

**Data Communications
TECHNICAL REFERENCE**

AT&T Private Line Service OC-12

**SERVICE DESCRIPTION
AND
INTERFACE SPECIFICATION**

July 1998



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1. Introduction

This Technical Reference provides Network Interface (NI) and Point of Interface (POI) Specifications for the AT&T Private Line OC-12 (Optical Carrier Level 12) Service. The document includes a description of the service, technical parameters, physical interface requirements, logical interface requirements, and other necessary criteria for connecting Customer Premises Equipment (CPE) and/or access to OC-12 circuits to obtain the performance characteristics identified in Section 3.

In conformance with the approach used in Industry Standards, this document uses "shall" to signify a mandatory requirement, and the word "should" to indicate recommended or advisory criteria.

1.1 Contents

The document consists of 8 sections that cover the following subjects:

Section 1. Introduction

Section 2. Service Description

Section 3. Availability and Error Performance Parameters

Section 4. Interface Specifications

Section 5. Synchronization and Timing

Section 6. Network Alarm and Status Conditions

Section 7. Customer Premises Equipment Characteristics

Section 8. Testing and Maintenance

1.2 Acronyms

ABMSC	AT&T Bandwidth Management Service Center
ADM	Add/Drop Multiplexer
AIS	Alarm Indication Signal
AIS-L	Alarm Indication Signal Line
AIS-P	Alarm Indication Signal Path
ANSI	American National Standards Institute
APLS	AT&T Private Line Service
APS	Automatic Protection Switching
BIP	Bit Interleave Parity
BITS	Building Integrated Timing Source
CAP	Competitive Access Provider
CI	Customer Installation
CO	Central Office
CPA	Customer Provided Access
CPE	Customer Premises Equipment
dBm	Decibels (referenced to milliwatt)
CV-P	Code Violation Path
DCC	Data Communications Channel

DS1	Digital Signal Level 1
DS3	Digital Signal Level 3
EFS	Error Free Seconds
%EFS	Percent Error Free Seconds
EIA	Electrical Institute of America
ES-P	Error Second Path
FC	Optical Connector Type Ferrule Connector
FCC	Federal Communications Commission
IOC	Inter-Office Channel
IR	Intermediate Reach
ISO	International Standards Organization
ITU-T	International Telecommunications Union – Telecommunications Standardization Sector
LC	Local Channel
LEC	Local Exchange Carrier
LGX	Light Guide Cross-connect
LOF	Loss of Frame
LOP	Loss of Pointer
LOP-P	Loss of Pointer Path
LOS	Loss of Signal
LTE	Line Terminating Equipment
Mbps	Megabits per second
NE	Network Element
NI	Network Interface
nm	nano-meter
OC-12	Optical Carrier Level 12
OC-3	Optical Carrier Level 3
POI	Point of Interface
POP	Point of Presence
PTE	Path Terminating Equipment
RDI-L	Remote Defect Indication Line
REI-L	Remote Error Indicator Line
RFI-P	Remote Failure Indicator Path
SC	Optical Connector Type Square Connector
SES-P	Severely Error Seconds Path
SMF	Single-Mode dispersion-unshifted Fiber
SONET	Synchronous Optical NETWORK
SR	Short Reach
ST	Optical Connector Type Straight Tip
STS	Synchronous Transport Signal
STS-1	Synchronous Transport Signal Level 1
STS-12c	Synchronous Transport Signal Level 12 Concatenated
STS-3c	Synchronous Transport Signal Level 3 Concatenated
STS-N	Synchronous Transport Signal Level N
STS-Nc	Synchronous Transport Signal Level N Concatenated
SWC	Serving Wiring Center
T1	DS1 Electrical Interface and Carrier
T3	DS3 Electrical Interface and Carrier
TCPA	Turnkey Customer Provided Access

TR	Technical Reference
VT1.5	Virtual Tributary containing a DS1

1.3 Relationship With Other AT&T Technical References And Industry Standards

Interface specifications pertaining to ACCUNET® T45 Service can be found in Technical Reference (TR) 54014 and its addenda^[1]. Interface specifications pertaining to ACCUNET T1.5 Service can be found in TR 62411^[2]. Access specifications for ACCUNET T1.5 and T45 can be found in TR 62415^[3].

