



**Local Interconnection Mid–Span Meet Facility  
(LI–MSMF)  
Technical Specifications**

NOTICE

This Technical Reference describes Local Interconnection Mid-Span Meet Facility (LI-MSMF) which provides a point-to-point arrangement between a BellSouth Telecommunications, Inc. (BST) central office (Serving Wire Center) and a Competitive Local Exchange Carrier (CLEC) location.

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If further information is required, please contact:

Director – Transport Systems Engineering  
BellSouth Telecommunications, Inc.  
1884 Data Drive  
Birmingham, Alabama 35244

## Local Interconnection Mid–Span Meet Facility (LI–MSMF) Technical Specifications

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# Local Interconnection Mid–Span Meet Facility (LI–MSMF) Technical Specifications

## 1. General

This document provides the technical specifications for Local Interconnection Mid–Span Meet Facility (LI–MSMF) which provides a point–to–point arrangement between a BellSouth Telecommunications, Inc. (BST) central office (Serving Wire Center) and a Competitive Local Exchange Carrier (CLEC) location.

### 1.1 Scope

This Technical Reference (TR) provides the technical specifications necessary for compatible operation between BST and CLECs. The requirements in this document were developed to establish a practical interface. Compliance with these specifications should provide a satisfactory interface in a high percentage of installations. If cases arise that have not been adequately addressed in this document, any resulting problems should be resolved through the cooperation of the user, BST and suppliers. BST encourages customer participation to ensure an orderly, functional and mutually trouble–free interface at all locations.

## 2. Service Description

LI–MSMF provides a transmission path at the OC–3, OC–12, or OC–48 level with BST providing the associated electronics on one end of the facility. This facility includes the transport from the Point of Interconnection (POI) to the BST central office (Serving Wire Center). This service arrangement consists of four optical fibers and fiber terminating equipment as shown in Figure 1. This local interconnection arrangement will allow for transport of DS1s in a mid–span meet arrangement.

The CLEC’s SONET Transmission system is required to be compatible with BST’s currently approved for new deployment hardware and software. The line side of the SONET system will be arranged as a two–node ring, utilizing ring software. The same vendor’s equipment and software version must be used and BST reserves the right to determine the equipment it employs for service. BST and the CLEC will jointly engineer the LI–MSMF optical interface.

## 3. Network Rearrangements

BST reserves the right to rearrange and modify (including upgrade) its network in order to meet its overall service requirements. This includes, but is not limited to, the right to engineer, construct, and maintain BST fiber optic facilities and electronics in accordance with BST normal operating procedures without the requirement to modify those procedures to suit a specific CLEC request.

## 4. SONET OC–3, OC–12 & OC–48 Network Interface Requirements

This section defines the Synchronous Optical Network (SONET) OC–3, OC–12 & OC–48 Optical Network Interface (NI) requirements. It denotes existing documentation that details signal specifications and provides BST variations and clarifications. The SONET interface is delineated in the following specifications.

GR-253-CORE	<i>Synchronous Optical Network (SONET) Transport Systems: Common Criteria Physical Layer</i>
ANSI T1.105	<i>Synchronous Optical Network (SONET) – Basic Description including Multiplex Structure, Rates, and Formats</i>

It is recommended that BST and the CLEC jointly engineer SONET optical interfaces. The line side of the SONET system will be arranged as a two-ring node, utilizing ring software. The CLEC's SONET Transmission system is required to be compatible with BST's currently approved for new deployment hardware and software. The same vendor's equipment and software version must be used, and the Data Communications Channel (DCC) must be turned off. BST reserves the right to determine the equipment it employs for service.

#### 4.1 SONET Rates

SONET defines a progressive hierarchy of optical signal and line rates. The basic building block is the STS-1 (Synchronous Transport Signal at level 1), operating at 51.840 Mb/s. All higher rate signals (STS-N) are multiples (N) of the basic STS-1 signal rate. One example of forming a STS-N signal is by synchronously byte-interleaving N STS-1 signals<sup>1</sup>. The values of N currently recognized in Industry Standards are 1, 3, 12, 24, 48, and 192. The optical counterpart of a STS-N is the OC-N, operating at the same rate as the corresponding STS-N.

SONET takes a layered approach, starting with the lowest layer called the Physical Media Dependent (PMD) layer, followed by the logical layers called the Section, Line and Path<sup>2</sup> layers in ascending order. These layers together constitute the lowest layer, the Physical layer, in the 7-layer Open Systems Interconnection (OSI) Reference Model. The layers are largely independent. Each NE (Network Element) terminates at least the PMD<sup>3</sup>, which provides for the optical or electrical transmission of bits. Each logical layer has an associated overhead that is generated and terminated by NEs operating at the respective level. These NEs are called Section Terminating Equipment (STE), Line Terminating Equipment (LTE<sup>4</sup>) and Path Terminating Equipment (PTE) in ascending order. A NE may terminate one or more than one layer; for example, STE and LTE functions may be combined in one piece of equipment.

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<sup>1</sup> In more general terms, an STS-N signal may consist of an appropriate number of STS-M signals, where  $M < N$ . An STS-M signal in turn may consist of multiple STS-1 signals or it may be a concatenated STS-Mc or STS-Xc signal, where  $X < M$ , or a mixture thereof.

<sup>2</sup> The Path layer is subdivided into the STS (Synchronous Transport Signal) Path layer and depending on multiplexing arrangements, VT (Virtual Tributary) Path layer.

<sup>3</sup> Except the Physical layer regenerator.

<sup>4</sup> Line Terminating Equipment (LTE) from two different vendors is only compatible if transmission as well as Physical layer overhead and operational characteristics match.

**4.2 SONET Signal Format**

The signal format at the SONET interface is based on the SONET frame structure as specified in GR-253-CORE and ANSI T1.105. The STS-1 frame structure consists of the Transport Overhead with Section and Line Overhead portions, the Path Overhead, and the payload. The payload and the Path Overhead together are also referred to as the STS SPE (Synchronous Payload Envelope).

