Sensitivity as per ITU-T G.957 (dBm)	Actual (dBm)
1					
2					
3					

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Remarks

_____

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-005: SDH Optical Units - Laser Safety Check

Equipment Under Test : **SDH Optical Units**

Test Parameters : **Laser Safety Check**

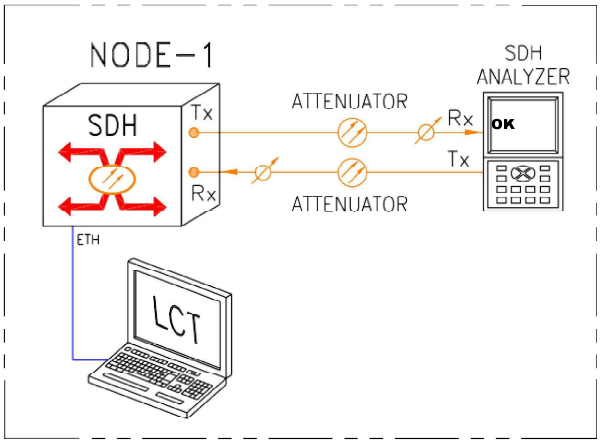
1.0 TEST DESCRIPTION

The aim of this test is to check the Laser safety (ALS: Automatic Laser Shutdown) functionality of the SDH optical interfaces. In this test it is checked if the laser shuts down automatically when the fiber link is broken.

2.0 TEST EQUIPMENT

1. SDH Analyzer
2. Optical Attenuators
3. Local Craft Terminal (LCT)
4. Low loss optical patch cord

3.0 TEST SETUP



4.0 TEST PROCEDURE

1. Set up E1 / Ethernet traffic and loop back the STM-4/16 optical path.
2. Enable ALS in the optical ports (STM-16/STM-4) used.
3. Inject LOS alarm by breaking Rx fiber.
4. Since ALS is enabled, the transmitter will switch OFF after 500 ms or more.
5. Measure the optical power output at Tx of STM-4/16 optical card, no power to be shown.
6. Restore the Rx fiber, the alarm to be cleared and the transmitter should be ON.
7. Record the result.

5.0 TEST RESULT RECORD

Sr. No.	Node / Station	Slot No. / Port No/Sr. no.	Optical Interface	Test Description	Specification	Results (OK/ Not OK)
1				ALS	Optical transmitter should shut off as per G.664 when the optical port receives LOS alarm.	
2				ALS	Optical transmitter should shut off as per G.664 when the optical port receives LOS alarm.	
3				ALS	Optical transmitter should shut off as per G.664 when the optical port receives LOS alarm.	

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Remarks

_____

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)

Date : _____ Date : _____

TPS-FOTS-006: Electrical Interface Input Jitter Tolerance

Equipment Under Test : **E1 (2 Mbit/s) Interface Unit**

Test Parameters : **Electrical (E1) Interface Input Jitter Tolerance**

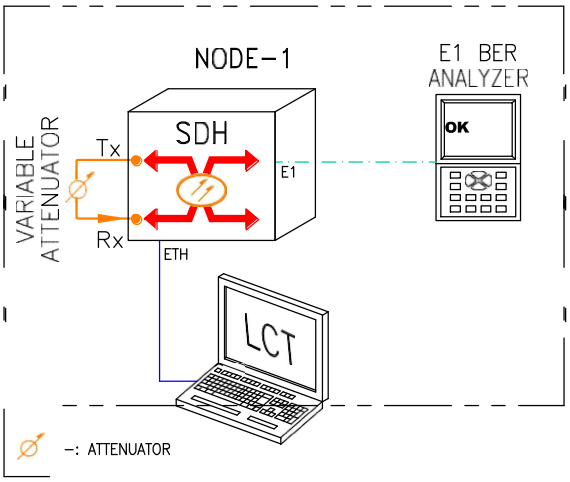
1.0 TEST DESCRIPTION

Measurement of input jitter tolerance of the electrical interface in compliance with ITU-T G.823

2.0 TEST EQUIPMENT

1. E1 Analyzer
2. Local Craft Terminal (LCT)
3. Connecting Cables

3.0 TEST SETUP



4.0 TEST PROCEDURE

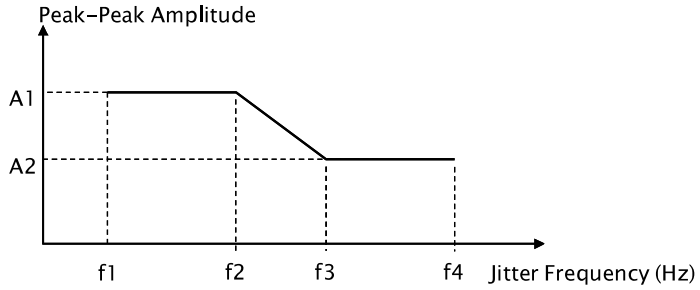
1. Choose one SDH node with E1 interface card (DUT). Use cable to connect the electrical output port of the tested node to the electrical input port of E1 Analyzer and connect the electrical input port of the tested node to the electrical output port of E1 Analyzer.
2. Select relevant rate for E1 Analyzer Rx / Tx port.
3. Set up E1Traffic from E1 Analyzer.
4. Loop back the optical port of the SDH equipment.
5. With the loop-back, there shall be no bit errors reported in the test set.
6. Setup the E1 Analyzer for jitter tolerance measurement. Choose an ITU-T G.823 mask.
7. Now go to Jitter Test Menu and perform Jitter Tolerance test by selecting Auto Tolerance Menu from the options (In Auto Jitter Tolerance test, the E1 Analyzer automatically increases the Jitter

until the point of failure and plots the point on the graph and then proceeds to the next Jitter Frequency).