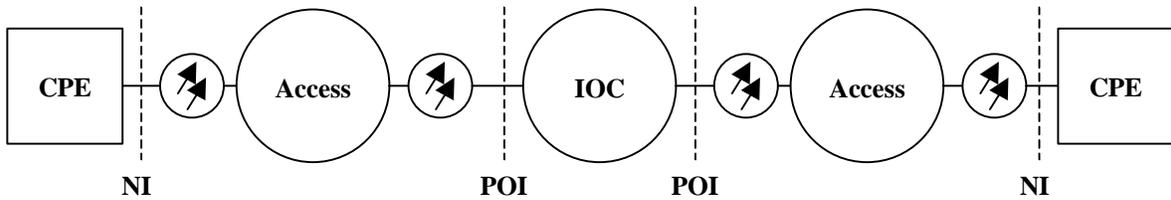
Information about the optical interface and payload mappings can be found in (with their supporting references): AT&T TR 54018 OC-3 Optical Interface Specifications^[4], ANSI T1.101-1994 – Synchronous Interface Standards^[5], ANSI T1.105.01-1994 Telecommunications – Synchronous Optical Network (SONET) – Automatic Protection Switching^[6], ANSI T1.105.02-1995 Telecommunications – Synchronous Optical Network (SONET) – Payload Mappings^[7], ANSI T1.105.03-1995 Telecommunications – Synchronous Optical Network (SONET) – Jitter at Network Interfaces^[8], ANSI T1.105.03a-1995 Telecommunications – Synchronous Optical Network (SONET) – Jitter at Network Interfaces – DS1 Supplement^[9], and ANSI T1.105.03b-1997 Telecommunications – Synchronous Optical Network (SONET) – Jitter at Network Interfaces – DS3 Wander Supplement^[10], ANSI T1.105.04-1995 Telecommunications – Synchronous Optical Network (SONET) – Data Communication Channel Protocols and Architectures^[11], ANSI T1.105.06-1995 Synchronous Optical Network (SONET) – Physical Layer Specifications^[25], ANSI T1.105.09-1995 Telecommunications – Synchronous Optical Network (SONET) - Timing and Synchronization^[13], ANSI T1.107-1995 Telecommunications - Digital Hierarchy - Formats Specifications^[14], ANSI T1.231-1997 – Digital Hierarchy – Layer 1 In-service Digital Transmission Performance Monitoring^[15], ANSI T1.514-1995 Network Performance Parameters and Objectives for Dedicated Digital Services – SONET Bit Rates^[16], Bellcore Synchronous Optical Network (SONET) Transport Systems Common Generic Criteria (GR-253-CORE)^[17], Bellcore (GR-499-CORE)^[18], Bellcore Clocks for the Synchronized Network: Common Generic Criteria (GR-1244-CORE)^[19], Bellcore SONET Private Line Service Interface Generic Criteria for End Users (GR-1365-CORE)^[20], ATM Forum af-phy-0046.000 “622.08 Mbps Physical Layer Specification,” January 1996^[21].

AT&T intends to continue to review the emerging SONET (Synchronous Optical NETWORK) standards as they are defined and adopt them as appropriate.

2. Service Description

2.1 OC-12 Inter-Office Channel Service

The AT&T Private Line Service (APLS) OC-12 Inter-Office Channel (IOC) Service is a service that provides dedicated point-to-point 622.08 Megabits per second (Mbps) digital service. A point-to-point service is defined as a two-way service where traffic originates/terminates in one location and terminates/originates in the other. The OC-12 IOC is comprised of STS-1 (Synchronous Transport Signal Level 1), and/or STS-3c (Synchronous Transport Signal Level 3 concatenated), or STS-12c (Synchronous Transport Signal Level 12 concatenated) tributary signals as required per customer application. The differences between the line rates and effective customer payloads are due to bits reserved for SONET overhead signaling. OC-12 service features optical interfaces at the NI and the POI. Figure 1 illustrates a typical point-to-point OC-12 circuit with significant components and points of demarcation.



Note – All NI and POI interfaces are Optical.

Figure 1. Typical Point-to-point OC-12 Circuit

More details about SONET format Standards are given in Section 4 “Interface Specifications”.

2.1.1 Zero Mile IOC Service

This is a special configuration that supports OC-12 connectivity in the same office, i.e. access-to-access.

2.2 OC-12 SONET Multiplexing Function

The DS1 (Digital Signal Level 1), DS3 (Digital Signal Level 3), and/or STS-3c channels which are carried through the OC-12 system are full duplex and will meet the interface requirements of APLS DS1, APLS DS3 and APLS OC-3 (Optical Carrier Level 3) services. OC-12 SONET multiplexing function is an offering by AT&T in addition to the IOC OC-12 offering. SONET Multiplexing function extends the transport mechanism to include multiplexing and cross-connect capabilities based on which DS1, DS3, STS-1, and/or STS-3c are combined into or derived from OC-12. **Figure 2** and **Figure 3** illustrates two possible multiplexing configurations. Service Assurance Warranty applies to the OC-12 circuit failure, inclusive of the multiplexer.

