STATE OF NEW JERSEY
DEPARTMENT OF TRANSPORTATION
TRENTON, NEW JERSEY 08625

METRIC SPECIFICATIONS FOR SONET
(SINGLE MODE FIBER OPTIC LONG HAUL SONET MULTIPLEXER)

N.J. Specification No. EBM-SONET Effective Date: July 1, 2001

New Jersey Department of Transportation Specifications for a SONET compliant long haul communication system designed to operate on single mode fiber optic cable.

The purpose of these specifications is to describe minimum acceptable design and operating requirements for this equipment.

GENERAL - I

1-1 General Requirements

The data transmission system shall be designed for high speed long distance communication over single mode fiber-optic cable via a nodal network. The multiplexer system shall be fully compliant with all ANSI and Bellcore SONET standards. In addition, Bellcore TA/TR and NEBS requirements shall be satisfied.

1-2 Single Mode Fiber and Optical Budgets

The SONET multiplexer system shall operate with complete self-healing capability with no more than four single mode fibers on any link. The equipment shall be capable of operating at 1 300 and/or 1 550 nanometers wavelength(s). The multiplexers shall be configured to operate at 1 550 nanometers. The transmission equipment shall have an optical budget of at least 26 decibels between SONET nodes.

1-3 Environment

All transmission equipment shall operate in the temperature range of 0 °C to 50 °C and a relative humidity of 5 to 95 percent non-condensing. The equipment may be housed in an above ground concrete hut with supplemental heating and air conditioning which will maintain the environment within the above range. The manufacturer shall supply certification by an independent technical laboratory confirming that the equipment complies with these environmental specifications.

1-4 Testing

The equipment is subject to testing as described in Section IV of this specification.

1-5 Electrical Power

All equipment defined in this specification shall operate on standard 120 volts AC electrical service. The equipment shall operate over a voltage range of 105 to 125 volts AC at 60 hertz. An external power supply, suitable for mounting in a 584 millimeter rack, can be utilized to convert from AC line voltage to the voltage levels required by each component. The power supply system shall contain a premium surge suppression system which shall protect the equipment from all reasonable variances. Minimum specifications for surge suppression are:

A. UL 1449 Suppression Voltage: 600 volts

B. Maximum Single Surge Current
Withstand: 16 kiloamps

C. Surge Energy Capability: 500 joules

D. Surge Life Cycles
3 kiloamps, 8/20 microseconds: >1500 operations
10 kiloamps, 8/20 microseconds: >200 operations

E. Response Time: < 5 nanoseconds

However, superior surge suppression capability shall be supplied, if the manufacturer's standard literature requires it.

1-6 Components

The SONET multiplexer system includes the following components:

A. SONET OC-12 Multiplexer Node and Rack

B. Rack-Mounted PC System

The special provisions and/or contract drawings shall specify the exact quantities of additional interface cards, over the minimum specified in this document.

All necessary interconnection cables and other components required to provide a fully operational system shall be provided incidentally with the associated component.

1-7 SONET Certification and Support

In order to insure that the equipment is SONET compliant and that an adequate service organization exists to support the equipment, the SONET multiplexer shall be in active use in at least one Regional Telephone Company in the United States or Canada or major long distance telephone company (i.e., AT&T, MCI or Sprint). A copy of the acceptance of the equipment, by one of these companies, that confirms that the multiplexer is SONET compliant shall be provided as part of the submittal process prior to acceptance of the equipment.

The manufacturer of the equipment shall also maintain an active service organization in New Jersey who can respond within 8 hours of receipt of a service call anywhere in the state.

SONET OC-12 MULTIPLEXER NODE AND RACK - II

2-1 Multiplexer Speed

The SONET Multiplexer shall operate at a minimum speed of OC-12 (622.08 MB/S). ANSI T1.106/88, ANSI T1.105/88, and T1.105a/90, TA-253, Iss 6, TA-496 standards shall be complied with. Each node shall be capable of accepting twelve OC-1 or DS-3 (electrical) transmission streams as input.

2-2 Bit Error Rate

The BER of the SONET multiplexer shall not exceed 10 to the -8 between any two nodes of the system.

2-3 584 millimeter Communication Rack

Each SONET assembly shall be supplied completely installed in a standard 2.13 meter 584 millimeter communication rack. At least 33% of the rack space shall be left vacant. The rack shall be supplied complete with all necessary ventilation fans, power supplies, circuit breakers, fiber optic patch panels, and all incidental components recommended by the manufacturer's standard literature. Redundant power supplies (120 volt AC Line Voltage to -48 DC) shall be included in the rack to insure maximum equipment availability. Upon the loss of one supply, the all active components shall automatically switch to the second without any interruption in service. The rack shall be supplied with all door assemblies and/or blank panels, as required by the equipment configuration. In addition, at least three standard AC outlets shall be included in the chassis. A complete shop drawing of the cabinet layout shall be provided for the approval of the Engineer prior to delivery of the equipment.

