



AM-TR-NIS-000111

## Ameritech OC-3, OC-12, OC-48 And OC-192 Service Interface Specifications

A technical description of the User/Network Interface for Ameritech OC-3 service, Ameritech OC-12 service, Ameritech OC-48 service and Ameritech OC-192 service.

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**TECHNICAL REFERENCE NOTICE**

This Technical Reference is published by Ameritech to provide a technical description of the User/Network Interface for Ameritech's OC-3, OC-12, OC-48 and OC-192 (SONET) Services. It provides interface specifications and operating requirements as a guide for system users and vendors.

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## 1. PURPOSE

This document describes the User/Network Interface specifications for Ameritech OC-3, Ameritech OC-12, Ameritech OC-48 and Ameritech OC-192 (SONET) services. The term OC-N service, as used here, shall refer to any of these services, collectively and individually.

## 2. CHANGE AND REISSUE

This is the fifth issue of this document. The significant changes from Issue 4 include the addition of specifications for Ameritech OC-192 service, updating of References (e.g, addition of GR-1377-CORE for OC-192 specific changes from GR-253-CORE) to the most current versions, and revision of reference source from Bellcore to Telcordia.

## 3. GENERAL

Ameritech OC-3 service, Ameritech OC-12 service, Ameritech OC-48 service and Ameritech OC-192 service provide high-speed (155.52 Mb/s, 622.08 Mb/s, 2488.32 Mb/s, and 9953.28 Mb/s, respectively), optical fiber-based full duplex data transmission capabilities based upon the Synchronous Digital Hierarchy (SDH) and Synchronous Optical Network (SONET) standards approved by the International Telecommunication Union - Telecommunication Standardization Sector (ITU-T, formerly CCITT) and the American National Standards Institute (ANSI), respectively.

## 4. OVERVIEW

SONET is a set of international standards for fiber-based transmission systems that uses a synchronous multiplexing scheme. SONET provides standard transmission rates based on a basic modular Synchronous Transport Signal level 1 (STS-1) rate of 51.84 Mb/s. Byte interleaving of multiple STS-1 signals creates a standard STS-N ( $N \times 51.84$  Mb/s) signal. Other higher rate services require  $N$  multiples of the STS-1 rate, which are known as concatenated rates, STS-Nc, and carried by an STS-N line signal. The optical counterpart of an STS-N signal is the Optical Carrier-level  $N$  signal (OC-N), which is the result of a direct optical conversion of the STS-N after frame synchronous scrambling.

SONET-based facilities provide for the flexible transport of various different service signals contained in the payload portion of the STS-N format. SONET-based facilities have the capability to accept non-SONET formats for transport in the SONET payload structure. This makes them backward compatible with existing data rates, i.e., DS1 and DS3 as well as future rates and formats, e.g., Asynchronous Transfer Mode (ATM). SONET provides for the transport of all services below the existing DS3 rate in sub-STS-1 payloads, referred to as Virtual Tributaries (VTs). Transport of services at the DS3 level and above occupy the payload portion of one or more entire STS-1 signals. Ameritech OC-N services (OC-3, OC-12, OC-48 and OC-192) cur-

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rently allow those payload mappings which support the transport of 1) DS1 services with a VT1.5 Virtual Tributary structure and 2) DS3 services within an STS-1 structure. Transport of STS-1 channels without constraint to payload mapping is supported by Ameritech OC-N services when the STS-1 channels do not terminate inside the Ameritech network. Non-channelized Super Rate service (above STS-1) transport is also supported by Ameritech OC-N services with concatenated STS-3c, STS-12c and STS-48c channels, each without constraint to payload mapping.

SONET technology has also led to the development of new Network Element (NE) capabilities, i.e., add/drop multiplexing and integrated optical terminations. These capabilities have been the catalyst for the continuing development of new architectures, such as self-healing rings with integrated protection switching, while at the same time remaining compatible with existing architectures, such as point-to-point. They allow for transport between intermediate locations without the need to demultiplex and convert the entire high speed signal to lower speed electrical signals.

SONET's overhead and transport functions are divided into layers that increase in complexity. Each layer communicates to other terminal equipment within the same layer, and processes certain information and passes it to equipment in other layers. The layers are referred to as Path, Line, Section and Physical (see Figure 1 ). The Path layer adds non-SONET to SONET mapping overhead to the input DS1, DS3, etc., electrical signals for passage to the Line layer. The Line layer provides synchronization and multiplexing of a number of payload envelopes, plus the addition of maintenance and protection overhead to the Path layer for transfer to the Section layer. The functions of the Section layer include framing, scrambling, section error monitoring and adding communication overhead (i.e., order wire) from the Line layer before passing the frame down to the Physical level. Finally, the OC-N Physical layer cares for electrical to optical signal conversion and transport of bits as optical pulses across the physical fiber-optic medium.

## **5. SERVICE DESCRIPTION**

Ameritech OC-N (OC-3, OC-12, OC-48 and OC-192) services will provide point-to-point full duplex transmission across optical User/Network Interfaces which are the subject of specifications contained in this document.

Ameritech OC-3 service provides transport of the optical signal that results from the optical conversion of an electrical STS-3 signal, which is comprised of either:

1. three interleaved STS-1 channels which each contain:
  - a) one DS3 that is STS-1 mapped, or
  - b) up to 28 DS1s that are VT mapped, or

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- c) an STS-1 channel without constraint to payload mapping when the STS-1 channel does not terminate via an add/drop function to DS1 or DS3 services within the Ameritech network, or
- 2. a single concatenated STS-3c channel.

Ameritech OC-12 service provides transport of the optical signal that results from the optical conversion of an electrical STS-12 signal, which is comprised of either:

- 1. twelve interleaved STS-1 channels which each contain:
  - a) one DS3 that is STS-1 mapped, or
  - b) up to 28 DS1s that are VT mapped, or
  - c) an STS-1 channel without constraint to payload mapping when the STS-1 channel does not terminate via an add/drop function to DS1 or DS3 services within the Ameritech network, or
- 2. four interleaved concatenated STS-3c channels, or
- 3. from one to three interleaved concatenated STS-3c channels, mixed with from three to nine STS-1 channels as in 1) above, subject to utilization of the total STS-12 capacity, or
- 4. a single concatenated STS-12c channel.

Ameritech OC-48 service provides transport of the optical signal that results from the optical conversion of an electrical STS-48 signal, which is comprised of either:

- 1. forty-eight interleaved STS-1 channels which each contain:
  - a) one DS3 that is STS-1 mapped, or
  - b) up to 28 DS1s that are VT mapped, or
  - c) an STS-1 channel without constraint to payload mapping when the STS-1 channel does not terminate via an add/drop function to DS1 or DS3 services within the Ameritech network, or
- 2. sixteen interleaved concatenated STS-3c channels, or

3. from one to fifteen interleaved concatenated STS-3c channels, mixed with from three to forty-five STS-1 channels as in 1) above, subject to utilization of the total STS-48 capacity, or
4. four interleaved concatenated STS-12c channels, or
5. from one to three interleaved concatenated STS-12c channels, mixed with from twelve to thirty-six STS-1 channels as in 1) above, subject to utilization of the total STS-48 capacity, or
6. from one to three interleaved concatenated STS-12c channels, mixed with from four to twelve concatenated STS-3c channels, subject to utilization of the total STS-48 capacity, or
7. from one to three interleaved concatenated STS-12c channels, mixed with from one to eleven concatenated STS-3c channels, also mixed with from three to thirty-three STS-1 channels as in 1) above, subject to utilization of the total STS-48 capacity.

Ameritech OC-192 service provides transport of the optical signal that results from the optical conversion of the electrical STS-192 signal, which is comprised of either:

1. one-hundred and ninety-two interleaved STS-1 channels which each contain:
  - a) one DS3 that is STS-1 mapped, or
  - b) up to 28 DS1s that are VT-mapped, or
  - c) an STS-1 channel without constraint to payload mapping when the STS-1 channel does not terminate via an add/drop function to DS1 or DS3 services within the Ameritech network, or
2. sixty-four interleaved concatenated STS-3c channels, or
3. from one to sixty-three interleaved concatenated STS-3c channels, mixed with from three to one-hundred and eighty-nine STS-1 channels as in 1) above, subject to utilization of the total STS-192 capacity, or
4. sixteen interleaved concatenated STS-12c channels, or
5. from one to fifteen interleaved concatenated STS-12c channels, mixed with from twelve to one-hundred and eighty STS-1 channels as in 1) above, subject to utilization of the total STS-192 capacity, or

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6. from one to fifteen interleaved concatenated STS-12c channels, mixed with from four to sixty concatenated STS-3c channels subject to utilization of the total STS-192 capacity, or
7. from one to fifteen interleaved concatenated STS-12c channels, mixed with from one to fifty-nine concatenated STS-3c channels, also mixed with from three to one-hundred and seventy-seven STS-1 channels as in 1) above, subject to utilization of the total STS-192 capacity, or
8. four interleaved concatenated STS-48c channels, or
9. from one to three interleaved concatenated STS-48c channels, mixed with from forty-eight to one-hundred and forty-four STS-1 channels as in 1) above, subject to utilization of the total STS-192 capacity, or
10. from one to three interleaved concatenated STS-48c channels, mixed with from sixteen to forty-eight STS-3c channels, subject to utilization of the total STS-192 capacity, or
11. from one to three interleaved concatenated STS-48c channels, mixed with from four to twelve STS-12c channels, subject to utilization of the total STS-192 capacity, or
12. from one to three interleaved concatenated STS-48c channels, mixed with from one to forty-seven concatenated STS-3c channels, also mixed with from three to one-hundred and forty-one STS-1 channels as in 1) above, subject to utilization of the total STS-192 capacity, or
13. from one to three interleaved concatenated STS-48c channels, mixed with from one to eleven concatenated STS-12c channels, also mixed with from twelve to one-hundred and thirty-two STS-1 channels as in 1) above, subject to utilization of the total STS-192 capacity, or
14. from one to three interleaved concatenated STS-48c channels, mixed with from one to eleven concatenated STS-12c channels, also mixed with from four to forty-four concatenated STS-3c channels, subject to utilization of the total STS-192 capacity, or
15. from one to three interleaved concatenated STS-48c channels, mixed with from one to eleven concatenated STS-12c channels, also mixed with from one to forty-three concatenated STS-3c channels, also mixed with from three to one-hundred and twenty-nine STS-1 channels as in 1) above, subject to utilization of the total STS-192 capacity.