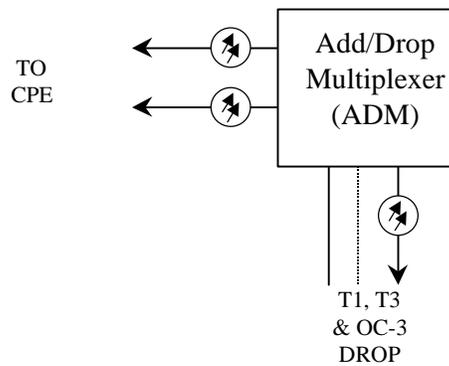


Figure 2. OC-12 Standalone Multiplexing Function

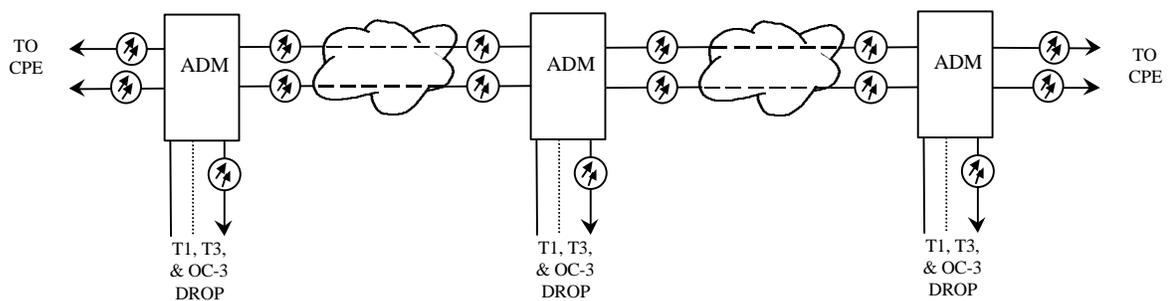


Figure 3. OC-12 Multiplexing And Linear Add/Drop

2.3 Network Interface and Point-Of-Interface

Per Federal Communications Commission (FCC) Tariff 9, the definition of the NI is the point of demarcation on the end user's premises at which the access supplier's responsibility for the provision of access ends. The POI is defined as the point of demarcation between AT&T and an access supplier. The POI located in an AT&T Central Office (CO) establishes the service demarcation between access and the IOC.

The NI and POI for OC-12 shall be optical. This signal shall be comprised of STS-1 and/or STS-3c, or STS-12c (as required by customer applications) formatted tributaries per GR-253^[17] section 3.2, ANSI T1.105.02^[7]. The signal at the NI and POI shall conform to the SONET standards. Path overhead shall only terminate at the CPE or equivalent end-point of the SONET channel. Unprotected POI interconnections are implemented over 2 fibers (one pair). The protected POI interconnections are implemented over 4 fibers (two pairs).

2.4 Access Architecture

Figure 4 illustrates a typical access connection. The CPE is connected to the OC-12 service via the NI. The NI should allow test access to all of the fiber pairs interconnecting the CPE with the access supplier's OC-12 Line Terminating Equipment (LTE). The NI is typically located on customer premises. The Network Interface for OC-12 Local Channel (LC) is defined as an Optical Fiber Connection Panel.

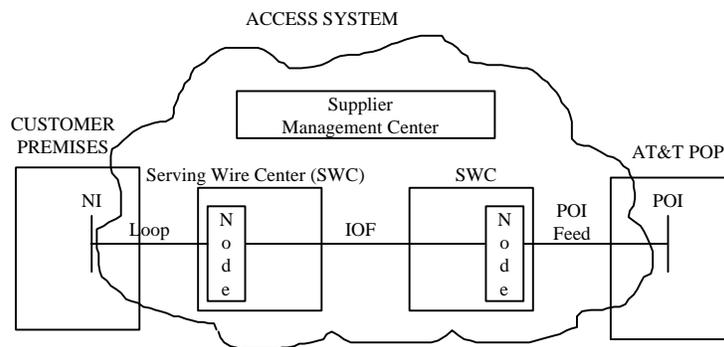


Figure 4. OC-12 LC Circuit and Access Network Components

The 622.08 Mbps signal at the NI shall be Optical in both directions. This signaling shall be comprised of STS-1 and/or STS-3c, or STS-12c (as required by customer applications) formatted tributaries per GR-253^[17] sections 3.2 and 3.4 and ANSI T1.105.02^[7]. The optical power levels required at the NI should be compliant with standards for Short Reach (SR) optics per GR-253^[17] sections 4.1 and 4.2 and ANSI T1.105.06^[25] and are given in Table 1 in dBm (decibels milliwatt reference). Also, the Customer Installation shall meet the loss requirements as specified in GR-253^[17] section 4.2. The CPE will determine the fiber type (signal mode or multi-mode) to connect the CPE to the NI Optical Fiber Connection Panel. Table 1 shows the AT&T required levels. The NI Optical Fiber Connection Panel supports optical connector options as required by the customer application (i.e., SC, FC, ST, etc.). The NI configuration supports 2 fiber (one pair) duplex unprotected operation or 4 fiber (two pairs) duplex 1:1 linear protected based on customer application needs.

Table 1. Optical Power Requirements at the NI

Receive to CPE	Transmit from CPE
P_{\max} : -8 dBm	P_{\max} : - 8 dBm
P_{\min} : - 23 dBm	P_{\min} : - 15dBm

The OC-12 POI is implemented via an AT&T-owned Light Guide Cross-Connect (LGX) shelf with ST bulkhead connectors. Single mode fiber to AT&T assigned jacks on the rear of the LGX POI shelf shall be used. Unprotected POI interconnections are implemented over 2 fibers (one pair). The protected POI interconnections are implemented over 4 fibers (two pairs).