8. Print out the plot of the result.

5.0 TEST RESULTS

Input jitter tolerance of E1 electrical interfaces:



Measured value should be as per ITU-T G.823. The test results will be attached with this test record.

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Node Details

Station _____

Unit Type _____

Remarks

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-007: Electrical (2 Mbit/s) Interface Output Jitter Generation

Equipment Under Test : **E1 (2 Mbit/s) Interface Unit**

Test Parameters : **Electrical (2 Mbit/s) Interface Output Jitter Generation**

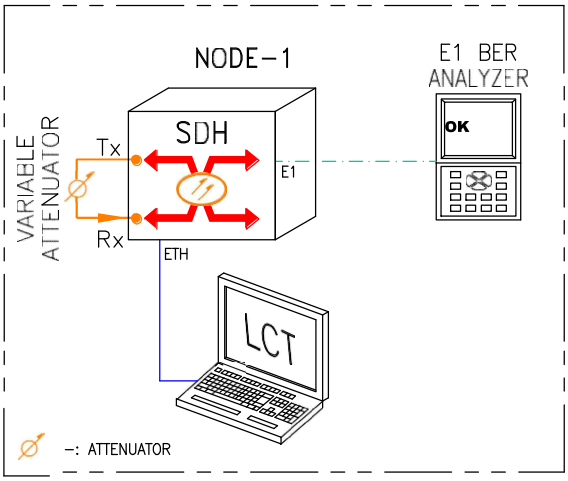
1.0 TEST DESCRIPTION

The aim of this test is to measure the jitter in 2Mbit/s output signal and check if it is as per ITU-T G.823.

2.0 TEST EQUIPMENT

1. E1 Analyzer
2. Local Craft Terminal (LCT)
3. Low loss optical patch cord

3.0 TEST SETUP



4.0 TEST PROCEDURE

1. Make setup as shown in above figure.
2. Set up E1 Traffic from E1 Analyzer.
3. Loop back the optical port of the SDH equipment.
4. With the loop-back, there shall be no bit errors reported in the test set.
5. Apply E1 Analyzer to send test signals, and configure proper measurement filter at the receiving end.
6. Perform continuous test with duration of 60 seconds.
7. Record the measured maximum peak-to-peak value of jitter.

5.0 TEST RESULTS

Interface	Measuring Filter		Peak-peak Jitter
2048 Kbit/s (E1 Interface)	20Hz to 100kHz (LP+HP1)	Standard	1.50 UI
		Measured	
	18kHz to 100kHz (LP+HP2)	Standard	0.2 UI
		Measured	

The measured value should not exceed the limits given in the above table.

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Node Details

Station _____

Unit Type _____

Remarks

_____

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)

Date : _____ Date : _____

TPS-FOTS-008: Electrical Interface Line Rate Tolerance

Equipment Under Test : **E1 (2 Mbit/s) Interface Unit**

Test Parameters : **Electrical (2 Mbit/s) Interface Line Rate Tolerance**

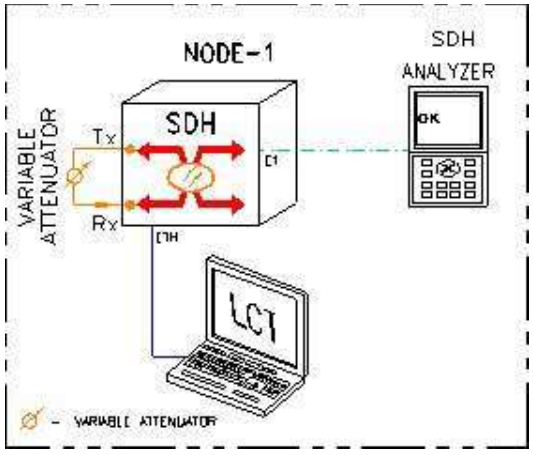
1.0 TEST DESCRIPTION

Measurement of line rate tolerance of the Electrical interface in compliance with ITU-T G.703

2.0 TEST EQUIPMENT

1. SDH Analyzer
2. Local Craft Terminal (LCT)

3.0 TEST SETUP



4.0 TEST PROCEDURE

1. Set up E1 traffic from SDH Analyzer and make suitable cross-connection using LCT.
2. Loop back optical port of SDH by means of an attenuator.
3. Setup the SDH Analyzer for BER testing.
4. Vary the offset ppm value up to the tolerable value in both positive and negative sides.
5. Record the result.

5.0 TEST RESULTS

Interface	Line Rate Tolerance	Measurement
E1 (2 Mbit/s)	2.048Mbits/s ± 50 ppm	

There should not be any errors during the test.