2-4 Battery Backup

Sufficient rechargeable battery backup shall be supplied in the rack, or internal to the equipment, to keep the communication equipment operational for a power failure of at least two hours in duration. The batteries shall be able to completely recharge in under twelve hours.

2-5 Redundant Fiber/Self-Healing Ring

The SONET multiplexer system shall be capable of operating in a Self-Healing architecture. Redundant fiber loops shall be accomplished via "collapsed ring" or true alternate routed fiber-optic paths. Self-healing refers to the ability of the SONET network to maintain operation upon loss of a single fiber automatically. In addition, the malfunction or power failure of a single SONET node (except the master node), shall not bring down any of the other nodes of the network.

2-6 Mechanical Dimension and Weight

The complete SONET multiplexer and support equipment shall not require more than 67% of the rack space as described in Subsection 2-3. The total weight of the assembled rack shall not exceed 113 kilograms.

2-7 Fiber Optic Connectors

The SONET multiplexer shall utilize FC/PC single mode fiber connectors. The FC/PC connectors shall meet all relevant performance specifications and testing described in EBM-FOC-ST-1. Two transmit and two receiver connectors shall be mounted on the main shelf's face plate. Indicator alarms shall be present to indicate the loss of either data ring.

2-8 DS-3 Speed Interface

The SONET multiplexer shall have the ability to support one or more DS-3 interface cards defined as follows:

A. Rate = 44.736 megabits per second

B. Line Code = B3ZS

C. Connector = BNC

D. Distance from Source = 135 meters maximum

E. Impedance = 75 ohms ± 5%

The number of DS-3 interfaces for each SONET node shall be stipulated in the special provisions and/or contract documents.

2-9 STS-1 Interface

The SONET multiplexer shall have the ability to support one or more STS-1 interface cards defined as follows:

A. Rate = 51.84 megabits per second

B. Line Code = B3ZS, SONET scrambled

C. Connector = BNC
D. Distance from Source = 135 meters maximum

E. Impedance = 75 ohms ± 5%

The number of STS-1 interfaces for each SONET node shall be stipulated in the special provisions and/or contract documents.

2-10 OC-3 Interface

The SONET multiplexer shall have the option to support at least one OC-3 SONET lightwave interface defined as follows:

A. Rate = 155.52 megabits per second

B. Connector = FC/PC

The purpose of this interface card is to allow an OC-3 SONET data stream to be received, transported around the OC-12 network, and transmitted back to an external OC-3 SONET system at another node on the network. The OC-3 interface shall be able to synchronize to the incoming OC-3 data stream.

The number of OC-3 Interfaces at a particular node shall be stipulated in the contract documents.

2-11 Craft Interface

The SONET multiplexer shall be equipped with at least one RS232 port which supports a Craft terminal. This terminal shall be a rack mounted PC as described in Section III. A suitable MSDOS emulation software program shall be provided to communicate with the Craft interface. The Craft interface shall operate in command, prompt, and menu mode and shall be adequate to fully configure the SONET Multiplexer and to trouble shoot operational problems. If an enhanced MSDOS or WINDOWS version of the interface software exists in the manufacturer's standard product line, the PC based software shall be provided in addition to the standard program.

The Craft interface software shall include the following features:

A. Automation of core OAM&P Functionality

B. Centralized Autonomous Message Reporting

C. Concentrated TBO5, LCN, and X.25 Interfaces

D. Definable Site Alarms and Controls

E. Commands and Messages displayed in a TL1 Format

F. I.D. and Password Database Security to Prevent Access by Unauthorized Users

G. Ability to Save and Restore System Configuration Info on the PC Disk System

2-12 Configuration

The configuration of the SONET node shall be maintained in non-volatile memory and shall be secure for power failures exceeding one month in duration. The configuration of any node shall be downloadable from the master node. In addition, a software

program, executable from the PC defined in Section III, shall be provided to graphically illustrate and upload/download a configuration to the SONET multiplexer.

2-13 Synchronization

The SONET multiplexer shall be able to synchronize to any of the following sources via user configuration at any node:

A. External DS1

B. Free-running (Internal Clock)

C. Loop Derived from Incoming OC-12 or OC-3 SONET data stream.

RACK-MOUNTED PC SYSTEM - III

Each SONET Multiplexer rack shall be equipped with a rack mounted PC. This PC shall be utilized to interface with the Craft RS232 port of the SONET Multiplexer. In addition, the PC may serve other application and diagnostic functions.