The 622.08 Mbps signal at the POI shall be Optical in both directions. Signal power levels at the POI are to be within the following range:

Table 2. Optical Power Requirements at the POI

Receive to AT&T	Transmit from AT&T
P_{\max} : -8 dBm	P_{\max} : - 8 dBm
P_{\min} : - 19 dBm	P_{\min} : - 19 dBm

Note: AT&T expects that under most circumstances these levels can be achieved using SR capable equipment with a 4 dB fiber loss budget from Access equipment to POI and a 4 dB fiber loss budget from AT&T equipment to POI.

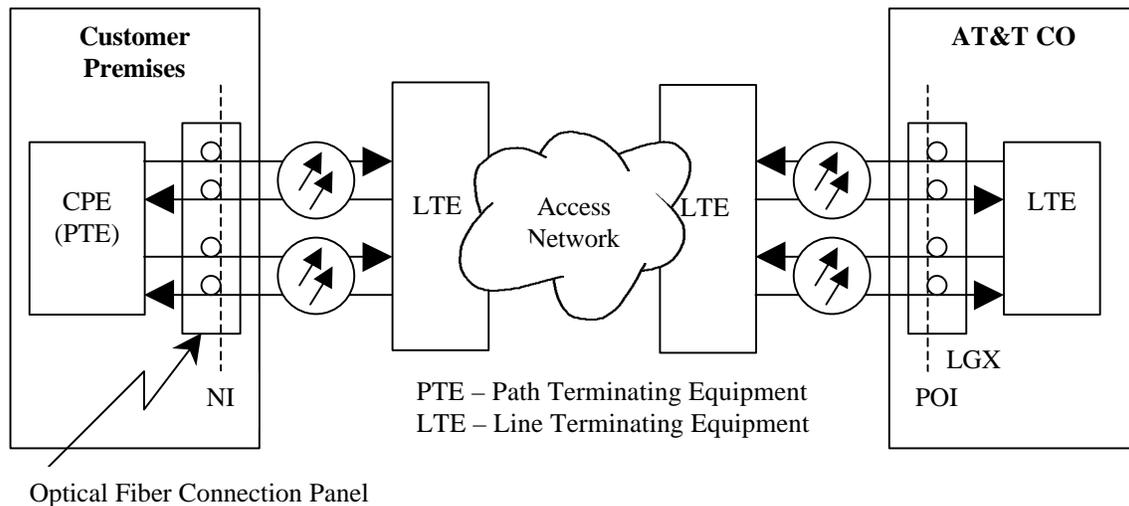


Figure 5. APLS OC-12 Access Connections

Figure 5 illustrates the OC-12 connections at the NI and POI. This OC-12 signal shall be comprised of STS-1s and/or STS-3cs, or STS-12c (as required by customer applications) formatted tributaries per GR-253⁽¹⁷⁾ sections 3.2 and 3.4 and ANSI T1.105.02⁽⁷⁾. The customer shall provide the STS-1/STS-3c or STS-12c mapping to AT&T, and shall conform to the following 17 permitted combinations listed in Table 3.

Table 3. Permissible STS-1/STS-3c and STS-12c Mappings in the OC-12 Signal

OC-12 Structure Identifier	TRIBUTARY SIGNAL ARRANGEMENT											
	STS-12c											
STS12-01	STS-3c			STS-3c			STS-3c			STS-3c		
STS12-02	STS-3c			STS-3c			STS-3c			STS-1	STS-1	STS-1
STS12-03	STS-3c			STS-3c			STS-1	STS-1	STS-1	STS-3c		
STS12-04	STS-3c			STS-3c			STS-1	STS-1	STS-1	STS-1	STS-1	STS-1
STS12-05	STS-3c			STS-1	STS-1	STS-1	STS-3c			STS-3c		
STS12-06	STS-3c			STS-1	STS-1	STS-1	STS-3c			STS-1	STS-1	STS-1
STS12-07	STS-3c			STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-3c		
STS12-08	STS-3c			STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1
STS12-09	STS-1	STS-1	STS-1	STS-3c			STS-3c			STS-3c		
STS12-10	STS-1	STS-1	STS-1	STS-3c			STS-3c			STS-1	STS-1	STS-1
STS12-11	STS-1	STS-1	STS-1	STS-3c			STS-1	STS-1	STS-1	STS-3c		
STS12-12	STS-1	STS-1	STS-1	STS-3c			STS-1	STS-1	STS-1	STS-1	STS-1	STS-1
STS12-13	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-3c			STS-3c		
STS12-14	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-3c			STS-1	STS-1	STS-1
STS12-15	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-3c		
STS12-16	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1	STS-1

2.5 Access Arrangements

Customers may provide their own access to OC-12 Service or may acquire access through a third party.

2.5.1 AT&T Provided Access

The customer may purchase an OC-12 in Total Service arrangement from customer premises to customer premises. ACCU-Ring Network Access Service may be used to provide an OC-12 access connection to the OC-12 IOC.

2.5.2 AT&T Coordinated Access

Access which is coordinated by AT&T, is ordered at the time the customer initiates a Service Order. When providing *coordinated access*, AT&T assumes responsibility for the following functions: Design, Ordering, Installation coordination, Preservice testing and service turn-up, Trouble sectionalization and Restoration coordination.