**6. OPTICAL INTERFACE REQUIREMENTS**

The physical interconnection will be at a telephone company-provided optical cross-connect panel, using customer-provided 1310 nm conventional single mode fiber (C-SMF) patch cords (capable of supporting second window for 1550 nm applications) meeting EIA Class IVa requirements and equipped with single position SC connectors (SCFOC/2.5), as specified in the Ameritech SC Connector Specification V.02.

Attenuation and dispersion limits across the optical interface are as follows:

Attenuation:	0 to 12 dB (OC-3) 10 to 28 dB (OC-3 [Long Reach])#@ 10 to 24 dB (OC-12)# 17 to 25.4 dB (OC-48 1310 nm option)# 15 to 23.4 dB (OC-48 1550 nm option)# 6 to 17 dB (OC-192 1550 nm)#
Dispersion:	96 ps/nm maximum (OC-3) 210 ps/nm maximum (OC-3 [Long Reach], OC-12, OC-48 1310 nm option) 1220 ps/nm maximum (OC-48 1550 nm option) 720 ps/nm maximum (OC-192 1550 nm)*

# Ameritech OC-N services shall provide for the minimum attenuation losses across the optical interface, as required.

@ An OC-3 Long Reach option shall be available for application with the optional feature 1+1 Protection with Central Office Survivability with Ameritech OC-3 service.

\* A Polarization Mode Dispersion (PMD) limit, of 10 ps, applies to OC-192 services.

**6.1. OPTICAL LINE CODING**

For all SONET interfaces, binary Non-Return-to Zero (NRZ) optical line coding shall be used after scrambling.

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## **6.2. PAYLOAD MAPPING**

Two types of payload mapping are available with Ameritech OC-3, Ameritech OC-12, Ameritech OC-48 and Ameritech OC-192 services: STS-1 and sub-STS-1. Transport of concatenated STS-3c, STS-12c and STS-48c channels by Ameritech OC-3, Ameritech OC-12, Ameritech OC-48 and Ameritech OC-192 services is provided without constraint to payload mapping.

Only asynchronous mapping for DS3, as described in Section 3.4.2.1 of Telcordia Document GR-253-CORE shall be supported for the STS-1 level. STS-1 channel transport without constraint to payload mapping is supported when the channels do not terminate inside the Ameritech network (i.e., customer premises-to-customer premises).

Only asynchronous mapping into a floating VT1.5 SPE for clear channel DS1, as described in Section 3.4.1.2 of Telcordia Document GR-253-CORE, "SONET Common Generic Criteria," will be supported for the sub-STS-1 level.

STS-1 and concatenated STS-Nc signals accepted for non-channelized transport by Ameritech OC-N services shall conform to the STS-1 requirements of Section 3.5.1.4 and Section 5.1.2 of Telcordia technical reference GR-253-CORE.

## **6.3. LINE RATE**

For Ameritech OC-3 service, the bit rate at the physical layer is 155.520 Mb/s +/- 20 ppm.

For Ameritech OC-12 service, the bit rate at the physical layer is 622.080 Mb/s +/- 20 ppm.

For Ameritech OC-48 service, the bit rate at the physical layer is 2488.32 Mb/s +/- 20 ppm.

For Ameritech OC-192 service, the bit rate at the physical layer is 9953.28 Mb/s +/- 20 ppm.

All the above 20 ppm bit rate tolerances apply to free running modes. The normal operating mode, however, is the synchronized mode (see Section 7.5 SYNCHRONIZATION ).

## **6.4. TRANSMITTER AND RECEIVER REQUIREMENTS**

SLM or MLM laser-equipped transmitters with the following parameters are utilized:

Center Wavelength:	1260 - 1360 nm (OC-3) 1275 - 1340 nm (OC-3 [Long Reach]) 1285 - 1330 nm (OC-12, OC-48 1310 nm option) 1525 - 1575 nm (OC-48 1550 nm option) 1553 - 1561 nm (OC-192 1550 nm)
Spectral Width (MLM):	Max. 40 nm RMS* (OC-3) Max. 4.0 nm RMS* (OC-3 [Long Reach]) Max. 2.0 nm RMS* (OC-12)
Spectral Width (SLM):	Max. 1 nm** (OC-12, OC-48, OC-192)

\* Measured out to and including 20 dB down from the peak mode.

\*\* Measured 20 dB down from the maximum amplitude of the central wavelength. Also, the minimum side-mode suppression ratio is 30 dB.

Output Power:	-5.4 to -15 dBm (OC-3) +4.6 to -5 dBm (OC-3 [Long Reach]) +2 to -3 dBm (OC-12) +6 to -3 dBm (OC-48 1310 nm option) +4 to -2.6 dBm (OC-48 1550 nm option) +1 to -5.5 dBm (OC-192 1550 nm)
Extinction Ratio:	8.2 dB minimum (OC-3, OC-48) 10 dB minimum (OC-3 [Long Reach], OC-12, OC-192)
Eye Pattern Mask:	See Section 4.2.4.4 of Telcordia Document GR-253-CORE  <b>NOTE:</b> GR-253-CORE provides criteria for OC-48 and below. Currently as provided in Section 4.2.4.4 of GR-1377-CORE, such criteria for OC-192 is "for further study".

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Receiver Sensitivity:	-28 dBm minimum (OC-3) -33 dBm minimum (OC-3 [Long Reach]) -27 dBm minimum (OC-12) -26 dBm minimum (OC-48) -21.5 dBm minimum (OC-192)
Receiver Overload:	-8 dBm maximum (OC-3, OC-12) -10 dBm maximum (OC-3 [Long Reach]) -11 dBm maximum (OC-48) -5 dBm maximum (OC-192)

Also, the receiver must tolerate an optical path-power penalty not exceeding 1 dB.

## 7. ARCHITECTURAL FEATURE REQUIREMENTS

### 7.1. INTERLEAVING

The STS-1 frame ( Figure 2 ) consists of 90 columns and nine rows of 8-bit bytes, for a total of 810 bytes (6480 bits). The first three columns make up the Transport Overhead. Nine bytes are used as Section Overhead and 18 bytes as Line Overhead. The remaining 87 columns make up the Synchronous Payload Envelope (SPE), which contains one column of Path Overhead and 86 columns of actual payload.

An STS-3 signal shall be formed by interleaving three STS-1 signals, one byte at a time, sequentially starting with the A1 framing byte from STS-1 number 1, followed sequentially by the A1 byte from STS-1 number 2 and so on. The first bit to be transmitted in the STS-3 signal shall be the most significant bit (leftmost bit) of the A1 framing byte from STS-1 number 1.

An STS-12 signal shall be formed either by interleaving four STS-3 or STS-3c signals, one byte at a time sequentially starting with STS-3(c) number 1, or by byte interleaving 12 STS-1 signals in an order that simulates four STS-3 signals (i.e., byte 1 from STS-1 number 1 followed by byte 1 from STS-1 number 4, and so on).

An STS-48 signal shall be formed either by interleaving four STS-12 or STS-12c signals, four bytes at a time sequentially starting with four bytes from STS-12(c) number 1 followed by four bytes from STS-12(c) number 2 or by byte interleaving 16 STS-3 or STS-3c signals in an order

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that simulates four STS-12 signals (i.e., byte 1 from each of STS-3(c) numbers 1 through 4 followed by byte 1 from each of STS-3(c) numbers 13 through 16, and so on).

An STS-192 signal shall be formed either by interleaving four STS-48 or STS-48c signals, sixteen bytes at a time sequentially starting with sixteen bytes from STS-48(c) number 1 followed by sixteen bytes from STS-48(c) number 2 or by byte interleaving sixteen STS-12 or STS-12c signals in an order that simulates four STS-48 signals (i.e., the first four bytes from each of STS-12(c) numbers 1 through 4 followed by the first four bytes from each STS-12(c) numbers 13 through 16, and so on) or by byte interleaving sixty-four STS-3 or STS-3c signals in an order that simulates four STS-48 signals (i.e., byte one from each of STS-3(c) numbers 1 through 16 followed by byte one from each of STS-3(c) numbers 49 through 64, and so on).

Before byte interleaving to form an STS-3, STS-12, STS-48 or STS-192 signal, the transport overhead of all constituent STS-1, STS-3, STS-12 or STS-48 signals shall be frame aligned. This is accomplished by adjusting the payload pointers of the lower rate signals to reflect the new relative position of the SPEs.