**4.3 Overhead Bytes Active Across NI**

The function of overhead bytes active across the NI shall be consistent with the specifications contained in GR-253-CORE and ANSI T1.105. Transport and Path Overhead bytes active across the interface are summarized in Table 4-1. The Data Communications Channel (DCC) will not be active across the interface at this time. Therefore, receiving equipment must be capable of ignoring their content. Any future utilization of those Overhead bytes is expected to be consistent with SONET Industry Standards.

**Table 4-1 Overhead Bytes Active Across NI**

Transport Overhead				Path Overhead
Section Overhead	Framing A1	Framing A2	Section Trace J0	PathTrace J1
	Section BIP-8 B1			Path BIP-8 B3
				Signal Label C2
Line Overhead	Pointer H1	Pointer H2	Pointer Action H3	Path Status G1
	Line BIP-8 B2	APS K1	APS K2	
				Indicator H4*
		M1 STS-N Line REI		

\* These bytes could be active across the interface for specific applications.

**4.3.1 Framing Information**

Framing information is contained in the A1 and A2 bytes. Equipment on either side of the NI shall meet the requirements for going from an in-frame condition to an out-of-frame condition and for going from an out-of-frame condition to an in-frame condition, as well as for entering and exiting the loss of frame state, as specified in GR-253-CORE.

### 4.3.2 Automatic Protection Switching

Automatic Protection Switching (APS) is controlled by the K1 and K2 bytes. For LI–MSMF Service with a 4 fiber interface, unidirectional 1+1 non–revertive APS will be provided across the NI. Use of the K1 and K2 bytes is specified in GR–253–CORE and ANSI T1.105.01, *Synchronous Optical Network (SONET) – Automatic Protection Switching*.

### 4.3.3 Data Communications Channel

The Section Data Communications Channel (DCC) consists of 192 kbps located in bytes D1, D2 and D3, and the Line DCC consists of 576 kbps located in bytes D4–D12. The Section DCC and Line DCC will not be active across the SONET Interface – receiving equipment must be capable of ignoring their content.

### 4.4 Payload Compatibility

For payloads terminated within the BST network, payload compatibility must be assured. Payload mappings for Synchronous Payload Envelopes (SPEs) terminated in the BST network are defined in ANSI T1.105.02, *Synchronous Optical Network (SONET) – Payload Mappings* and currently limited to the following:

- Asynchronous mapping for DS1 signals into floating VT1.5 SPE.
- Asynchronous mapping for DS3 signals with DS3 framing structure into STS–1 SPE.
- STS–1 signals mapping into STS–3 SPE or STS–12 SPE.

The OC–3, OC–12 and OC–48 LI–MSMF interfaces support transport of properly mapped STS–1, STS–3, STS–3c (concatenated) and STS–12 signals. Payloads that are transported but not terminated in the BST network must be contained in one of the supported frame structures.

#### 4.4.1 Sub–STS–1 Level Multiplexing

DS1 payloads can be directly mapped into the VT1.5 SPE using the asynchronous mapping for a DS1 contained in ANSI T1.105.02. DS1 payloads contained within a DS3 must be mapped using the asynchronous M13 multiplex format (combination of M12 and M23 formats) for terminal equipment that multiplexes 28 DS1s into a DS3, as defined in ANSI T1.107, *Digital Hierarchy Formats Specifications*. The DS3 signal must be framed utilizing the framing structure in ANSI T1.107 and use the asynchronous mapping for a DS3 into an STS–1 SPE.

### 4.5 Fiber Transmission Media

LI–MSMF service shall be provided via single–mode fiber with a nominal zero dispersion wavelength at 1310 nanometers. The conventional dispersion–unshifted single–mode fiber (also known as EIA/TIA Class IVa fiber) shall generally meet the requirements detailed in Bellcore GR–20–CORE, *Generic Requirements for Optical Fiber and Optical Fiber Cables*, and ITU Recommendation G.652, *Characteristics of a Single–Mode Optical Fiber Cable*.

#### 4.5.1 Operating Wavelengths

The service is provided over BST single-mode fiber optic cable which support operating wavelengths of 1310 nanometers (nm) and 1550 nm.

#### 4.5.2 Typical Performance Characteristics

Table 4–2 provides typical characteristics of optical fiber and components commonly utilized in BST’s network:

**Table 4–2 Typical Technical Characteristics of BST Optical Fiber and Components**

Wavelength ( $\lambda$ )	1310 nm	1550 nm
Typical Fiber Loss	0.5 dB/km	0.35 dB/km
Discrete Reflectance (Splices, Connectors)	–40.0 dB	–40.0 dB
Medium Zero Dispersion Wavelength	1310 $\pm$ 3 nm	Not Applicable
Chromatic Dispersion (Fiber Cable)	3.5 ps/nm–km	18.0 ps/nm–km
Chromatic Dispersion Slope (Fiber Cable)	0.093 ps/(nm–km <sup>2</sup> )	0.093 ps/(nm–km <sup>2</sup> )

The transmission characteristics of a specific LI–MSMF application may differ from the above typical performance characteristics.

#### 4.6 Mechanical Interface

At mid-span meet locations BST will establish the method of interconnection. The preferred method of interconnection for all outside plant locations will be a BST provided fusion splice. BST will provide, install, splice and maintain the closure, which will contain the Network Interface (NI) splice. The splice will be the demarcation point between BST and the CLEC.

In those limited cases where the point of interconnection is inside a building, the method of interconnection may be a SC connector. BST will provide, install, splice and maintain the SC connector jack/NI box (housing). Both BST and the CLEC must each provide two connector plugs (duplexable EIA/TIA SCFOC/2.5) to terminate the 2 fiber pairs (4 individual fibers – 2 working and 2 protection) at the NI. Each connector plug will contain 2 fibers, one for each direction of transmission as shown in Figure 2. The connector jack will be the demarcation point between BST and the CLEC.

#### 4.7 Physical Media Characteristics

The interface shall meet the physical media characteristics defined in GR–253–CORE for Short Reach (SR), Intermediate Reach–1 (IR–1) or Long Reach (LR) applications. Transmitter, optical path and receiver parameters are summarized in Tables 4–3 through 4–5.