2.5.3 Customer Provided Access

With Customer Provided Access (CPA), the access facilities are furnished by the customer from the Customer Installation (CI) to the servicing AT&T CO. The serving AT&T CO must be a designated OC-12 Point Of Presence (POP).

The customer has total responsibility for the engineering, installation, operation, and maintenance of the CPA facility terminating at the AT&T POI. AT&T provides the installation, maintenance, and testing support required to interconnect the CPA to the OC-12 POP. Either a Local Exchange Carrier (LEC) or a Competitive Access Provider (CAP) may provide CPA facilities.

2.5.4 Turnkey Customer Provided Access (TCPA)

TCPA is an arrangement under which AT&T will design, engineer, furnish, and install as well as maintain a complete access facility from the customer's premises to the AT&T CO. The unique feature of this arrangement is that the customer owns the entire access facility. The TCPA consists of AT&T standard products and is provided on a contractual basis.

2.6 OC-12 SONET Service Features

The following OC-12 Service features will be available:

- OC-12 SONET Multiplexing Function – OC-12 SONET multiplexing function allows multiplexing and demultiplexing of DS1, DS3, STS-1 and STS-3c traffic into and out of the OC-12 capacity.
- Optical Interface – OC-12 Service interface at the NI and POI is optical, operating at 622.08 Mbps.
- Protected Connectivity at the POI – Fiber connections at the POI may be two pairs for protected or one pair for unprotected.
- Fiber-Only-Routing – OC-12 provisioning guidelines guarantee all fiber routing within the IOC.
- APLS SONET Services maintenance support: APLS OC12 Service will be supported by the AT&T Bandwidth Management Service Center (ABMSC), the maintenance center that currently maintains APLS OC3 Service.
- Circuit Monitoring – OC-12 Service features non-intrusive circuit monitoring of the OC-12 via SONET overhead.

3. Availability and Error Performance Parameters

This section provides performance objectives and characteristics for the OC-12 service. Tables 3-5 are provided to describe relevant service parameters.

Availability is a measure of the time during which the circuit is available for useful transmission. This measurement is the complement of unavailability or Outage (%Availability = 100 - %Outage). An outage begins when the customer releases a circuit to AT&T for repair and ends when AT&T returns the circuit to the customer.

The error parameters Code Violations Path, Error Seconds Path, and Severely Error Seconds Path have been defined in GR-253^[17] section 6.2.2, ANSI T1.231^[15], ANSI T1.514^[16], and ANSI T1.105.04^[11] and are reproduced here for reference. Note that various equipment vendors and communications service providers may have implemented these definitions differently.

- Synchronous Transport Signal (STS) Code Violation Path (CV-P) – A CV-P is a Bit Interleave Parity (BIP) error that is detected at the STS Path layer of the incoming SONET signal. CV-Ps is collected using the BIP in the B3 byte located in the STS Path Overhead.
- STS Error Seconds Path (ES-P) – An ES-P is a one second interval during which at least one CV-P occurred, or a one second interval during which (at any point during the second) the Alarm Indication Signal Path (AIS-P) defect, or Loss of pointer Path (LOP-P) defect was detected.
- STS Path Severely Error Seconds (SES-P) – A SES-P is a one-second interval with 2400 or more CV-Ps, or a one-second interval during which (at any point during the second) the AIS-P defect, or LOP-P defect, was detected.
- Percent of Error Free Seconds (%EFS) – Percent EFS is defined as the ratio of one-second intervals not containing any bit errors to the total number of seconds in an observation period, which is usually 24 hours. The percent EFS calculation applies only to time intervals over which the circuit is available.
- Availability – The measure of time during which the circuit is available for use.

The following tables show performance and availability objectives for end-to-end, inter-office, and access service in the context of OC-12 service.

Table 4. OC-12 Performance Objective: NI-to-CO OC-12 Access

Performance		Availability	
(ES-P)/day	SES-P/day	%/year	%/quarter
50	5	99.975	99.975

Note: The NI-to-CO performance projections assume a typical access circuit is < 100 miles in length.

Table 5. OC-12 Performance Objective: CO-to-CO (inter-office)

Circuit Length (Airline Miles)	Performance		Availability	
	(ES-P)/day	SES-P/day	%/year	%/quarter
< 250	20	2	99.97	99.95
250 to 1000	30	4	99.90	99.85
> 1000	50	6	99.78	99.71

Note: CO is same as the AT&T Service Node

Table 6. OC-12 Performance Objective: NI-to-NI (end-to-end)

Circuit Length (Airline Miles)	Performance		Availability	
	(ES-P)/day	SES-P/day	%/year	%/quarter
< 250	100	6	99.92	99.89
250 to 1000	110	9	99.85	99.80
> 1000	130	12	99.73	99.64

Note: OC-12 service will have at least 99.85 EFS

Availability objectives assume an unprotected access implementation. Self-healing ring architectures for access provide better availability than unprotected access architectures. Where this option is available, the availability will be better than the objectives in this table.

