SPECIAL SPECIFICATION

8678

OC-3/OC-12 SONET Multiplexors

1. Description. This Item shall govern for the furnishing and installation of the SONET OC-3, and/or OC-12 Digital Lightwave Multiplexers configured in a path-switched ring architecture at designated locations as shown on the plans, as detailed in accordance with these specifications, and as directed by the Engineer. All multiplexers shall be of the same manufacture and model.


   (1) General Requirements. All equipment shall be new, corrosion resistant and in strict accordance with the details shown on the plans and in the specifications.

   (2) Adherence to Standards. All SONET Digital Lightwave Multiplexers furnished, assembled, fabricated or installed under this item shall be compliant with:

      * ANSI (T1.105/88, T1.106/88 and T1.105a/90) Synchronous Optical Networks (SONET) Phase 1 and Phase 2 standards.


      * BELLCORE TR-TSY-000496 Supplement1, September 1991 on "Unidirectional Dual-Fed Path Protection Ring Implementation".


      * Ignitability requirements specified in T1Y1/88-014.

   (3) Functional Requirements.

      (a) Physical Design Requirements. The Multiplexer physical design shall feature ease of configuration with a limited number of shelves and circuit packs required to implement the various SONET architecture's at the OC-3 and OC-12 rates. The equipment shall be modular in design such that major portions may be readily replaced in the field. Dust covers shall be placed over unused card slots. Modules of unlike functions shall be mechanically keyed to prevent insertion into the wrong socket or connector. All modules and assemblies shall be clearly identified with
name, model number, serial number, and any other pertinent information required
to facilitate equipment maintenance. The Multiplexor shall have the following
additional physical design characteristics:

* All OC-3 and OC-12 architecture's, including rings, shall be configurable by
circuit pack and software changes within a single ring design.

* OC-3 and OC-12 Multiplexer architectures shall include an STS-1E electrical
multiplexer configuration.

* All OC-12 architectures, including rings, shall be configurable to support OC-3
virtual rings.

* The OC-3 shelf shall provide DS1 and DS3 interfaces, and a single shelf shall be
able to terminate the entire OC-3 payload of 84 DS1 signals, 3 DS3 signals, or any
combination thereof. Electrical EC-1 (STS-1) interfaces shall be available to
support future requirements.

* The OC-12 shelf shall provide DS-3 interfaces, and shall be able to terminate the
entire OC-12 payload of 12 DS3 signals. Electrical EC-1 (STS-1) interfaces shall be
available to support future requirements.

* OC-3 and OC-12 shelves shall share circuit packs as appropriate to reduce spares
inventory. No more than 16 different circuit packs shall be required to configure
all OC-3 shelf architectures, and; no more than 16 different circuit packs shall be
required to configure all OC-12 architectures.

* Power converters shall be distributed and located on each circuit pack for
improved heat dissipation and reliability. Multiplexors shall have primary and
redundant power feeds.

* Multiplexers shall require no more than 14 inches of vertical shelf space and be
configured for front access.

* All external connectors shall be made by means of connectors attached to a
wiring harness or cable. The connectors shall be keyed to preclude improper
hookups. All wire to and from the connectors shall be color coded and/or
appropriately marked. All appropriate connectors, cable harnesses, and accessories
shall be provided with the equipment.

(b) **Multiplexor Add/Drop Requirements.** The multiplexors shall implement a
flexible Time Slot Interchange (TSI) capability that maximizes the flexibility with
which payload signals can be added and dropped at intermediate node sites. Time
Slot Assignment (TSA) algorithms are not acceptable. Specifically, the
multiplexor shall have the following add/drop characteristics:

A Time Slot Interchange shall be provided on the OC-3 product that can:

* Add/Drop any VT-1.5 in the entire OC-3 payload
* Add/Drop a single VT-1.5 without having to add/drop an entire VT group of 4 VT-1.5s

* Add/Drop all 84 VT1.5s using a single shelf at a logical hubbing node in a TA-496 ring architecture

A Time Slot Interchange shall be provided on the OC-12 product that can:

* Add/Drop any STS-1 in the entire OC-12 payload

* Add/Drop any STS-1 over the entire OC-12 payload

* Add/Drop all 12 STS-1s using a single shelf at a logical hubbing node in a TA-496 ring architecture

* Multiplexors in a point to point configuration shall support OC-3 fiber hubbing to be deployed in spur applications. Capabilities shall include OC-3 fiber hubbing with STS-1 linear drop capability serving: Up to three remote sites (OC-3 Multiplexers); or twelve remote sites (OC-12 Multiplexer).

