Component Specification	**Specification Number: WSOA-1**
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Optical Networking Group	**Date: October 11, 2000**

Lucent WaveStar™ Optical Line System 400G

Optical Amplifier Module (OAM) Specification

Introduction:
This specification is developed for the optical amplifier module (OAM) to satisfy Lucent Technologies – Optical Networking Group requirements for central office applications and transmission stations (hereafter referred to as CO). This specification addresses the module performance, physical and mechanical, environmental, reliability, qualification, manufacturability, and vendor cooperation requirements.

Reason for Issue/Reissue:

The specification has been revised to clarify requirements for qualification, Section 6.B has been removed.

Change History Information:
All changes to Issue 3.1, dated 08/22/00, are marked in red. A ~~strikethrough~~ format is used for removed items. Additionally, Appendix A provides a summary of all changes.

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This specification is developed for the Wavestar™ 400G Optical Amplifier Module (OAM) to satisfy Lucent Technologies – Optical Networking Group requirements for central office applications and transmission stations (hereafter referred to as CO). This specification addresses the component performance, physical and mechanical, environmental, reliability, qualification, manufacturability, and vendor cooperation requirements.

Normal CO-use environments impose minimal stresses on the component and represents the environment for which the component reliability requirements are specified. However, factory handling, shipping and storage, CO product installation, and CO emergency conditions also require component robustness that must be demonstrated according to this specification.

- **Section 1: General Description**
- **Section 2: Optical and Electrical Performance Specifications**
- **Section 3: Physical Dimensions and Mechanical Specifications**
- **Section 4: Fiber Pigtail, Component Packaging, and Material Specifications**
- **Section 5: Environmental Test Specifications**
- **Section 6: Reliability Specifications**
- **Section 7: Reliability Qualification Specifications**
- **Section 8: U.S. FDA/CDRH Regularity Compliance Specifications**
- **Section 9: Labeling and Accompanied Test Data Specifications**
- **Section 10: Vendor Cooperation**
- **Appendix A: Change History Information**

The references associated with this specification are:

- **Lucent Document 640-252-053, Issue 3, *Assembly Instructions for LC Fiber Optic Behind-The-Wall (BTW) Connectors***
- **Lucent Document 640-252-056, Issue 1, *LC Connector Product Specification***
- **Lucent Document FOCCP, *Specification for Fiber Optic Connector Cleaning***
- **Telcordia GR-63-CORE, *Network Equipment Building System (NEBS) – Generic Equipment Requirements***
- **Telcordia GR-326-CORE, *Generic Requirements for Optical Fiber Connectors and Connectorized Jumper Cables***
- **Telcordia TR-NWT-000357, *Component Reliability Assurance - Generic Requirements for Telecommunications Equipment***
- **Telcordia GR-1221-CORE, *Generic Reliability Assurance Requirements for Fiber Optic Branching Components***
- **Telcordia GR-1312-CORE, *Generic Requirements for Optical Fiber Amplifiers and Proprietary DWDM Systems***
- **Military Standard MIL-STD-883, *Test Methods and Procedures for Microelectronics***
- **ASTM Standard G21, *Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi***
- **ASTM Standard D2863-97, *Standard Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)***
- **ANSI T1.307, *Telecommunications – Fire Resistance Criteria – Ignitability Requirements for Equipment Assemblies and Fire Spread Requirements for Wire and Cable***
- **Lucent Document RELQUAL, Lucent Component Specification, *Specification for Product Compliance and Reliability Qualification of Optoelectronic Components, Modules, and Subsystems***
- **Lucent Document PKG-91NJ1045, *Packaging, Packing, Palletization, Labeling and Marking Requirements for Material Being Delivered to Lucent Technologies***

SECTION 1: GENERAL DESCRIPTION

The optical amplifier module (OAM) specified in this document is to be used in the optical amplifiers in Lucent Wavestar^{TM} Optical Line System (OLS) 400G. The OAM provides uniform gain in the 1530-1563 nm band for transmission signals, add/drop accesses in the 1500-1520 nm band for the supervisory channel, a pair of optical ports into which a dispersion compensation module (DCM) can be connected, and multiple input and output taps for performance monitoring, fault location and amplifier operation control. The OAM also incorporates an internal variable optical attenuator (VOA) for optical amplifier gain tilt adjustment

SECTION 2: OPTICAL AND ELECTRICAL SPECIFICATIONS

2A Optical Specification

2A.1 Optical Band and Port Definitions

Four optical bands are defined in Table 2A.1. Signal band is to be used for wavelength-division-multiplexed optical channels. Supervisory band is reserved for the supervisory channel that relays system performance and maintenance data between optical amplifier nodes. The 980 nm and 1480 nm pump bands define the wavelength range of the two types of pump lasers used in the OAM.

Table 2A.1: Optical Band Definition

Band	*Symbol*	*Wavelength Range (nm)*		*Frequency Range (THz)*	
Signal	S-Band	1530.334	1562.640	191.850	195.900
Supervisory	T-Band	1500.000	1520.000	197.232	199.862
980 nm Pump	P980-Band	970.000	990.000	302.821	309.064
1480 nm Pump	P1480-Band	1455.000	1490.000	201.203	206.043

Fourteen optical ports are defined in Table 2A.2 for line input and output, intermediate access ports for DCM, supervisory channel add and drop, and various input and output monitors. Pump lasers are to be included inside the OAM and their performance and electrical interface are specified in Sections 2B and 2D, respectively.

Table 2A.2: Optical Port Definition

Port	*Notation*
a	Line Input (S-Band and T-Band)
b	Line Output (S-Band and T-Band)
c	Supervisory Channel Drop I (T-Band)
d	Supervisory Channel Drop II (T-Band)
e	Supervisory Channel Add (T-Band)
f	Supervisory Channel Verification (T-Band)
g	DCM out (S-Band)
h	DCM in (S-Band)
i	Input Monitor I: Optical Port for Face Plate (S-Band)
k	Input Monitor II: Input Power Monitor (S-Band)
m	DCM power Monitor (S-Band)
n	Output Monitor III: Optical Port for OMON Pack (S-Band)
o	Output Monitor II: Output Signal Monitor (S-Band)
p	Output Monitor I: Optical Port for Face Plate (S-Band)

2A.2 Test Conditions and Specification Limits

The total number of 980 nm and 1480 nm pump lasers contained in the OAM shall not exceed six. These pump lasers must meet the performance specification and electrical interface definition described in Sections 2B and 2D, respectively.

The OAM shall operate within the specification over heat sink average temperature range 0 to 70°C, over all input signal polarization states, with optical line return losses greater than 20 dB at all optical ports, and with optical ports *c, d, f, e, i,* and *p* left unconnected, unless noted otherwise. The time during which the OAM operates at the heat sink temperature in the range of 60 to 70°C is 600 hours per year. Room temperature is defined to 25 ± 5°C.

The OAM performance specification contained in this document should not be interpreted as manufacturing targets, instead, vendors are expected to continuously improve their manufacturing process and OAM performance.

Currently, Lucent accepts performance data reported as measured values for all parameters excluding return loss, tap port ratios, suppression and leakage values. Therefore, measurement correlation between the vendor and Lucent has to be established.

The notation Z_x used in this document denotes power in the Z band measured at port "x," and notation Z_{xy} denotes the ratio of Z band power measured at port "x" to that measured at port "y," where Z can be S, T, P980 and P1480, and, x and y can stand for a, b …… p.

Table 2A.3: High Pumping Test Conditions

Condition	L_{gh} (dB) *(Note 1)*	S_a (dBm) (*Note 2*)	Pump Laser Setting *(Note 3),* Line Output Power S_b *(Note 4)* DCM Output Power S_g *(Note 4, Note 7)*	VOA Loss L_{att} *(Note 5),* Gain Tilt $S_{ba\text{-}t}$ *(Note 6)*
0	9.0	-2.5	Pump lasers are set such that S_b = 22.7 dBm, and $S_g = S_{g\_set}$ which shall satisfy 13.5 dBm < S_{g_set} < 16.5 dBm	$L_{att} = L_0$ such that $S_{ba\text{-}t}$ = 0.0 dB
1	9.0	-2.5	Pump lasers are set such that S_b = 22.7 dBm, and $S_g = S_{g\_set}$ which shall satisfy 13.5 dBm < S_{g_set} < 16.5 dBm	$L_{att} = L_1$ such that $S_{ba\text{-}t}$ = -1.0 dB
2	9.0	-2.5	Pump lasers are set such that S_b = 22.7 dBm, and $S_g = S_{g\_set}$ which shall satisfy 13.5 dBm < S_{g_set} < 16.5 dBm	$L_{att} = L_2$ such that $S_{ba\text{-}t}$ = -2.6 dB
3	9.0	0	Pump lasers are set such that S_b = 22.7 dBm, and $S_g = S_{g\_set}$ which shall satisfy 13.5 dBm < S_{g_set} < 16.5 dBm	$L_{att} = L_3$ such that $S_{ba\text{-}t}$ = -1.0 dB
4	9.0	0	Pump lasers are set such that S_b = 22.7 dBm, and $S_g = S_{g\_set}$ which shall satisfy 13.5 dBm < S_{g_set} < 16.5 dBm.	$L_{att} = L_4$ such that $S_{ba\text{-}t}$ = -2.6 dB
5	9.0	2.5	Pump lasers are set such that S_b = 22.7 dBm, and $S_g = S_{g\_set}$ which shall satisfy 13.5 dBm < S_{g_set} < 16.5 dBm	$L_{att} = L_5$ such that $S_{ba\text{-}t}$ = -1.0 dB
6	9.0	2.5	Pump lasers are set such that S_b = 22.7 dBm, and $S_g = S_{g\_set}$ which shall satisfy 13.5 dBm < S_{g_set} < 16.5 dBm	$L_{att} = L_6$ such that $S_{ba\text{-}t}$ = -2.6 dB

Table 2A.4: Low Pumping Test Conditions

Condition	L_{gh} (dB) *(Note 1)*	S_a (dBm) (*Note 2*)	Pump Laser Setting *(Note 3),* Line Output Power S_b *(Note 4)* DCM Output Power S_g *(Note 4, Note 7)*	VOA Loss L_{att} *(Note 5)*
7	9.0	-15.0	Pump lasers are set such that $S_g = S_{g\_set}$ – 12.5 dBm and S_b = 10.2 dBm	L_1

8	9.0	-12.5	Pump lasers are set such that $S_g = S_{g\_set}$ – 12.5 dBm and S_b = 10.2 dBm	L_3
9	9.0	-10.0	Pump lasers are set such that $S_g = S_{g\_set}$ – 12.5 dBm and S_b = 10.2 dBm	L_5

Table 2A.5: Low DCM Loss Test Conditions (Note 12)

Condition	L_{gh} (dB)	S_a (dBm) (*Note 2*)	Pump Laser Setting *(Note 3),* Line Output Power S_b *(Note 4)* DCM Output Power S_g *(Note 4), (Note 7)*	VOA Loss L_{att} *(Note 5)*
10	0.0	-10.5	Pump lasers are set such that S_b = 22.7 dBm, and $S_g = S_{g\_set}$ – 3 dBm	$L_{att} = L_{10}$ such that $S_{ba\text{-}t}$ = -1.0 dB
11	0.0	-10.5	Pump lasers are set such that S_b = 22.7 dBm, and $S_g = S_{g\_set}$ – 3 dBm	$L_{att} = L_{11}$ such that $S_{ba\text{-}t}$ = -2.6 dB
12	0.0	-23.0	Pump lasers are set such that S_b = 10.2 dBm, and $S_g = S_{g\_set}$ – 12.5 dBm and	$L_{att} = L_{12}$ such that $S_{ba\text{-}t}$ = -1.0 dB

2A.3 Optical Specification for Signal Band

Table 2A.6: S-Band Specification
Specification in this table shall be met under all test conditions (1-12), Unless noted otherwise.

Parameter	*Symbol*	*Condition*	*Limit*		*Unit*
Beginning of Life	BOL		Min	Max	
Tolerable Input Power (Damaging value)	P_{MAX}	At all optical ports	24.7	-	dBm
Line Input Return Loss	S_{aa}	All pumps unpowered	-	-40	dB
Line Output Return Loss	S_{bb}	All pumps unpowered	-	-40	dB
DCM Output Return Loss	S_{gg}	All pumps unpowered	-	-20	dB
DCM Input Return Loss	S_{hh}	All pumps unpowered	-	-20	dB
Unamplified Signal Gain	$S_{ba\text{-}u}$	All pumps unpowered	-	-30	dB
S-Band Gain Variation (Note 8)	δS_{ba}	Over S-Band; At room temperature Test conditions 1, 3 and 5		1.00	dB
		Over S-Band; Test conditions 1, 3 and 5		1.10	dB
		Over S-Band; Test conditions 7, 8, and 9		1.20	dB
		Over S-Band; Test conditions 10 and 12		1.50	dB
S-Band Polarization-dependent Gain (Note 9)	PDG_{ba}	All test conditions Mean value at worst case wavelength	-	0.35	dB
		All test conditions 99% of cumulative distribution at worst case wavelength		0.55	dB

S-Band Polarization - mode Dispersion (Note 10)	PMD_{ba}	Over S-Band; All test conditions	-	0.50	ps
Extended Tilt Range	$\Delta S_{ba\text{-}t,ext}$	Conditions 1,3,5,7,8,9,10 and 12 VOA Loss L_{att} adjusted as necessary, S_b drop < 0.5 dB, NF degradation compared with Condition 2,11: < 1.0 dB Condition 4: < 1.5 dB Condition 6: < 2.0 dB	-4.0	-2.6	dB
Noise Figure (A)	NF_A	Over S-Band; Test conditions 1, 2, with L_{gh} = 10.0 dB	-	6.50	dB
Noise Figure (B)	NF_B	Over S-Band; Test conditions 3, 4, with L_{gh} = 10.0 dB	-	8.00	dB
Noise Figure (C)	NF_C	Over S-Band; Test condition 5 with L_{gh} = 10.0 dB	-	9.50	dB
		Over S-Band; Test condition 6, with L_{gh} = 10.0 dB	-	10.50	dB
Noise Figure (D)	NF_D	Over S-Band; Test conditions 10, 11 and 12	-	6.50	dB
Noise Figure (A)	NF_A	Over S-Band; Test condition 7, with L_{gh} = 10.0 dB	-	6.70	dB
Noise Figure (B)	NF_B	Over S-Band; Test condition 8, with L_{gh} = 10.0 dB	-	8.20	dB
Noise Figure (C)	NF_C	Over S-Band; Test condition 9, with L_{gh} = 10.0 dB	-	9.70	dB
S-Band Gain at DCM Output (A)	$S_{ga\text{-}A}$	Over S-Band; Test conditions 1 and 2	-	21.0	dB
S-Band Gain at DCM Output (B)	$S_{ga\text{-}B}$	Over S-Band; Test conditions 3 and 4	-	18.5	dB
S-Band Gain at DCM Output (C)	$S_{ga\text{-}C}$	Over S-Band; Test conditions 5 and 6	-	16.0	dB
S-Band Gain at DCM Output (D)	$S_{ga\text{-}D}$	Over S-Band; Test conditions 10 and 11	-	29.0	dB
Input Mon. Ratio	S_{ia} S_{ka}	All pumps unpowered	-22.7	-19.7	dB
Input Mon. Ratio Variation vs. Wavelength	δS_{ia_λ} δS_{ka_λ}	All pumps unpowered, over S-Band, at constant temperature, measured with unpolarized input signals	-	0.35	dB
Input Mon. Ratio Variation vs. Temperature and Polarization	δS_{ia_TP} δS_{ia_TP}	All pumps unpowered, at any given S-Band wavelength, over temperature range 0 – 70 °C, and over all polarization states	-0.20	0.20	dB
DCM Power Mon. Ratio	S_{mg}		- 19.1	-16.1	dB
DCM Power Mon. Ratio Variation vs. Wavelength	δS_{mg_λ} δS_{mg_λ}	Over S-Band, at constant temperature, measured with unpolarized input signals	-	0.40	dB
DCM Power Mon. Ratio Variation vs. Temperature and Polarization	δS_{mg_TP} δS_{mg_TP}	At any given S-Band wavelength, over temperature range 0 – 70 °C, and over all polarization states	-0.20	0.20	dB
Output Mon. I Ratio	S_{pb}		-24.9	-21.9	dB
Output Mon. II Ratio	S_{ob}		-24.9	-21.9	dB
Output Mon. III Ratio	S_{nb}		-21.6	-18.6	dB

Output Mon. Ratio Variation vs. Wavelength	δS_{pb_λ} δS_{ob_λ}	Over S-Band, at at constant temperature, measured with unpolarized input signals	-	0.35	dB
	δS_{nb_λ}		-	0.50	dB
Output Mon. Ratio Variation vs. Temperature and Polarization	δS_{pb_TP} δS_{ob_TP} δS_{nb_TP}	At any given S-Band wavelength, over temperature range 0 – 70 °C, and over all polarization states	-0.20	0.20	dB
Supv Drop I S-Band Suppression	S_{ca}	All pumps unpowered, T_{ca} is defined in Table 2A.7	-	T_{ca} – 40.0	dB
Supv Drop II S-Band Suppression	S_{da}	All pumps unpowered, T_{da} is defined in Table 2A.7	-	T_{da} – 40.0	dB

2A.4 Optical Specification for Supervisory Band

Table 2A.7: T-Band Specification
The specification in this table shall be met under all test conditions (1-12)

Parameter	*Symbol*	*Condition*	*Limit*		*Unit*
Beginning of Life	BOL		Min	Max	
Supv Drop I Ratio	T_{ca}		- 7.2	-	dB
Supv Drop II Ratio	T_{da}		- 7.2	-	dB
Supv Add Ratio	T_{be}		- 2.0	-	dB
Supv Verification Ratio	T_{fe}		-19.4	-16.4	dB
Output Supv Gain	T_{ba}		-	-10.0	dB
Supv Leakage at Input Monitor I	T_{ia}		-	S_{ia}-12.0	dB
Supv Leakage at Input Monitor II	T_{ka}		-	S_{ka}-12.0	dB
Supv Leakage at Output Monitor I	T_{pa}		-	S_{pa}-20.0	dB
Supv Leakage at Output Monitor II	T_{oa}		-	S_{oa}-20.0	dB
Supv Leakage at Output Monitor III	T_{na}		-	S_{na}-20.0	dB

2A.5 Optical Specification for Pump Bands

Table 2A.8: P980-Band and P1480-Band Specification
The specification in this table shall be met under all test conditions (1-12)

Parameter	*Symbol*	*Condition*	*Limit*		*Unit*
Beginning of Life	BOL		Min	Max	
Pump Suppression at Supv Drop I	$P980_{ca} + P1480_{ca}$		-	T_{ca}	dB
Pump Suppression at Supv Drop II	$P980_{da} + P1480_{da}$		-	T_{da}	dB
Pump Leakage at Line Input	$P980_{a} + P1480_{a}$		-	-30.0	dBm
Pump Leakage at Input Monitor I	$P980_{i} + P1480_{i}$	Note 11	-	S_i - 25.0	dBm
Pump Leakage at Input Monitor II	$P980_{k} + P1480_{k}$	Note 11	-	S_k - 25.0	dBm
Pump Leakage at DCM Power Monitor	$P980_{m} + P1480_{m}$		-	S_m - 25.0	dBm
980 nm Pump Leakage at Output Monitor I, II and III	$P980_p$		-	S_p - 40.0	dBm
	$P980_o$		-	S_o - 40.0	dBm
	$P980_n$		-	S_n - 40.0	dBm
1480 nm Pump Leakage at Output Monitor I, II and III	$P1480_p$		-	S_p - 25.0	dBm
	$P1480_o$		-	S_o - 25.0	dBm
	$P1480_n$		-	S_n - 25.0	dBm
Pump Leakage at Line Output	$P980_{b} + P1480_{b}$		-	- 10.0	dBm

2A.6 OAM End-of-Life Specifications

End-of-life (EOL) shall have occurred when any pump laser reaches EOL specification defined in Table 2B.2 and Table 2B.4, or the OAM fails to meet any of the following specification.