Table 4–3 OC–3 Optical Parameters

Parameter	SR	IR–1	LR–1	Units
<b>Transmitter</b>	MLM/LED	MLM	MLM	
$\lambda_{Tmin} - \lambda_{Tmax}$	1260–1360	1261–1360	1280–1335	nm
$\Delta\lambda_{rms}$	40/80	7.7	4	nm
$\Delta\lambda_{20}$	NA	NA	NA	nm
SSR <sub>min</sub>	NA	NA	NA	dB
P <sub>Tmax</sub>	–8	–8	0	dBm
P <sub>Tmin</sub>	–15	–15	–5	dBm
r <sub>emin</sub>	8.2	8.2	10	dB
<b>Optical Path</b>				
System ORL <sub>min</sub> <sup>1</sup>	NA	NA	NA	dB
D <sub>SRmax</sub>	18/25	96	185	ps/nm
Attenuation	0–7	0–12	10–28	dB
Max. Reflectance Between S and R	NA	NA	NA	dB
<b>Receiver</b>				
P <sub>Rmax</sub>	–8	–8	–10	dBm
P <sub>Rmin</sub>	–23	–28	–34	dBm
P <sub>O</sub>	1	1	1	dB
Max. Receiver Reflectance	NA	NA	NA	dB

<sup>1</sup> For all applications, it is an objective that the optical system suffer a power penalty less than 1 dB in the presence of –8.5 dB reflectance.

Table 4-4 OC-12 Optical Parameters

Parameter	SR	IR-1	LR-1		Units
<b>Transmitter</b>	MLM/LED	MLM	MLM	SLM	
$\lambda_{Tmin} - \lambda_{Tmax}$	1261-1360	1293-1334 (1274-1356) <sup>1</sup>	1300-1325 (1296-1330) <sup>1</sup>	1280-1335	nm
$\Delta\lambda_{rms}$	14.5/35	4.0 (2.5) <sup>1</sup>	2.0 (1.7) <sup>1</sup>	NA	nm
$\Delta\lambda_{20}$	NA	NA	NA	1	nm
SSR <sub>min</sub>	NA	NA	NA	30	dB
P <sub>Tmax</sub>	-8	-8	+2	+2	dBm
P <sub>Tmin</sub>	-15	-15	-3	-3	dBm
r <sub>emin</sub>	8.2	8.2	10	10	dB
<b>Optical Path</b>					
System ORL <sub>min</sub> <sup>2</sup>	NA	NA	20	20	dB
D <sub>Srmax</sub>	13/14	46 (74) <sup>1</sup>	92 (109) <sup>1</sup>	NA	ps/nm
Attenuation	0-7	0-12	10-24	10-24	dB
Max. Reflectance Between S and R	NA	NA	-25	-25	dB
<b>Receiver</b>					
P <sub>rmax</sub>	-8	-8	-8	-8	dBm
P <sub>rmin</sub>	-23	-28	-28	-28	dBm
P <sub>O</sub>	1	1	1	1	dB
Max. Receiver Reflectance	NA	NA	-14	-14	dB

Note 1: Transmitters meeting the narrower spectral width objective are allowed a wider central wavelength range ( $\lambda_{Tmin} - \lambda_{Tmax}$ ).

Note 2: For all applications, it is an objective that the optical system suffer a power penalty less than 1 dB in the presence of -8.5dB reflectance.

Table 4–5 OC–48 Optical Parameters

Parameter	SR	IR–1	LR–1	Units
<b>Transmitter</b>	MLM	SLM	SLM	
$\lambda_{Tmin} - \lambda_{Tmax}$	1266–1360	1260–1360	1280–1335	nm
$\Delta\lambda_{rms}$	4	NA	NA	nm
$\Delta\lambda_{20}$	NA	1	1	nm
SSR <sub>min</sub>	NA	30	30	dB
P <sub>Tmax</sub>	–3	0	+3	dBm
P <sub>Tmin</sub>	–10	–5	–2	dBm
r <sub>emin</sub>	8.2	8.2	8.2	dB
<b>Optical Path</b>				
System ORL <sub>min</sub> <sup>1</sup>	24	24	24	dB
DSR <sub>max</sub>	12	NA	NA	ps/nm
Attenuation	0–7	0–12	10–24	dB
Max. Reflectance Between S and R	–27	–27	–27	dB
<b>Receiver</b>				
P <sub>Rmax</sub>	–3	0	–9	dBm
P <sub>Rmin</sub>	–18	–18	–27	dBm
P <sub>O</sub>	1	1	1	dB
Max. Receiver Reflectance	–27 <sup>2</sup>	–27 <sup>2</sup>	–27 <sup>2</sup>	dB

<sup>1</sup> For all applications, it is an objective that the optical system suffer a power penalty less than 1 dB in the presence of –8.5 dB reflectance.

<sup>2</sup> This value is intended to ensure acceptable penalties due to multiple reflections for all likely system configurations. For systems employing few or higher–performance optical components (e.g., a system with only two connectors), a –14 dB receiver reflectance may be considered acceptable.

#### 4.7.1 Optical Parameter Definitions

The following definitions apply to the parameter values listed in Tables 4–2 through 4–5.

LED	Light Emitting Diode
MLM	Multi–Longitudinal Mode laser
SLM	Single–Longitudinal Mode laser
$\lambda_{Tmin}, \lambda_{Tmax}$	The range of central operating wavelengths – minimum and maximum central operating wavelengths, under worst–case variations due to manufacturing, temperature, aging, and reflections.
$\Delta\lambda_{rms}$	Root–Mean–Square (RMS) spectral width under worst–case reflection conditions.
$\Delta\lambda_{20}$	Full spectral width measured 20 dB down from the maximum of the central wavelength peak of a single–longitudinal mode (SLM) transmitter operating fully modulated in the presence of worst–case reflections.
$P_{Tmax}, P_{Tmin}$	The maximum and minimum coupled transmitter power at point S in Figure 3, with a pseudo–random data sequence.
$r_{emin}$	The minimum value of the extinction ratio – ratio of the average optical energy in a logic one level to a logic zero level, under fully modulated conditions in the presence of worst–case reflections.
$ORL_{min}$	The minimum ratio in dB of optical power arriving downstream at a system interface to the optical power reflected back upstream to the same interface.
$D_{SRmax}$	The maximum dispersion between points S & R in Figure 3.
$P_{Rmax}, P_{Rmin}$	The maximum and minimum receiver power at point R in Figure 3 for $1 \times 10^{-10}$ BER.
$P_O$	Optical path power penalty between points S and R in Figure 3.