3-1 Specifications

A. Processor	80486DX - 50 megahertz Processor or Better
B. Main Memory	4 megabytes Minimum
C. Hard Disk	300 megabytes Minimum
D. Floppy Disk	1.44 megabyte - 90 millimeters
E. Keyboard	Alphanumeric with 101 Key Emulation Built in Rack Mounted Shelf Built in Trackball Mouse Emulator
F. Video Card	XGA-2 Video Card with 1024 x 768 or greater resolution. 256 Colors and 1 megabyte of on-board memory. Shall be supplied with OS/2 2.X Drivers
G. Monitor	229 millimeters Minimum full color. Compatible with Video Card specified in 3-1-F.
H. Clock	Battery backed up real-time clock/calendar.
I. RS232 Ports	Minimum of 4
J. Printer Port	Minimum of 1

3-2 The PC shall be certified to run OS/2 Version 2.X and MSDOS 6.0 or above.

3-3 One RS232 port shall be wired to the Craft Interface Port of the SONET multiplexer.

3-4 Software

A. MSDOS 6.0 or above

B. OS/2 2.X or above

C. Craft Terminal Emulation Software

D. PROCOMM-Plus (Latest Version)

E. Microsoft Windows 3.1 or above

TESTING - IV

All equipment defined in this specification shall be subject to factory testing as subsequently described. The factory test shall demonstrate or provide confirmation that all of the equipment operates over the specified environmental range for each component. In addition, the operation of all optional equipment, such as the T-1, DS-1, DS-3, STS-1, and OC-3 interface cards shall be demonstrated. The rack mounted PC system shall be configured and utilized to run the Craft diagnostic and configuration software. For each interface, the factory test procedure shall demonstrate that data can be transferred between two or more SONET nodes over the optical budget required in the specifications. In addition, the test shall demonstrate that the specified BER (Bit Error Rate) is obtainable.

The supplier shall be responsible for submitting a test plan which has been designed to exercise and monitor the equipment for the purpose of determining compliance with the specifications.

TRAINING - V

Prior to the acceptance of the first unit of each type, training shall be provided for the Department's engineering, maintenance and operations staff, at a facility provided by the Department. The training shall include all material and manuals required for each participant. The training shall be as follows:

5-1 Maintenance Training

The training shall be provided for a minimum of 80 hours for at least five (5) personnel with an electronics background. The training shall include operation instructions, theory of operation, circuit description, field adjustments, preventive maintenance procedures, troubleshooting, operation of diagnostic and configuration software, and repair of all components.

5-2 Engineering Training

The training shall be provided for a minimum of 40 hours for at least twenty (20) engineering and operations personnel. The training shall include a complete demonstration of the operation and capabilities of the equipment. This session should

include a complete review of any field adjustments or calibration of the transmission equipment which may be necessary for optimum performance and should stress day-to-day operation and isolation of problems down to the unit level. For example, procedures should be discussed of identifying a faulty module in the field, as opposed to board level repairs covered in Subsection 5-1. Particular attention shall be given to the operation of the Craft interface package including procedures for configuring the network and diagnosing faults.

INSTRUCTIONS AND GUARANTEES - VI

6-1 One set of complete schematics and operations/maintenance manuals of each component shall be supplied with each assembly furnished. Maintenance manuals shall include complete sub-component parts listing.

6-2 No changes or substitutions in these requirements will be acceptable unless authorized in writing. Inquiries regarding this specification shall be addressed to the Manager, Office of ITS Engineering, New Jersey Department of Transportation, P.O. Box 613, 1035 Parkway Avenue, Trenton, New Jersey 08625.

6-3 All components shall carry a two-year guarantee from the date of acceptance against any imperfections in workmanship or materials.

6-4 The manufacturer agrees to, upon the request of the Manager, Office of ITS Engineering to deliver to the Office, a sample of each assembly to be supplied in compliance with these specifications for inspection and test before acceptance. After completion of the test, the sample shall be returned.

6-5 The Supplier shall furnish any and all equipment which they deem necessary for safe and reliable field operation of the communication equipment as part of the quoted price for the specified equipment.

6-6 All components furnished under this specification shall be current production equipment and of recent manufacturer, identical models of which are in field operation in not less than five locations in the United States or Canada. Untried or prototype units shall not be considered for acceptance.

6-7 All major components shall be identified with a metal plate containing the serial number with a bar code identification.

6-8 Any repairs made by a manufacturer or representative shall be documented and returned with units when warranty repaired. This documentation shall include an explanation of the exact repairs made and identification of parts replaced by part number and circuit number. All warranty repairs shall be completed within seven days of delivery of the equipment to the designated repair depot. If the component is critical to the operation of the assembly, a "loaner" shall be provided within 24 hours of notice of the problem, to serve until the repaired component is returned.