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Node Details

Station _____

Unit Type _____

Remarks

_____

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-009: Protection Switching of Redundant Cards

Equipment Under Test : **SDH Equipment**

Test Parameters : **Equipment Protection**

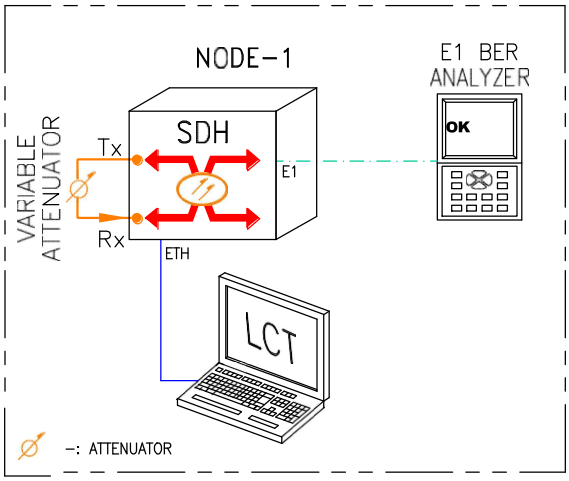
1.0 TEST DESCRIPTION

To verify that the protection switching mechanisms for the Common Control & Cross-connect card of SDH node is working properly.

2.0 TEST EQUIPMENT

1. E1 Analyzer
2. Local Craft Terminal (LCT)
3. Low loss optical patch cord

3.0 TEST SETUP



4.0 TEST PROCEDURE

a. Connect the electrical (Tx, Rx) of the SDH equipment to the E1 Analyzer.

b. Loop back the optical port (Tx, Rx) of the SDH equipment.

c. Create the cross connection between the electrical port and the optical port.

d. Unplug the active Common Control & Cross-connect card of SDH node from card slot.

e. The standby Common Control & Cross-connect card should take over, and the traffic should be restored.

5.0 TEST RESULTS

Traffic is restored even if one of the Common Control & Cross-connect cards failed.

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Node Details

Station _____

Unit Type _____

Remarks

_____

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-010: Multiplex Section Protection in SDH Network

Equipment Under Test : **SDH Transmission System**

Test Parameters : **Multiplex Section Protection**

1.0 TEST DESCRIPTION

The aim of this test to check the multiplex section protection scheme in compliance with the ITU-T G.841.