#### 4.8 System Budget – Joint Engineering

The establishment of optical interfaces will require joint engineering between BST and the CLEC using commonly accepted engineering practices. The design approach should be based on ANSI/EIA/TIA–559, *Single–Mode Fiber Optic System Transmission Design* and GR–253–CORE procedures.

For the purpose of optical parameter specifications, optical interfaces are referred to an optical system reference diagram as shown in Figure 3. Point S is a reference point on the optical fiber just after the transmitter (Tx) optical connector (CTx). Point R is a reference point on the optical fiber just before the receiver (Rx) optical connector (CRx). Points S and R provide a convenient separation of the optical link into a transmitter subsection, a receiver subsection, and an optical path subsection. Optical parameters are specified for the transmitter at point S, for the receiver at point R, and for the optical path between Points S and R. All parameter values specified are worst–case values and are to be met over the ranges of standard operating conditions (i.e., temperature and humidity ranges); they include aging effects. The parameters are specified relative to an optical section design objective of a bit error ratio (BER) better than  $1 \times 10^{-10}$ .

To ensure proper system performance it is necessary to specify attenuation and dispersion characteristics of the optical path. Attenuation shall be in the range of 0–7 dB for SR applications, 0–12 dB for IR applications, and 10–24/28 dB for LR applications. This specification is assumed to represent worst–case values including losses due to splices, connectors, optical attenuators (if used), or other passive optical devices, and any additional cable margin to cover allowances for the following:

- (1) future modifications to the cable configuration (additional splices, increased cable lengths, etc.),
- (2) fiber cable performance variations due to environmental factors, and
- (3) degradation of any connector, optical attenuator (if used), or other passive optical device when provided.

For design purposes, BST will provide the CLEC the following information:

- Length of the fiber cable including 3% extra for possible cable reroute.
- Loss budget value in decibels/kilometer (dB/km) of fiber cable at  $\lambda = 1310 \text{ nm}$  or  $\lambda = 1550 \text{ nm}$ .
- Number of splices constructed and anticipated number of maintenance splices.
- Loss budget value of each splice in dB/splice.
- Loss budget value of single–mode fiber jumper in dB/jumper.
- Loss budget value of jumpers and connectors at the Lightguide Terminal Interconnect Equipment (LTIE) in dB at customer premises.
- Loss budget values of jumpers and connectors in dB used to connect fibers in BST office(s).

**Note:** Loss Budget Values are end-of-life values that account for aging and are usually greater than actual measured values.

## **5. Operations and Maintenance**

The SONET interface may terminate in the network at three hierarchical layers: the Section, Line, and Path. The SONET path termination may include STS-Path, VT Path, or DS<sub>n</sub> Path. Maintenance capabilities associated with the Section, Line, and Path layers include Performance Monitoring (PM), alarm surveillance, and facility testing. Such maintenance capabilities are performed by Section, Line, and Path termination equipment contained within SONET network elements and are made possible by maintenance tools built into the Section, Line, and Path overhead fields of the SONET framing structure.

The SONET overhead bytes required to perform such operations and maintenance functions for SONET are identified in GR-253-CORE and ANSI T1.105 and have previously been defined as active across the interface.

The CLEC must cooperatively disable (turn-off) any optical transmission equipment on a LI-MSMF whenever BST must perform maintenance on those facilities.

### **5.1 Fault and Alarm Management**

Alarm surveillance deals with the detection and reporting of certain failure conditions in the network. SONET CI equipment is required to detect certain failure conditions relevant to the layer of functionality they provide. Detection of a failure in the network is often communicated throughout relevant portions of the network via maintenance signals built into the SONET frame structure. STS Path level maintenance signals include STS Path Alarm Indication Signal (AIS) and STS Path Remote Defect Indication (RDI). RDI is a performance indicator that is initiated immediately upon detection of a defect.

### **5.2 Failure States**

The failure states, Loss of Signal (LOS), Loss of Frame (LOF), and Loss of Pointer (LOP) are defined in GR-253-CORE. SONET equipment shall detect failure states relevant to the layer of SONET overhead functionality it provides.

### **5.3 Equipment Failures**

SONET CI equipment failures should be detected and reported according to the equipment failure conditions specified in GR-253-CORE.

## 5.4 Maintenance Signals

Failure states that persist for a defined period of time lead to indications that are reported to SONET equipment using the following maintenance signals.

### Alarm Indication Signal (AIS)

SONET provided equipment provides different AISs for various layers of functionality including DS1, DS3, Path, and Line AISs. The Line AIS, STS Path AIS, and/or VT Path AIS generation and detection shall meet the criteria stated in GR-253-CORE.

In many applications, SONET will be a transport medium for lower speeds digital signals such as DS1 and DS3. Because of this, SONET CPE that has these DS<sub>n</sub> digital interfaces may need to detect and generate DS<sub>n</sub> AISs associated with these interfaces. On detection of a failure (Line AIS, STS Path AIS, and/or VT Path AIS) STS PTE (or VT PTE) shall generate downstream DS<sub>n</sub> AIS depending on the composition of the STS SPE (or VT PTE) or the functionality of the STS or VT PTE. SONET STS PTE, or VT PTE shall detect DS<sub>n</sub> AIS at all DS<sub>n</sub> interfaces at which DS<sub>n</sub> path is terminated. GR-253-CORE and TR-TSY-000191 specify requirements for DS1 and DS3 AIS.

### Line Remote Defect Indication

Line Remote Defect Indication (RDI), formerly line Far End Receive Failure, alerts the upstream equipment that a failure has been detected. SONET terminals shall generate, detect, and deactivate (remove) STS Line RDI according to GR-253-CORE.

### DSN Remote Failure Indication

Certain SONET payload mappings may require CPE with digital signal interfaces to detect and generate DS<sub>n</sub> Remote Failure Indication (RFI), formerly Yellow. DS<sub>n</sub> RFI shall be detected or generated for DS<sub>n</sub> paths that are terminated according to GR-253-CORE.