## **7.2. SCRAMBLING**

STS-N line signals shall be scrambled using a frame synchronous scrambler of sequence length 127, operating at the line rate. The generating polynomial shall be  $1+x^6+x^7$ . The scrambler shall be reset to "1111111" on the most significant bit of the byte following the STS-1 number N C1 (STS-1 ID, see following note) byte. This bit and all subsequent bits to be scrambled shall be added, modulo 2, to the output from the x7 position of the scrambler. The scrambler shall run continuously throughout the complete STS-N frame. The frame bytes (A1 and A2) and the STS-1 identification byte (C1, see following note) from STS-1 number 1 through STS-1 number N shall not be scrambled.

**NOTE:** Since Issue 1 (December 1994) of Telcordia Document GR-253-CORE, the C1 byte has been redefined as either the Section Trace Byte (JO, in the first STS-1 of the STS-N) or a Section Growth Byte (ZO, in the second through Nth STS-1s), as provided in Section 3.3.2.1 of the current revision of GR-253-CORE and Section 3.3 of GR-1377-CORE.

## **7.3. GENERATING AND PROCESSING OVERHEAD**

The overhead bytes referenced in Section 3.3 and Section 5.2 of Telcordia's technical reference GR-253-CORE (with OC-192 exceptions noted in the same sections of GR-1377-CORE) shall be active across the interface, except for the following:

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Section Data Communications Channel	(D1 - D3)
Line Data Communications Channel	(D4 - D12)
Section Trace	(J0)
Section Growth	(Z0)
Section Local Orderwire	(E1)
Section User Channel	(F1)
Line Express Orderwire	(E2)
Path User Channel	(F2)
Synchronization Status	(S1)
Path Growth	(Z3)
Tandem Connection	(Z5)

Concerning the overhead bytes listed directly above, Ameritech OC-N services will not process or recognize information transmitted by the customer installation. Ameritech OC-N services will also not transmit information intended for use by the customer installation in the overhead bytes listed directly above.

STS-1 and STS-Nc concatenated signals accepted for non-channelized transport by Ameritech OC-N services shall conform to the overhead requirements of Section 3.3.2 of Telcordia technical reference GR-253-CORE and Section 3.3 of GR-1377-CORE.

For STS Path Overhead bytes and the VT Path Overhead byte (V5) described in Section 3.3.2.3 and Section 3.3.3, respectively, of Telcordia's technical reference GR-253-CORE, except for non-channelized transport of STS-1 and concatenated STS-3c, STS-12c and STS-48c service channels, there is no guarantee of network continuity across Ameritech OC-N services.

The STS Path Trace function implemented in STS Path Overhead byte J1 shall contain a 62 ASCII character message terminated with a Carriage Return/Line Feed sequence (ASCII Hex "0D 0A") as specified in Section 3.3.2.3 of Telcordia technical reference GR-253-CORE in order to be recognized by the Ameritech OC-N service.

As an objective, the customer installation should activate the STS-N Line Remote Error Indication (REI-L, formerly referred to as Line Far End Block Error, FEBE) function to convey received line performance information to the Ameritech OC-N service network. The STS-N REI-L function is implemented in the M1 byte of STS-1 number 3 as specified in Section 3.3.2.2 of Telcordia technical reference GR-253-CORE and Section 3.3 of GR-1377-CORE.

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#### **7.4. AUTOMATIC PROTECTION SWITCHING**

Automatic Protection Switching (APS) will be optionally employed across the interface. APS employed on the customer's side should conform to OC-N line switching criteria specified in Telcordia's technical reference TR-NWT-000499, "Transport Systems Generic Requirements," and in Section 5.3 of GR-253-CORE, "SONET Common Generic Criteria."

**NOTE:** Since Issue 1 (December 1994) of Telcordia Document GR-253-CORE, the APS criteria previously appearing in TR-NWT-000499 (which do not appear in GR-499-CORE) are now in the current revision of GR-253-CORE.

If provided, a 1+1 protection switch architecture shall be used. In a 1+1 architecture, the working channel is permanently bridged to a protection channel. The 1+1 APS shall operate in a unidirectional and non-revertive mode. If provided, the K1 and K2 line overhead bytes in STS-1 number 1 shall be used across the interface for administering 1+1 protection switching signaling. The K1 byte shall indicate a request for switch action according to the APS channel protocol specified in Section 5.3.5 of GR-253-CORE. The K2 byte shall be coded according to the generation rules in Section 5.3.5.2.2 of GR-253-CORE. The application of bits 6 to 8 of the K2 byte to indicate the Line AIS signal (AIS-L) and Line Remote Defect Indication (RDI-L) signals shall take precedence over the APS applications of these same bits.

An optional feature to be provided with Ameritech OC-3 and OC-12 services associated with 1+1 protection and Central Office Survivability will require APS employed on the customer's side to conform to criteria specified in Telcordia's Generic Requirements GR-1400-CORE, Issue 2, January 1999. When this optional service feature is selected, the customer equipment shall provide STS/VT path protection equipment functions specified in Section 5.1 (R) 5-3 and (R) 5-4 of GR-1400-CORE. For this option, customer equipment shall be required to operate APS according to STS/VT path protection switching criteria contained in Section 5.3.3 of GR-1400-CORE. VT-level APS operation shall be required with this option for individual STS-1 channels which are VT mapped. STS level APS operation shall be required with this option for all other individual STS channels. STS/VT Path protection switching shall operate in lieu of OC-N line protection switching when this optional feature is selected.

#### **7.5. SYNCHRONIZATION**

The OC-N service customer installation shall be synchronized to a source traceable to a Primary Reference Source (PRS) (i.e., Stratum 1 clock) meeting requirements specified in Telcordia's Generic Requirements GR-436-CORE, "Digital Network Synchronization Plan" and GR-1244-CORE, "Clocks for the Synchronized Network: Common Generic Criteria". This source may be a Stratum 3 or better quality clock that is traceable to a Stratum 1 clock.

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The OC-N service customer installation may choose to derive its clock from the SONET OC-N signal received from the Ameritech network. In this case, terminating timing shall be accomplished using a loop timing mode and the customer shall meet the loop timing requirements specified in Sections 5.4.3 and 5.4.4 of Telcordia technical reference GR-253-CORE, "SONET Common Generic Criteria".

The OC-N service customer installation may choose to derive its clock from an external timing source. Customers considering use of an external timing source should review EIA/TIA-594-91, "Private Digital Network Synchronization," and/or Telcordia SR-NWT-002224, "SONET Synchronization Planning Guidelines" (This information now in GR-436-CORE), prior to deciding which mode (external or loop timing) to employ. Customer equipment shall have the capability to switch automatically to an alternate timing reference when the active reference fails. If external timing is employed, it must conform to specifications contained in Section 5.4.3.1 of Telcordia's technical reference GR-253-CORE. In this case, the customer shall operate pleochronously with traceability to a different Stratum 1 clock than in the Ameritech network.

**NOTE:** For OC-192 Line layer terminations, Section 5.4 of Telcordia Document GR-1377-CORE modifies Section 5.4.4.1 of GR-253-CORE to require that "at a minimum, stratum 3 internal clocks" supersedes any sub-stratum 3 clock requirements within GR-253-CORE.

## 7.6. JITTER

The maximum permissible levels of output jitter at the OC-3, OC-12, OC-48 and OC-192 interfaces are as follows:

	B1 [Hz]	B2 [kHz]	B3 [MHz]	A1 [UIp-p]	A2 [UIp-p]
<b>OC-3</b>	500	65	1.3	1.5	0.15
<b>OC-12</b>	1000	250	5	1.5	0.15
<b>OC-48</b>	5000	1000	20	1.5	0.15
<b>OC-192</b>	10000	4000	80	1.5	0.15

**NOTE:** At the January 1999 meeting of T1X1.3, a US Study Group B contribution to ITU-T Study Group 13 proposed that the OC-192 B1 frequency be 20 kHz, rather than the 10 kHz shown above and in GR-1377-CORE, Section 5.6.1.

Timing jitter as measured over a 60-second interval with a bandpass filter with a lower cutoff frequency B1 and a minimum upper cutoff frequency B3 shall not exceed A1 Unit Intervals (UI) peak-to-peak. Timing jitter as measured over a 60-second interval with a bandpass filter with a lower cutoff frequency B2 and a minimum upper cutoff frequency B3 shall not exceed A2 UI

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peak-to-peak. The roll-off at lower cutoff frequency and upper cutoff frequency shall be 20 dB per decade. Since the amount of jitter at frequencies above B3 are expected to be very small while any significant amount of high frequency jitter can adversely impact system performances (which the user should know is present), current revisions of GR-253-CORE and GR-1377-CORE no longer specify the upper cutoff frequency roll-off characteristics.

For loop timed applications, reasonable jitter transfer characteristics are assumed to limit the jitter accumulation effect and to aid in the control of SONET pointer movements.

A receiver's jitter tolerance is defined as the peak-to-peak amplitude of sinusoidal jitter applied on the input signal that causes a 1 dB power penalty. Such a stress test will ensure that no additional penalty is incurred under operating conditions.

The OC-N service customer installation shall tolerate, as a minimum, the input jitter applied according to the mask shown in Figure 5-27 of Telcordia document GR-253-CORE, "SONET Common Generic Criteria". For OC-192, the mask to be used is shown in Figure 5-3 of GR-1377-CORE.