Table 2A.9: End of Life Specification
The specification in this table shall be met under all test conditions (1-12), unless noted otherwise.

Parameter	*Symbol*	*Condition*	*Limit*		*Unit*
End of Life	EOL		Min	Max	
Saturation Output Power Degradation	ΔS_b	Total OAM heat dissipation not exceeding 30 W and pump operation currents not exceeding the specification listed in Table 2B.1 and Table 2B.3	-	0.50	dB
Noise Figure Degradation	ΔNF		-	0.50	dB
S-Band Gain Variation (Note 8)	δS_{ba}	Over S-Band; At room temperature Test conditions 1, 3 and 5		1.20	dB
		Over S-Band; Test conditions 1, 3 and 5	-	1.30	dB
		Over S-Band; Test conditions 7, 8 and 9		1.40	dB
		Over S-Band; Test conditions 10 and 12	-	1.80	dB
Change in Mon. Ratio Due to Aging Effects	ΔS_{ia_A} ΔS_{ka_A} ΔS_{mg_A} ΔS_{pb_A} ΔS_{ob_A} ΔS_{nb_A}	The change shall be measured at 25 °C and with unpolarized input signals, the same condition under which the BOL value is measured.	- 0.10	0.10	dB

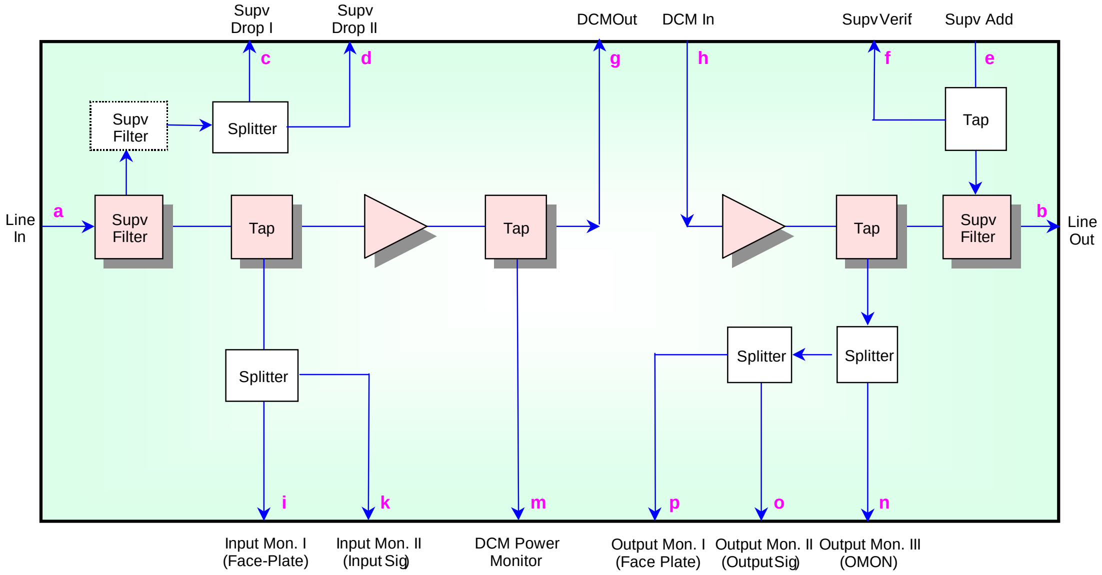
2A.7 Notes for Test Conditions and Optical Specifications

Table 2A.10: Notes for Test Conditions and Optical Specifications

Note	*Note Content*
1	An optical attenuator with a loss of L_{gh} is connected to the DCM ports "*g*" and "*h*." The attenuation variation over the S-Band, over all polarization states shall be within ±0.1 dB of the specified value
2	Input signal shall be composed of 42 saturating signals, at optical frequencies of 195.90 - *i* x 0.1 THz, *i* = 0, 40 and one channel either at 191.85 THz or 191.80 THz, each having a power of $S_a - 10*\log_{10}(42)$ dBm. The data for 191.85 THz can be interpolated using the numbers for the adjacent channels using the latter scheme. Alternatively, the input signal can be reduced to 40 channels located on the grid defined above, each having a power of $S_a - 10*\log_{10}(40)$ dBm. In that case, the position of the two 200 GHz gaps has to be accepted by Lucent. The total input power S_a shall be measured by connecting the pigtail connector directly into a broad area optical power meter. The power shall be set within ±0.2 dB. That tolerance includes the error of the optical powermeter head. The difference between nominal per channel power and the actual per channel power shall be within ±0.3 dB. The difference between the maximum power level and the minimum power level of a linear fit (least mean square error) through the input signal power levels over wavelength shall be within ±0.5 dB.
3	All pump lasers shall be operated under conditions that meet the requirements set forth in Sections 2B and 2D. The total heat dissipation of the OAM, including all pump lasers, heaters and VOA driver, shall not exceed 30 W.
4	Optical power shall be measured by connecting the pigtail connector directly into a broad area optical power meter. The power shall be set within ±0.2 dB of the specified value. That tolerance includes the error of the optical powermeter head.

5	The VOA loss L_{att} is defined as the amount of attenuation in excess to its intrinsic insertion loss. VOA loss and pump power can be readjusted if the gain tilt changes due to temperature variations. If necessary, tilt can be re-adjusted to –1.0 dB by changing VOA and pump power for condition 7, 8 and 9 in order to meet the gain variation spec. In that case, the gain variation has to meet the same requirement as specified for conditions 1, 3 and 5.
6	Gain tilt S_{ba_t} is defined as gain slope times 32.3 nm. Gain slope is calculated by performing standard linear regression algorithm on $\{g_j, \lambda_j\}$, where g_j is the signal gain S_{ba} measured at the wavelengths defined in Note 2. Gain tilt shall be set within $\pm$0.1 dB of the specified value.
7	Once S_{g_set} is chosen the same value must be used for condition 1 to 6, 10 and 11. That value is also the reference for the calculation of condition 7, 8, 9 and 12. The resulting target power for S_g shall be set according to the accuracy requested in Note 4. While doing so, the 'S-Band Gain at DCM Output' limit must not be exceeded.
8	Gain variation is defined as the maximum difference of the signal gain values (S_{ba}) measured at wavelengths defined in Note 2. As measured at a tilted condition, the gain values have to be normalized by calculating the difference to a linear line determined with a standard linear regression algorithm. The gain variation is then defined as the maximum divergence of the normalized gain values.
9	Polarization dependent gain (PDG) shall be measured by varying the polarization state of one of the channels while fixing the polarization states of the remaining channels (as defined in Note 2). PDG is the maximum change of the signal gain at the channel whose polarization state is varied. PDG is specified by its mean value and the 99% point of the cumulative distribution. A Gaussian fit of the distribution can be used to predict those values. The distribution should be calculated based on component PDL distributions at each signal wavelength. Hence, it is the distribution at the same wavelength over a number of OAMs and not a distribution over the signal wavelengths for one OAM.
10	Polarization-mode dispersion shall be measured using the Jones Matrix method.
11	There is no pump light going into Port a.
12	Those test conditions shall be met 'by design'. Currently, it is not required to measure them in an outgoing test. Therefore, they are not reported on the data disk described in Section 9A.2.

2A.8 OAM Optical Layout



2B Pump Laser Specification

There are up to six pump lasers in the OAM. This section contains the specification for these 980 nm and 1480 nm lasers. All notes for Table 2B.2 and Table 2B.4 are summarized in section 2B.3.

2B.1 1480 nm Pump Laser Specification

The values shown in Table 2B.1 and Table 2B.2 are applicable over the temperature range according to T_{op} given in Table 2B.1unless otherwise stated.

Table 2B.1: Absolute Maximum Ratings for 1480 nm Pump Lasers

Parameter	*Symbol*	*Condition*	*Limit*		*Unit*
			Min	*Max*	
Operating OAM heat sink average temperature	T_{op}		0	+70	
Storage temperature	T_{stg}		-40	+75	°C
Optical power	P_f		-	1.2 P_{op}	mW
LD reverse voltage	V_r		-	2	V
LD forward current	I_{f_max}		-	800	mA
LD current transient		1 µs maximum	-	1500	mA
PD reverse voltage	V_{PD}		-	20	V
PD forward current	I_{PF}		-	10	mA
Electrostatic discharge (ESD)	V_{ESD}	C = 100 pF, R = 1.5 kΩ, HBM	-	500	V
Cooler current	I_c	Unlimited time	-	1.65	A
		Limited time (Note 14)	-	2.0	A
Cooler voltage	V_c		-	3.5	V

Table 2B.2: Optical and Electrical Characteristics of 1480 nm Pump Lasers

Parameter	*Symbol*	*Condition*	*Limit*		*Unit*
			Min	*Max*	
BEGINNING OF LIFE	**BOL**	**Note 1**			
Laser Submount Temperature	T_{sub}	Definition of T_{set} and T_{sub_max} see Note 2	T_{set}	T_{sub_max}	°C
Operating Forward Current	I_{op}	Note 3		600	mA
Fiber Output Power Range	P_f	$I_{min} \le I_f \le I_{op}$, V_f <2.5V $P_{op} = P_f(I_{op})$ $P_{min} = P_f(I_{min})$ Note 4	P_{min}	P_{op}	mW
Maximum Output Power	P_{max}	Note 5	1.1 P_{op}	-	mW
BOL Threshold Current	$I_{th\text{-}BOL}$	Note 6	-	70	mA
Forward Voltage	V_f	CW, $I_f = I_{op}$,	-	2.5	V
Peak Wavelength	λ_P	$P_{min} \le P_f \le P_{op}$, in normal operation (spliced to OAM)	1455	1490	nm
Optical Power Stability	ΔP_{f_t}	$P_{min} \le P_f \le P_{op}$, I_{BF} = const., T_{sub} = const., ORL as used in application Frequency range = [DC .. 50kHz] Observation time = 10min Note 7	-0.03	0.03	dB
Tracking Ratio	TR_{fb}	Note 8	0.90	1.10	

Tracking Error	TE_{fb}	Note 9	-8	+8	%
Monitor Diode Current	I_{BF}	$P_{min} \leq P_f \leq P_{op}$	5	3000	μA
Monitor Diode Dark Current	I_{dm}	5V reverse bias, over the whole temperature range	-	100	nA
Monitor Diode Capacitance	C_t	5V reverse bias, f = 1MHz	-	15	pF
TEC Cooling Capacity	ΔT_{TEC}	$P_{TEC} \leq 4.0$W $I_f = I_{op}$ Note 15	T_{op_max} - T_{sub_max}	-	K
TEC Current	I_{TEC}	$\Delta T_{TEC} = T_{op\_max} - T_{set}$, at P_{op} Note 15	-	1.5	A
TEC Voltage	V_{TEC}	$\Delta T_{TEC} = T_{op\_max} - T_{set}$, at P_{op} Note 15	-	3.2	V
TEC Power Dissipation	P_{TEC}	$\Delta T_{TEC} = T_{op\_max} - T_{sub\_max}$, at P_{op} Note 15		4.0	W
Thermistor Resistance	R_{th}	T_{set} = 25°C	9.5	10.5	kΩ
Average Thermistor Constant	B_{avg}	Note 10	3400	4100	K
Thermistor Constant	B	Note 10	B_{avg} - 200	B_{avg} + 200	K
END OF LIFE	**EOL**	**Note 11**			
EOL Threshold Current	$I_{th\text{-}EOL}$	Note 6	-	1.2 $I_{th\text{-}BOL}$	mA
Forward Current	I_{op_EOL}	Continuous current to maintain P_{op}, Note 12		1.2 I_{op}	mA
Forward Voltage	V_{f_EOL}	CW, $I_f = I_{op\_EOL}$,	-	3.0	V
Fiber Output Power	P_{f_EOL}		P_{op}		mW
Change in back-facet monitor tracking	ΔTR_{fb}	$P_{min} \leq P_f \leq P_{op}$, *constant* T_{sub},, *constant* T_{case} Note 13	0.95	1.05	
Tracking Error	TE_{fb}		-10	+10	%
Monitor Diode Dark Current	I_{dm_EOL}	5V reverse bias, over the whole temperature range	-	150	nA
TEC Current	I_{TEC_EOL}	$\Delta T_{TEC} = T_{op\_max} - T_{set}$, at P_{op} Note 15	-	1.5	A
TEC Voltage	V_{TEC_EOL}	$\Delta T_{TEC} = T_{op\_max} - T_{set}$, at P_{op} Note 15		3.5	V
TEC Power Dissipation	P_{TEC_EOL}	$\Delta T_{TEC} = T_{op\_max} - T_{sub\_max}$, at P_{op} Note 15		4.4	W
Thermistor	ΔR_{th}	Change in thermistor value relative to BOL value	-5	+5	%

2B.2 980 nm Pump Laser Specification

The values shown in Table 2B.3 and Table 2B.4 are applicable over the temperature range according to T_{op} given in Table 2B.3 unless otherwise stated.

All data related to the back facet monitor diode will also apply to a front facet monitoring scheme, if implemented.

Table 2B.3: Absolute Maximum Ratings for 980 nm Pump Lasers

Parameter	*Symbol*	*Condition*	*Limit*		*Unit*
			Min	*Max*	
Operating OAM heat sink average temperature	T_{op}		0	+70	°C
Storage temperature	T_{stg}		-40	+75	°C
Optical power	P_f		-	1.2 P_{op}	mW
LD reverse voltage	V_r		-	2	V
LD forward current	$I_{f\ max}$		-	500	mA
LD current transient		1 µs maximum	-	1000	mA
PD reverse voltage	V_{PD}		-	15	V
PD forward current	I_{PF}		-	10	mA
Electrostatic discharge (ESD)	V_{ESD}	C = 100 pF, R = 1.5 kΩ, HBM	-	500	V
Cooler current	I_c	Unlimited time	-	1.65	A
		Limited time (Note 14)	-	2.0	A
Cooler voltage	V_c		-	3.5	V

Table 2B.4: Optical and Electrical Characteristics of 980 nm Pump Lasers

Parameter	*Symbol*	*Condition*	*Limit*		*Unit*
			Min	*Max*	
BEGINNING OF LIFE	**BOL**	**Note 1**			
Laser Submount Temperature	T_{sub}	Definition of T_{set} and T_{sub_max} see Note 2	T_{set}	T_{sub_max}	°C
Operating Forward Current	I_{op}	Note 3		360	mA
Fiber Output Power Range	P_f	$I_{min} \le I_f \le I_{op}$, V_f <2.5V $P_{op} = P_f(I_{op})$ $P_{min} = P_f(I_{min})$ Note 4	P_{min}	P_{op}	mW
Maximum Output Power	P_{max}	Note 5	1.1 P_{op}	-	mW
BOL Threshold Current	$I_{th\text{-}BOL}$	Note 6	-	40	mA
Forward Voltage	V_f	CW, $I_f = I_{op}$,	-	2.5	V
Peak Wavelength	λ_P	$P_{min} \le P_f \le P_{op}$, in normal operation (spliced to OAM)	972	985	nm
Optical Power Stability	ΔP_{f_t}	$P_{min} \le P_f \le P_{op}$, I_{BF} = const., T_{sub} = const., ORL as used in application Frequency range = [DC .. 50kHz] Observation time = 10min Note 7	-0.075	0.075	dB
Tracking Ratio	TR_{fb}	Note 8	0.9	1.1	
		Note 8, P_f < 20 mW	0.8	1.2	
Tracking Error	TE_{fb}	Note 9	-8	+8	%
Monitor Diode Current	I_{BF}	$P_{min} \le P_f \le P_{op}$	5	3000	µA

Monitor Diode Dark Current	I_{dm}	5V reverse bias, over the whole temperature range	-	50	nA
Monitor Diode Capacitance	C_t	5V reverse bias, f =1MHz	-	10	pF
TEC Cooling Capacity	ΔT_{TEC}	$P_{TEC} \leq$ 4.0W $I_f = I_{op}$ Note 15	T_{op_max} - T_{sub_max}	-	K
TEC Current	I_C	$\Delta T_{TEC} = T_{op\_max} - T_{set}$, at P_{op} Note 15	-	1.5	A
TEC Voltage	V_C	$\Delta T_{TEC} = T_{op\_max} - T_{set}$, at P_{op} Note 15	-	3.2	V
TEC Power Dissipation	P_{TEC}	$\Delta T_{TEC} = T_{op\_max} - T_{sub\_max}$, at P_{op} Note 15		4.0	W
Thermistor Resistance	R_{th}	T_{set} = 25°C	9.5	10.5	kΩ
Average Thermistor Constant	B_{avg}	Note 10	3400	4100	K
Thermistor Constant	B	Note 10	B_{avg} - 200	B_{avg} + 200	K
END OF LIFE	**EOL**	**Note 11**			
EOL Threshold Current	$I_{th\text{-}EOL}$	Note 6	-	1.2 $I_{th\text{-}BOL}$	mA
Forward Current	I_{op_EOL}	Continuous current to maintain P_{op}, Note 12		1.2 I_{op}	mA
Forward Voltage	V_{f_EOL}	CW, $I_f = I_{op\_EOL}$,	-	3.0	V
Fiber Output Power Range	P_{f_EOL}		P_{op}		mW
Change in back-facet monitor tracking	ΔTR_{fb}	$P_{min} \leq P_f \leq P_{op}$, *constant* T_{sub},, *constant* T_{case} Note 13	0.95	1.05	
Tracking Error	TE_{fb}		-10	+10	%
Monitor Diode Dark Current	I_{dm_EOL}	5V reverse bias, over the whole temperature range	-	100	NA
TEC Current	I_{TEC_EOL}	$\Delta T_{TEC} = T_{op\_max} - T_{set}$, at P_{op} Note 15	-	1.5	A
TEC Voltage	V_{TEC_EOL}	$\Delta T_{TEC} = T_{op\_max} - T_{set}$, at P_{op} Note 15		3.5	V
TEC Power Dissipation	P_{TEC_EOL}	$\Delta T_{TEC} = T_{op\_max} - T_{sub\_max}$, at P_{op} Note 15		4.4	W
Thermistor	ΔR_{th}	change in thermistor value relative to BOL value	-5	+5	%

2B.3 Table Notes for 1480 nm and 980 nm Pump Specifications

Note 1 Except where other conditions are specified, all measurements at BOL shall be taken at T_{set}, case temperature at 40°C and at P_{op}.