2.0 TEST EQUIPMENT

1. E1 Analyzer
2. Ethernet Analyzer
3. Cables and accessories

3.0 TEST SETUP

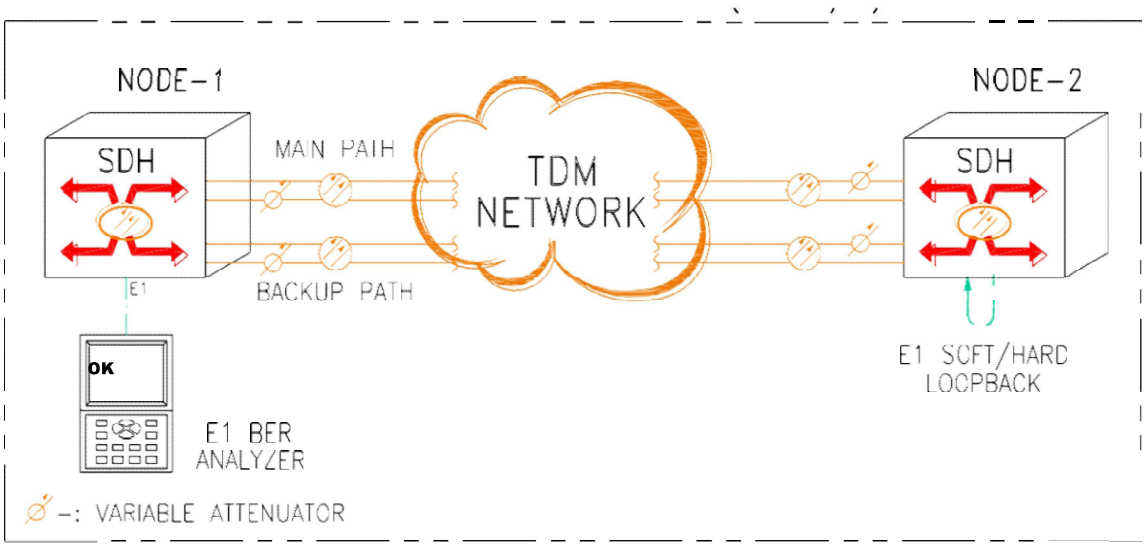


Figure 1: MSP Protection Test E1

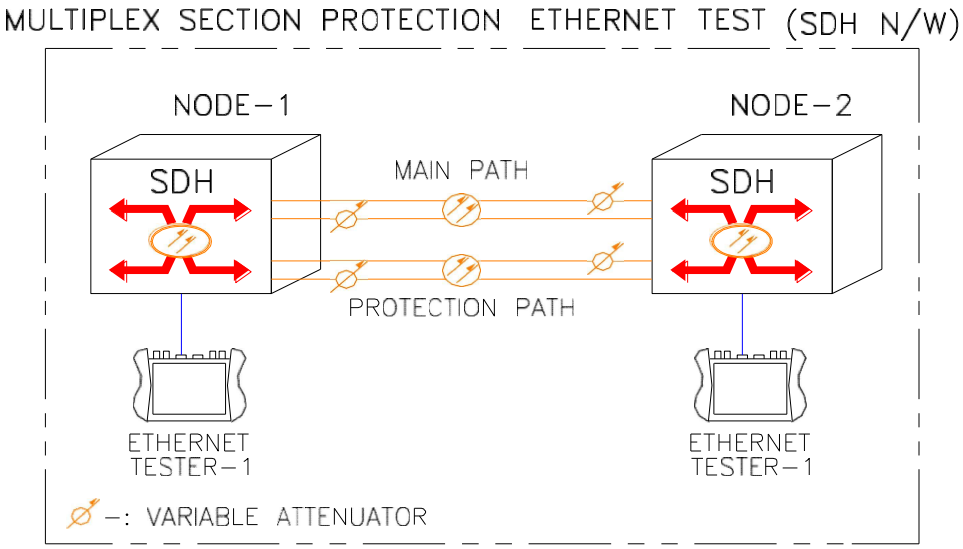


Figure 2: MSP Protection Test Ethernet

4.0 TEST PROCEDURE

E1 Protection test

- Make the test setup as shown in Figure 1.
- Create the required cross connections with Switching Protection in the SDH Nodes across the link through which the testing will be done.
- Set up an E1 from the E1 Analyzer and connect it to the local SDH node.
- Provide a soft loop / hard loop on the configured E1 of the remote SDH node.
- The tester will show "OK" with the loop back on the remote node concerning the configured channel.
- With the loop-back, there shall be no bit errors.
- Break main link between the two stations and verify that E1 signal is through over standby link.
- Verify the Cross-connect redundancy, by jacking out one of the redundant module at a time.
- Tabulate the observation in test result table at Point 1 , 2 and 3.

Ethernet Protection test

- Make the test setup as shown in Figure 2.
- Create the required cross connections with Switching Protection in the SDH Nodes across the link through which the testing will be done.
- Set up an E1 / Ethernet Traffic from the Ethernet Analyzer and connect it to the local SDH node.
- Provide a soft loop on the configured Ethernet of the remote Ethernet Tester.
- The tester will show "OK" with the loop back on the remote node concerning the configured channel.
- With the loop-back, there shall be errors.

- Break main link between the two stations and verify that Ethernet signal is through over standby link.
- Verify the Cross-connect redundancy, by jacking out one of the redundant module at a time.
- Tabulate the observation in test result table at Point 4 & 5.

5.0 TEST RESULT

Sr. No.	Test Description	Results (OK / Not OK)
1	Switching to standby path is occurred when working path failed for E1 test	
2	Switching can be auto-restored after the fail disappeared for E1 test.	
3	Switching time should be less than 50ms (Applicable to APS test)	
4	Switching to standby path is occurred when working path failed for Ethernet test.	
5	Switching can be auto-restored after the fail disappeared for Ethernet test.	

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Remarks

_____

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-011: Sub Network Connection Protection (SNCP) in SDH Network

Equipment Under Test : **Fiber Optic Transmission System**

Test Parameters : **Sub Network Connection Protection (SNCP)**

1.0 TEST DESCRIPTION

The aim of this test to check the sub network connection protection scheme in compliance with the ITU-T G.841.

2.0 TEST EQUIPMENT

1. E1 Analyzer
2. Cables and accessories

3.0 TEST SETUP

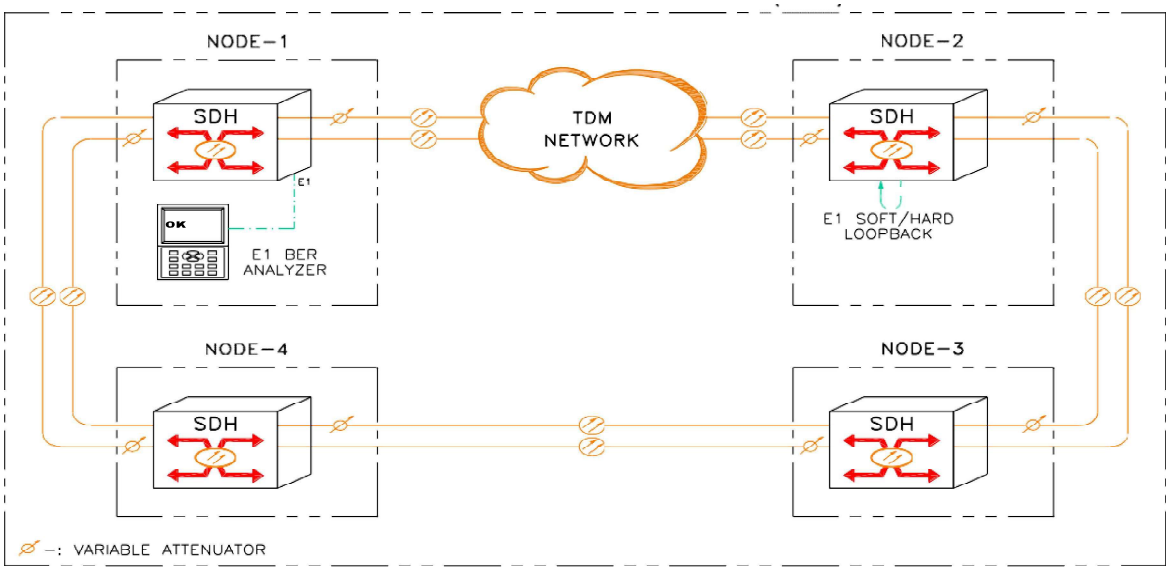


Figure 1: SNCP Protection Test

4.0 TEST PROCEDURE

- Make the test setup as shown in Figure 1.
- Create the E1 channel from STM node-1 to STM Node-2 via STM optical path.
- Configure the protection path for the E1 channel between Node-1 to Node-2 using sub-network connection protection in that particular ring via Node-4 to Node-3 STM path as shown in above figure.
- Connect the tested port (E1) at Node-1 to the E1 Analyzer and loop back the corresponding tributary at Node-2.