* When used as an electrical STS-1E multiplexer, the OC-3 multiplexer shall be able to add/drop individual VT-1.5s from the STS-1E signal while allowing other VT1.5s to pass on to other locations.

(c) **Optical Interface Requirements.** The optical interfaces shall conform to the SONET standards as stated in section 2.(2) Additional requirements for the optical interfaces are stated below:

* Optical detectors shall be a positive intrinsic negative diode (PIN) or approved equal. Laser and diode shall be modular in design. External units shall not be permitted.

* OC-3 and OC-12 optical interfaces in the TR-496 ring architecture shall permit operation at distances up to 33 km at 1310 nm in an uncontrolled environment. This shall include operation at temperatures between -40°C and +75°C and relative humidity of 5% to 95% (non-condensing).

* A low-cost optical signal shall be available for interconnecting the OC-3 multiplexer shelf and the OC-12 multiplexer at the OC-3 rate.

* Additionally, OC-3 and OC-12 optical interfaces in the TR-496 ring architecture shall permit operation at distances up to 50 km at 1310 nm in an uncontrolled environment as defined above to accommodate longer spans.

(d) **Low Speed Interface Requirements.** All SONET Digital Lightwave Multiplexer furnished, assembled, fabricated, or installed under this item and configured for the path-switched ring architecture shall have the following low speed interface requirements:
1. **DS-1 Interfaces.**

* Number of DS-1s shall be 84 per OC-3 multiplexor shelf. Data rate shall be 1.544 Mb/s + 130 ppm asynchronous.

* Line code shall be user selectable to be bipolar 8 zero substitution (B8ZS) or alternate mark inversion (AMI).

* Each DS1 shall be provisionable independently for B8ZS or AMI coding.

* Line impedance of 100 ohms +5% balanced.

* Multiplexor shall not add more than 0.3 time slot of rms jitter to a DS-1 signal when looped at the DS-3 point.

* Line drivers shall support cable lengths up to 650 ft.

2. **DS-3 Interfaces.**

* Number of DS-3s shall be 3 per shelf (OC-3) and 12 per shelf (OC-12).

* Data rate shall be 44.736 Mb/s +20 ppm.

* Line code shall be bipolar 3 zero substitution (B3ZS).

* Line impedance shall be 75 ohms +/- 5%.

* Line drivers shall support cable lengths up to 450 ft.

(e) **Timing and Synchronization Requirements.** All SONET Digital Lightwave Multiplexors furnished, assembled, fabricated, or installed under this Item and configured for the path-switched ring architecture shall be compliant with:

* At least three different synchronization reference configurations including external timing, free-running and loop timing.

* Bellcore Category II and CCITT Type A Jitter Specifications for improved jitter performance.

* 1X1 protected DS1 timing outputs provided with a signaling method to communicate interoffice synchronization messages.

(f) **Protection Switching Requirements.** Equipment and path protection switching for all SONET Digital Lightwave Multiplexors furnished, assembled, fabricated, or installed under this Item shall adhere to the following requirements:

* Path switching shall adhere to the TR-496 standard and shall meet the 60 ms switch completion time specified by Bellcore.

* Path switching shall be unidirectional and non-revertive.

* Manual protection switching shall be provided on a per path basis.
* Multiplexor circuit packs shall be 1 X 1 protected with the exception of the DS1 circuit packs.

* OC-3 Multiplexor DS-1 circuit packs shall be 1 X N protected where N is 1 or up to 7 respectively.

* TR-496 path switching shall be implemented at the VT1.5 level for DS1 payload signals and at the STS-1 level for DS3 payload signals.

* The multiplexor shall be capable of SONET dual ring interworking, whereby service is restored within 60 ms of a failure on circuits that originate on one ring and terminate on another ring. This restoration capability shall include loss of one of the two common nodes between the rings. SONET ring interworking shall be at the STS-1 level, and the DS1 and DS3 paths shall not be terminated between rings.

* The multiplexor shall provide an alarm when a drop circuit on the protection ring is provisioned differently than a drop circuit on the service ring.

3. **Power Requirements.** The Digital Multiplexer shall meet all of its specified requirements when the input power is 115 VAC plus or minus 10%, 60 plus or minus 3 Hz.

   The equipment operations shall not be affected by the transient voltages, surges and sags normally experienced on commercial power lines. It is the Contractor's responsibility to check the local power service to determine if any special design is needed for the equipment. The extra cost, if required, shall be included in the bid of this Item.

   1) **Primary Input Power Interruption.** The equipment shall meet all the requirements in Section 2.1.4 "Power Interruption" of the National Electrical Manufacturers Association (NEMA) Standard TS1 for Traffic Control System.