### STS-Path Remote Defect Indication

STS-Path RDI, formerly Far End Receive Failure (FERF), alerts the upstream equipment that a failure state has been detected. It is an objective for SONET to meet the STS-Path RDI as described in GR-253-CORE.

## 5.5 Performance Monitoring

In order to support effective maintenance and maintain high service levels, it is desirable that BST and CI SONET equipment provide the same performance monitoring capabilities.

BST will support performance monitoring (PM) in accordance with the strategies and set of layered PM parameters contained in the GR-253-CORE. Except as specifically noted, the layered PM requirements in GR-253-CORE apply to BST SONET interfaces.

SONET STS-Path terminated equipment shall provide Section, Line, and Path performance monitoring on incoming OC-N facilities and be capable of reporting threshold crossings according to the generic requirements in GR-253-CORE.

SONET equipment, if terminating the VT–Path level, shall also provide VT–Path performance monitoring according to GR–253–CORE.

SONET CLEC equipment interfacing with a DS1 or DS3 signal shall detect Loss of Signal (LOS) on those signals according to the requirements in Bellcore TR–TSY–000191, *Alarm Indication Signals Requirements and Objectives*.

## 6. Synchronization

To insure proper operation when connected to the BST digital network, channelized DS1 circuits should follow the guidelines of Bellcore GR–436–CORE, *Digital Network Synchronization Plan*. Timing information may be transmitted as part of the DS1 signal. Improper timing will result in transmission impairing slips that can cause loss of data information.

CLEC synchronization may be achieved by deriving timing from a BST channelized DS1, by deriving timing from a different DS1 traceable to a Primary Reference Source (PRS) and timing all other facilities from it, or by providing timing traceable to a PRS. For BST services with central office channelization, it has been recommended that the customer equipment be loop–timed (slaved) to the incoming bit stream from the network.

It is important to note that Synchronous Optical Network (SONET) facilities will be used to transport LI–MSMF Service. SONET facilities may introduce DS1 phase transients as a result of pointer adjustments. Characteristics of the phase transients at the network interface have been addressed in the latest version of ANSI T1.403. Customer equipment must be capable of accommodating these phase transients. Further information about phase transients due to SONET pointer adjustments is contained in ANSI T1.403.

## 7. Optical Power Limitations

CLEC provided lasers shall not exceed +17.0 dBm in output power at 1550 nm (Class IIIB laser). In addition, the CLEC shall tell BST which class of laser (see Section 9) that they will be utilizing on their equipment.

## 8. Safety Requirements

The fiber optic system and required optical test equipment shall be registered and certified with the Department of Health, Education and Welfare Bureau of Radiological Health as specified in 21 CFR 1040.10. This document specifies performance requirements, labeling requirements and informational requirements. Documentation demonstrating system certification shall be available to assist in the determination of fiber optic safety precautions required to install, operate and maintain the system.

Optical powers from lasers are also classified by the International Electrotechnical Commission (IEC). Depending on the potential danger, IEC 825 requires that all laser equipment be classified into one of the following classes; 1, 2, 3a, 3b, or 4. Because the minimum power limits for class 4 lasers are not used in telecommunications, they are not considered for the purposes of this document. The other classes of lasers, the power limitations and the accompanying safety requirements are summarized in Table 8–1 below:

**Table 8–1 IEC 825–1 and 825–2 Classes of Lasers, Power Limits & Safety Requirements**

Laser	Maximum Power Levels		Safety Requirements
	1310 nm	1550 nm	
Class 1	9.4 dBm	10.0 dBm	Inherently Safe <ul style="list-style-type: none"> <li>● Protective housing to prevent higher than classified emission.</li> <li>● Safety interlock in the housing to prevent access to non–classified emission levels.</li> <li>● Classification labels on the product and in the promotional literature.</li> <li>● Caution labels on service panels, interlocked or not</li> <li>● User safety information in operator and service manuals.</li> </ul>
Class 2 <sup>5</sup>	NA	NA	NA
Class 3a	13.8 dBm	17.0 dBm	Safe unless viewing aids are used Additional requirements to all of the above: <ul style="list-style-type: none"> <li>● Key control</li> <li>● Beam stop to automatically disable the laser if no access is required.</li> <li>● Audible or visible “Laser On” warning.</li> </ul>
Class 3b	27.0 dBm	27.0 dBm	Additional requirements to all of the above: <ul style="list-style-type: none"> <li>● Remote control switch to allow disabling the laser by a door circuit.</li> <li>● Aperture label to indicate the location of the radiation output.</li> </ul>

<sup>5</sup> Class 2 is used for visible laser products emitting wavelengths from 400 to 700 nm, these requirements are not considered pertinent.

Special precautions and requirements for installation and use of optical systems (including amplifiers) and a description of viewing aids are given in IEC 825–2.

## 9. Channel Codes

The Network Channel (NC) Code identifies the service and provides an encoded representation of the channel from the Local Interconnection Mid–Span Meet Facility (LI–MSMF) Point of Interface (POI) to the BST central office (Serving Wire Center). The electrical characteristics of the interface at the POI are identified by the Network Channel Interface (NCI) Code.

When ordering service, the customer must specify compatible codes. Definitions of specific codes that apply to LI–MSMF are covered in this Section. Descriptions of the component parts of the code are provided to aid the customer in understanding the relationship of these codes to the electrical characteristics of the interface.

The appropriate interface ordering procedures, which use these NC and NCI codes, are covered in other publications such as Bellcore SR–STS–000307 and the NC/NCI Decoder. LI–MSMF will utilize existing codes.

### 9.1 Network Channel Code

The Network Channel (NC) Code is a 4–character code that consists of two (2) data elements:

Channel Code	A two–character code in positions 1&2 that describes the channel service in an abbreviated form. Code <b>HC</b> identifies a High Capacity Channel Service HC1.
Optional Feature Code	A two–character code in positions 3&4 that identifies the option codes available for each Channel Code. The third character defines functions of the channel, i.e. protocols B8ZS, SF and ESF etc. The fourth character is used to further enhance the third character of the NC Code by defining features of the channel, i.e. multiplexing etc.