- Setup the BER Tester for BER testing. While the BER test is in progress, now break the working fiber link (STM path) between Node-1 & Node-2, verify whether the protection to alternate path (Node-3 and Node-4 i.e., optical path in ring) occurred correctly.
- Restore the working fiber links; verify whether the switching can be auto restored after the failure disappeared.
- Tabulate the results as under Section 5.0.

5.0 TEST RESULT

Sr. No.	Test Description	Results (OK / Not OK)
1	Switching to alternate path is occurred when working path failed.	
2	Switching can be auto-restored after the fail disappeared.	
3	Switching time should be less than 50ms.	

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Remarks

_____

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-012: Measurement of Order Wire channel

Equipment Under Test : **SDH Optical Units**

Test Parameters : **EOW Station to Station Dial Testing**

1.0 TEST DESCRIPTION

The purpose of this test will be an operational test to be performed for checking the satisfactory EOW operation.

2.0 TEST EQUIPMENT

1. EOW Phone.
2. LAN Cable

3.0 TEST SETUP

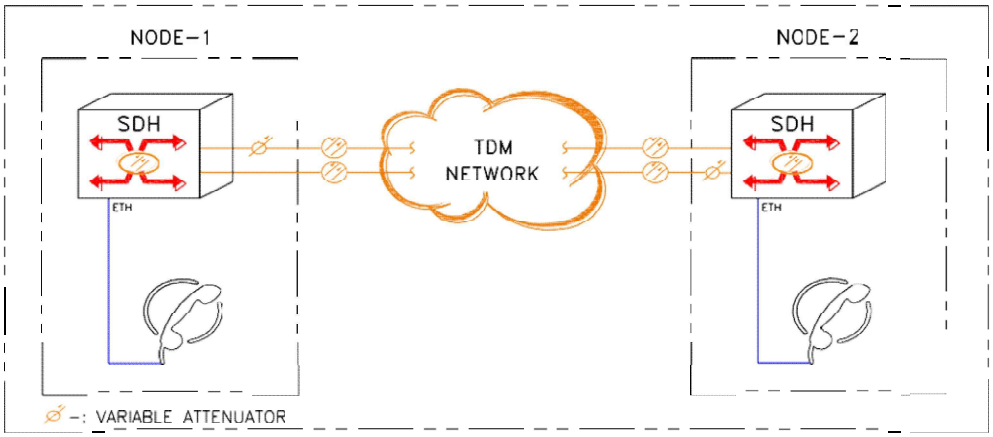


Figure 1: EOW Functionality

4.0 TEST PROCEDURE

- By using the EOW telephone connected on SDH system, dial the telephone number of any other SDH station and check the EOW operation. Repeat the test for other stations.
- Check the operation of EOW as specified above and tabulate the results as under section 5

5.0 TEST RESULT RECORD

Sr.No.	Station	EOW Number	Station	EOW Number	Results (OK / NOT OK)
1					
2					

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Remarks

_____

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-013: SDH Equipment (STM 16 & STM 4) - Power Supply Test

Equipment Under Test : **SDH Equipment (STM 16 & STM 4)**

Test Parameters : **Power Supply Test**

1.0 TEST DESCRIPTION

The purpose of this test is to check the operation of SDH equipment in power supply conditions as listed below of a fully equipped equipment rack.

1. Test of equipment against input power variation from -40 to -60V DC.
2. Automatic recovery of the equipment when the power supply is restored to normal.
3. Reverse power protection test (polarity reversal) and automatic recovery.
4. Short circuit protection
5. Power supply protection test

2.0 TEST EQUIPMENT

1. Variable DC power supply
2. SDH Analyzer
3. Local Craft Terminal (LCT)
4. Cables and accessories

3.0 TEST SETUP

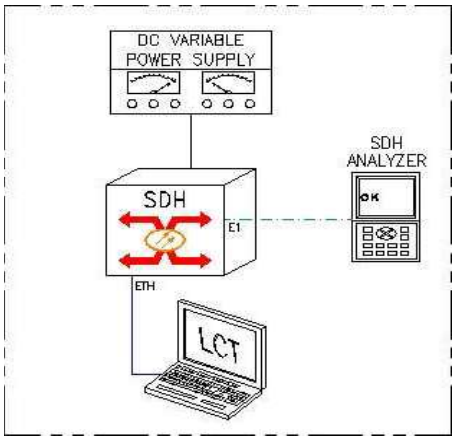


Figure 2: Test set up for Variable Power supply Measurement test

4.0 TEST PROCEDURE

1. **Maximum Voltage, Minimum Voltage Test**

a) Connect the input supply cables from variable power supply unit and the SDH Analyzer to the equipment sub-rack as shown in above figure.

b) Adjust the output voltage of the variable power supply unit to -48 VDC and switch ON the SDH equipment.

c) Vary the input power supply from -48 Volts to -60 Volts (in steps) at this point check the operation of SDH equipment with the help of SDH Analyzer and it should operate as in normal condition.

d) Restore the power supply to normal i.e. -48 Volts and check the operation of SDH equipment. It should operate as in normal condition.

e) Vary the input power supply from -48 Volts to -40 Volts (in steps) at this point check the operation of SDH equipment with the help of SDH Analyzer and it should operate as in normal condition.

f) Restore the power supply to normal again i.e. -48 Volts and check the operation of SDH equipment. It should operate as in normal condition.

g) Switch off the power supply and the switch on the power supply and check the operation of SDH equipment. It should operate as in normal condition.