When loopback or loop timing is utilized by the customer installation, the jitter transfer function shall be under the curve shown in Figure 5-26 of Telcordia document GR-253-CORE, when input sinusoidal jitter up to the mask level in Figure 5-27 of that document (Figure 5-3 of GR-1377-CORE for OC-192) is applied. Jitter generation shall not exceed 0.01 UI rms (0.10 UIpp for OC-192, as measuring rms phase variations with less than 0.01 UI granularity may not be feasible). A high-pass filter with a 12 kHz (50 kHz for OC-192) cutoff frequency (with roll-off of 20 dB per decade) and low-pass filter with cutoff frequency of at least B3 shall be used.

## **8. REFERENCES**

- [1] Telcordia Generic Requirements GR-1365-CORE - SONET Private Line Service Interface Generic Criteria for End Users, Issue 1, December 1994
- [2] Telcordia Generic Requirements GR-1374-CORE - SONET Inter-Carrier Interface Physical Layer Generic Criteria for Carriers, Issue 1, December 1994
- [3] Telcordia Generic Requirements GR-253-CORE - Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria, Issue 2, December 1995, Revision 2, January 1999
- [4] Telcordia Generic Requirements GR-1400-CORE - SONET Dual-Fed Unidirectional Path Switched Ring (UPSR) Equipment Generic Criteria, Issue 2, January 1999
- [5] Telcordia TR-NWT-000499 - Transport Systems Generic Requirements (TSGR): Common Requirements, Issue 5, December 1993

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[6] Telcordia Generic Requirements GR-436-CORE - Digital Network Synchronization Plan, Issue 1, June 1994

[7] Telcordia SR-NWT-002224 - SONET Synchronization Planning Guidelines, Issue 1, February 1992

[8] Ameritech SC Connector Specification V.02

[9] EIA/TIA-594-91 - Private Digital Network Synchronization

[10] Telcordia Generic Requirements GR-499-CORE - Transport Systems Generic Requirements (TSGR): Common Requirements, Issue 2, December 1998

[11] Telcordia Generic Requirements GR-1377-CORE - SONET OC-192 Transport System Generic Criteria, Issue 5, December 1998

[12] Telcordia Generic Requirements GR-1244-CORE - Clocks for the Synchronized Network: Common Generic Criteria, Issue 1, June 1995

**To order Ameritech reference documents, contact:**

847-248-4324

847-248-4328 (Help Desk)

**To order Telcordia (formerly Bellcore) reference documents, contact:**

Telcordia Customer Service

8 Corporate Place, Room 3A-184

Piscataway, NJ 08854-4156

1-800-521-CORE (2673) (USA and Canada)

(908) 699-5800 (All others)

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2001 Pennsylvania, NW

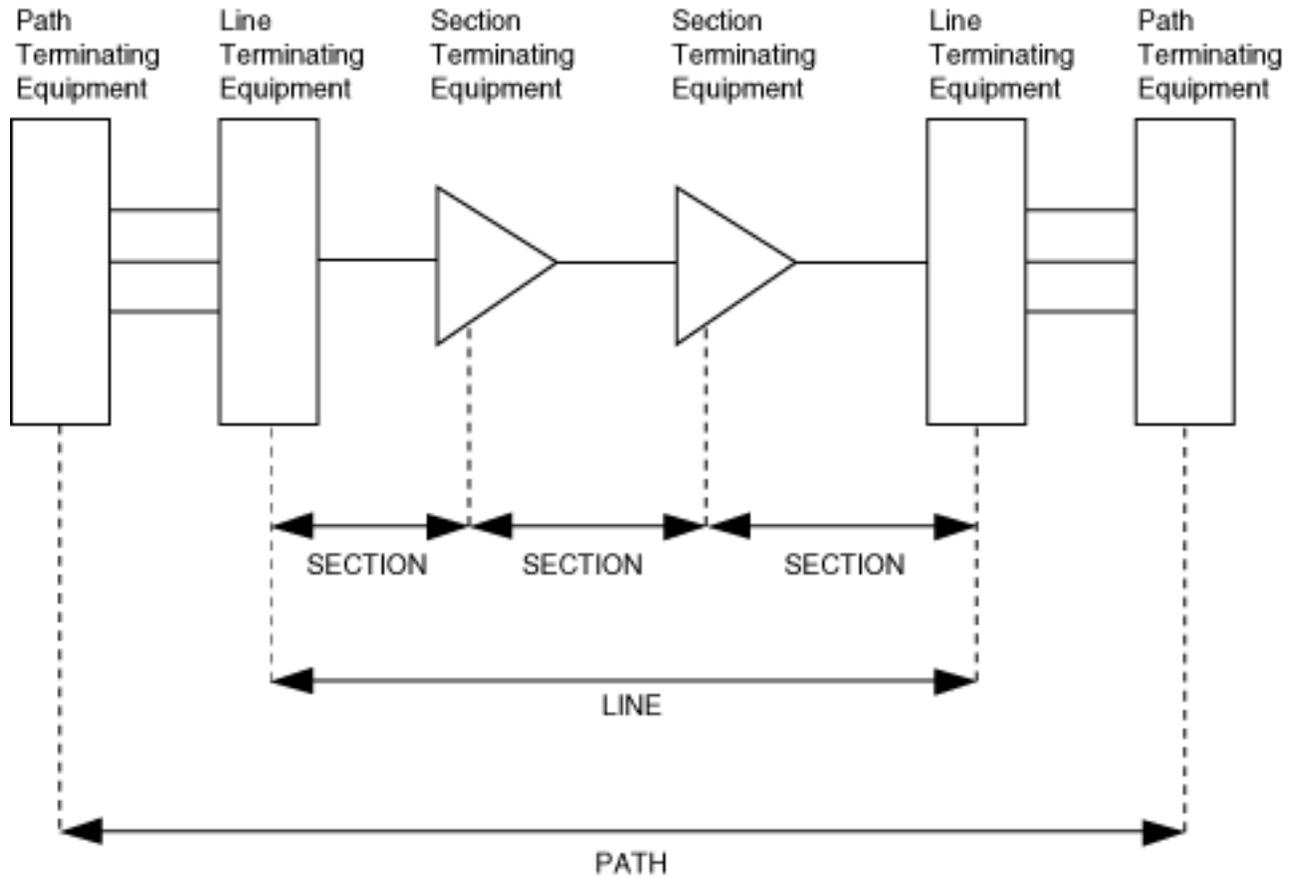
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Figure 1.

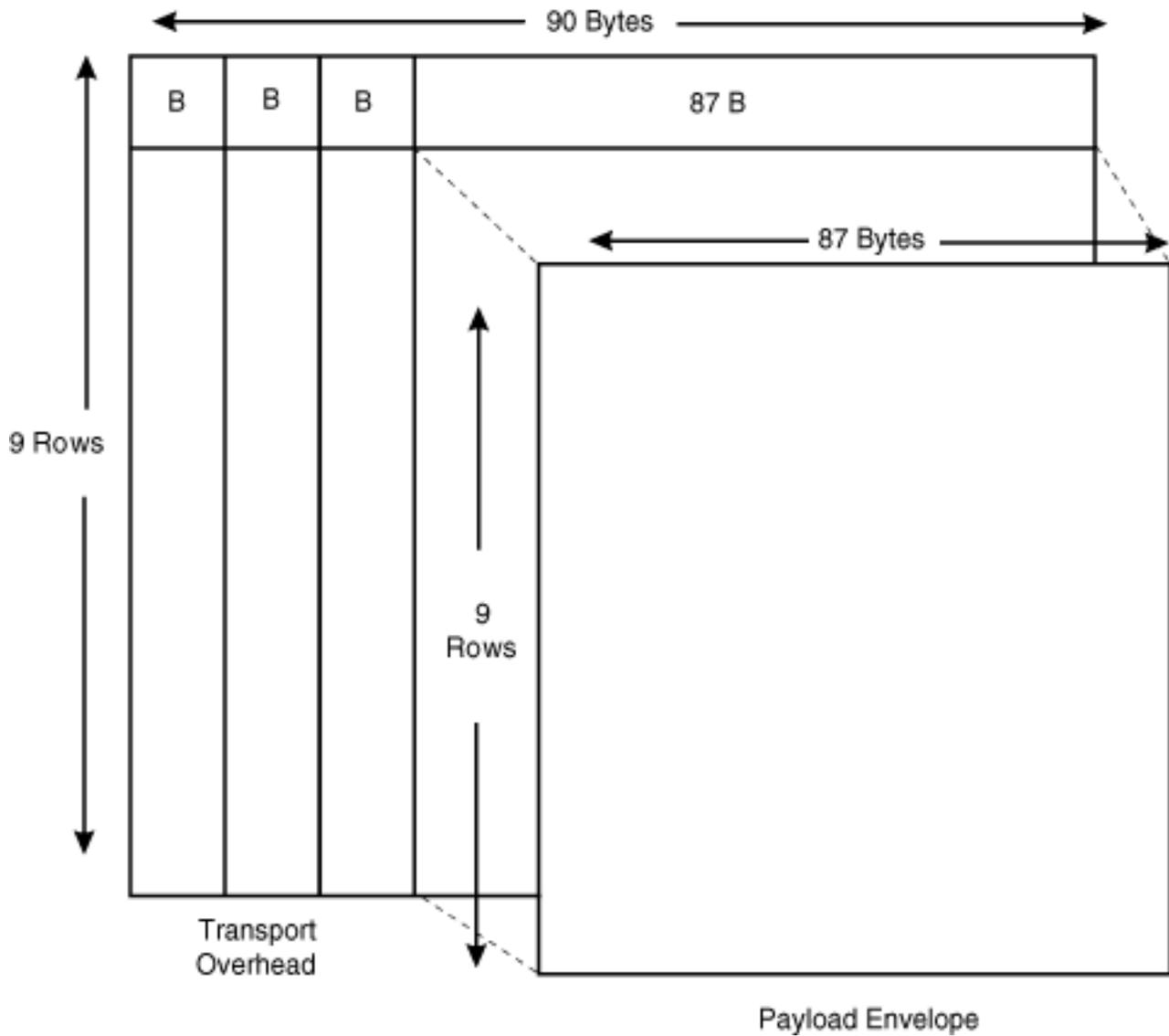


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Figure 2.