Note 2 The nominal chip set temperature (T_{set}) has to be 25 ±2°C and the maximum chip temperature T_{sub_max} for each pump laser is 37°C. The laser chip temperature is allowed to rise to T_{sub_max}, if the maximum power dissipation of the TEC is reached. At this higher temperature the OAM performance specification must still be satisfied. The pump laser FIT-value shall not be increased by more than 200 FIT per 1480 nm pumps and 100 FIT per 980 nm pumps, respectively, based on 600 hours per year at T_{OP} greater than 60°C.

Note 3 The operating current (I_{op}) is the pump laser forward current (I_f) required by Condition 6 in Table 2A.3.

Note 4 Defined as the pump power and the corresponding forward current to satisfy Condition 7 in Table 2A.4.

Note 5 A kink is a discontinuity in the L-I-curve of the pump laser. Kinkfree operation means that the first derivation of the L-I-curve is not lower than half and not greater than twice the BOL value at the specified nominal operating point.

$$0.5 \cdot \frac{\partial P_f}{\partial I_f} \le \frac{\partial}{\partial I_f} P_f(I_{OP}) \le 2 \cdot \frac{\partial P_f}{\partial I_f}$$

The failure rate of the laser diode operating at P_{kink} should not exceeding two times the rate specified for P_{op}.

Note 6 Threshold current is defined as the laser bias current at which the derivative of fiber output power (P_f) versus forward current (I_f) or dP_f/dI_f curve attains half its maximum value.

Note 7 The power stability is defined as the peak-to-peak change in output power over time at a constant back-facet current, a constant thermistor resistance and an certain optical return loss. P_f shall be measured in a frequency range from DC to 50kHz over a period of 10 minutes in a time-based measurement.

Note 8 The Tracking Ratio is a measure of the front-to-back tracking when the output power is varied. On a plot of optical power versus back-facet photo current, a straight line is drawn between the minimum power P_{min} and the operating power P_{op} points. A linear fit through all points between P_{min} and the operating power P_{op} as a reference is also allowed. The tracking ratio is defined as the ratio between measured optical power (shown as data points on the plot) to the value derived from the straight line.

Note 9 The Tracking Error is defined as the normalized change of output power relative to P_{op} , i.e., $(P_f - P_{op})/P_{op}$, over case temperature range 0°C to 75°C, at constant back-facet monitor current corresponding to $P_f = P_{op}$ at 25°C.

Note 10 Definition of the thermistor constant *B*.

$$B = \left(-\frac{T^2}{R_{th}}\right) * \left(\frac{dR_{th}}{dT}\right)$$

with B = Thermistor constant [K]
T_{sub} = temperature of thermistor [°C]
$T = T_{sub} + 273.15$ K
R_{th} = Thermistor resistance
dR_{th}/dT = the first derivation of the R_{th} –T-curve

The average thermistor constant B_{avg} is defined as the mean value of a distribution of B from a specific pump laser with a lot size not smaller than 100. The actual thermistor constant has to be in the specified range relative to the average value.

Note 11 End of life shall have occurred when any of the EOL specifications are exceeded.

Note 12 It is allowed to specify the $I_{op\_EOL} = 1.1\ I_{op}$ if the pump laser fulfills the reliability requirements. In this case, the BOL current can be higher than the specified value, but the specified EOL current must not exceed 720mA.

Lucent limits the pumplaser current to $I_f = I_{op\_EOL} \pm 2\%$. Within the +2% guardband the specification for kinkfree operation is relaxed and the derivation might change by more than specified in Note 5 down to 10% of the BOL value for the slope at the specified nominal operating point.

Note 13 The change of the front-to-back-facet monitor tracking is defined as the ratio between EOL measured optical power to the BOL measured optical power at the same back-facet monitor photo current. The ratio has to be determined between P_{min} and P_{op} at each data point.

Note 14 The cooler is operated in a closed loop. Hence the time, the maximum TEC current applies, depends on the thermal time constant of the module and the interworking with the control circuitry on the optical amplifier circuit pack. The cooler shall withstand a peak current as given in the table. The duration will be defined separately for the different pump laser modules.

Note 15 T_{op_max} is the maximum operating OAM heat sink average temperature defined in Table 2B.1 and Table 2B.3, respectively. It is used here as reference rather than the actual pump laser case temperature. The case temperature can be calculated by adding the temperature difference, which is caused by the thermal resistance between the heat sink and the pump laser case. It might also be necessary to take an unequal distribution of the heat sink temperature over the heat sink into account.

2C Variable Optical Attenuator Specification

There is one Variable Optical Attenuator in the OAM. This section contains the specification for this device. Only parameters which affect the interface of the VOA and which could affect control algorithms used by Lucent are specified. All notes for Table 2C.1 and Table 2C.2 are summarized in 2C.3 Table Notes for VOA Specifications.

This specification is written for step motor driven VOAs. Other qualified technologies may be used. If another technology shall be used, this specification will be revised in order to cover the new requirements.

2C.1 General Requirements

Lucent requires that a step motor driven VOA is equipped with a device that senses the position of the attenuation device inside the VOA, preferably a potentiometer connected directly to the moving part of the mechanism. Therefore, the readout of this device can be used to determine the corresponding attenuation by use of a calibration table. The readout can also be used to determine if the step motor operates when the VOA is actuated.

Lucent requires that the VOA can be driven to 25 end-of-travel steps for a minimum of 100 times.

Lucent requires that the VOA used for VOA group 1 can be switched to a 'reduced-power' mode, i.e. to a lower hold current when the step motor is not actuated.

The VOA used for VOA group 2 falls automatically into a 'reduced power' mode after a defined delay. The OAM should be equipped with a switch in order to enable/disable the feature. There is no signal pin at the connector, which controls the 'reduced-power' mode. The switch shall be set as defined by Lucent.

2C.2 Characteristics

The values shown in Table 2C.1 and Table 2C.2 are applicable over the temperature range according to T_{op} given in Table 2C.1 unless otherwise stated.

Table 2C.1: Absolute Maximum Ratings for VOA

Parameter	Symbol	*Condition*	Limit		Unit
			Min	*Max*	
Operating OAM heat sink average temperature	T_{op}		0	+70	°C
Storage temperature	T_{stg}		-40	+75	°C
Potentiometer Voltage	V_{pot_max}	Note 1		10	V
Wiper Current	I_{wip_max}	Note 1	-	1	mA
Coil Current	I_{coil_max}	limited time, Note 1 & Note 10	-	400	mA
Electrostatic discharge (ESD)	V_{ESD}	C = 100 pF, R = 1.5 kΩ, HBM	-	500	V

Table 2C.2: VOA Characteristics					
Parameter	*Symbol*	*Condition*	*Limit*		*Unit*
			Min	*Max*	
Attenuation range	$\Delta\alpha$	without insertion loss	15	-	dB
Attenuation resolution	α_{step}	full step or INC/DEC mode		0.1	dB
		full step or INC/DEC mode, over attenuation range $\Delta\alpha$		750	steps/ $\Delta\alpha$
Potentiometer voltage range	ΔV_{pot}	over $\Delta\alpha$ 5V applied across the potentiometer, see Note 2	2.0	-	V
Maximum readout voltage	$V_{pot,max}$	At end of attenuation range $\Delta\alpha$		4.9	V
Change in readout voltage for 3 sets of 5 steps accumulative		Either full or half step mode as indicated by the ID bits	10		mV
Backlash	$\Delta\alpha_{blash}$	see Note 3	-0.2	0.2	dB
Repeatability	$\Delta\alpha_{rep}$	see Note 4	-0.1	0.1	dB
Adjustment speed	v_{adj}	VOA Group 1: in full step mode	500		steps/ sec
		VOA Group 2: INC/DEC mode			
Latching	α_{lash}	see Note 5	-0.2	0.2	dB
Coil current	I_{coil}	VOA actuated, min. current to move stepper motor, Note 1	170		mA
Coil voltage	V_{coil}	VOA actuated, Note 1	3.0	3.6	V
Coil Resistance	R_{coil}		14	18	Ω
Coil Inductance	L_{coil}			10	mH
Static coil current	I_{coil_stat}	VOA not actuated, Note 1& 6	30	40	mA
Change of attenuation due to current switching	$\alpha_{switch1}$	VOA Group 1, See Note 7	-0.1	0.1	dB
Change of attenuation while going to 'reduced power' mode	$\alpha_{switch2}$	VOA Group 2, See Note 8	-0.1	0.1	dB
Look-up table inaccuracy	$\Delta\alpha_{lookup}$	See Note 9, includes the uncertainty due to backlash	-0.5	0.5	dB

2C.3 Table Notes for VOA Specifications

Note 1 Does not apply if the VOA is connected to VOA Group 2

Note 2 ΔV_{pot} is the voltage difference between the potentiometer wiper VOA(W) and the negative potentiometer port VOA(L), when +5V is applied between the positive and the negative potentiometer ports. The maximum attenuation corresponds to the maximum ΔV_{pot}. The values given in the look-up table (SECTION 9: , Table 13) should be normalized to exactly +5.00V applied between VOA(H) and VOA(L) or at VCC(+5).

This specification also applies to the readout used in VOA Group 2 with the exception that the readout VOUT shall be independent on the applied voltage at VCC(+5).

Note 3 Difference in attenuation on return to a particular attenuation from a random location. Where the potentiometer voltage or the voltage readout, respectively, is a measure for the attenuation. Temperature dependent and aging effects are excluded.

Note 4 Difference in attenuation on return to a particular attenuation from a random location approaching from the original direction. Where the potentiometer voltage or the voltage readout, respectively, is a measure for the attenuation. Temperature dependent and aging effects are excluded.

Note 5 Change in attenuation when the power to the motor is turned off.

Note 6 The coil current is reduced in order to reduce the power dissipation when the VOA is not moving ('reduced-power' mode).

Note 7 $\alpha_{switch1}$ is defined as the change in attenuation when the coil current limit is switched from I_{coil} to I_{coil_stat} or vice-versa, i.e. switching 'reduced-power' mode on or off, respectively.

Note 8 $\alpha_{switch2}$ is defined as the change in attenuation when the VOA automatically falls into the 'reduced-power' mode. This specification applies to VOA Group 2.

Note 9 The look-up table inaccuracy includes backlash, degradation in the potentiometer and wear-out of the mechanical moving mechanism, etc. The difference between the reported values in the look-up table and the actual attenuation must not be greater than the specified limit over lifetime, i.e. this item is an end-of-life specification.

Note 10 While the coils should withstand a peak current as given in the table, the duty cycle is limited to 5 sec in 1minute period, not to exceed the power dissipation limit. That limit is defined to 1.9 W up to 40°C, and has to be reduced with 2%/°C above.

2D Electrical Specification

All electrical connections shall be made through a pair of 60 pin connectors with the relative pin locations shown in the following tables. The connectors shall be compatible with our part number: 69154-630. Specifications for each connection follow below. It should be noted, that while individual specifications allow for considerable power dissipation, the total power delivered for all connections shall not exceed 30 W over the entire operating temperature range at EOL parameters as noted in the Environment Test Specifications in Section 5. During the initial start-up procedure the power dissipation is allowed to exceed the 30 W limit (see also 2D.4).

2D.1 Pinning

Table 2D.1: Pin Definition for Connector 1

Pin	*Connection*	*Component*	Pin	*Connection*	*Component*
1	NA		60	NA	
2	+5 Volts	Plus 5V OAM Power Supply	59	-5 Volts	Minus 5V OAM Power Supply
3	GND	Ground	58	GND	Ground
4	GND	Pump Laser 3 GND, Laser Diode Anode, Thermistor Return	57	LBIAS3	Pump Laser 3 Laser Diode Cathode
5	BFMA3	Pump Laser 3 Backfacet Monitor Anode	56	BFMC3	Pump Laser 3 Backfacet Monitor Cathode
6	GND	Pump Laser 3 GND, Laser Diode Anode, Thermistor Return	55	THER3	Pump Laser 3 Thermistor
7	TECP3	Pump Laser 3 TEC Plus	54	TECP3	Pump Laser 3 TEC Plus
8	TECM3	Pump Laser 3 TEC Minus	53	TECM3	Pump Laser 3 TEC Minus
9	NA		52	NA	
10	Thermistor1B	2nd Thermistor for Auxiliary Heater 1	51	Thermistor1BRTN	2nd Thermistor Return for Auxiliary Heater 1
11	Thermistor1A	1st Thermistor for Auxiliary Heater 1	50	Thermistor1ARTN	1st Thermistor Return for Auxiliary Heater 1
12	Heater1P	Heater 1 Plus	49	Heater1M	Heater 2 Minus
13	NA		48	NA	
14	GND	Pump Laser 2 GND, Laser Diode Anode, Thermistor Return	47	LBIAS2	Pump Laser 2 Laser Diode Cathode
15	BFMA2	Pump Laser 2 Backfacet Monitor Anode	46	BFMC2	Pump Laser 2 Backfacet Monitor Cathode
16	GND	Pump Laser 2 GND, Laser Diode Anode, Thermistor Return	45	THER2	Pump Laser 2 Thermistor
17	TECP2	Pump Laser 2 TEC Plus	44	TECP2	Pump Laser 2 TEC Plus
18	TECM2	Pump Laser 2 TEC Minus	43	TECM2	Pump Laser 2 TEC Minus
19	NA		42	NA	
20	VOAStep4	VOA Step Motor	41	VOARTN	VOA Return
21	VOAStep3	VOA Step Motor	40	VOA(H)	VOA Potentiometer High
22	VOAStep2	VOA Step Motor	39	VOA(L)	VOA Potentiometer Low
23	VOAStep1	VOA Step Motor	38	VOA(W)	VOA Potentiometer Wiper
24	NA		37	NA	
25	GND	Pump Laser 1 GND, Laser Diode Anode, Thermistor Return	36	LBIAS1	Pump Laser 1 Laser Diode Cathode
26	BFMA1	Pump Laser 1 Backfacet Monitor Anode	35	BFMC1	Pump Laser 1 Backfacet Monitor Cathode
27	GND	Pump Laser 1 GND, Laser Diode Anode, Thermistor Return	34	THER1	Pump Laser 1 Thermistor
28	TECP1	Pump Laser 1 TEC Plus	33	TECP1	Pump Laser 1 TEC Plus
29	TECM1	Pump Laser 1 TEC Minus	32	TECM1	Pump Laser 1 TEC Minus
30	NA		31	NA	

Table 2D.2: Pin Definition for Connector 2

Pin	*Connection*	*Component*	*Pin*	*Connection*	*Component*
1	NA		60	NA	
2	ID3	Identification	59	ID7	Identification
3	ID2	Identification	58	ID6	Identification
4	ID1	Identification	57	ID5	Identification
5	ID0	Identification	56	ID4	Identification
6	GND	Ground	55	NA	
7	TECM6	Pump Laser 6 TEC Minus	54	TECM6	Pump Laser 6 TEC Minus
8	TECP6	Pump Laser 6 TEC Plus	53	TECP6	Pump Laser 6 TEC Plus
9	THER6	Pump Laser 6 Thermistor	52	GND	Pump Laser 6 GND, Laser Diode Anode, Thermistor Return
10	BFMC6	Pump Laser 6 Backfacet Monitor Cathode	51	BFMA6	Pump Laser 6 Backfacet Monitor Anode
11	LBIAS6	Pump Laser 6 Laser Diode Cathode	50	GND	Pump Laser 6 GND, Laser Diode Anode, Thermistor Return
12	TECM5	Pump Laser 5 TEC Minus	49	TECM5	Pump Laser 5 TEC Minus
13	TECP5	Pump Laser 5 TEC Plus	48	TECP5	Pump Laser 5 TEC Plus
14	THER5	Pump Laser 5 Thermistor	47	GND	Pump Laser 5 GND, Laser Diode Anode, Thermistor Return
15	BFMC5	Pump Laser 5 Backfacet Monitor Cathode	46	BFMA5	Pump Laser 5 Backfacet Monitor Anode
16	LBIAS5	Pump Laser 5 Laser Diode Cathode	45	GND	Pump Laser 5 GND, Laser Diode Anode, Thermistor Return
17	Thermistor2B	2nd Thermistor for Auxiliary Heater 2	44	Thermistor2BRTN	2nd Thermistor Return for Auxiliary Heater 2
18	Thermistor2A	1st Thermistor for Auxiliary Heater 2	43	Thermistor2ARTN	1st Thermistor Return for Auxiliary Heater 2
19	Heater2P	Heater 2 Plus	42	Heater2M	Heater 2 Minus
20	VOA_RTN	Analog Ground, Note 1	41	GND	Ground
21	VCC (+5)	VOA Control	40	VSS (-5)	VOA Control
22	GND	Ground	39	GND	Ground
23	RST	VOA Control, Note 2	38	VOUT	VOA Control
24	INC	VOA Control	37	DEC	VOA Control
25	TECM4	Pump Laser 4 TEC Minus	36	TECM4	Pump Laser 4 TEC Minus
26	TECP4	Pump Laser 4 TEC Plus	35	TECP4	Pump Laser 4 TEC Plus
27	THER4	Pump Laser 4 Thermistor	34	GND	Pump Laser 4 GND, Laser Diode Anode, Thermistor Return
28	BFMC4	Pump Laser 4 Backfacet Monitor Cathode	33	BFMA4	Pump Laser 4 Backfacet Monitor Anode
29	LBIAS4	Pump Laser 4 Laser Diode Cathode	32	GND	Pump Laser 4 GND, Laser Diode Anode, Thermistor Return
30	NA		31	STATUS	Status Bit, Note 3

Note 1 The analog ground is separated from the digital ground and tied at a common single point close to the power supply. Pin 20 is used as analog ground.