Table 9–1 NC Code HC\_ \_ High Capacity Channel Service HC1

Network Channel HC_ _	Optional Feature Code Character 3	Optional Feature Code Character 4
HC–D	SF & AMI –	Direct Digital Connection On a Switch D
HC–M	SF & AMI –	Central Office Multiplex To Analog Voice M
HCDD	ANSI T1.403 ESF & AMI D	Direct Digital Connection On a Switch D
HCDM	ANSI T1.403 ESF & AMI D	Central Office Multiplex To Analog Voice M
HCED	ANSI T1.403 ESF & B8ZS E	Direct Digital Connection On a Switch D
HCEM	ANSI T1.403 ESF & B8ZS E	Central Office Multiplex To Analog Voice M
HCZD	B8ZS & SF D	Direct Digital Connection On a Switch D
HCZM	B8ZS & SF M	Central Office Multiplex To Analog Voice M

## 9.2 Network Channel Interface Codes

The Network Channel Interface (NCI) Code is a maximum twelve-character code that can consist of five data elements and two delimiters. The NCI describes the number of conductors, protocol, impedance, protocol options and transmission level point(s) reflecting characteristics at the Central Office or Network Interface (NI)/Point of Interface (POI).

Number of Conductors	A two-character code in positions 1& 2 that identifies the total number of physical conductors, i.e. code <b>04</b> identifies four wires or four optical fibers.
Protocol	A two-character code in positions 3 & 4 that represents requirements for the interface regarding signaling/transmission and digital applications, i.e. code <b>SO</b> represents SONET optical.
Impedance	A one-character code in position 5 that identifies the nominal reference impedance that will terminate the channel for the purpose of evaluating the transmission performance at the POI, i.e. <b>F</b> represents optical fiber.
Delimiter	A “.” is used as a delimiter in position 6.
Protocol Options	A one-to three-character code in positions 7, 8 and 9 that broadly describes the technical capabilities of the interface, i.e. <b>B</b> indicates LR1-SLM.
TLP	Transmission Level Point (TLP) can be contained in positions 8 through 12. A one- or two-character code corresponding to a value for the TLP(s) with a delimiter. This code will not be used for LI-MSMF.

For ordering purposes the NCI code for LI-MSMF should be specified as **04SO.F.B**. This code represents a four-fiber SONET optical interface with LR1-SLM lasers. The optical interface will be jointly engineered BST and the CLEC selecting the most appropriate transmitter and receiver for the specific application.

## 10. Acronyms

AIS	Alarm Indication Signal
ANSI	American National Standards Institute
APS	Automatic Protection Switching
ATM	Asynchronous Transfer Mode
B3ZS	Bipolar with Three–Zero Substitution
BIP	Bit Interleaved Parity
CLEC	Competitive Local Exchange Carrier
CXR	Carrier
DCC	Data Communications Channel
DCS	Digital Cross–Connect System
$D_{SRmax}$	Maximum Dispersion Between Points S & R
DQDB	Distributed Queue Dual Bus
DS0	Digital Signal Level 0
DS1	Digital Signal Level 1
DS3	Digital Signal Level 3
DSX–1	Cross Connect for DS1 Signals
DSX–3	Cross Connect for DS3 Signals
EU	End User
FDDI	Fiber Distributed Data Interface
FEBE	Far End Block Error
FERF	Far End Receive Failure
IEC	Interexchange Carrier
IR	Intermediate Reach (Optical Standard)
ITU/TSS	International Telecommunication Union/Telecommunication Standardization Sector
LEC	Local Exchange Carrier
LED	Light Emitting Diode
LTE	Line Terminating Equipment
MLM	Multi–Longitudinal Mode
NE	Network Element
OC–12	Optical Carrier level 12
OC–N	Optical Carrier level–N
$ORL_{min}$	Minimum System Optical Return Loss
OSI	Open Systems Interconnection
PMD	Physical Medium Dependent
PO	Optical Path Power Penalty Between Points S and R
POH	Path OverHead

PPM	Parts per Million
$P_{Rmax}, P_{Rmin}$	Maximum and Minimum Receiver Power at Point R for $1 \times 10^{-10}$ BER
PRS	Primary Reference Source
PTE	Path Terminating Equipment
$P_{Tmax}, P_{Tmin}$	Maximum and Minimum Coupled Transmitter Power at Point S
RDI	Remote Defect indicator
$r_{emin}$	Minimum Value of the Extinction Ratio
REI	Remote Error Indication
RFI	Remote Failure Indication (Formerly Yellow)
SDH	Synchronous Digital Hierarchy
SLM	Single Longitudinal Mode
SOH	Section OverHead
SONET	Synchronous Optical Network
SPE	Synchronous Payload Envelope
SR	Short Reach (Optical Standard)
$SSR_{min}$	Minimum Acceptable Side–Mode Suppression Ratio (SSR)
STE	Section Terminating Equipment
STM	Synchronous Transfer Mode
STS–N	Synchronous Transport Signal level N
STS–Nc	Concatenated Synchronous Transport Signal level N
TA	Technical Advisory
TR	Technical Requirement
VT1.5	Virtual Tributary at 1.5 Mb/s
$\lambda_{Tmin}, \lambda_{Tmax}$	Minimum and Maximum Central Operating Wavelengths
$\Delta\lambda_{rms}$	Root–Mean–Square (RMS) Spectral Width
$\Delta\lambda_{20}$	Full Spectral Width Measured 20 dB Down

## 11. References

- ANSI T1.101–1994      American National Standard for Telecommunications –  
*Synchronization Interface for Digital Networks*
- ANSI T1.102–1993      American National Standard for Telecommunications –  
*Digital Hierarchy – Electrical Interfaces*
- ANSI T1.105–1995      American National Standard for Telecommunications –  
*Synchronous Optical Network (SONET) – Basic Description including  
Multiplex Structure, Rates, and Formats*
- ANSI T1.105.01–1995    American National Standard for Telecommunications –  
*Synchronous Optical Network (SONET) – Automatic Protection Switching*
- ANSI T1.105.02–1995    American National Standard for Telecommunications –  
*Synchronous Optical Network (SONET) – Payload Mappings*
- ANSI T1.105.03–1994    American National Standard for Telecommunications –  
*Synchronous Optical Network (SONET) – Jitter at Network Interfaces*
- ANSI T1.105.03a–1995   American National Standard for Telecommunications –  
*Synchronous Optical Network (SONET) – Jitter at Network Interfaces –  
DS1 Supplement*
- ANSI T1.107–1995      American National Standard for Telecommunications –  
*Digital Hierarchy – Formats Specifications*
- ANSI T1.403–1995      American National Standard for Telecommunications –  
*Network-to-Customer Installation – DS1 Metallic Interface*
- ANSI Z136.2–1988      *American National Standard for the Safe Use of Optical Fiber Communica-  
tions Systems Utilizing Laser Diode and LED Sources*
- IEC 825–1              *Safety of Laser Products, Part 1: Equipment classification, requirements and  
user’s guide, First Edition, 1993–11*
- IEC 825–2              *Safety of Laser Products, Part 2: Safety of optical fiber communication  
systems, First Edition, 1993–09*