3.1 Delay

OC-12 circuits will experience one-way delay of no more than 60 milliseconds end-to-end during normal operations. Because of facility reconfigurations this delay may not remain constant on a given circuit over time. During network events (i.e. protection switching, disaster recovery, restorations, etc.) delay may exceed 60 milliseconds. Customers should ensure that the delay resulting from the equipment on the Customer Installation, when added to the OC-12 transmission delay, is acceptable to their applications.

4. Interface Specifications

The signal at the NI and POI shall conform to the relevant SONET standards for OC-12 signals as cited in the following sections. The NI and POI are specified in terms of three layers: Physical, Optical, and Logical. The logical level is further broken down into section, line, and path.

4.1 Physical Specifications

All physical connectivity to the POI shall be via Single-Mode dispersion-unshifted Fiber (SMF). Two fiber pairs are recommended at the POI. Physical connectivity to the NI may be over one or two fiber pairs. These fiber connections shall conform to GR-1365^[20] section 3.4. Two pairs of fiber (one pair for service and one pair for protection) are required to provide protected operation.

4.1.1 Network Interface

The physical interface at the NI shall be to an optical fiber connector panel. The connector panel will allow ease of CPE connection and the ability to create a manual loopback for testing

4.1.2 Point of Interface

The physical interface at the POI shall be the AT&T LGX. The pair assignment on the LGX will be administered by AT&T. ST connectors shall be used at the POI.

The access supplier will have responsibility and ownership of all access facilities up to the LGX POI. Access supplier entry will be allowed for installation and maintenance activities up to the POI. AT&T will provide space, environment and power (for equipment required in the AT&T building) for the access supplier to deliver access.

4.2 Optical Signal Specifications

Optical signals shall conform to the OC-12 signal characteristics described in GR-253^[17] sections 4.1 and 4.2 and ANSI T1.105.06^[12] with sources at the nominal 1310 nano-meter (nm) wavelength.

4.2.1 Network Interface

CPE shall follow the optical interface specifications for the application category relevant to the CPE vendor requirements. The customer shall provide a system compatible with the access facility. CPE should follow the optical interface specifications for the application category as given in GR-1365^[20].

4.2.2 Point of Interface

The AT&T LTE at the POI meets the optical category specified as OC-12 SR MLM in GR-253^[17] sections 4.1 and 4.2 and ANSI T1.105.06^[12].

4.2.3 Jitter

Timing jitter is the short term (> 10 Hz) variation in the significant instances of a digital signal as compared to an ideal clock. GR-253^[17] section 5.6, ANSI T1.105.03^[8], and ANSI T1.105.03a^[9] contains equipment jitter specifications (i.e. jitter transfer, jitter tolerance, and jitter generation) that are to be used to engineer CPE to the Network Interface Jitter Specification. CPE designs shall be engineered to have a tolerance specification which is better than the requirements represented by the standard to ensure problem free operation.

4.2.4 Wander

Timing wander is the long-term (< 10 Hz) variation in the significant instances of a digital signal as compared to an ideal clock. GR-253^[17] section 5.4.4.3.2, GR-1244^[19] sections 4.3 and 5.4, ANSI T1.105.09^[13], and ANSI T1.105.03b^[10] contains equipment wander specifications (i.e. wander transfer, wander tolerance, and wander generation) that are to be used to engineer CPE to the Network Interface. CPE designs shall be engineered to have a wander specification which is better than the requirements represented by the standard to ensure problem free operation.

4.3 Logical Signal Specifications

The logical signal ((Synchronous Transport Signal Level N (STS-N)) contains the customer payload along with the section, line, and path overhead required by the SONET standard. The STS-N signal shall conform to the STS-1 and/or STS-3c or STS-12c formats as defined in GR-253^[17] section 3 and ANSI T1.105.02^[7]. The customer shall notify AT&T of the signaling format and tributary configuration. The customer shall keep a valid signal on the circuit in order to maintain performance monitoring. The CPE or network equipment shall not be turned off without notifying AT&T.

4.3.1 Section Overhead

The STS-N shall provide all section overhead functions with the possible exception of the Section Data Communications Channel (DCC) (bytes D1-D3), Section Orderwire (byte E1), and Section User Channel (byte F1). To manage network integrity and sustain service quality, section DCC capabilities are disabled at the edge of the AT&T network. Section overhead is terminated at or before the AT&T network, therefore, any information contained in the bytes reserved for Section DCC (D1-D3), Section Orderwire (E1), and Section User Channel (F1) will not be transported end-to-end (NI-to-NI). This is consistent with SONET standards for section overhead.

4.3.2 Line Overhead

The STS-N shall provide all line overhead functions with the possible exception of Line DCC (bytes D4-D12), Synch Status Messaging (byte S1), and Line Orderwire (byte E2). To manage network integrity and sustain service quality, line DCC capabilities are disabled at the edge of the AT&T network. Line

overhead is terminated at or before the AT&T network, therefore, any information contained in the bytes reserved for Line DCC (D4-D12) and Line Orderwire (E2) will not be transported end-to-end (NI-to-NI). This is consistent with the SONET standard for line overhead. At the time of this publication, AT&T does not support any functionality based on the use of growth bytes. Information contained in these bytes shall not be transported.