   2) **Power Service Transients.** The equipment shall meet the requirements of Section 2.1.6, "Transients, Power Service" of the NEMA Standard TS1.

   3) **Wiring.** All wiring shall meet the requirements of the National Electric Code. All wires shall be cut to proper length before assembly. No wire shall be doubled-back to take up slack. Wires shall be neatly laced into cable with nylon lacing or plastic straps. Cables shall be secured with clamps. Service loops shall be provided at all connections.

   4) **Transient Suppression.** All DC relays, solenoids and holding coils shall have diodes or other protective devices across the coils for transient suppression.

   5) **Power Service Protection.** The equipment shall contain readily accessible, manually resettable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection.

      Circuit breakers or fuses shall be provided and sized such that no wire, component, connector, PC board or assembly shall be subjected to sustained current in excess of their respective design limits upon the failure of any single circuit element or wiring.

   6) **Fail Safe Provision.** The equipment shall be designed such that the failures of the equipment shall not cause the failure of any other unit of equipment.
(7) **Modular Design.** The equipment shall be modular in design to allow major portions to be readily replaced in the field.

Modules and assemblies shall be clearly identified with name, model number, serial number and any other pertinent information required to facilitate equipment maintenance.

(8) **Connectors and Harnesses.** External connections shall be made by means of connectors. The connectors shall be keyed to preclude improper hookups. All wires to and from the connectors shall be color coded and/or appropriately marked.

Connecting harnesses of appropriate length and terminated with matching connectors shall be provided for interconnection with the communications system equipment.

All pins and mating connector shall be plated with not less than 20 microns of gold. Connectors utilizing solder type connections shall have each soldered connection covered by a piece of heat shrink tubing securely shrunk to insure that it protects the connection.

4. **Environmental, Safety, and Reliability Requirements.** All SONET Digital Lightwave Multiplexors furnished, assembled, fabricated or installed under this item and configured for the path-switched ring architecture shall be compliant with the following:

(1) **Environmental Requirements.**

(a) Environmental specifications for controlled environments in BELLCORE TR-TSY-000063, "NEBS Generic Equipment Requirements, Issue 3".

(b) Environmental operation in Controlled Equipment Vaults (CEVs) as defined in BELLCORE TR-26 Issue 1 and Bellcore TR-46 Issue 1.

(c) All specified requirements shall be met during uncontrolled environmental operation characterized by a temperature range of -40°C to +75°C and a humidity range of 5% to 95% (non-condensing).

(d) Electromagnetic Compatibility specified in Federal Communications Commission Rules, Part 15, Subpart B, Class A.

(e) The multiplexer shall meet the requirements as specified by ANSI/IEEE C39-90 for "Electromagnetic Susceptibility" compliance and meet requirements as specified by TR 1089 for "Lightning Protection".

(2) **Safety Requirements.**

(a) Underwriter's Laboratories (UL) listing for restricted access installations in business and customer premises applications. This listing is required by the National Electrical Code for premises installations.

(b) Fire resistance requirements specified by Underwriter's Laboratories in UL 1459, 2nd Edition.
(3) **Reliability Requirements.**

(a) Meets all the applicable bellcore reliability requirements that over transmission availability, operation system (os) availability, silent failures, optical module maintenance and infant mortality.

5. **Operations and Maintenance Requirements**. The multiplexer shall meet the following operations and maintenance requirements:

(1) **Alarm Indications.**

(a) Individual circuit packs shall have face plate LEDs to indicate an alarm or failure condition.

(b) Alarms shall be provided that indicate:
   1. One or more lines out of service (major alarm).
   2. A potential loss of service or maintainability (minor alarm).
   3. Loss of incoming power (power alarm).

(2) **Single-ended Maintenance and Control.** The multiplexer shall provide two levels of single-ended maintenance and control:

(a) A user panel permitting less experienced personnel to interact with the system using pushbuttons and LED displays, without the need for a terminal or PC interface.

(b) A sophisticated terminal or PC-based user interface terminal for more sophisticated message-based operations by experienced personnel.

(c) The user panel shall permit a user to read system alarms and status, and execute basic system control functions, at the local multiplexor or at any remote multiplexor on the ring interconnected via the SONET Data Communications Channel (DCC). The user panel shall include a minor power alarm.

(d) The user interface terminal shall permit a user to sophisticated system operations and access and control all multiplexors on the ring from a single location. This location shall be co-located with a ring node or located at a remote control center not on the ring or as directed by the Engineer. The user interface terminal shall be a MS-DOS PC. Menu-driven command and prompt modes shall be supplied with extensive help features. A user friendly screen and associated reports shall support provisioning and monitoring activities from the central location.

(e) The multiplexer shall be capable of remote software downloads to all multiplexors on the ring from a single location.