2. Power Supply Protection Test

a) Connect both the input power supply cables to the power inputs of the SDH equipment.

b) Switch ON the equipment power supply.

c) Disconnect one of the power supply input from the power interface panel, the equipment should operate in normal condition.

3. Reverse Power Supply Protection Test

a) Apply power with reverse polarity at the input, check if the system is protected against reverse polarity connection of the input supply. Restore the normal power supply connection and check if the system gets powered ON and working.

4. Short Circuit Protection

Verify whether the power supply card shuts off on short circuit

5.0 TEST RESULT RECORD

Sr. No.	Test Description	Specification	Results (OK/NOT OK)
1	Operation of SDH equipment at -48 volt DC input supply	No bit errors	

2	Operation of SDH equipment at -60 volt DC input supply	No bit errors	
3	Operation of SDH equipment at -40 Volt DC input supply	No bit errors	
4	Power supply protection	Should be protected.	
5	Reverse polarity connection	Should be protected.	
6	Short Circuit test	Should be protected.	

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Node Details

Station _____

Unit Type _____

Remarks

_____

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-014: Ethernet Parameters Measurements

Equipment Under Test : **SDH Equipment along with Ethernet Interface Unit**

Test Parameters : **Throughput, Latency and Frame Loss Test**

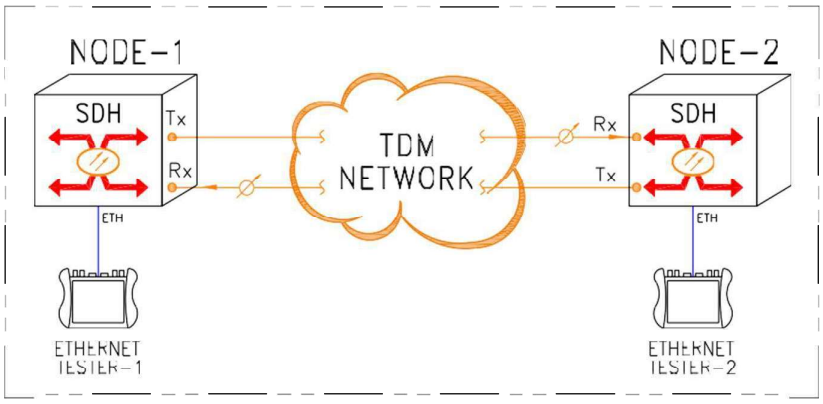
1.0 TEST DESCRIPTION

To verify that the Ethernet card is in compliance with the specifications of IEEE 802.3. The ethernet link shall be tested for Throughput, Latency and Frame loss as per RFC2544.

2.0 TEST EQUIPMENT

1. Ethernet Analyzer
2. Local Craft Terminal (LCT)
3. Low loss optical patch cord & CAT cable

3.0 TEST SETUP



4.0 TEST PROCEDURE

1. **Data Channel (Throughput) Test**

   a. Connect the two (2) SDH nodes (Node-1 & 2) with optical patch cords as shown in above figure.

   b. Connect one of the Ethernet Analyzer to LAN port-1 of Node-1 & another Ethernet Analyzer to LAN port-1 of Node-2 with CAT cable.

   c. Set the LAN ports of both the nodes on "100M full duplex" mode.

   d. Set the test duration to 10 seconds and the length of test frame to 1518 bytes. Measure the throughput.

   e. Observe and record the test results.

2. **Latency Measurement**

   a. Connect the two (2) SDH nodes (Node-1 & 2) with optical patch cords as shown in above figure.

b. Connect one of the Ethernet Analyzer to LAN port-1 of Node-1 & another Ethernet Analyzer to LAN port-1 of Node-2 with CAT cable.

c. Set the LAN ports of both the nodes on "100M full duplex" mode.

d. Set the test duration to 10 seconds and the length of test frame to 1518 bytes respectively. Test the latency.

e. Observe and record the test results.

3. Frame Loss

a. Connect the two (2) SDH nodes (Node-1 & 2) with optical patch cords as shown in above figure.

b. Connect one of the Ethernet Analyzer to LAN port-1 of Node-1 & another Ethernet Analyzer to LAN port-1 of Node-2 with CAT cable.

c. Set the LAN ports of both the nodes on "100M full duplex" mode.

d. Set the test duration to 10 seconds and the length of test frame to 1518 bytes respectively. Test the Frame Loss.

e. There should be no frame loss, record the test results.

5.0 TEST RESULTS

Throughput

The throughput of the Ethernet card should not be less than the bandwidth configured.