4.3.2.1 Automatic Protection Switching (APS)

GR-253^[17] section 5.3 and ANSI T1.105.01^[6] specify criteria for implementing Automatic Protection Switching (APS). The K1 and K2 bytes located in the line overhead shall be used for APS. The STS-N shall conform to linear 1+1, unidirectional, non-revertive protection switching and linear 1:1 protection switching. The term “unidirectional” means that only the impaired direction of service will be restored.

4.3.3 Path Overhead

The STS-N or STS-Nc shall provide all path overhead functions with the possible exception of Path User Channel (byte F2), and Growth Channels (bytes Z3 and Z4). Use of bytes F2 and H4 is optional, but must be in accordance with ANSI T1.105.02^[25] and GR-253^[17]. As per ANSI T1.105, bytes Z3 and Z4 are reserved for future use. At the time of this publication, AT&T does not support any functionality based on the use of these growth channels. The service shall be STS-1 and/or STS-3c or STS-12c end-to-end or add/drop. Path status and parity bytes may be monitored for performance information.

5. Synchronization and Timing

All CPE and network equipment providing AT&T OC-12 service shall conform to timing and synchronization specifications described in ANSI T1.105.09^[13], ANSI T1.101^[5], and GR-1244^[19]. AT&T network equipment shall be externally timed from a Building Integrated Timing Source (BITS) clock traceable to a Stratum 1 source. The access supplier equipment should be able to receive timing from a co-located external reference clock of Stratum 3 or higher accuracy traceable to a Stratum 1 source. Alternatively, the access supplier equipment should be able to synchronize its clock to the timing received from an incoming OC-12 signal from the AT&T CO. CPE may either be line-timed from the OC-12 signal, or timed to a co-located external reference clock of Stratum 3 or higher accuracy traceable to a Stratum 1 source.

5.1 Line-Timing Mode

CPE timed in line-timing mode draws its synchronization timing from the network equipment terminating the customer's optical signal. This configuration is shown in Figure 6. In a line-timing mode, timing may be taken from the OC-12 signal and distributed for other network uses. In the case where the OC-12 signal is de-muxed down to a DS1 signal, the timing should be taken from the OC-12 and distributed. The customer should not distribute the de-muxed DS1 as timing for other network uses. This DS1 may have residual mux de-mux jitter, making it unsuitable as a timing source.

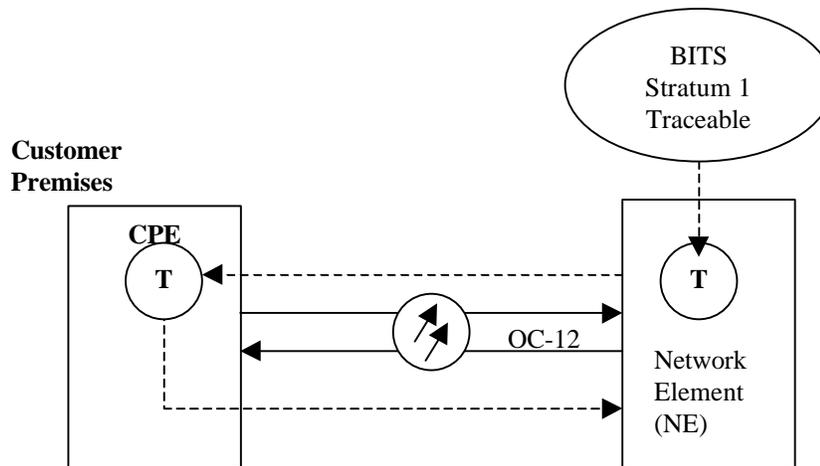


Figure 6. Line-Timing Mode

5.2 External Timing Mode

CPE timed in external timing mode draws its synchronization from an independent timing source. This source shall be Stratum 3 or better and traceable to a Stratum 1 source. This configuration is shown in Figure 7.