Note 2 If not used it should be not connected.

Note 3 Currently, not used and therefore not connected.

2D.2 Pump Laser Interface

The pump laser interface is specified in section 2B and the following table.

Table 2D.3: Pump Laser Connection Specifications		
Characteristics	*Pin*	*Limitations*
Maximum TEC Current	TECP[1:6] TECM[1:6]	≤ 1.65 A unlimited time ≤ 2.0 A for limited time as defined in Note 14 of Section 2B: Pump Laser Specification
Ripple on TEC current	TECP[1:6] TECM[1:6]	≤ 200 mAp-p

2D.3 Variable Optical Attenuator Interface

The VOA interface facilitates both control of the OAM built-in Variable Optical Attenuator and monitoring of the VOA's set position via a potentiometer. Two different VOA interfaces are defined:

- **VOA Group 1** is a interface with direct access to a step motor driven VOA
- **VOA Group 2** is a more general interface that assumes that the VOA driver is part of the OAM. This interface could also be used to control a VOA other than a step motor driven VOA.

The vendor can choose one of these interfaces for implementation. The corresponding group has to be indicated in the accompanied data (see Section SECTION 9: , Table 13: VOA Calibration Table). The unused group shall be treated as not connected.

The VOA interfaces are specified in section 2C and the following sections.

2D.3.1 VOA Group 1

In VOA Group 1 the connections to the step motor are defined by the driver IC used, i.e. Motorola SAA1042 or a compatible device. Refer to Motorola SAA1042 datasheet revision 2.

Table 2D.4: VOA Group 1 Connection Specifications		
Characteristics	*Pin*	*Limitations*
Step Motor see Note 1	VOAStep1	Connected to SAA1042 Pin 3
	VOAStep2	Connected to SAA1042 Pin 1
	VOAStep3	Connected to SAA1042 Pin 14
	VOAStep4	Connected to SAA1042 Pin 16
Potentiometer	VOA(W) VOA(H) VOA(L)	See Section 2C.2
VOA Ground Connection	VOARTN	

Note 1 The motor coils shall be configured such that the VOA will increase optical attenuation while pin 10 of SAA1042 is held low when actuating the step motor.

2D.3.2 VOA Group 2

Table 2D.5: VOA Group 2 Connection Specifications		
Characteristics	*Pin*	*Limitations*
Increment Attenuation	INC	TTL-Signal level, Minimum pulse width 50 µs, Negative going pulse increments attenuation Logic High in steady state,
Decrement Attenuation	DEC	TTL-Signal level, Minimum pulse width 50 µs Negative going pulse decrements attenuation Logic High in steady state
Reset VOA	RST	TTL-Signal level, Minimum pulse width 50 µs, Negative going pulse resets VOA Logic High in steady state Set VOA to minimum attenuation position If not used expected to be not connected
Time between last pulse and power save mode		$3s \leq \Delta t_{powersave} \leq 5s$ see Note 1
Readout Voltage	VOUT	See Section 2C.2, ΔV_{pot} , $I_{VOUT} \leq 100\ \mu A$
Analog Ground	RTN	Shall be used as readout return
+5V Power Supply Voltage for VOA	VCC(+5)	+5V +/-0.25V
Maximum Current at +5V Power Supply for VOA		≤ 250mA
-5V Power Supply Voltage for VOA	VSS(-5)	-5V +/-0.25V
Maximum Current at -5V Power Supply for VOA		≤ 250mA

Note 1 The ‘reduced -power’ mode shall be activated 4 seconds after the last pulse on pin INC or DEC, respectively. ‘Reduced-Power’ mode has to be turned off instantaneously without suppressing pulses on INC or DEC.

2D.4 Heater Interface

Table 2D.6: Heater Connection Specifications		
Characteristics	*Pin*	*Limitations*
Maximum Heater[1:2] Voltage	Heater1P Heater1M Heater2P Heater2M	≤ 4 V ≤ 5 V during initial startup See Note 1
Maximum Heater[1:2] Current	Heater1P Heater1M Heater2P Heater2M	≤ 2 A unlimited time ≤ 3 A as maximum rating until thermistor set point is reached, Note 1
Ripple on heater current	Heater[1:2]P Heater[1:2]M	≤ 200mAp-p
Temperature Sensors for Heater[1:2]	Thermistor1A Thermistor1ARTN Thermistor1B Thermistor1BRTN Thermistor2A Thermistor2ARTN	Two thermistor connections are provided for each heater. If merely one is used, an open circuit should replace the other.

	Thermistor2B Thermistor2BRTN	
Thermistor Resistance		10+/-1kΩ @ 65°C, see Note 2
Thermistor Constant	*B*	3500 K ≤ B ≤ 4100 K
Thermistor Set Point	aux_therm_res	≥ 7 kΩ, as reported on data disk in Table 2 (refer to 9A.2.2 Table 2: Auxiliary Heater Thermistor Values)
Isolation between Heater*x* and Thermistor*ny*		≥ 10°C, see Note 2

Note 1 The module is expected to reach the set point, reflected by the thermistor resistance, within this initial start-up interval of max. 10min.

Note 2 The isolation between heater*x* and thermistor*ny* is defined as the temperature difference between thermistor nx and thermistor ny at 25ºC heat sink temperature and thermistor nx at target temperature. Only heater*x* is turned on, i.e. heater*y* is off.

2D.5 Definition of Identification Bits and Status Bit

The ID bits are 'hard-coded' bits, which provide information about the OAM vendor, the functionality, and the VOA operating mode. As there is a pull-up resistor on the PCB an ID bit should not be connected to indicate logic 'HIGH' and be shorted to ground to indicate a logic 'LOW' reading.

The status bit is a flag which will be checked from the PCB periodically and can be used to report a changing status of the OAM.

Table 2D.7: Identification Bits and Status Bit Specifications

Connections	*Description*	*Setting*
ID[0:2]	Vendor identification	Supplier identifier (will be assigned by Lucent) Default is open circuit
ID[3] ID[4] ID[5] ID[6] See Note 1	Functionality	Open circuit Open circuit Open circuit Open circuit
ID[7] See Note 2	Full step table	Open circuit (Default)
	Half step table	Ground
STATUS See Note 3	Status bit	TTL-Signal level Functionality t.b.d.

Note 1 These four ID bits indicate the functionality of the OAM. There might be other OAMs with differences in their characteristic compared with a 400G functionality but used on the same circuit pack design.

Note 2 This ID bit indicates whether Table 13: VOA Calibration Table in SECTION 9: is taken by driving the VOA of Group 1 in full step mode or in half step mode and how the VOA has to be operated.
INC/DEC operation mode of VOA Group 2 is defined as full step mode.

Note 3 Currently not used and therefore not connected.

2D.6 Power Supply

Table 2D.8: Power Supply Connection Specifications		
Characteristics	*Pin*	*Limitations*
+5V Power Supply Voltage	+5 Volts	+5V +/-0.25 V
Maximum Current at +5V Power Supply	+5 Volts	≤ 250 mA
-5V Power Supply Voltage	-5 Volts	-5V +/-0.25 V
Maximum Current at -5V Power Supply	-5 Volts	≤ 250 mA

2E OAM Control requirements

This section defines the requirements on the data that shall be reported in order to adjust the pump laser to meet the specified performance.

2E.1 Stage Assignmet

The OAM is divided in two stages: stage one between port a and g, stage two between port h and b, respectively.

The pump lasers shall be assigned to either of these stages (refer to section 9A.2.21 on how the assignment shall be reported).

2E.2 Requirements on reported Data

Since the pump lasers have to be adjusted for a particular operating point, two tables have to be reported where the pump laser back-facet and bias currents for different input- and output power conditions are given (see sections 9A.2.9 and 9A.2.11 for more details). These tables will be used as look-up tables in the adjustment routine.

It is required that the reported data fulfill the following requirement for all pump lasers:

$$1\mu\mathrm{A} \le I_{BF}(i+1) - I_{BF}(i)$$

$I_{BF}(i)$ is the pump laser back-facet current from sections 9A.2.9 and 9A.2.11, respectively. It says that two consecutive table entries shall have at least a difference of 1µA.

Exception:

It is allowed that one pump laser of the second stage has a slope of zero, but only between the last four entries of Table 9A.1: Test Condition A and Table 9A.2: Test Condition B, respectively.

In addition to these requirements, any adjustment procedure has to be approved by Lucent Technologies.

SECTION 3: PHYSICAL DIMENSIONS AND MECHANICAL SPECIFICATIONS

3A Component Case and Footprint Specifications

The OAM shall be supplied mounted on a heat sink which includes the mounting standoffs and the faceplate mounting blocks as shown in Figure 3A-2. Maximum dimensions for the OAM are given in Figure 3A-3. The details of the heat sink, the standoff and the faceplate mounting block as well as the location of the headers used for the electrical connections are described below.

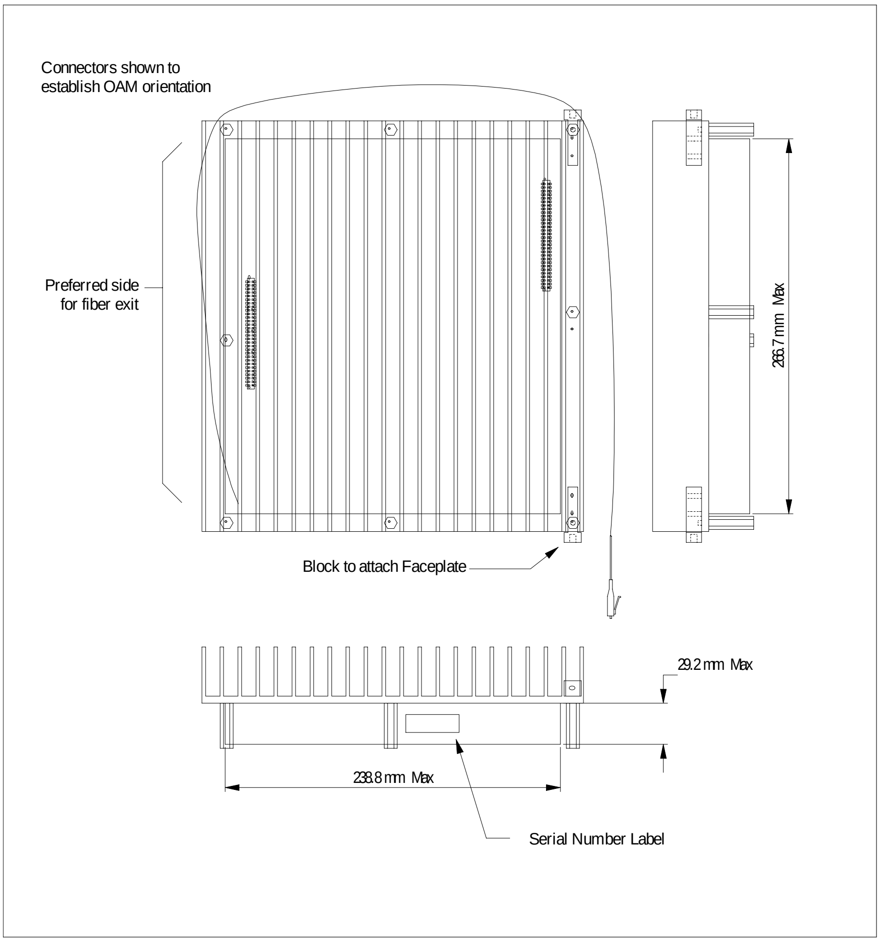


Figure 3A-1

Figure 3A-2 specifies the maximum height of the OAM housing as 29.2mm. If the height, H, as shown in Figure 3A-2 is greater than 28.6mm then clearance slots identified as “Slot B” in Figure 3A-2 are required. These slots are necessary to allow clearance for various through hole leads which are on the Lucent printed wiring board. Slots identified as “Slot A”, are the clearance slots associated with the electrical connectors for the OAM. Slots may extend to boundary of housing if necessary to accommodate the bending of the housing sides. If the height, H is less than 28.6 mm, then the size of the opening of slot A need only be large enough to provide clearance for the electrical header as located in Figure 3A.6.

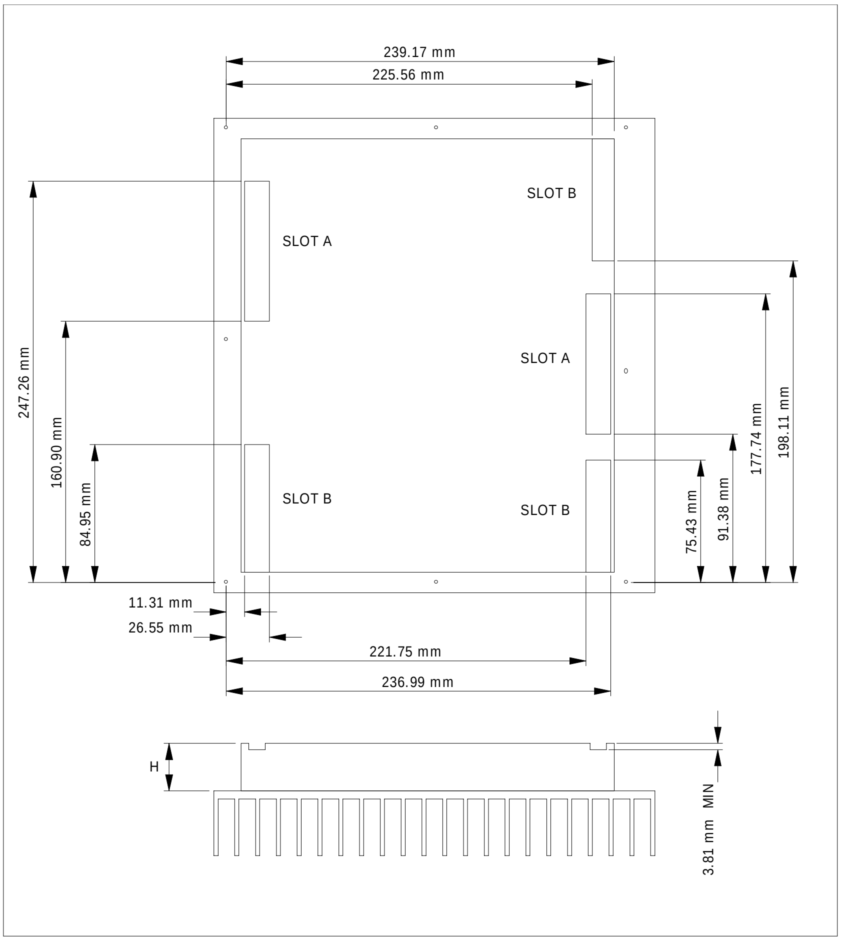


Figure 3A-2

Dimensional details of the heat sink are given in Figure 3A-3. The material for the heat sink shall be aluminum alloy, 6061-T6 ASTM B211 if machined or 6063-T6 ASTM B221 if extruded and shall be cleaned using an alkali etch. If an anodized finish is used it shall be clear. The eight standoffs shall be attached to the heat sink located as shown in Figure 3A.1 and are described as follows: Male/Female standoff stainless steel type 303 hex material. The threads are to be M3x0.5 and the length is to be 32 mm ± 0.1. The flat to flat dimension is to be 8 mm (5/16 inch hex rod may be used in place of the 8 mm).