Sr. No.	Bandwidth (Mbit/s)	Measured Throughput	Data Channel Results (OK / Not OK)
1	2		
2	4		
3	10		
4	100		

Latency

Sr. No.	Bandwidth (Mbit/s)	Measured Latency	Results (OK / Not OK)
1	2		
2	4		
3	10		
4	100		

Frame Loss

Sr. No.	Bandwidth (Mbit/s)	Throughput Rate%	Frame Loss	Results (OK / Not OK)
1	2			
2	4			
3	10			
4	100			

Status

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Node - 1 Details

Station _____

Unit Type _____

Node - 2 Details

Station _____

Unit Type _____

Remarks

_____

_____

Tested By : _____ (Manufacturer)

Date : _____

Witnessed By : _____ (POWERGRID)/Constituent

Date : _____

TPS-FOTS-015: Ethernet Provisioning and VLAN Separation Test

Equipment Under Test : **SDH Transmission System**

Test Parameters : **Ethernet Provisioning and VLAN Separation**

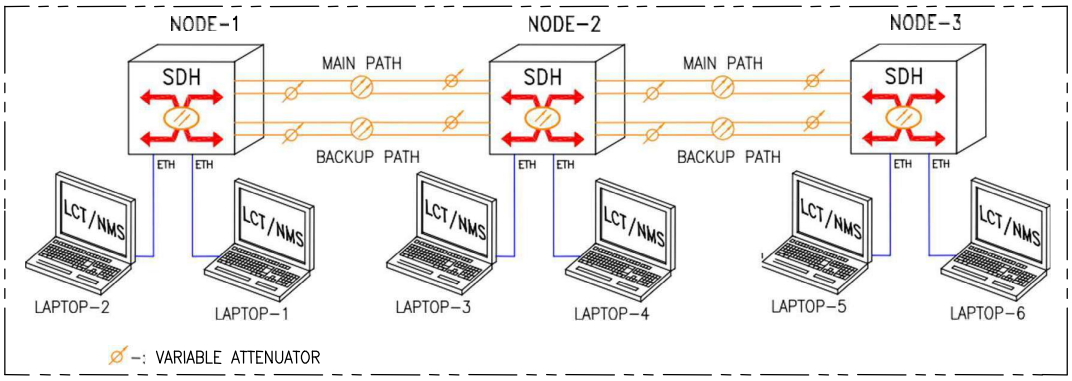
TEST DESCRIPTION

The purpose of this test is to check the provisioning of Ethernet channels and configuration of VLAN per application. Enable traffic separation at layer 2 thus segregating Broadcast domains based VLAN membership

2.0 TEST EQUIPMENT

1. Ethernet Analyzer
2. Cables and accessories

3.0 TEST SETUP



4.0 TEST PROCEDURE

- Make the test setup as per Figure 1.
- Create the required cross connections to provision an Ethernet link and assignment of VLAN in the SDH Nodes across the link through which the testing will be done.
- Ping response should be present between the two laptops.
- Tabulate the results as under Section 5
- Verify that laptops connected on same VLAN can communicate and laptops on separate VLAN's cannot communicate with each other.
- Repeat the procedure on other Ethernet Channels (if required).

5.0 TEST RESULT

The tested ports can receive continuous packet each other and WAN bandwidth capacity should be as per Ethernet channel plan.

Sr. No	Local Station	Remote Station	Slot No. / Port No.		VLAN Configuration (OK / Not OK)
			Local	Remote	
1			SL___/P___	SL___/P___	
2			SL___/P___	SL___/P___	
3			SL___/P___	SL___/P___	
4			SL___/P___	SL___/P___	

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Remarks

_____

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-016: E1 (2 Mbit/s) Interface Unit - Bit Error Rate

Equipment Under Test : **E1 (2 Mbit/s) Interface Unit**

Test Parameters : **Bit Error Rate**

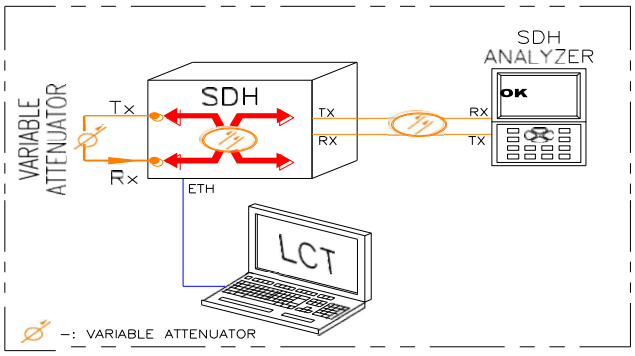
TEST DESCRIPTION

The purpose of this test is to check Bit Error Rate (BER) in E1 (2 Mbit/s) interface unit of SDH node in compliance with ITU-T G.821.

2.0 TEST EQUIPMENT

1. SDH Analyzer
2. Local Craft Terminal (LCT)
3. Low loss optical patch cord

3.0 TEST SETUP



4.0 TEST PROCEDURE

1. The test set-up will be as indicated in above figure.
2. Connect the SDH Analyzer to the configured E1 of the 2M tributary card of STM-4/16 node.
3. Create the cross connection to terminate E1 from one of the optical port. Apply soft or hard loop back on the optical port using fixed attenuator.
4. Set-up SDH Analyzer to perform 2 Mbit/s BER testing.
5. Commence the BER testing and run the BER test for 10 Minutes duration.
6. Record the result. The test results recorded will be as per ITU-T recommendation G.821.