IEC and ANSI documents can be ordered from:

Global Engineering Documents  
15 Inverness Way East  
Englewood, CO 80112–5704  
(800) 854–7179

EIA/TIA-559	<i>Single-Mode Fiber Optic System Transmission Design</i>
OFSTP-2	<i>Effective Transmitter Output Power Coupled into Single-Mode Fiber Optic Cable</i>
OFSTP-3	<i>Fiber Optic Terminal Receiver Sensitivity and Maximum Receiver Input</i>
OFSTP-10	<i>Measurement of Dispersion Power Penalty in Single-Mode Systems</i>
OFSTP-11	<i>Measurement of Single Reflection Power Penalty for Fiber Optic Terminal Equipment</i>

EIA/TIA documents may be ordered by contacting:

Telecommunications Industry Association  
Engineering Department  
2001 Pennsylvania Avenue N.W.  
Washington, D.C. 20006

GR-20-CORE	<i>Generic Requirements for Optical Fiber and Optical Fiber Cables, Issue 1, December, 1994</i>
GR-253-CORE	<i>Synchronous Optical Network (SONET) Transport Systems: Common Criteria Physical Layer, Issue 1, December 1994</i>
GR-342-CORE	<i>High-Capacity Digital Special Access Service Transmission Parameter Limits and Interface Combination, Issue 1, December, 1995</i>
GR-436-CORE	<i>Digital Network Synchronization Plan, Issue 1, June 1994</i>
GR-1365-CORE	<i>SONET Private Line Service Interface Generic Criteria for End Users, Issue 1, December 1994</i>
TR-TSY-000191	<i>Alarm Indication Signals Requirements and Objectives, Issue 1, May, 1986</i>
SR-ST5-000307	<i>NC/NCI Code Dictionary, Issue 8, April, 1997</i>
NC/NCI Decoder	PC based application with a 1-year subscription for the NC/NCI code set, Issue 3Q, September 1998

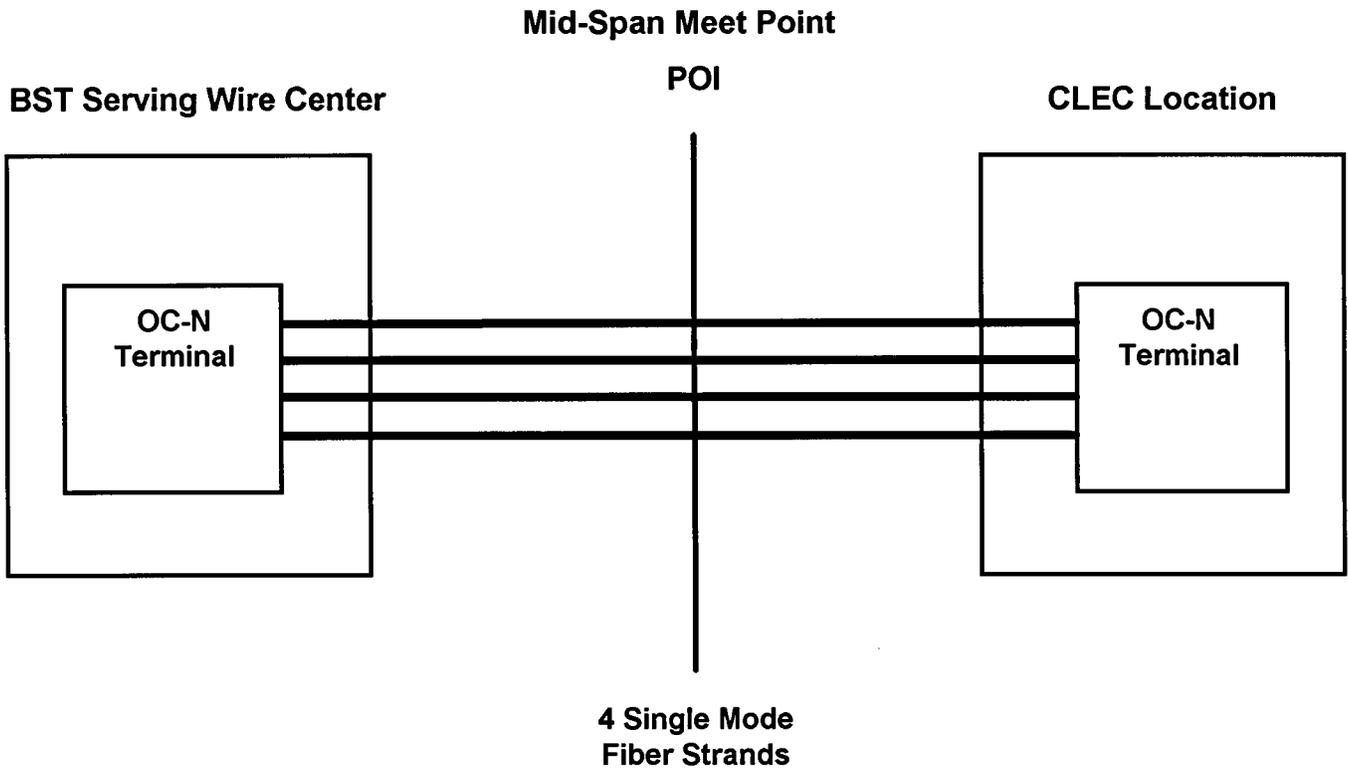
Bellcore Technical References and Documents may be ordered by contacting:

Bellcore Customer Relations  
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1-800-521-2673

21 CFR 1040, Performance Standard for Laser Products.

This document may be obtained by contacting:

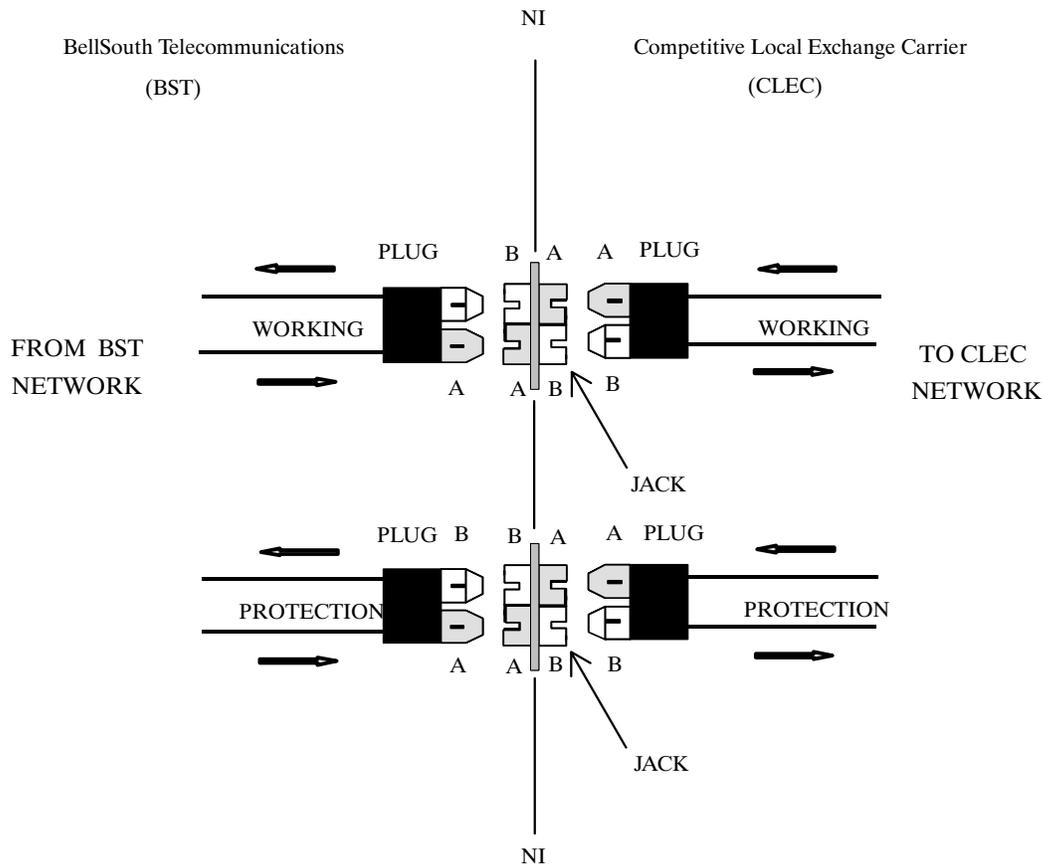
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Note: At the Point of Interface (POI), the 4 individual single-mode fiber strands (2 working and 2 protection) will be spliced using fusion techniques or alternatively interconnected using an SC type connector.

**Figure 1 – Local Interconnection Mid-Span Meet Point of Interface (POI)**

**FOR USE IN A BUILDING, OR CONTROLLED ENVIRONMENT STRUCTURE**



NOTES:

- 1 LIGHT LEAVES "A" PLUG AND ENTERS "A" JACK
- 2 LIGHT LEAVES "B" JACK AND ENTERS "B" PLUG
- 3 JACK AT NI PROVIDED BY BST (OPTIONALLY MAY BE PART OF OTHER NETWORK EQUIPMENT)
- 4 A SINGLE FIBER IS USED FOR EACH DIRECTION OF TRANSMISSION
- 5 FOR 4 FIBER INTERFACE BOTH WORKING AND PROTECTION PROVIDED

➔ DIRECTION OF LIGHT

**Figure 2 – 4 Fiber SC Connector Network Interface**

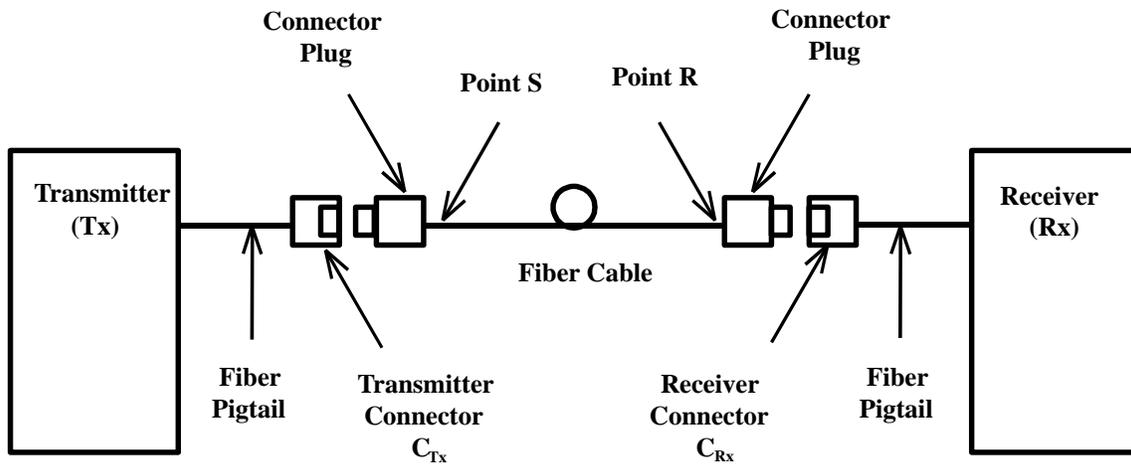


Figure 3 – Optical System Interfaces (Points S and R)

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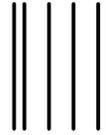
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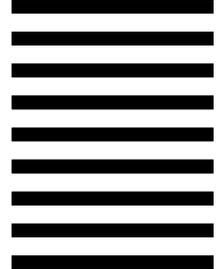
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