(f) The multiplexer shall be capable of taking inventory of all circuit pack types, software versions, CLEI codes, and manufacturing serial numbers from all multiplexors on the ring from a single location.
(g) The Contractor shall supply all necessary software described above.

(3) **Message-Based Operations Interface Requirements.**

(a) The multiplexer message-based operations interface shall use Transaction Level 1 (TL-1) messages.

(b) The multiplexer message-based operations interface shall be capable of a software-only upgrade to the future SONET ASN.1 message interface without the use of an external mediation device.

(c) Communications protocols over the SONET DCC shall be the Open Systems Interconnect (OSI) 7-layer stack as provided in the SONET standard.

(d) A warning message shall be issued to the user for all service-affecting commands.

(e) A command shall be provided to retrieve which multiplexor shelves are connected in the ring to the shelf the user is logged into.

(4) **Other Operations and Maintenance Requirements.**

(a) The multiplexor shall provide an office alarm interface via relay closures.

(b) The multiplexor shall provide a parallel telemetry interface.

(c) The multiplexor shall provide a means for collecting remote miscellaneous discrete alarm and status points external to the multiplexor system such as open door alarms or temperature alarms, with the remote indications collected by relay closures.

(d) The multiplexor shall provide a means for exercising miscellaneous remote control points external to the multiplexor system such as door locks, with the remote control provided by relay closures.

(e) The multiplexor shall provide full SONET performance monitoring information.

(f) The multiplexor shall read American National Standard Institute (ANSI) T1.403 performance message over an appropriately equipped DS1 employing Extended Superframe framing.

(g) The multiplexor shall implement remote interface circuit pack autopropository, whereby the circuit pack memories are updated automatically on the new circuit packs when failed circuit packs are replaced.

(h) The multiplexor shall implement remote processor autopropository, whereby a new processor's memories are automatically updated with the parameters of all interface circuit packs when a failed processor is replaced.

(i) The multiplexor shall provide built in test signal generation such that no external test equipment or terminal is needed for routine installation, turn-up, or repair.
(j) The multiplexor shall provide automatic turn-up and system test capabilities whereby complete tests are performed automatically by the multiplexors using the built-in test generators.

(k) The multiplexors shall have no periodic maintenance requirements except optical maintenance, with mean time between optical maintenance activities of greater than 60000 hours.

(l) Multiplexor software upgrades shall be distributed via floppy disks.

(m) The basic software for the multiplexer shall include the following maintenance and operations capabilities:

- local alarms
- local protection switching
- local diagnostics
- single ended operations
- telemetry
- loopbacks
- auto turn-up
- software download
- signal monitoring (LOS, BPV, threshold crossing alerts, etc.)
- inventory reports
- signal monitoring provisioning
- maintenance history

6. **Technical Assistance.** The Contractor shall ensure that a manufacturer's technical representative is available on site to assist the contractor's technical personnel at each installation site and with SONET digital lightwave multiplexors installation and communication system configuration.

The initial powering up of the SONET multiplexors shall not be executed without the permission of the manufacturer's representative.

7. **Construction Methods.**

1) **General.** The equipment design and construction shall utilize the latest available techniques with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.
The equipment shall be designed for ease of maintenance. All component parts shall be readily accessible for inspection and maintenance. Test points shall be provided for checking essential voltages and waveforms.

(2) **Electronic Components.** All electronic components shall comply with Special Specification Item, "Electronic Components".

(3) **Mechanical Components.** All external screws, nuts and locking washers shall be stainless steel; no self-tapping screws shall be used unless specifically approved by the Engineer.

All parts shall be made of corrosion resistant material, such as plastic, stainless steel, anodized aluminum or brass.

All materials used in construction shall be protected from fungus growth and moisture deterioration.

Dissimilar metals shall be separated by an inert dielectric material.

8. **Documentation Requirements.** The documentation requirements shall be in accordance with Special Specification Item, "Testing, Training, Documentation, Final Acceptance and Warranty", section 4.0.


10. **Training.** The training shall be in accordance with Special Specification Item, "Testing, Training, Documentation, Final Acceptance and Warranty", section 3.0.

11. **Warranty.** The warranty shall be in accordance with Special Specification Item, "Testing, Training, Documentation, Final Acceptance and Warranty", section 6.0

12. **Measurement.** This Item will be measured as each unit furnished, installed, made fully functional and tested in accordance with these special specifications or as directed by the Engineer.

13. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit bid price for each "OC-12 SONET System". This price will include all equipment described under this Item with all cables and connectors; all documentation and testing and shall also include the cost of furnishing all labor, materials, warranty, training and equipment necessary to complete the work.