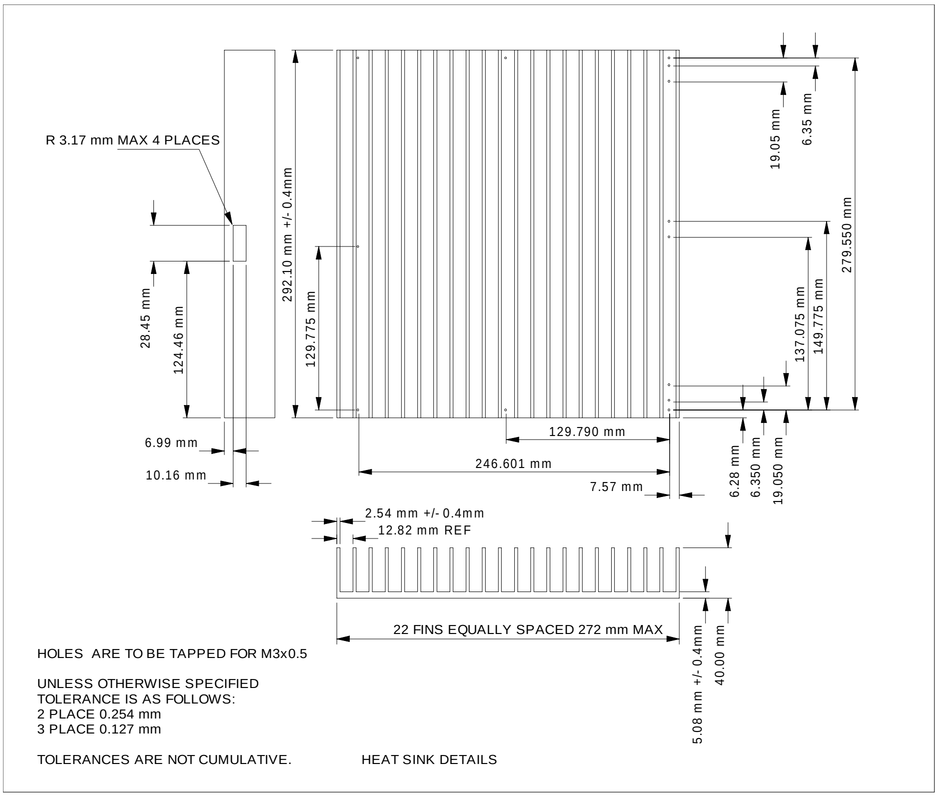


Figure 3A-3

Figure 3A-4 shows the faceplate mounting block details. The material shall be Celcon or an approved equivalent.

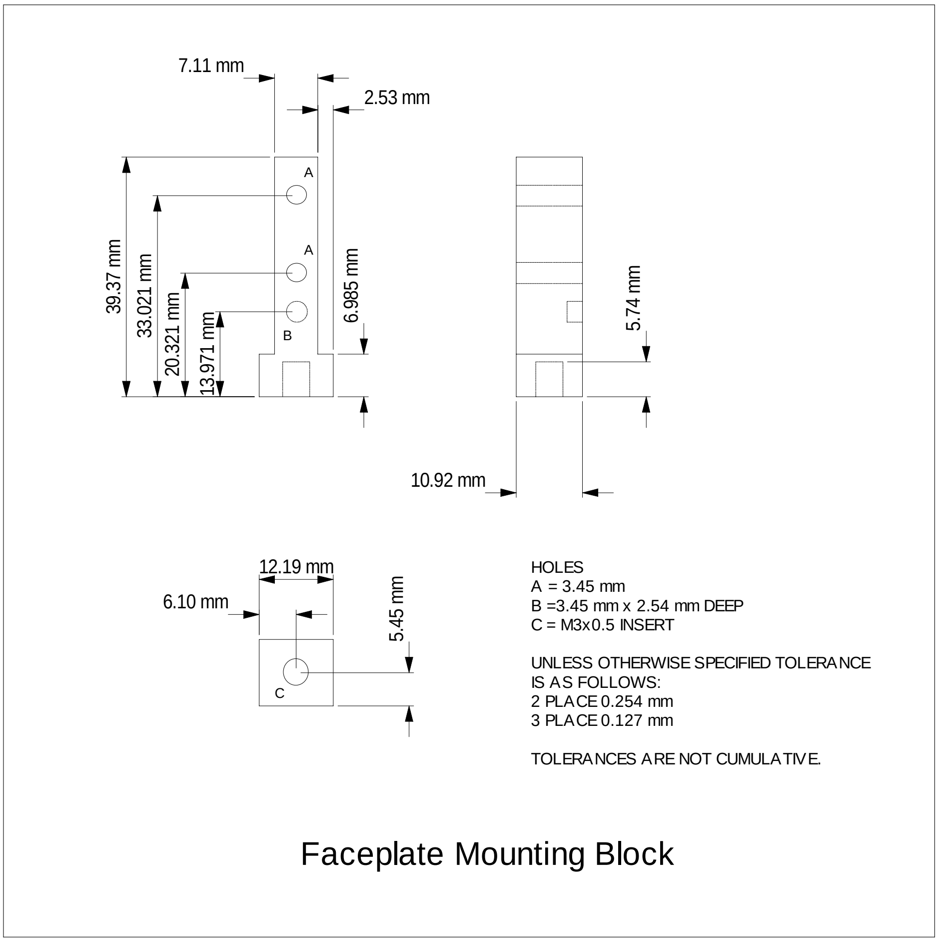


Figure 3A-4

Table 3A.1 lists the fiber designations, the identification label and the connector type as used on the OAM.

The length of the fiber listed in the table below is given from a point (point A) to the end of the connector (point B). Refer to Figure 3A-5 for details. This is to allow the fiber to exit from various places on the OAM and be long enough to reach the required termination point. The fiber shall be contained to a route around the body of the OAM so that the route does not extend beyond the boundary of the heat sink. This may be accomplished by using clips or tubing to constrain the fiber.

Table 3A.1: Fiber Designations, Identification Label and Connector Type

Functional Designation	*Label Near Connector*	*Connector Type*	*Length from Point A to Point B* (See Figure 3)
Line Out	B	LC	765 ± 25mm
Line In	A	LC	765 ± 25mm
Supv Drop I	C	LC	765 ± 25mm
Supv Add	E	LC	765 ± 25mm
DCM In	H	LC	765 ± 25mm
DCM Out	G	LC	765 ± 25mm
Input Monitor I	I	LC	765 ± 25mm
Output Monitor I	P	LC	765 ± 25mm
Output Monitor III	N	LC	765 ± 25mm
Supv Drop II	D	ST	765 ± 25mm
Supv Verif	F	ST	765 ± 25mm
Output Monitor II	O	ST	765 ± 25mm
DCM Power Monitor	M	ST	765 ± 25mm
Input Monitor II	K	ST	765 ± 25mm

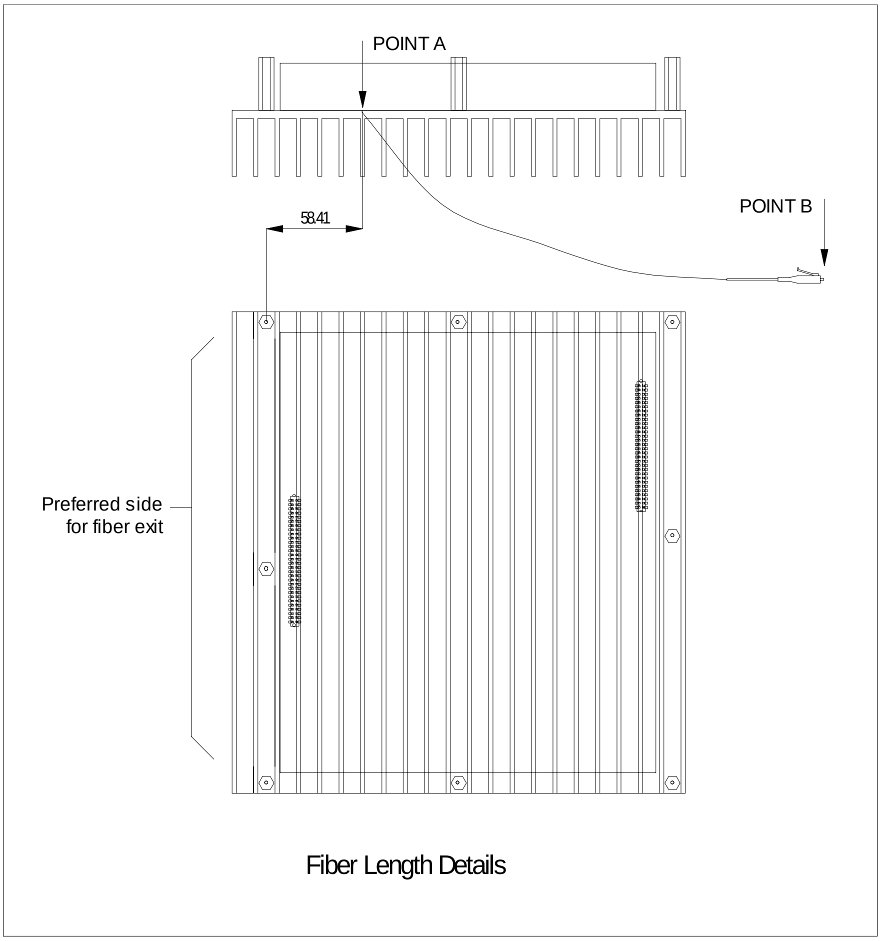

POINT A
POINT B
58.41
Preferred side
for fiber exit
Fiber Length Details

Figure 3A-5

Figure 3A-6 shows the location of the center of pin 1 of each connector.

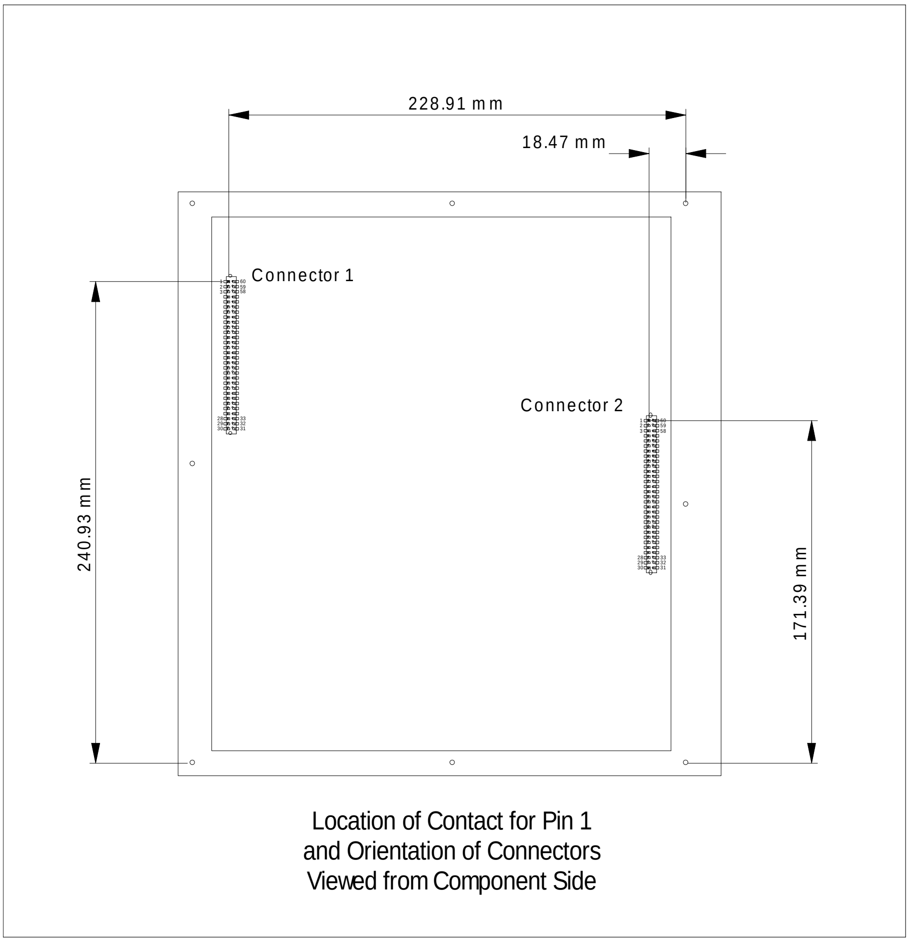


Figure 3A-6

Figure 3A-7 shows a close up view of the connector and the connector pin numbering.

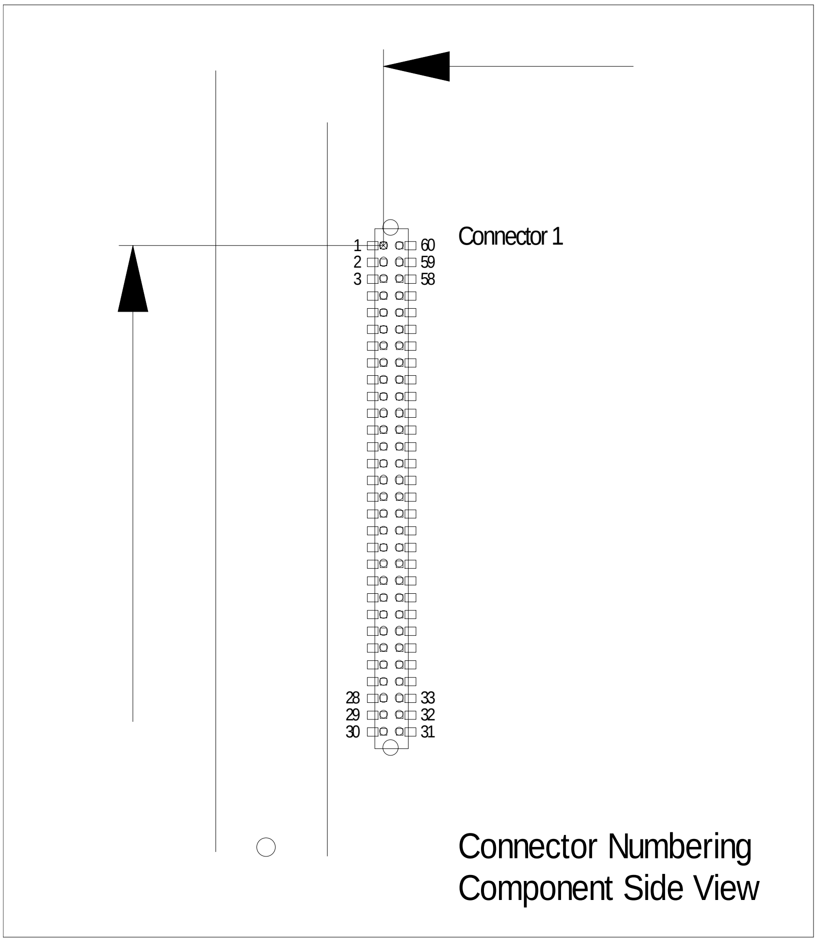


Figure 3A-7

Figure 3A-8 shows the requested method for connecting the OAM.

It uses a stacker (Item A) mated with a receptacle (Item B) on the printed wiring board of the OAM. The stacker may be shrouded. This method allows the header to be shipped loose as to avoid damage to the header. The pins of the header or stacker shall be plated with 0.76 um gold on both contact surfaces. The mating height and pin length for both methods is given in the table below. If an un-shrouded stacker is used then the pin length shall be the same for both ends.

The dimensions are given with the stacker fully seated in the receptacle of the OAM.

Table 3A.2: Dimensions for Header/Stacker		
Dimension A	Mating Height	30.5 ± 1.5mm
Dimension B	Pin Length	10.0mm Min 12.2mm Max

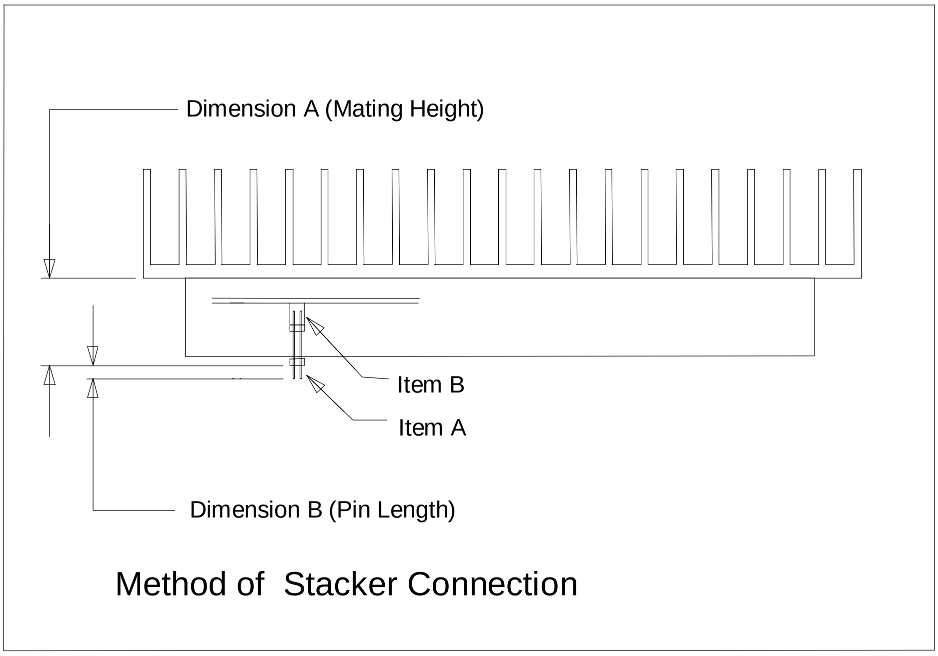


Figure 3A-8

Fiber labeling scheme (see Figure 3A-9 and Figure 3A-10)

Each fiber pigtail shall be marked at the boot of the fiber optic connector with an adhesive label. The label shall wrap completely around the flat portion of the boot at least 1.5 times. Do not stick the label on to the tapered portion of the boot. The label should not stick out from the connector boot in any way. If necessary, the label's width can be reduced. The label must use an adhesive strong enough to hold it in place over the life of the component and its operating environment (see Section 6 for definition of component life).