STS-1 Frame



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## APPENDIX A - AMERITECH SC CONNECTOR SPECIFICATION V.02

**DOCUMENT CHANGE HISTORY**

<u>AFFECTED SECTION</u>	<u>REASON FOR CHANGE</u>	<u>NEW ISSUE NUMBER</u>
ALL	Updated requirements and corrections to V.01	V2.0
5	Updated TR-NWT-000326, Issue 1 references to GR-326-CORE, Issue 3	V.02

**A.1. 1 SCOPE**

This document covers the specifications and performance requirements for simplex SC connectors for use by Ameritech.

The simplex SC optical fiber connector is a sub family of the SC family of connectors which includes multi-fiber and high-density SC connector configurations. The SC connector is characterized by a push-pull coupling mechanism and a cylindrical ferrule with a diameter of 2.5 mm.

This specification defines the simplex SC connector interface affecting the intermatability and compatibility of connector plugs and adapters.

The performance requirements apply to SC connectors terminated on jacketed fiber optic cable and on buffered fiber.

**A.2. 2 REFERENCES**

TIA/EIA 475F000, SC FOC/2.5

TIA/EIA FOCIS 3

JIS C 5973

GR-326-CORE, Issue 3

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**A.3. 3 SC CONNECTOR SPECIFICATIONS****A.3.1. 3.1 FERRULE GRADES**

Ferrule grades are based on Table 1.

**Table 1.**  
**Table 1: Ferrule Grades**

Ferrule grades are based on Table 1.

<b>Grade</b>	<b>Tolerance of Dimension A (mm)</b>	<b>Dimension B (mm)</b>	<b>Dimension C (mm)</b>	<b>Angle (degrees)</b>
SM	+0.001 0	2.499 +/- 0.0005	0.0007 or less	0.5 or less
MM	+0.002 0	2.499 +/-0.001	0.004 or less	0.5 or less

**A.3.2. 3.2 COUPLING REGION OF SC CONNECTOR**

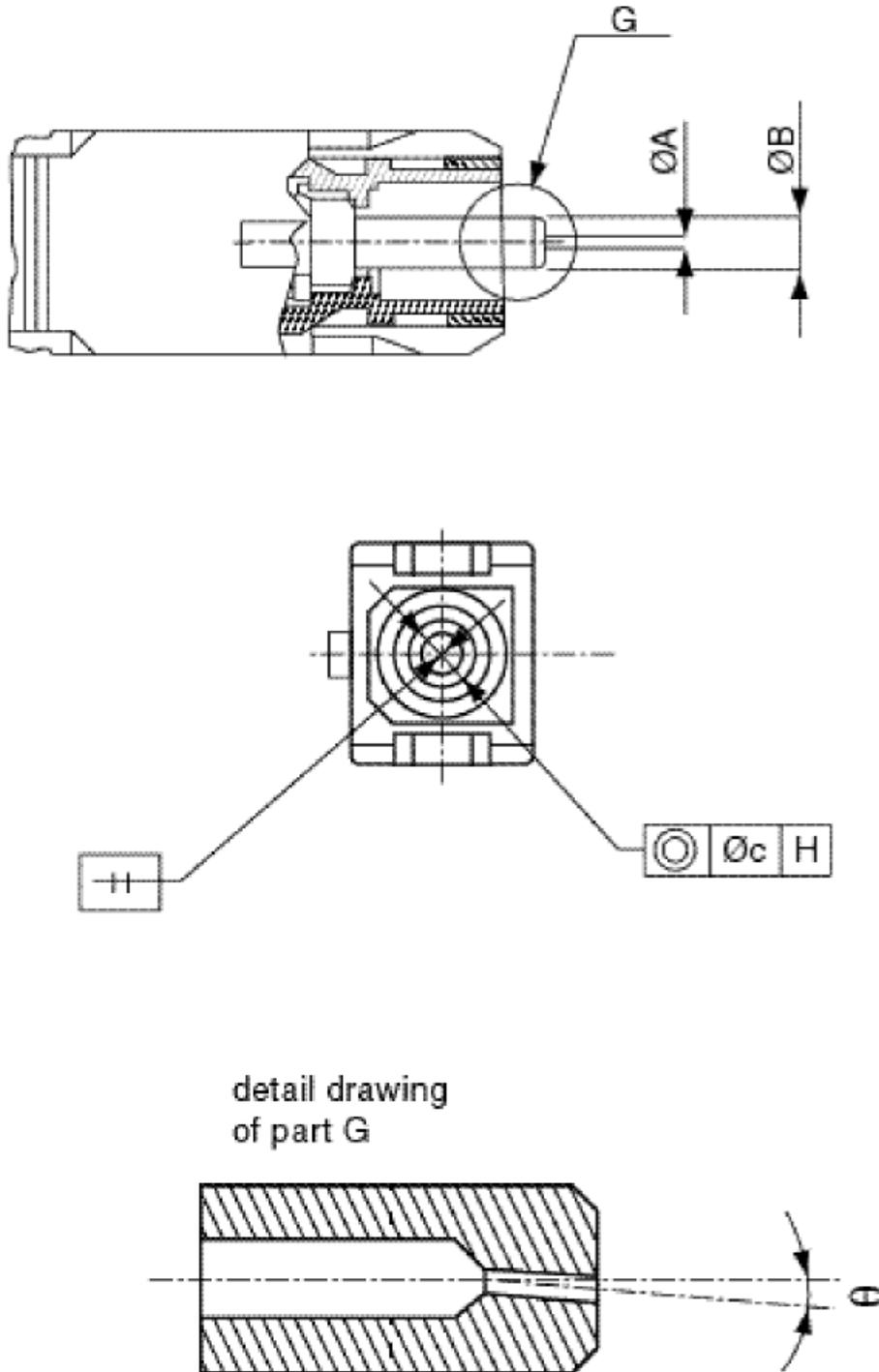
The construction, shape and dimension of the coupling region of the optical connectors are shown in Figures 3 and 4.

Dimensions of the metal parts are dimensions after surface treatment. Furthermore, the construction and shape of those places for which no dimension has been stipulated are shown as a reference. The dimensional tolerance for places where no dimensional tolerance is given will be based on JIS C5973.

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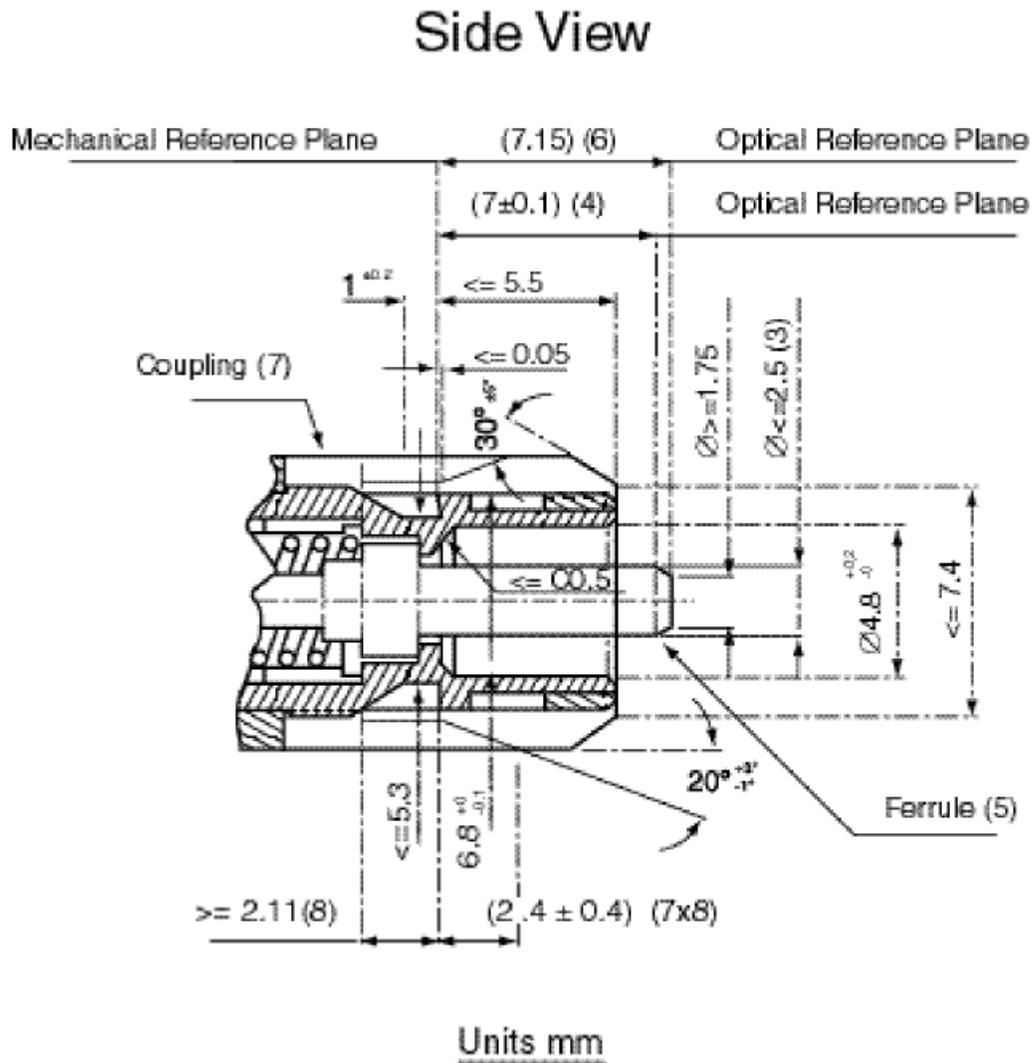
Figure 1. Ferrule Detail