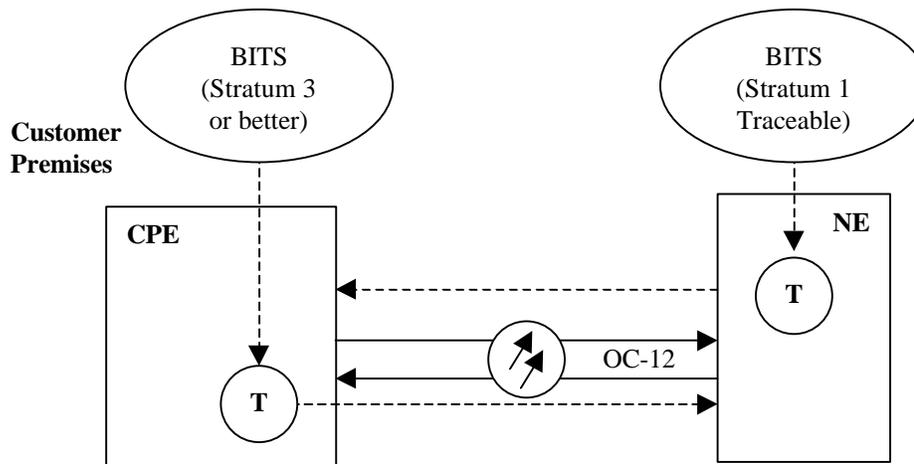


Figure 7. External Timing Mode

6. Network Alarm And Status Conditions

Failure states, maintenance signals, and alarm conditions shall conform to GR-253^[17] section 6 and ANSI T1.231. Maintenance signals include Alarm Indication Signal Line (AIS-L), Remote Defect Indicator Line (RDI-L), Alarm Indication Signal Path (AIS-P), Remote Failure Indicator Path (RFI-P), and Remote Defect Indication Path (RDI-P). The failure states include Loss of Signal (LOS), Loss of Frame (LOF), Loss of Pointer (LOP), Remote Error Indication Line (REI-L), and Remote Error Indication Path (REI-P).

The access network equipment shall monitor SONET signals to detect LOS, LOF LOP, and AIS-L. Maintenance signals shall be transmitted when failure states are detected in access. AT&T will transmit AIS-P when failure states are detected in the network and RDI-L when failures are detected in access.

AT&T will monitor the path overhead to isolate failures to the access or the AT&T network. Further sectionalization to the connection between the AT&T LTE and the first access supplier LTE can be done using the line overhead and failure states.

7. Customer Premises Equipment Characteristics

7.1 CPE Requirements

CPE shall generate alarms as described in GR-253^[17] section 6. For any unused STS-3c and/or STS-1 channels the CPE shall transmit a valid idle code and set the path label to unequipped. CPE shall monitor SONET signals to detect AIS, LOS, LOF, and LOP. The CPE shall transmit maintenance signals when failure states are detected in the network. Maintenance signals include AIS-L, RDI-L, AIS-P, RDI-P, and RFI-P.

7.2 Loopback

To conduct circuit testing and fault sectionalization of the two-way OC-12 circuit, an optical loopback on the CPE side of the NI toward the network *shall* be provided as shown in Figure 8. To aid in the sectionalization, an optical loopback on the CPE side of the NI toward the CPE (facility loopback) and one toward the network (terminal loopback) *should* be provided as shown in Figure 8. AT&T will coordinate with the customer when loopbacks are required and will enlist the customer's support in establishing loopbacks at the NI.

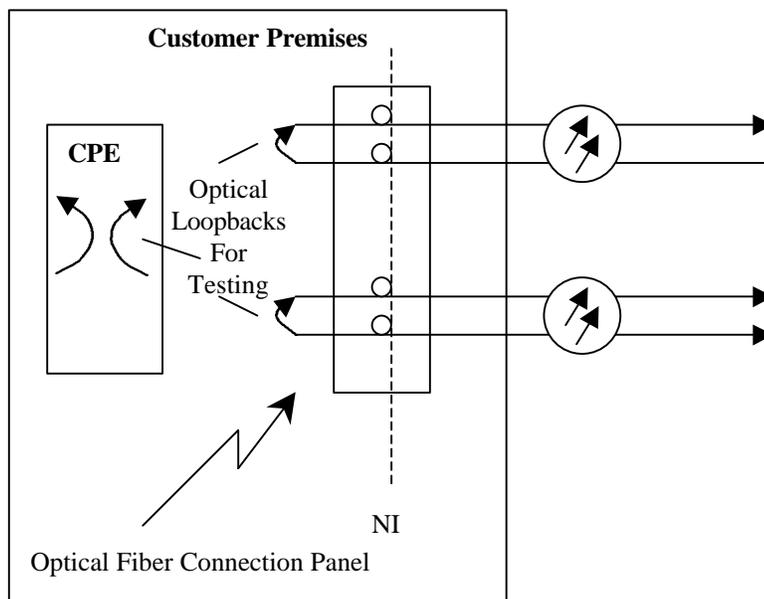


Figure 8. Optical Loopback at NI

7.3 Automatic Protection Switching

Protection switching is described in GR-253^[17] and ANSI T1.105^[12], section 13. All CPE should be designed to tolerate an upstream protection-switching event without declaring a failure.

8. Testing and Maintenance

The OC-12 Service will be managed as a total circuit transporting STS-1 and/or STS-3c or STS-12c tributaries as specified. Testing and maintenance may require the customer to relinquish the total circuit.

A point of contact for testing and maintenance issues will be provided by AT&T at the time of service installation. AT&T can perform testing and repair most efficiently when a complete and accurate description of the trouble is provided by the customer. Information such as, date, time, and nature of the problem should be provided in reporting trouble.

In addition, when problems are encountered by the customer, it is essential that the CPE (and access facilities that are non-AT&T maintained) be checked for proper operation before reporting the trouble. Diagnostics capabilities of the CPE, such as loopbacks (shown in Figure 8), can also be useful in trouble isolation. The customers should be acquainted with the basic equipment layouts, visual indicators on CPE, and be knowledgeable in fundamental maintenance techniques. This action will eliminate unnecessary dispatches of repair personnel by AT&T. For such dispatches; the customer may be required to pay a "maintenance or service charge" if the problem is isolated to the customer's segment of the circuit.

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