5.0 TEST RESULTS

Test Description	Results (OK / NOT OK)
BER measurement on 2 Mbit/s (E1) port	BER result should be better than 10^{-10}

Status

( ) Tested – OK _____

( ) Tested – Failed _____

Node Details

Station _____

Unit Type _____

Remarks

_____

_____

_____

Tested By : _____ Witnessed By : _____

(Manufacturer) (POWERGRID)/Constituent

Date : _____ Date : _____

TPS-FOTS-017: SDH Network - NMS & LCT Functionality Test

Equipment Under Test : **SDH Network Management System & LCT**

Test Parameters : **NMS & LCT Functionality Test**

1.0 TEST DESCRIPTION

The purpose of this test is to confirm proper operation of network management system (TNMS) and Local Craft Terminal (LCT) for SDH system for this project as indicated below.

2.0 TEST EQUIPMENT

- SDH Network Management System (TNMS)
- Local Craft terminal (LCT)
- SDH Analyzer
- Cables and accessories

3.0 TEST SETUP

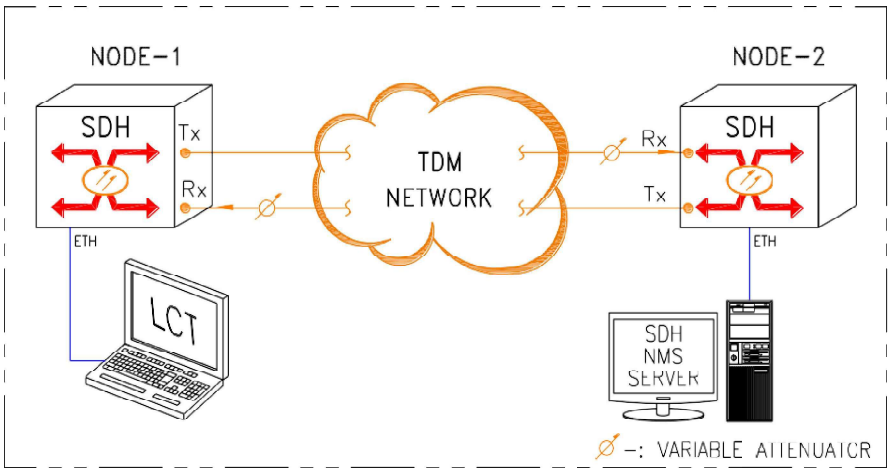


Figure 1: Remote Node Management

4.0 TEST PROCEDURE

CONFIGURATION MANAGEMENT

- Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.
- Ensure the SDH equipment is working.
- Login NMS as user of advanced level.
- Check the NMS whether it can establish and maintain the network topology.

- Check the NMS whether it provides the tools for planning, establishing and changing the static equipment configuration, this item can be conducted by changing some parameters & cross connection of the SDH equipment.
- Check the NMS whether it provide verification testing to support new equipment installation, this can be tested by adding a new NE.
- For creating the cross connection, establish the cross connection between any of the two ports in the same or different card.

FAULT MANAGEMENT

- Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.
- Ensure the SDH equipment is working.
- Login NMS as user of advanced level.
- Generate the various alarms; check the NMS for relevant alarm status.
- For example, pull out one card from SDH sub-rack; check the NMS for alarm of that fault.
- Insert the card, and then the alarm disappears.
- Check the alarm history, which includes all alarm events.
- Check the capability of alarm retrieval filter. Change the setting and retrieve.
- Check the colors for different level alarm events.
- Print alarm report.

SECURITY MANAGEMENT

- Connect the TNMS system with the management interface of SDH equipment by using Ethernet cable.
- Ensure the SDH equipment is working.
- Login as Administrator
- Add a user and define the user profile.
- Login as user and verify that user is able to perform various tasks as per profile.

LCT FUNCTIONALITY TEST

- Connect the LCT to the SDH equipment through LCT interface.
- Ensure the SDH equipment is working.
- Login the LCT.
- Change some configurations of the equipment.
- Get the fault information from the SDH equipment.

5.0 TEST RESULT

Sr. No.	Test Description	Results (OK / Not OK)
1.0	**CONFIGURATION MANAGEMENT**	
1.1	Capability to establish and maintain the backbone topology.	
1.2	Capability to provide graphical maps depicting the sub-rack configurations.	
1.3	Capability to plan, establish and change the static equipment configuration.	
1.4	Verification testing to support new equipment installation.	
1.5	Cross-connect capability between any of the two ports in same or different card.	
2.0	**FAULT MANAGEMENT**	
2.1	After generating an alarm, it is automatically displayed.	
2.2	Alarm has been shown automatically when there is card failure.	
2.3	NMS can maintain an alarm summary of unacknowledged current alarm.	
2.4	NMS can maintain an alarm history.	
2.5	Operator can acknowledge and clear alarms.	
2.6	Alarm retrieval filter is available.	
2.7	Alarms can be classified and configured as critical alarms, major alarms and minor alarms, in different colors.	
2.8	Alarm reports can be extracted.	
3.0	**SECURITY MANAGEMENT**	
3.1	Security Management functionality allows user addition and user profile definition.	
4.0	**LCT Functionality Test**	
4.1	LCT can get fault information from the connected SDH node.	
4.2	LCT is able to change the configuration of the connected SDH node.	
4.3	LCT is able to check for remote loopback & local loopback	
4.4	LCT can get fault/alarm information from the unconnected NE.	
4.5	LCT can get performance data from the unconnected NE.	

Status

( ) Tested – OK _____

( ) Tested – Failed _____