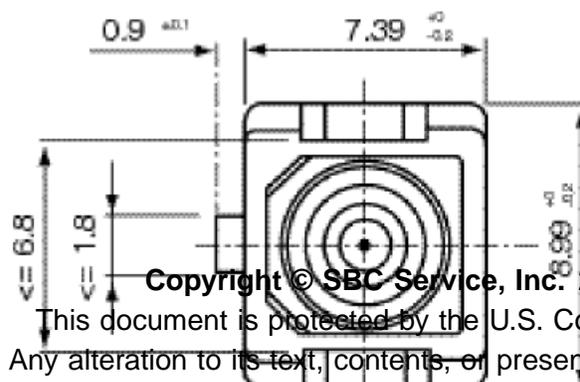
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Figure 2. Coupling Region of Connector Plug



### Front View



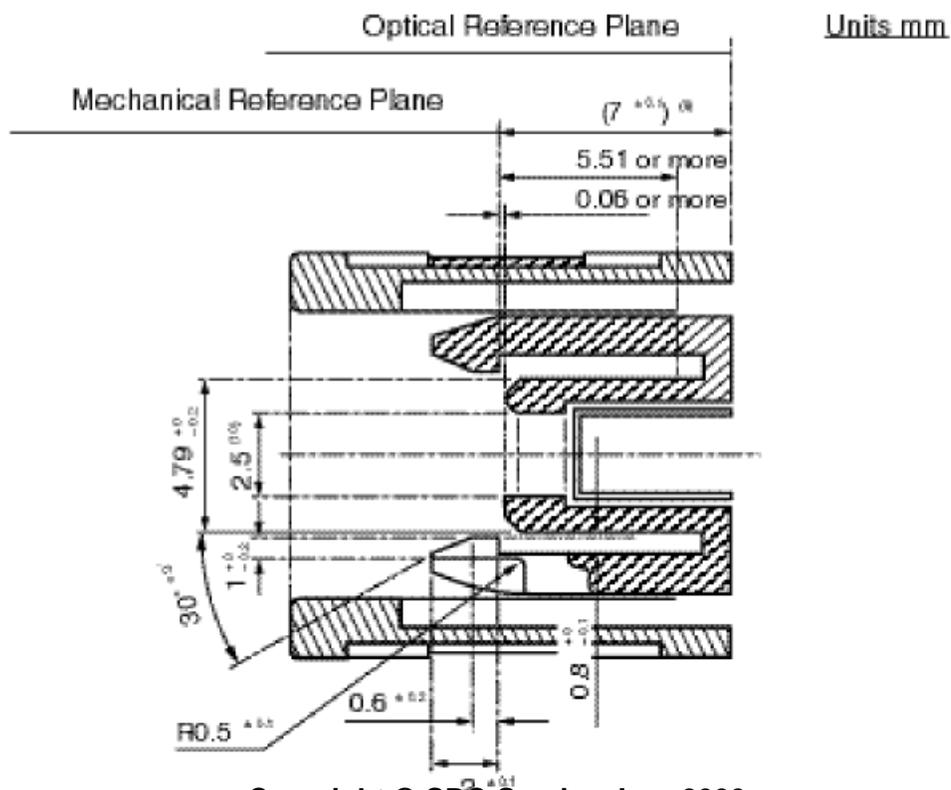
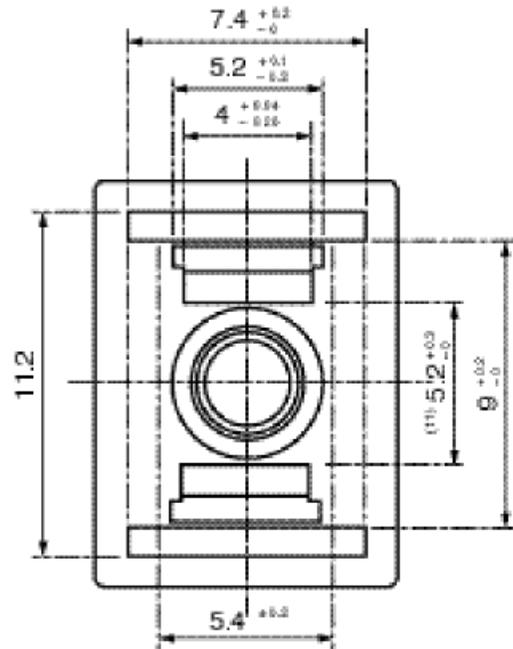
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**NOTE:**

- (3) The peripheral surface from the ferrule end face to 1.2 mm is arbitrary.
- (4) This dimension is the design distance from the mechanical reference plane in the optical connection position to the ferrule end face when connected with the corresponding optical connector, and will not be subject to measurement.
- (5) The ferrule must be constructed to allow displacement to the left in the figure in resistance to the elastic force.
- (6) The dimension is the minimum dimension necessary after ferrule end face polishing, and will not be subject to measurement.
- (7) The coupling device must be constructed to allow movement to the left and release of the adapter's coupling region. But in such a case, the dimension  $2.4 \pm 0.4$  must be less than 0.
- (8) This is the dimension after the coupling device has been shifted to the right in the figure, and will not be subject to measurement.

Figure 3. Coupling Region of Adapter



Units mm

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**NOTE:**

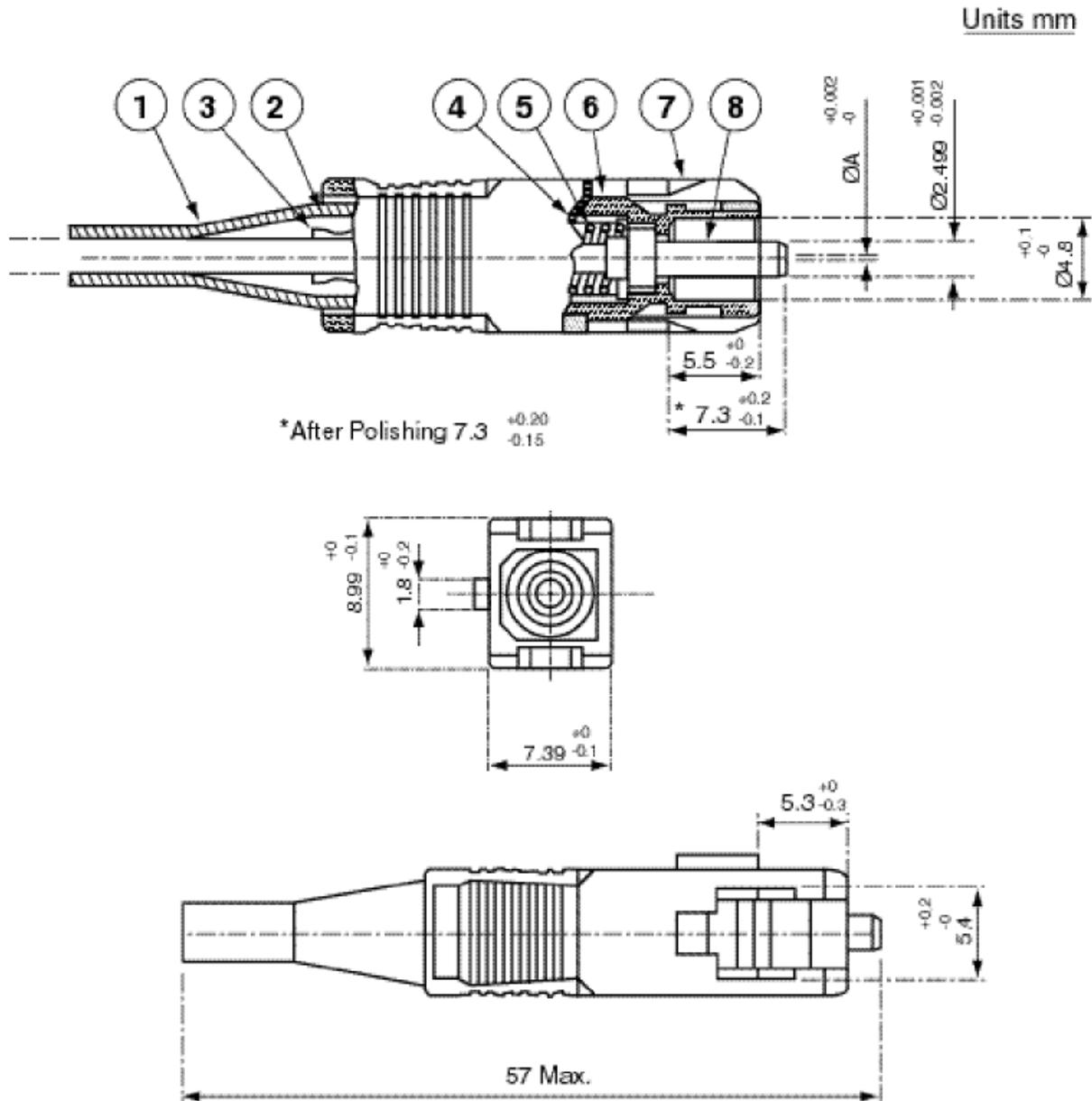
(9) This dimension is the design distance from the mechanical reference plane, while optically connected to the ferrule, and face within the adapter after being connected with the plug, and will not be subject to measurement.