The text for the label is given in Table 3A.1. Each row shall appear at least three times with equal spacing around the label after it is applied to the connector. See Figure 3A-9 and Figure 3A-10 for details. This should allow the text to be visible from any angle. For single character text per row, the text must be in Arial, 10pt font. For double and triple characters per row, the text must be in Arial font with font sizes of 8pt and 6pt respectively. If the given text is numbers, all number sixes and nines must be underlined for clarity: **6 9**

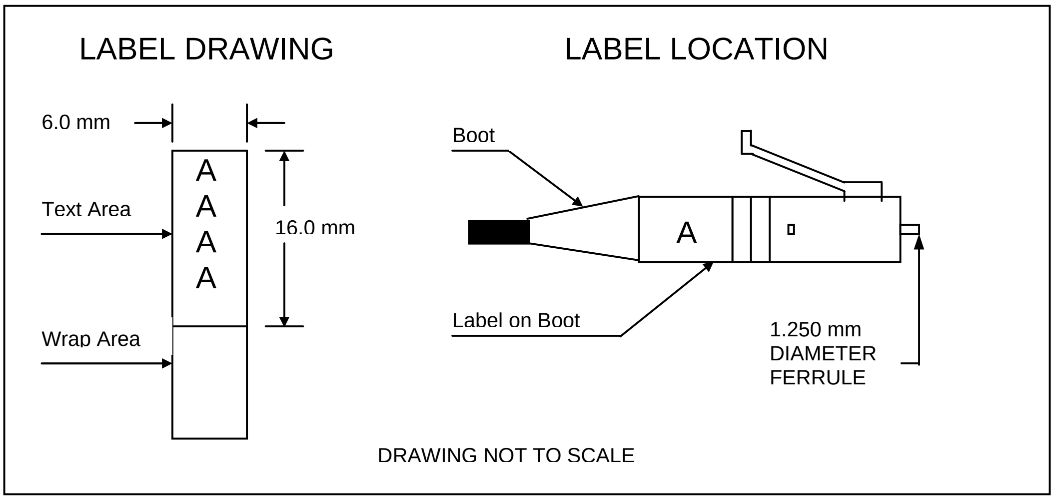


Figure 3A-9: LC connector label position

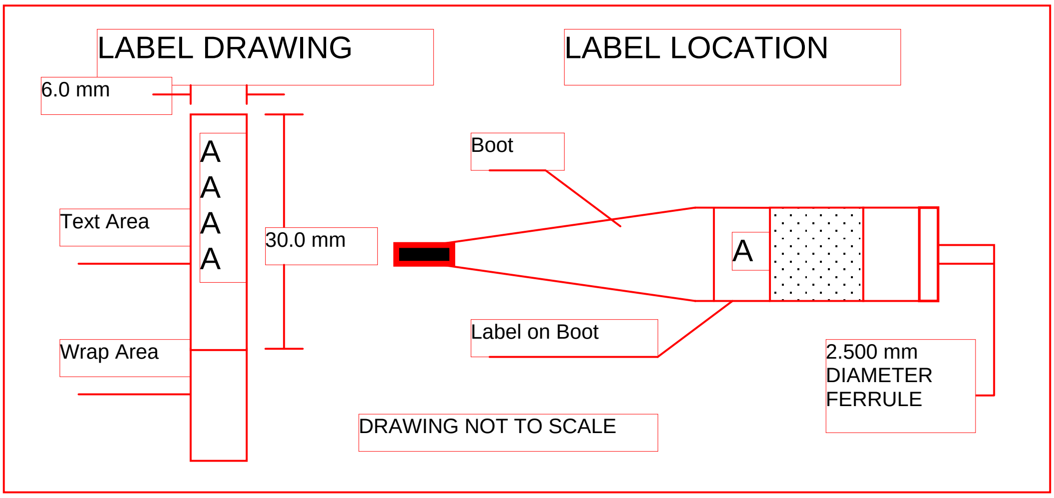


Figure 3A-10: ST connector label position

SECTION 4: FIBER PIGTAIL, COMPONENT PACKAGING, AND MATERIAL SPECIFICATIONS

4A Fiber Pigtail and Connector Specifications

All optical connector ports shall be clean and protected by appropriate dust covers.

Fiber Pigtail Buffer Material

All fibers pigtail buffer shall be 0.9mm in diameter. Loose buffered fiber such as tubing must not be used on the component pigtails without Lucent approval of test data indicating that all the criteria listed below are met. Nylon buffer material must not be used in order to avoid difficulties associated with fiber dressing due to stiffness reasons.

If there are two or less pigtails on the component, then the approved buffer materials are SBJ, PVC, and HYTREL.

For components with more than two pigtails, the approved buffer materials are SBJ and PVC. Other buffer materials such as HYTREL can not be used in this case due to flammability reasons unless it can be shown that these buffer materials satisfy the flammability specifications.

Use of other buffer materials must be discussed with Lucent before approval is granted. Besides component packaging criteria such as hermeticity, other criteria that must be satisfied by the buffer material are:

- Fiber protection against tension, torsion, and bending (per Section 5A and 5B)
- Compatibility with BTW LC connector and its boot (Lucent Document 640-252-053, Issue 3, *Assembly Instructions for LC Fiber Optic Behind-The-Wall (BTW) Connectors)*.
- It is important to note that the choice of buffer impacts optical performance under side load, strength of the fiber-to-boot interface, and fiber protection under external load. Buffers that have performed best with the BTW LC connector boot are listed in descending order of performance: SBJ, HYTREL, and PVC.
- Buffer material stiffness (low stiffness with low memory is required for fiber dressing, Nylon can not be used)
- Flammability (if there are more than two pigtails used on the component, then the buffer material must comply with Section 4C of this document)

Fiber Pigtail LC Connector

A pre-assembled and tested 15-foot fiber with 0.9mm SBJ tight buffer and connectorized ends can be purchased from Lucent. This jumper has the part number BS-1LC-LC-15 and comcode 108056508. This jumper satisfies the Telcordia GR-326 requirements for Type-II fiber.

Other approved sources of fiber jumpers with LC connectors can also be used as long as they satisfy the fiber buffer material and connector specifications. Two alternative methods are:

1) Appropriately assemble the LC connectors after the fiber has been attached to the component.
2) Purchase qualified pre-connectorized fibers with LC connectors (with tuning) on one end and the appropriate terminations on the other end from licensed suppliers.

Loose LC connectors can be purchased from Lucent and other licensed suppliers. LC connectors in bulk can be procured from Lucent by using part number P1101A-Z-125-B with comcode 108247420. This part number provides 100 connectors.

There are three areas that need attention to ensure proper connector performance:

- ***Connector assembly and polishing for proper ferrule end-face geometry***
- ***LC Connector tuning***
- ***Cleanliness and use of dust caps***

Connector Assembly and Polishing

Fibers shall be terminated with *behind the wall* (BTW) LC connectors with zirconia ferrules having a domed PC polish. The LC connector ferrule is 1.250 mm in diameter and requires proper polishing procedures to ensure appropriate end-face geometry. Refer to Lucent document 640-252-053, Issue 3, *Assembly Instructions for LC Fiber Optic Behind-The-Wall (BTW) Connectors* for ferrule end-face geometry requirements and details on proper assembly and polishing instructions including material ordering information. Note that the EZ Method shown in this document is not allowed and must not be used.

LC Connector Tuning

Enhanced insertion loss performance can be achieved by appropriate rotational alignment of the fiber with respect to the ferrule to account for the three eccentricity factors of connector assembly:

- fiber core eccentricity
- diametric slop between ferrule center hole and fiber
- ferrule center hole eccentricity

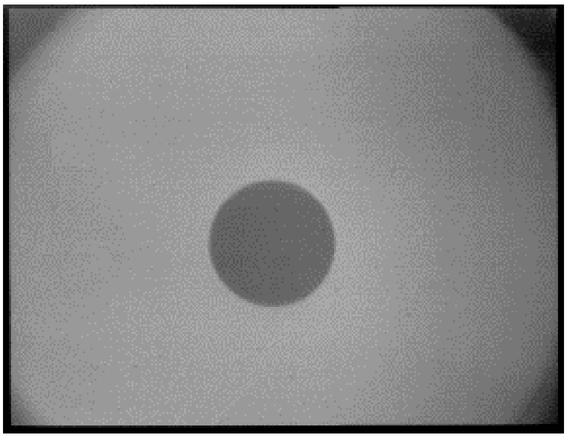
The LC connector tuning minimizes the space between the fiber core center and the ferrule boarder such that the fiber core center is as close as possible to the connector locking latch (12 'o' clock position).

All LC connectors must be tuned. Refer to Lucent document 640-252-053, Issue 3, *Assembly Instructions for LC Fiber Optic Behind-The-Wall (BTW) Connectors* for appropriate tuning procedures and the associated kits.

Connector Cleaning

The end face of the ferrule shall be clean and free of dirt, grease, dust, and foreign materials. After cleaning the connector, inspect the ferrule end-face to ensure that it is free from any particulate contamination using an optical fiber inspection scope of at least 200X magnification. At a minimum, all connectors must satisfy the visual inspection criteria stated in Section 5.11, Lucent Document 640-252-056, Issue 1, *LC Connector Product Specification*. However, the objective must be that all connectors visually look like the picture shown below. Refer to Lucent document FOCCP "Specification for Fiber Optic Connector Cleaning" for recommended cleaning procedures. All optical connectors must make use of Lucent recommended protective dust caps. The preferred dust caps are hard plastic, not vinyl, and should fit the inside diameter of the LC housing, not touching the ferrule.

The figure below shows the expected condition of a clean fiber connector end-face as viewed from a 200X microscope:



LC Singlemode Connector Specifications (applies to a single connection)

- Insertion Loss Mean Value: 0.08 dB
- Insertion Loss Standard Deviation: 0.07 dB
- Maximum Insertion Loss: 0.25 dB
- Maximum Reflectance*: -50.0 dB (requirement)
- Maximum Reflectance*: -55.0 dB (objective)

Fiber Pigtail ST Connector

Fibers shall be terminated with ST connectors with zirconia ferrules having a domed PC polish.

ST Singlemode Connector Specifications (applies to a single connection)

- Insertion Loss Mean Value: 0.20 dB
- Insertion Loss Standard Deviation: 0.15 dB
- Maximum Insertion Loss: 0.50 dB
- Maximum Reflectance*: -40.0 dB

** Since this performance may not be measured after the fiber-connector is assembled to the component, it must be verified independently as part of the fiber-connector assembly process with appropriate periodic inspections to ensure ongoing performance.*

Fiber Medium Specifications

Type: single-mode, depressed clad fiber, silica, self mode stripping

Note that use of matched clad fiber is allowed. However, depressed clad fiber is preferred over matched clad fiber because of higher bending losses associated with matched clad fiber for small bend radii (less than 0.2 inches).

Mode Field Diameter (Depressed Clad): 8.80 ± 0.50 μm at 1300 nm and 9.70 ± 0.60 μm at 1550 nm
Mode Field Diameter (Matched Clad): 9.30 ± 0.50 μm at 1300 nm and 10.50 ± 1.00 μm at 1550 nm

Core Diameter: 8.3 μm nominal

Cladding Diameter: 125 ± 0.5 μm

Maximum Core Eccentricity: 0.50 μm

Maximum Cutoff Wavelength: 1270 nm

Secondary Coating Outer Diameter (Jacket): 30 – 40 mils (0.8 – 1.0 mm)

Minimum Bend Radius (to avoid excess loss): 0.80 inch (20.3 mm)

Required Fiber Length: See Table 3A.1

Maximum Allowable Fiber (includes jacket if used) Short Term Operational Temperature: 75°C for 5000 hours

Maximum Allowable Fiber (includes jacket if used) Long Term Operational Temperature: 75°C

Fiber Tensile Strength without Secondary Coating (Non-Operational): 50K PSI (4.23N for 125 μm fiber diameter)

4B Hermeticity, Epoxy, Electrical I/O Finish and Stiffness Specifications

The 980 nm and 1480 nm pump lasers used in the OAM shall be hermetic. Hermetic casing for other types of components is desired but not required. Indium solder shall not be used for electrical connectivity. Epoxy shall not be used to achieve hermeticity. Use of epoxy, if any, must comply with GR-1221-CORE. Special care must be taken to avoid any out-gassing of construction materials used inside the case.

Hermetic components shall satisfy the criteria per MIL-STD-883C, Method 1014.9, Condition A or B, and C. Components with epoxy in the non-hermetic region can be tested for hermeticity with epoxy-free samples to prevent the epoxy from obscuring the results.

All electrical leads (if used) shall be solder coated with 3 μm to 100 μm of 63%/37% Tin/Lead as the final coating. Solder coat leads such that there shall be no solder in the first lead bend (the bend closest to the package). Coatings can be hot-dipped or electroplated without organic plating brighteners. Precious metals (gold, silver, etc.) shall not be used as the final termination finish. For electroplated solder coatings, a diffusion barrier of Nickel shall be used between the precious metal and the final solder coating. If the precious metal is completely removed before the final solder coating is applied, then the Nickel barrier is not required. For hot-dipped solder coatings, it is not necessary to remove the precious metal layer prior to the dipping operation. The dipping duration shall be 5 ± 1 seconds and the solder bath temperature shall be maintained at 232 ± 8°C. Solder baths shall be discarded before the precious metal to solder ratio by weight exceeds 0.25%.

If surface mount electrical leads are used, then the lead stiffness measured in the direction normal to the leaded side of the package (force applied at the tip of the lead) shall be no greater than 50 pounds per inch. The lead stiffness measured in the direction parallel to the leaded side of the package (force applied at the tip of the lead) shall be no greater than 250 pounds per inch.

4C Material Specifications

Toxicity: All materials with which personnel may come in contact shall be non-toxic, and shall not present any environmental hazards as defined by applicable federal or state laws and regulations or current industry standards. Where the suggested use of certain materials by the manufacturer may pose hazardous conditions, the manufacturer shall provide the necessary instructions for the handling and use of such materials.

Dissimilar Metals: Components shall ensure that no galvanic corrosion will occur when dissimilar metals are used in its construction.

Fungus Resistance: Exposed polymeric materials used in the component construction shall not support fungi growth as per ASTM-G21, *American Society for Testing and Materials-Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi*. A rating of zero is required.

Flammability: Exposed plastic materials, fiber pigtails, and fiber connector materials shall have an oxygen index of at least 28% as determined by actual test in accordance with ASTM ~~D2863-91~~, D2863-97, *American Society for Testing and Materials-Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (oxygen index)*. All materials used to construct the component must meet ANSI T1.307 – *American National Standard Institute* - *Telecommunications* - *Fire Resistance Criteria - Ignitability Requirements for Equipment Assemblies and Fire Spread Requirements for Wire and Cable*. Plastic materials, fiber pigtails, and fiber connector materials shall not sustain combustion when an open flame source is removed. These materials must have a rating of 94V-1 or better when tested according to the *Vertical Burning Test for Classifying Material*, Underwriters Laboratories publication UL94, *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.* Test procedure as per ANSI T1.307 - *Needle Flame Test* must be used to demonstrate compliance. Manufacturers may be requested to provide material samples of appropriate size to verify flammability compliance. Flammability tests shall be conducted on the materials as used in the final package form. All the labels must be placed on the final package form as part of this test.

SECTION 5: ENVIRONMENTAL SPECIFICATIONS

Note that non-operational tests are performed without operating the components during the test. However, the components are performance tested before and after the non-operational test to verify conformance with Sections 2 and 3 of this specification. Operational tests are those during which the components are monitored for performance while the loads (or environmental stresses) are applied and after the loads (or environmental stresses) are removed. All the optical parameters must satisfy the limits specified in Section 2 under loads (or environmental stresses) and after the loads are removed. The component sample-lot of three or greater must be used for these tests with no failures allowed. These sample-lots must be manufactured using the actual production facilities, including screening and burn-in effects.

5A Non-Operational Tests for Components

- **Cable Retention:** All fibers attached to the component are to withstand a 0° tensile pull force and 90° side loads (12 ‘o’ clock, 3 ‘o’ clock, 6 ‘o’ clock, and 9 ‘o’ clock positions) as per the following loads:
  - 0.57 kgf (1.25 lbf) for greater than 1.5 mm diameter buffered reinforced cable
  - 0.34 kgf (0.75 lbf) for 900 μm diameter buffered fiber
  - 0.23 kgf (0.5 lbf) for 250 μm diameter coated fiber with no buffer

- 0.23x*n* kgf (0.5x*n* lbf) for ribbon fibers where n is the number of fibers in the ribbon (test to be conducted on package side and fan-out side interfaces)

Load is to be applied gradually to the secured fiber at a minimum distance of 10 cm (4 inches) from the interface for a period of 1 minute after which it should be removed gradually.

- **Twist Test:** All fibers attached to the component are to withstand a twist test of 10 cycles with a 0.45 kgf (1 lbf) load. The load should be applied and removed gradually at a distance to 3 cm (1 inch) from the interface point. The twist axis should be normal to the component body and in line with the fiber axis. Each twist cycle shall consist of a 90° rotation (horizontal plane) in one direction, a 180° rotation in the opposite direction, followed by a 90° twist to return to the initial position. The twist rate shall be 30 cycles per minute. Note that 250 μm diameter coated fiber with no buffer, 900 μm diameter buffered fiber, and ribbon fibers are exempt from this test.

- **Flex Test:** All fibers attached to the component are to withstand a flex test of 100 cycles with a 0.45 kgf (1 lbf) load. The load is to be applied and removed gradually to one fiber at a time at a distance of 1 meter (3 feet) from the component body for fibers longer than 1 meter (3 feet) and 10 cm (4 inches) from the end of the fiber for fibers less than 1 meter (3 feet) in length. Cycle rate shall be 30 cycles per minute. Each flex cycle shall consist of a 180° motion to one side followed by another 180° motion back to the original position. The sweep angle with respect to the component body shall be 180° (side-to-side) during the test while maintaining a constant tensile load on the fiber to stress the fiber-to-component interface. Fiber bend radius of 3.8 cm (1.5 inches) for automated flexing methods and 12.7 cm (5 inches) for manual flexing methods shall be used. Note that 250 μm diameter coated fiber with no buffer, 900 μm diameter buffered fiber, and ribbon fibers are exempt from this test.

- **Airborne Contaminants:** This test only applies to non-hermetic electronic components with cavity packages or non-hermetic free-space optical alignment components. These components shall be tested per Telcordia GR-63-CORE; *Gaseous Contaminants Test Method for environmentally controlled indoor equipment*. The component shall meet all specifications after the test and suffer no physical or mechanical damage. If the component does not contain silver then the exposure to airborne contaminants occurs while the component is non-operational. However, if silver is used in the component, then the component must be operational during the exposure.