(10) This dimension applies when an elastic sleeve is used. The diameter must be greater than 2.5 for an inelastic sleeve.

(11) This dimension should be constructed to widen to 6.8 mm or more for engagement and detachment of the plug.

A.3.3. 3.3 DIMENSIONS AND PARTS LIST

Figure 4. Shape and Dimension of Plug



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1. Concentricity of the hole diameter (dimension A) and the outer diameter (dimension 2.499 +/- 0.0005) of the ferrule is to be  $\leq 0.0007$  and a special testing item.
2. Dimensions in parenthesis are reference values.

**Table 2.**  
**Table 2: Connector Plug Parts List**

Code	Part Name	Example of Usable Material	Example of Treatment	Quantity
1	Strain Relief	Synthetic Rubber <sup>1</sup>		1
2	Ring	Stainless Steel or Brass	Nickel Plating (if Brass)	1
3	Clamping Ring	Aluminum		1
4	Stop Ring	Brass	Nickel Plating	1
5	Spring	Stainless Steel or Steel	Nickel Plating (if Steel)	1
6	Plug Frame	Plastic-UL94V-0		1
7	Coupling Device	Plastic-UL94V-0		1
8	Ferrule	Zirconia		1

<sup>1</sup> The length from the ferrule tip to the end of the strain relief shall not exceed 57 mm.

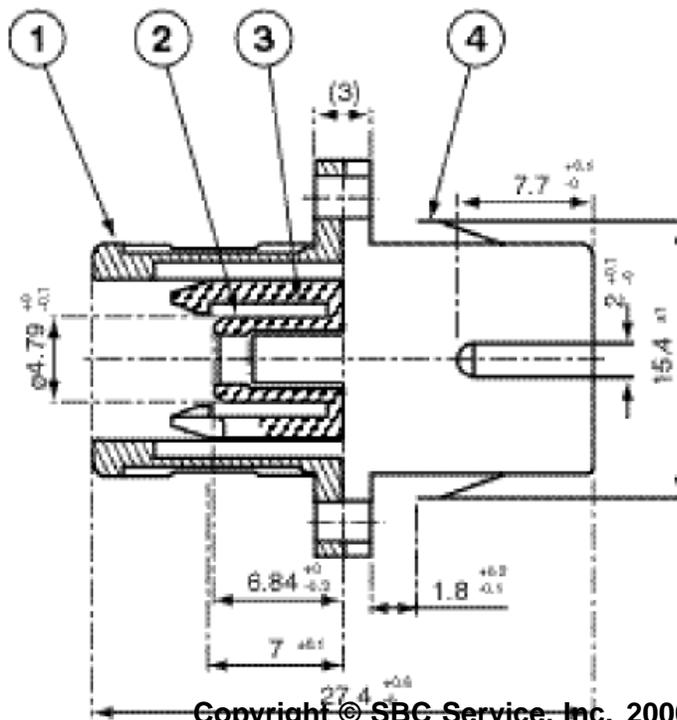
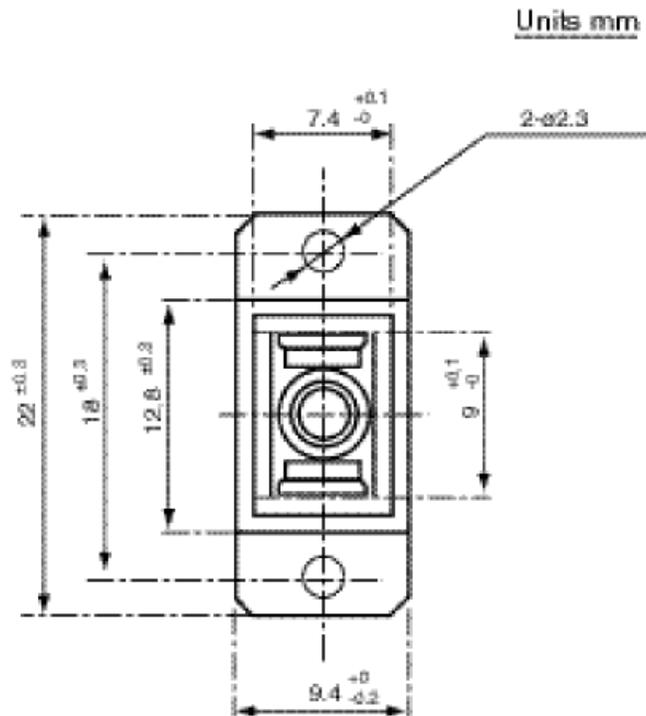
**NOTE:**

Items 1 to 4 in the above parts list may vary between suppliers. Acceptable designs will be at the discretion of Ameritech.

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Figure 5. Shape and Dimension of Plastic Adapter



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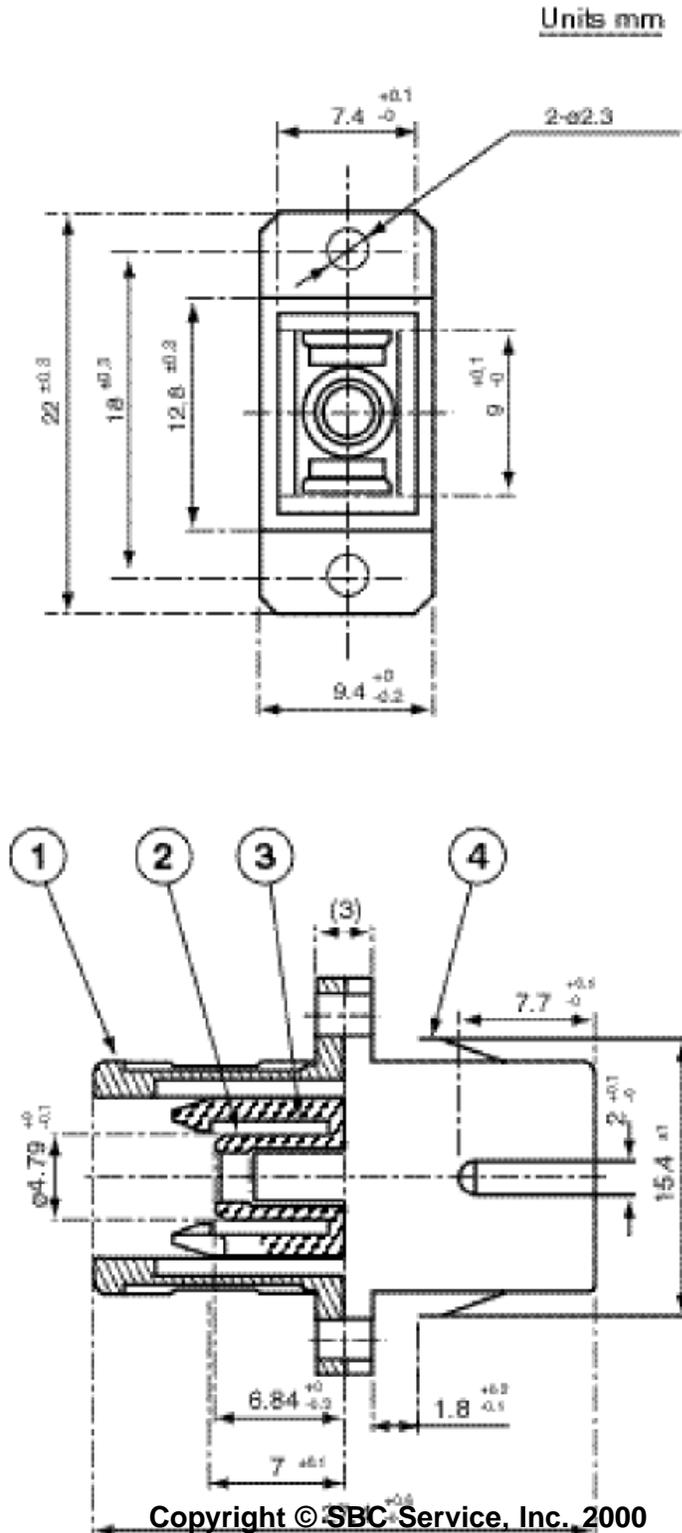
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**Table 3.**  
**Table 3: Plastic Adapter Parts List**

<b>Code</b>	<b>Part Number</b>	<b>Example of Usable Material</b>	<b>Quantity</b>	<b>Remarks</b>
1	Housing	Plastic- UL94V-0	2	
2	Sleeve Holder	Plastic- UL94V-0	2	
3	Sleeve	Phosphor Bronze or Zirconia <sup>1</sup>	1	
4	Spring	Stainless Steel	1	Plate Thickness of 1.6 mm for plate attachment

<sup>1</sup> In the case of Zirconia sleeves, proof test data which ensures that the sleeve will not stress crack over the long term (20 yrs) must be supplied by the manufacturer. Acceptable data will be at the discretion of Ameritech.

Figure 6. Shape and Dimension of Metal Adapter



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**Table 4.**  
**Table 4: Metal Adapter Parts List**

	<b>Part Number</b>	<b>Example of Usable Material</b>	<b>Quantity</b>	<b>Remarks</b>
1	Housing	Zinc Alloy - Nickel Plated	2	
2	Sleeve Holder	Plastic-UL94V-0	2	
3	Sleeve	Phosphor Bronze or Zirconia <sup>2</sup>	1	
4	Spring	Stainless Steel	1	Plate Thickness of 1.6 mm for plate attachment

<sup>2</sup> In the case of Zirconia sleeves, proof test data which ensures that the sleeve will not stress crack over the long term (20 yrs) must be supplied by the manufacturer. Acceptable data will be at the discretion of Ameritech.

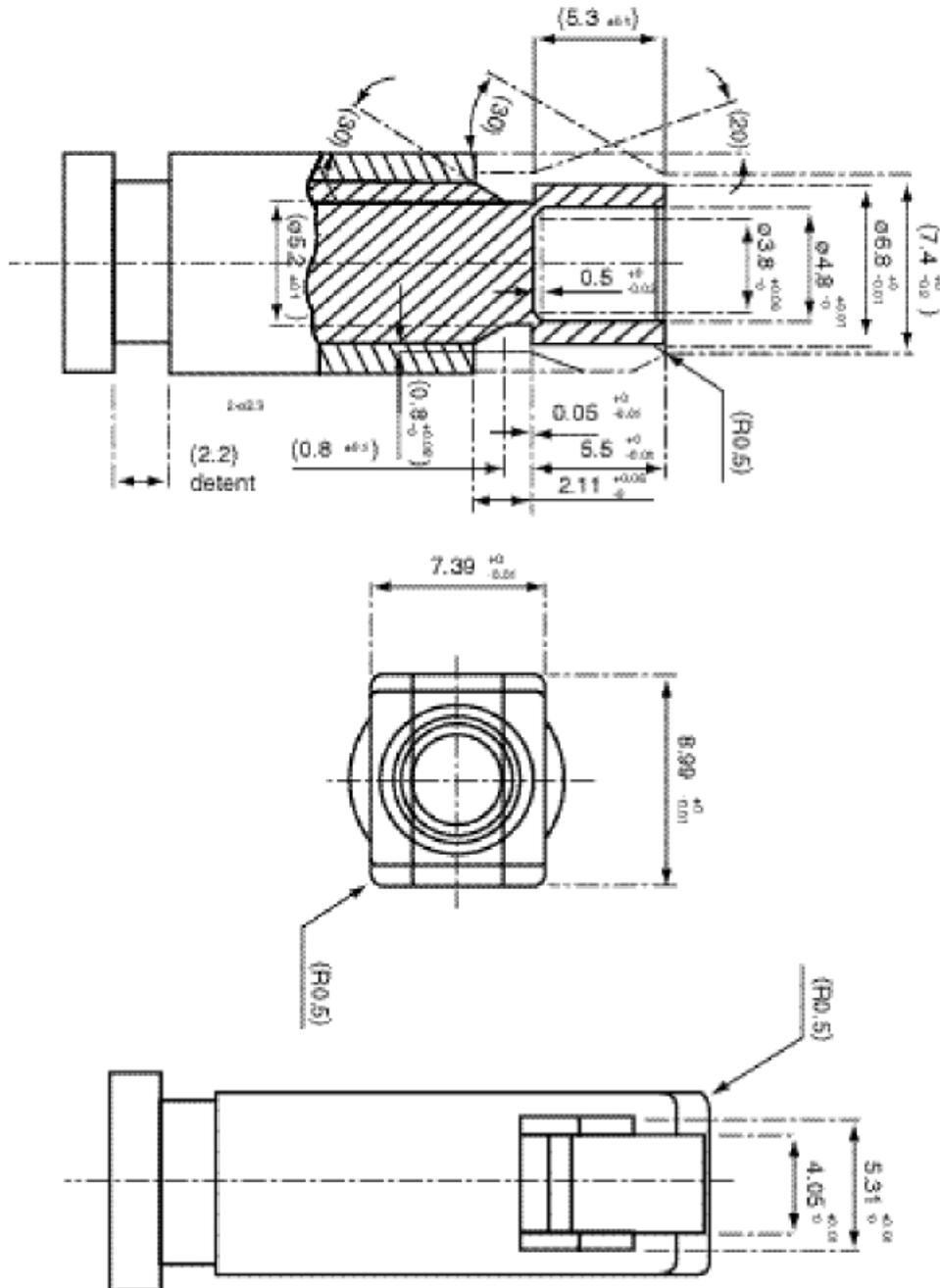
#### A.3.4. 3.4 ADAPTER INSPECTION GAUGE

The gauge structure is shown in Figure 7. The gauge is used to check the locking mechanism and mechanical intermatability performance of the mating part of an adapter.

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Figure 7. Inspection Gauge for Adapter



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**A.4. 4 ASSEMBLY AND FERRULE TIP FINISH SPECIFICATIONS****A.4.1. 4.1 EPOXY FOR MOUNTING FIBER ON CONNECTOR FERRULE**

The following two epoxys are approved for use. The epoxy should be cured using manufacturers' recommendations to minimize fiber withdrawal.

1. Epo-Tek 353ND
2. TRA-CON Tra-bond F253

**A.4.2. 4.2 FERRULE TIP FINISH SPECIFICATIONS**

1. Radius 20 mm + 5 mm/- 10 mm
2. Maximum eccentricity between fiber center and polish center shall be:  
30 um Max
3. Maximum Fiber Protrusion/undercut after finishing shall be:  
Max Protrusion 0.1 um  
Max Undercut 0.05 um

**A.5. 5. SC JUMPER CORD AND PIGTAIL PERFORMANCE REQUIREMENTS****A.5.1. 5.1 JACKETED CABLE**

Jumper cords and pigtails with SC connectors terminated on jacketed cable shall meet the requirements as stated in Telcordia GR-326-CORE, Issue 3 with the following modifications:

Insertion Loss Section 4.4.3.9 of GR-326-CORE, Issue 3

The Insertion Loss tests as specified in GR-326-CORE, Issue 3, have a requirement of mean loss  $\leq 0.3$  dB, maximum loss  $\leq 0.5$  dB, and an objective of mean loss  $\leq 0.2$  dB, maximum loss  $\leq 0.3$  dB. The Ameritech requirement shall be mean loss  $\leq 0.2$  dB, maximum loss  $\leq 0.3$  dB.

Proof Test (formerly Cable Retention) Section 4.4.3.4 of GR-326-CORE, Issue 3

The Cable Retention tests as specified in GR-326-CORE, Issue 3, are conducted per FOTP-6, in a non-operating mode. Ameritech SC connectors shall meet the test requirements in an op-

erating mode with a load of 10 lbs. The maximum allowable change in insertion loss shall be < 0.2 dB and in return loss shall be < 2.0 dB.

Flex Test Section 4.4.3.2 of GR-326-CORE, Issue 3

The cable Flex tests as specified in GR-326-CORE, Issue 3, are conducted per FOTP-1, in a non-operating mode. Ameritech SC connectors shall meet the test requirements in an operating mode with a load of 0.5 lbs. and 2.0 lbs. The maximum allowable change in insertion loss shall be < 0.2 dB and in return loss shall be < 2.0 dB.

Connector Durability Section 4.4.3.8 of GR-326-CORE, Issue 3

The Connector Durability test, as specified in GR-326-CORE, Issue 3, requires only the connector under test to be cleaned after each 25th mating with two-sided cleaning after each 50th mating. The procedure should be changed to allow, if necessary, cleaning both connectors and the adapter after each 25th mating.

Return Loss Section 4.2.2.4 of GR-326-CORE, Issue 3

Return Loss =>45 dB, Mean Return Loss =>50 dB.

#### *A.5.2. 5.2 BUFFERED FIBER*

Bellcore GR-326-CORE, Issue 3, is generally applicable to connectors terminated on jacketed cable. Therefore, jumper cords and pigtailed with SC connectors terminated on buffered fiber shall meet the requirements as stated in Bellcore GR-326-CORE, Issue 3, with the following modifications:

Insertion Loss Section 4.4.3.9 of GR-326-CORE, Issue 3

The Insertion Loss tests, as specified in GR-326-CORE, Issue 3, have a requirement of mean loss <= 0.3 dB, maximum loss <= 0.5 dB, and an objective of mean loss <=0.2 dB, maximum loss <= 0.3 dB. The Ameritech requirement shall be mean loss <= 0.2 dB, maximum loss <= 0.3 dB.

Proof Test (formerly Cable Retention) Section 4.4.3.4 of GR-326-CORE, Issue 3

Shall not apply.

Flex Test Section 4.4.3.2 of GR-326-CORE, Issue 3

Shall not apply.

Connector Durability Section 4.4.3.8 of GR-326-CORE, Issue 3

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The Connector Durability test as specified in GR-326-CORE, Issue 3, requires only the connector under test to be cleaned after each 25th mating with two-sided cleaning after each 50th mating. The procedure should be changed to allow, if necessary, cleaning both connectors and the adapter after each 25th mating.

Twist Test Section 4.4.3.3 of GR-326-CORE, Issue 3

Shall not apply.

Return Loss Section 4.2.2.4 of GR-326-CORE, Issue 3

Return Loss =>45 dB, Mean Return Loss =>50 dB.