5B Operational Test for Components

- **Side Pull for 1.5 mm (or greater) Diameter Buffered Reinforced Fiber:** All fibers attached to components are to be subjected to a tensile side load of 0.11 kgf (0.25 lbf). The load is applied at an angle of 90° for (5+*t*) seconds where *t* seconds is the time needed to measure signal change due to the side pull. The load is to be applied at a distance of 22 to 28 cm (8.7 to 11.0 inches) from the component body, one fiber at a time. Measure signal under load after 5 seconds from the time the load is applied and after 20 seconds from the time the load is removed.

- **Side Pull for 900 μm Diameter Buffered Fiber:** All fibers attached to components are to be subjected to a tensile side load of 0.05 kgf (0.01 lbf). The load is applied at an angle of 90° for (5+*t*) seconds where *t* seconds is the time needed to measure signal change due to the side pull. The load is to be applied at a distance of 22 to 28 cm (8.7 to 11.0 inches) from the component body, one fiber at a time. Measure signal under load after 5 seconds from the time the load is applied and after 20 seconds from the time the load is removed. All measurements must be within component specifications shown in Sections 2 and 3.

- **Side Pull for 250 μm Diameter Coated Fiber (no buffer):** All fibers attached to components are to be subjected to a tensile side load 0.008 kgf (0.018lbf). The load is applied at an angle of 90° for (5+*t*) seconds where *t* seconds is the time needed to measure signal change due to the side pull. The load is to be applied at a distance of 22 to 28 cm (8.7 to 11.0 inches) from the component body, one fiber at a time. Measure signal under load after 5 seconds from the time the load is applied and after 20 seconds from the time the load is removed. All measurements must be within component specifications shown in Sections 2 and 3.
- **Side Pull for Ribbon Fiber:** All component ribbon fiber interfaces (package sides and fan-out sides) are to be subjected to a tensile side load of 0.008x*n* kgf (0.018x*n* lbf) where *n* is the number of fibers in the ribbon. The load is applied at an angle of 90° for (5+*t*) seconds where *t* seconds is the time needed to measure signal change due to the side pull. The ribbon bend axis is parallel to the plane of the ribbon fiber. The load is to be applied at a distance of 22 to 28 cm (8.7 to 11.0 inches) from the component body, one fiber at a time. Measure signal under load after 5 seconds from the time the load is applied and after 20 seconds from the time the load is removed. All measurements must be within component specifications shown in Sections 2 and 3.
- **Temperature Cycling with Humidity:** This test is only applicable to highly integrated modules or subsystems. Refer to *RELQUAL, Table 2* for test procedure.

5C Non-Operational Tests for Shipping Packages

- **Shock:** Packaged components shall sustain a straight drop (acceleration due to gravity) of 36 inches above a concrete surface. Each package from the sample lot must be dropped once on all its corners and faces. Package used for this test must be the final form of shipping package including internal packaging details.
- **Vibration:** Refer to Section 5.4.3 of Telcordia GR-63-CORE for test procedure.
- **Relative Humidity and Temperature Cycles (These tests are only applicable to non-hermetic components such as plastic encapsulated devices and modules consisting of multiple components):** Packaged components shall sustain the following tests:
  - **Low Temperature Thermal Shock Test:** Refer to Section 5.1.1.1 of Telcordia GR-63-CORE for test procedure.
  - **High Temperature Thermal Shock Test:** Refer to Section 5.1.1.2 of Telcordia GR-63-CORE for test procedure.
  - **High Relative Humidity Test:** Refer to Section 5.1.1.3 of Telcordia GR-63-CORE for test procedure.

5D Electrostatic Discharge Threshold

- **Electrostatic Discharge Compatible Construction**

If the component package construction is electrically conductive, then the construction design of the component package shall be such that there is coherent electrical connection to circuit ground. For screw mounted packages, the metal screw threads of the package shall be electrically connected to the rest of the electrically conductive portions of the package. For electrically leaded components, the ground lead(s) shall be electrically connected to the rest of the electrically conductive portions of the package.

- **Electrostatic Discharge Test**

All electrically sensitive components and sub-components must withstand ESD levels ≥ 500 volts. Refer to TR-NWT-000357 for details on the test procedure for the human-body-model. It is preferred that the components withstand ESD levels of ≥1000 volts.

5E Shipping Package Specifications

Lucent Technologies Packaging Requirements are specified in "Packing Specification PKG-91NJ1045 - Packaging, Packing, Palletization, Labeling and Marking Requirements for Material Being Delivered to Lucent Technologies". This and other packaging and bar code labeling specifications can be accesses from http://www.lucentdocs.com/ (opening screen: click on "Other Libraries"; 2nd screen: select "Supplier Information"; 3rd screen: select a document such as "PKG-91NJ1045"). Refer to Lucent document PKG-91NJ1045 for complete details.

Transportation Package Identification: The requirements for product package identification are intended to minimize problems related to the provisioning (movement, storage, etc.) and product assembly operations which are performed in Lucent factories. The most common package identification problem is the omission of one or more of the following: Lucent Technologies part number (comcode), part description, quantity, and date of manufacture.

Transportation Packages must be labeled with:

Package Identification

Purchase Order Number

Part Number (Lucent comcode)

Quantity per transport package/unit load

Source Inspection Code (if applicable)

Part Description

Package Count (e.g. 1 of 5, 2 of 5, ... 5 of 5). Single container shall be marked 1 of 1.

Package Weight

Also, see "SECTION 9: LABELING AND ACCOMPANIED TEST DATA SPECIFICATIONS" for additional labeling requirements.

Electrostatic Discharge Protection: The Electrostatic Discharge (ESD) portion of the PKG-91NJ1045 packaging requirement applies, even if the product supplied is **not** ESD sensitive. The most common ESD packaging problem is the use of plastic based packaging materials that are not static-dissipative (>= $1x10^5$ and < $1x10^{12}$ ohms/square when tested according to ESD Association standard EOS/ESD S11.11). It is imperative that all of Lucent's supplying sources meet these requirements to protect our products from ESD damage, even though the products you furnish may not be ESD sensitive. Incoming packaging can migrate into manufacturing areas, thus posing a hazard to ESD sensitive products when they are not static-dissipative.

In general, paper, wood, fiberboard, topically treated, and static-dissipative packaging items are acceptable. The materials that pose the highest danger are untreated plastics, including bags, shrink films, foam wraps, bubble wraps, molded trays, and rigid foams. All of these materials are available in static-dissipative versions from many reputable sources. Please note that static shielding materials may be more costly than static-dissipative materials and that shielding is generally not necessary.

Component Package Size: Size of the component package should be minimized to reduce the amount of storage area required.

Component Package Quantity: One unit per component package is required. Multiple Component Packages of the same comcode may be shipped in a Transportation Package.

Component Package Recycling: Recycling or re-use programs for component package materials should be investigated. The return of shipping package material will be at Lucent's discretion.

Physical Protection: Adequate component and fiber protection must be provided by the component package. Fibers must not be shipped entangled. To prevent fibers from getting entangled, a narrow (about 1 inch wide) strip of foam or equivalent material with cut slots must be used to anchor the pigtails.The foam strips shall be removable from the component package. If the component has electrical leads, then they must be protected as well.

5F Temperature and Humidity Specifications

- **Cold Startup:** The component must have the ability to startup at -5°C and be able to operate within specifications in less than 15 minutes from cold startup. Note that 15 minutes is a requirement for maximum cold startup time. However the objective is to operate within specifications in less than 10 minutes from cold startup.
- **Operational Case Temperature:** 0 to 70°. Component operational case temperature range is specified to satisfy the CO emergency conditions such as air cooling or heating system failure. The case temperature of components not utilizing thermoelectric coolers (TECs) is defined as the component body temperature and is usually measured on top of the component case at the geometric center or some predetermined point. The case temperature of components utilizing TECs is defined as the temperature of the heat spreader body that is in contact with the TEC.
- **Operational Humidity:** 5 to 85% Relative Humidity
- **Transportation and Storage Temperature Range:** -40 to 70°C
- **Transportation and Storage Humidity Range:** 5 to 95% Relative Humidity
- **Minimum Component Dew Point:** -10°C (This applies to hermetic packages only, including those that are internal to integrated modules and assemblies).

SECTION 6: RELIABILITY

6A General Reliability Specifications

Component long-term use in the CO requires that it satisfy these reliability specifications.

The component initial failure rate is the time-weighted average failure rate during the first year of its use in the CO and includes all the infant mortality and learning curve effects. The component initial failure rate can be significantly improved by implementing a reliability growth process during its design and development and a 100% burn-in and screening process during manufacture.

The component long-term failure rate is the steady state failure rate over its useful life and does not include the first year effects. In general the long-term failure rate is mostly influenced by random failures with the wear-out failure rate being negligible. Useful life (also known as lifetime or end-of-life) is the time period over which the long-term failure rate remains approximately constant.

These reliability specifications are to be realized when the components are used in systems that are deployed in the field at normal operating conditions in controlled environments (typically 40° C case temperature and nominal electrical load). These specifications must be supported by long term aging tests that are specified in this document in *Section 7, Reliability Qualification Specifications*. The long-term failure rate is defined as the sum of the wear-out failure rate for 25-year lifetime and the random failure rate for 60% confidence level derived from the aging test. Refer to reference materials listed in Section 7 for details.

End-of-life is reached when the wear-out failure rate dominates the component failure rate and causes it to monotonically increase with time. End-of-life shall be estimated by conducting aging tests and simulating the appropriate end-of-life effects as per Section 2.

- **Maximum Initial Failure Rate:** 1.3 x λss
- **Maximum Long Term Failure Rate (λss):** Refer to table below

COMPONENT TECHNOLOGY/FUNCTION	λss (FIT)
OPTICAL PUMPS (980 and 1480 nm):	
≤ 90 mW output power level	500
≥ 90 mW but ≤ 150 mW output power level	750
> 150 mW output power level	1000
PASSIVE OPTICAL AMPLIFIERS (PUMPS NOT INCLUDED):	
40 and 80 Channel POAM Module	500

- **Minimum Lifetime Median:** 25 years

~~6B Reliability Supplementary Test Specifications~~

~~**Operating Vibration Test (applies to highly integrated modules and subsystems only):** This test procedure verifies proper operation of the component while it is in a state of vibration. This test is necessary to ensure that the component will continue error-free operation in a system exposed to the Zone 4 seismic vibration environments as specified by Bellcore GR-63-CORE.~~

~~Mount 3 or more components securely on a shaker table such that one of their three mutually perpendicular axes is in the direction of motion of the shaker table. Monitor the performance of these components under nominal operating conditions. Subject the components to a swept sine survey with a constant peak-to-peak displacement of 1.0 inch from 5 Hz to 10 Hz followed by a constant acceleration amplitude of 10 g from 10 Hz to 100 Hz. The sweep rate for this test is 0.10 octave per minute. This corresponds to a sweep time of 10.00 minutes for 5 Hz to 10 Hz and 33.22 minutes for 10 Hz to 100 Hz.~~

~~Repeat this test for the other two remaining mutually perpendicular axes.~~

~~Note that this test must be conducted on components representing manufactured product (not prototype models). The test can be performed one component at a time. No failures are allowed during this test.~~

~~**Other Tests:** NONE REQUIRED~~

SECTION 7: RELIABILITY QUALIFICATION SPECIFICATIONS

Beyond the specifications listed in the previous sections, Lucent requires that the component pass a series of reliability qualification criteria. These criteria are specified in the document listed below. A copy of this document must be obtained so that it can be adopted. The component will not be considered ready for use until the criteria in this document have been satisfied.

Specification for Product Compliance and Reliability Qualification of Optoelectronic Components, Modules, and Subsystems. (Obtain the latest issue of specification: *RELQUAL*).

SECTION 8: U.S. FDA/CDRH REGULATORY COMPLIANCE SPECIFICATIONS

The manufacturer of the laser (or laser-containing product) must register their laser product with the U.S. Food and Drug Administration/Center for Devices and Radiological Health (FDA/CDRH) by submitting a ten-part laser product report or a letter with the appropriate information to the FDA/CDRH Office of Compliance. This report (or letter) documents the laser products' compliance with the requirements of Title 21 - Code of Federal Regulations (21 CFR) - Parts 1010 and 1040. Upon review, the Office of Compliance will assign an Accession Number to the laser product report. The Accession Number shall be provided as verification of registration and compliance. All manufacturers of laser products, independent of the country of origin, shall register and comply with this federal regulation. Failure to do so, could result in fines, product recalls, product holds, and/or manufacturing plant shutdowns.

SECTION 9: LABELING AND ACCOMPANIED TEST DATA SPECIFICATIONS

9A Loose Data Sheets Accompanying Each Individual Component

9A.1 Floppy Disk

Each OAM shall be packaged and shipped with a properly formatted floppy disk. The required labeling on the floppy disk is specified in Section 9B. The floppy disk shall be a standard 3.5 inch high density disk. The floppy disk shall contain a file named in the following manner: **MCV12345.dat** where the first eight characters represent the OAM serial number with the year (YY) and supplier (SS) removed (see Section 9B for the serial number format description). The file shall contain the necessary OAM data in a format specifically defined by Merrimack Valley, Lucent Technologies. A second file (optional) may also be included in the floppy disk which contains the OAM data in the supplier's preferred format (i.e. supplier's data sheet format). The optional second file shall be named in the following manner: **MCV12345.txt**.

The data for each OAM shall be archived by the supplier and shall be available upon request.

9A.2 Test Data

All measurements shall be performed at room temperature.

The optical performance data shall be measured with a setup compliant with Table 2A.10.

In the file named "MCV12354.dat", the OAM data shall be presented in a series of data tables. All descriptors and data shall be in ASCII text. Each table shall have a unique name, which will be specified by Lucent. Each table will have a specified width or number of columns. Each column or field shall be separated by a comma (,). Note: A comma should only be used as a field separator. There shall be no spaces in the file. The end of a table shall be indicated by a semi-colon (;) on a new line. When new tables need to be added, they shall be added to the end of the data table list. All tables in this document are shown in bold, blue font color. The bold, blue font represents what the "MCV12345.dat" file shall contain. The format and precision are reflected by the number of 'x's in the tables. There are no leading zeros required.

For the case that specific conditions are not tested the disk data should be changed as follows:

Lines can be removed if they correspond to test conditions which have been eliminated; for instance VOA settings in Table 14: VOA values under test conditions or gain values at specific frequencies in Table 16 Gain S_{ba}. Columns associated with conditions which are not measured have to be replaced by zeros, for instance test conditions in Table 16: Gain S_{ba}. All measurement reductions have to be confirmed by Lucent.

9A.2.1 Table 1: Identification

The first table of the MCV12345.dat file shall identify the floppy disk and associated OAM. The first table shall be named "id_info". The id_info table shall be 3 columns wide. An example is shown in Table 1. In this table, the OAM serial number (12 characters), the OAM Lucent comcode (9 digits) and the floppy disk version shall be identified. The floppy disk version will start at Version 1.0 and will update when changes are made to the floppy disk data requirements.

id_info
serial,comcode,version
YYSSMCV12345,xxxxxxxxx,x.x
;
Table 1

9A.2.2 Table 2: Auxiliary Heater Thermistor Values

The second table shall identify the auxiliary heater thermistor set value in xx.xx kΩ (the accuracy shall be 0.01kΩ). This second table shall be named "aux_therm_res" . It shall be 2 columns wide as shown below. If a heater interface is not used the corresponding thermistor resistance should be reported as 00.00. The set value shall be ≥ 7 kΩ .

aux_therm_res
thermistor,resistance
thermistor1,xx.xx
thermistor2,xx.xx
;
Table 2

9A.2.3 Table 3: Auxiliary Heater End Of Life Current

The third table shall identify the auxiliary heater maximum end-of-life current given in xxxx.x mA for each heater. The Heater current is defined as the current that will be driven from pin HeaterxP to pin HeaterxM, where x stands for 1 or 2 according to the Heater number. The table shall be named "aux_heater_current". It shall be 2 columns wide as shown below. If a heater interface is not used the corresponding heater current should be reported as 0.0.

aux_heater_cur
heater,current
heater1,xxxx.x
heater2,xxxx.x
;
Table 3

9A.2.4 Table 4: Thermistor Resistance Set for Pump TEC

The 4th table shall identify the thermistor resistance set value for each pump given in xx.xx kohms (the accuracy shall be 0.01kΩ. The thermistor resistance is defined as the resistance which can be measured between pin THERx and pin GND, where x stands for 1,2, .. 6 according to the pump laser number (for the remainder of this document, the pump numbering should run according to the definition in Table 2D.1 and Table 2D.2). The data table shall be named "pump_therm_res". It shall be 2 columns wide as shown below. For unused pump laser interfaces "0.00" shall be reported.

pump_therm_res
thermistor,resistance
pth1,xx.xx
pth2,xx.xx
pth3,xx.xx
pth4,xx.xx
pth5,xx.xx
pth6,xx.xx
;
Table 4

9A.2.5 Table 5: Minimum Thermistor Resistance

The 5th table shall identify the minimum thermistor resistance value for each pump given in xx.xx kohms. This minimum resistance represents the maximum operating temperature of each pump laser under extreme environmental conditions. The table shall be named "min_pump_therm". It shall be 2 columns wide as shown below. For unused pump laser interfaces "0.00" shall be reported.

min_pump_therm
mintherm,resistance
minpth1,xx.xx
minpth2,xx.xx
minpth3,xx.xx
minpth4,xx.xx
minpth5,xx.xx
minpth6,xx.xx
;
Table 5

9A.2.6 Table 6: Thermistor B Constants

The 6th table shall identify the thermistor B constant for each pump given in xxxx K, as defined in section 2B. The table shall be named "pump_therm_b". It shall be 2 columns wide as shown below. For unused pump laser interfaces "0" shall be reported.

pump_therm_b
b,value
bth1,xxxx
bth2,xxxx
bth3,xxxx
bth4,xxxx
bth5,xxxx
bth6,xxxx
;
Table 6

9A.2.7 Table 7: End Of Life Current for Pump TECs

The 7th table shall identify the maximum end-of-life (EOL) TEC current given in xxxx.x mA for each pump. The TEC current is defined as the current which will be driven from pin TECPx to pin TECMx or vise-versa, where x stands for 1,2, .. 6 according to the pump laser number. The table shall be named "max_tec". It shall be 2 columns wide as shown below. For unused pump laser interfaces "0.0" shall be reported.

max_tec
maxtec,current
maxtec1,xxxx.x
maxtec2,xxxx.x
maxtec3,xxxx.x
maxtec4,xxxx.x
maxtec5,xxxx.x
maxtec6,xxxx.x
;
Table 7

9A.2.8 Table 8: End Of Life Bias Current for Pump Lasers

The 8th table shall identify the maximum end of life pump laser bias current, given in mA, necessary to achieve P_{op} under EOL conditions. The 8th table shall be named "pump_bias_eol". It shall be 2 columns wide as shown below. For unused pump laser interfaces "0" shall be reported.

pump_bias_eol
eolbias,current
eolbias1,xxx
eolbias2,xxx
eolbias3,xxx

eolbias4,xxx
eolbias5,xxx
eolbias6,xxx
;
Table 8

9A.2.9 Table 9: Backface Current Values (Condition A)

This table shall contain the OAM operating data. This data are backface monitor currents for different operating conditions given below. Notice that L_{gh} shall be set to 10dB (this value is **not** the same as in Table 2A.3). The VOA, however, shall be at the same attenuation level as that used for the measurement of S_{ba} for condition 1 in Table 2A.3. S_a, S_g and S_b shall adjusted according to Table 9A.1 (S_{g_set} shall have the same value as used in the conditions of Table 2A.3). S_a, S_g and S_b shall be measured with a broad area optical power meter that shall be calibrated at 1546.5nm.

Table 9A.1: Test Condition A For operating data		
Set L_{gh} = 10 dB, set L_{att} = L_1 (condition 1 Table 2A.3)		
S_a in dBm	S_g in dBm	S_b in dBm
-16.5	$S_{g\_set} - 14.0$	8.7
-14.5	$S_{g\_set} - 12.0$	10.7
-12.5	$S_{g\_set} - 10.0$	12.7
-10.5	$S_{g\_set} - 8.0$	14.7
-8.5	$S_{g\_set} - 6.0$	16.7
-6.5	$S_{g\_set} - 4.0$	18.7
-4.5	$S_{g\_set} - 2.0$	20.7
-2.5	S_{g_set}	22.7

The 9th table shall identify the pump backface current for each pump under the conditions given in Table 9.1 above. The backface current shall be given in xxxx microamperes with a relative accuracy of 0.2% and a +5V bias applied to each individual photodiode cathode. The backface current data shall be organized in a 9 column wide table named “pump_bf_conda” (which also includes the power levels measured at ports a). For unused pump laser interfaces the column shall be filled with “0”.

pump_bf_conda
porta,bfp1,bfp2,bfp3,bfp4,bfp5,bfp6
-16.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-14.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-12.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-10.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-8.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-6.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-4.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-2.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
;
Table 9

9A.2.10 Table 10: Pump Laser Bias Currents (Condition A)

The 10th table shall identify the pump bias current for each pump under Condition A given in Table 9A.1. The bias current shall be given in xxxx milliamperes. The 10th table shall be named "pump_bias_conda". It shall be 9 columns wide as shown below. For unused pump laser interfaces the column shall be filled with "0".

pump_bias_conda
porta,biasp1,biasp2,biasp3,biasp4,biasp5,biasp6
-16.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-14.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-12.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-10.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-8.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-6.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-4.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-2.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
;
Table 10

9A.2.11 Table 11: Backface Current Values (Condition B)

As above, L_{gh} shall be set to 10dB (this value is not the same as in Table 2A.3). The VOA however shall be set to the same attenuation that was needed for the measurement of S_{ba} for condition 6 in Table 2A.3. S_a, S_g and S_b shall adjusted according to Table 9A.2 (S_{g_set} shall have the same value as used in the conditions of Table 2A.3) . S_a, S_g and S_b shall be measured with a broad area optical power meter that shall be calibrated at 1546.5nm.

Table 9A.2: Test Condition B For operating data		
Set L_{gh} = 10 dB, set $L_{att} = L_6$ (condition 6 Table 2A.3)		
S_a in dBm	S_g in dBm	S_b in dBm
-11.5	$S_{g\_set} - 14.0$	8.7
-9.5	$S_{g\_set} - 12.0$	10.7
-7.5	$S_{g\_set} - 10.0$	12.7
-5.5	$S_{g\_set} - 8.0$	14.7
-3.5	$S_{g\_set} - 6.0$	16.7
-1.5	$S_{g\_set} - 4.0$	18.7
0.5	$S_{g\_set} - 2.0$	20.7
2.5	S_{g_set}	22.7

The 11th table shall identify the pump backface current for each pump under the conditions given in Table 9A.2 above. The backface current shall be given in xxxx microamperes with a relative accuracy of 0.2% and a +5V bias applied to each individual photodiode cathode. The backface current data shall be organized in a 9 column wide table named "pump_bf_condb". For unused pump laser interfaces the column shall be filled with "0".

pump_bf_condb
porta,bfp1,bfp2,bfp3,bfp4,bfp5,bfp6
-11.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-9.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-7.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-5.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-3.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-1.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
+0.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
+2.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
;

Table 11

9A.2.12 Table 12: Pump Laser Bias Currents (Condition B)

The 12th table shall identify the pump bias current for each pump under Condition B given in Table 9A.2. The bias current shall be given in xxxx milliamperes. The 10th table shall be named "pump_bias_condb". It shall be 7 columns wide as shown below. For unused pump laser interfaces the column shall be filled with "0".

pump_bias_condb
porta,biasp1,biasp2,biasp3,biasp4,biasp5,biasp6
-11.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-9.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-7.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-5.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-3.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
-1.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
+0.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
+2.5,xxxx,xxxx,xxxx,xxxx,xxxx,xxxx
;
Table 12

9A.2.13 Table 13: VOA Calibration Table

The 13th table shall identify the VOA calibration table, which gives the VOA read-out vs. VOA loss. The range for the VOA loss in excess to the intrinsic loss shall be from 0dB to 15dB. The VOA read-out is an analog voltage either across a potentiometer or direct delivered at pin VOUT.

The indication of the supplier's pin group (group1 or group2) shall be provided in the table name. The table name shall be "voa_cal_g1" or "voa_cal_g2" depending on the supplier's pin group. This table shall show the total number of steps in the table, steptotal, which does not include the minimum and maximum loss values. The step size for the VOA loss shall not be greater than 0.10dB. Therefore, vstep1(loss) shall be equal to voamin(loss) + [0..0.10] dB and vsteptotal(loss) shall be equal to voamax(loss) - [0..0.10] dB.

Both the readout voltage and the attenuation shall progressively increase with the number of steps. The values given in the look-up table should be normalized for group1 to exactly +5.00V applied between VOA(H) and VOA(L) or at VCC(+5). The readout VOUT for group 2 shall be independent on the applied voltage at VCC(+5). The maximum readout voltage shall not exceed 4.9V.

The width of this table shall be 3 columns as shown in Table 13. Please note that steptotal will have only one variable associated with it. Therefore, the third field associated with steptotal is a placeholder and shall be designated as 0. The attenuation shall be given in xx.xxx dB, the readout voltage in x.xxx V.

voa_cal_g1 or **voa_cal_g2** (depending on supplier's pin group)
voa,loss,voaout
steptotal,xx.x,0
voamax,xx.xxx,x.xxx
voamin,xx.xxx,x.xxx
vstep1,xx.xxx,x.xxx
vstep2,xx.xxx,x.xxx
vstep3,xx.xxx,x.xxx
.
.
.
vsteptotal,xx.xxx,x.xxx
;

Table 13

9A.2.14 Table 14: VOA Values under Test Conditions

The 14th table shall identify the VOA values to meet conditions 0 to 6 in Table 2A.3. The table name shall be “voa_loss”. The width of this table shall be 3 columns as shown below. The attenuation shall be given in xx.xxx dB, the readout voltage in x.xxx V.

The VOA settings for condition 7, 8 and 9 shall be reported when the VOA has been re-adjusted during those tests.

```
voa_loss
voa,loss,voaout
voacond0,xx.xxx,x.xxx
voacond1,xx.xxx,x.xxx
voacond2,xx.xxx,x.xxx
voacond3,xx.xxx,x.xxx
voacond4,xx.xxx,x.xxx
voacond5,xx.xxx,x.xxx
voacond6,xx.xxx,x.xxx
voacond7,xx.xxx,x.xxx
voacond8,xx.xxx,x.xxx
voacond9,xx.xxx,x.xxx
;
```

Table 14

9A.2.15 Table 15: S_{g_set} Power

The 15th table shall identify the power S_{g_set} for conditions specified in Table 2A.3. The value of S_{g_set} shall be within the limits defined in Table 2A.3, and is to be kept at the same value throughout the test procedure. The table name shall be “sgset” The width of the table shall be 2 columns as shown below. The power shall be given in xx.xx dBm.

```
sgset
sg,value
sgpwr,xx.xx
;
```

Table 15

9A.2.16 Table 16: Gain S_{ba}

The 16th table shall identify the gain S_{ba} at each wavelength that corresponds to the optical frequencies defined in Table 2A.10 and at condition 1 to 9 specified in Table 2A.3 and Table 2A.4. The total power at port g shall be constant for conditions 1 through 6 and equal to S_{g_set}, as given in Table 15 (within the specified limits). The table shall be named “gain”. The gain shall be given in xx.xx dB. The width of this table shall be 10 columns as shown below (not all frequencies are shown here).

```
gain
freq,sba_c1,sba_c2,sba_c3,sba_c4,sba_c5,sba_c6,sba_c7,sba_c8,sba_c9
sba9590,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx
sba9580,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx
sba9570,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx
    .
    .
    .
sba9200,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx
sba9190,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx
sba9185,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx
```

;
Table 16

9A.2.17 Table 17: Gain Variation

The 17th table shall identify the maximum gain variation (or flatness) for conditions 1,3,5,7,8,9 specified in Table 2A.3 and Table 2A.4. Gain variation is defined in Table 2A.10, Note 8. The data table shall be named "gain_var". The gain variation shall be given in x.xx dB. The width of this table shall be 2 columns as shown below.

gain_var
var,value
var1,x.xx
var3,x.xx
var5,x.xx
var7,x.xx
var8,x.xx
var9,x.xx
;
Table 17

9A.2.18 Table 18: Noise Figure

The 18th table shall identify the noise figure (NF) at each wavelength that corresponds to the optical frequencies defined in Table 2A.10 and at the conditions specified in Table 2A.3 and Table 2A.4, **except** for the loss between ports g and h L_{gh} which shall be set to 10 dB for this measurement. The total power at port g, S_g, shall be the same value as for the gain measurement. The table shall be named "nf". The noise figure shall be given in xx.xx dB. The width of this table shall be 10 columns as shown below.

nf
freq,nf_c1,nf_c2,nf_c3,nf_c4,nf_c5,nf_c6,nf_c7,nf_c8,nf_c9
nf9590,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx
nf9580,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx
nf9570,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx

.
.
nf9200,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx.
nf9190,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx
nf9185,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx,xx.xx
;
Table 18

9A.2.19 Table 19: Saturated Output Power

The 19th table shall identify the saturated output power $S_{b\text{-}sat}$ at the conditions specified in Table 2A.3. The power shall be measured without jumper cable, i.e. port b shall be directly connected to a broad area optical power meter calibrated at 1546.5nm. The table shall be named "satpwr". The saturation power shall be given in xx.xx dB. The width of this table shall be 2 columns as shown below.

satpwr
satpwr,value
satpwr1,xx.xx
satpwr2,xx.xx
satpwr3,xx.xx
satpwr4,xx.xx

satpwr5,xx.xx
satpwr6,xx.xx
;
Table 19

9A.2.20 Table 20: Maximal Backface Current

The 20th table shall identify the pump laser backface current in xxxx μA at the EOL bias current reported in Table 7. The 20th table shall be named "pump_backface_max". It shall be 2 columns wide as shown in Table 20. For unused pump laser interfaces "0" shall be reported.

pump_backface_max
bfmax,current
bfmax1,xxxx
bfmax2,xxxx
bfmax3,xxxx
bfmax4,xxxx
bfmax5,xxxx
bfmax6,xxxx
;
Table 20

9A.2.21 Table 21: Pump Laser Assignment

The 21st table shall identify which pump lasers are used for amplification of the signal between ports a and g (stage 1), and which lasers are used for amplification between ports h and b (stage 2). The table shall also identify the wavelength of the pump laser.

Valid values for stage are "1" for stage 1, "2" for stage 2 and "0" in case the interfaces is not used.

Valid values for wavelength are "0980" for 980nm, "1480" for 1480nm and "0" in case the interfaces is not used.

The table shall be named "pump_assign". The table shall be three columns wide as shown in Table 21.

pump_assign
pump,stage,wavelength
pump1,x,xxxx
pump2,x,xxxx
pump3,x,xxxx
pump4,x,xxxx
pump5,x,xxxx
pump6,x,xxxx
;
Table 21

9A.2.22 Table 22: Port n Calibration Data

S_{bn} shall be measured at all frequencies defined in Table 2A.10, item 2. Note that S_{bn} is a positive value. A linear least squares curve-fitting shall be calculated resulting in following equation

$$S_{bn\_fit}(f) = f_i \cdot m + b$$

where f_i is the frequency according to Table 2A.10, item 2, *m* and *b* are the fitted coefficients.

The tilt of S_{bn} is then defined as

$$Tilt = S_{bn\_fit}(191.90\text{THz}) - S_{bn\_fit}(195.85\text{THz})$$

and shall be given with a resolution of 0.01dB. *Tilt* is a positive value if S_{bn} is higher at higher wavelength.

The offset of S_{bn} is defined as S_{bn_fit}(195.85THz) and shall be given with a resolution of 0.01dB.

As both offset and tilt are relative measurements, the data should have an inaccuracy not greater than 0.1 dB in tilt and 0.2 dB in offset.

The 22nd table shall be named “port_n_cal”. It shall be 2 columns wide as shown in Table 22.

port_n_cal
port_n,value
tilt,x.xx
offset,xx.xx
;
Table 22

9A.2.23 Table 23: Pump Laser Bias Currents under Test Conditions

The 23rd table shall identify the pump laser bias currents to meet conditions 1 to 9 in Table 2A.3 and Table 2A.4, respectively. The table name shall be “cond_bias”. The width of this table shall be 7 columns as shown below. The bias current shall be given in mA. For unused pump laser interfaces the column shall be filled with “0”.

cond_bias
cond,bias1,bias2,bias3,bias4,bias5,bias6
cond1,xxx,xxx,xxx,xxx,xxx,xxx
cond2,xxx,xxx,xxx,xxx,xxx,xxx
cond3,xxx,xxx,xxx,xxx,xxx,xxx
cond4,xxx,xxx,xxx,xxx,xxx,xxx
cond5,xxx,xxx,xxx,xxx,xxx,xxx
cond6,xxx,xxx,xxx,xxx,xxx,xxx
cond7,xxx,xxx,xxx,xxx,xxx,xxx
cond8,xxx,xxx,xxx,xxx,xxx,xxx
cond9,xxx,xxx,xxx,xxx,xxx,xxx
;
Table 23

9B Printed (or Labeled) Data on Top of Each Individual Component

Data to be printed (or Labeled) on the product

In order to facilitate manufacturing and process control at Lucent, adherence to the barcode labeling scheme shown below is necessary.

Two barcode labels are required on the product itself: One on the top surface of the module (viewable when the component packing box is opened) and one on the side of the module (viewable when the module is assembled into a circuit pack). The location of this barcode/alphanumeric label is shown in Figure 3A-1. The label shall be 1.5 inches maximum width and 0.5 inches maximum height. A width up to 2 inches can be tolerated. The label shall be placed on a flat surface and the view of the label shall not be obstructed by the standoffs. The labels must use an adhesive strong enough so that they shall not fall off during assembly or over time (over Lucent's storage and operating specifications for the module). Please allow enough quiet zone space on the labels. A quiet zone is the white space to the left and right of the bars on a barcode. The quiet zone should be **at least** ten times the width of the narrowest bar/space element.

The OAM serial number bar code/alphanumeric label shall also be placed on the top of the floppy disk.

Top label:

The top label must, at a minimum, contain the following:

- Vendor name
- Serial number (must be unique) of the product (as defined below) in both alphanumeric and barcode (code 39 or code 128)
- Short description of module (if component size allows):
- Lucent comcode number in both alphanumeric and barcode (code 39 or code 128)

The top label may also be used for the shipping box label (see description below):

Side label(s):

The side label(s) must contain the following:

- Serial number (must be unique) of the product (as defined below) in both alphanumeric and barcode (code 39 or code 128)

Please note that for prototypes/models/initial production, a loose "side" label must be provided in the box with the component.

If the component is physically too small for a 12 digit barcode, then reduction of the serial number to 4 digits is allowed.

YYSSMCV12345

Figure 9B-1: Sample of Side Label

The serial number is defined as follows:

YYSSMCV1234(5)

YY	Year of Manufacture
SS	Supplier Code (Assigned by Merrimack Valley Manufacturing)
M	Month of Manufacture 1-9, O, N, D (where 1=January, 2=February, …, O=October, N=November, D=December)
C	Part Identifier or Code (Assigned by Merrimack Valley Manufacturing)
V	Version A – Z (Begin with A. If the component undergoes changes, Merrimack Valley Manufacturing may upgrade this field).
1234(5)	Device Serial Number (Extracted from supplier's original serial number)

Data to be labeled on the component package (one component per box)

The box that the product is shipped in must have two barcode labels. The top must be labeled with the same information as the Top Label described above. It is acceptable to use the same label in both applications.

The side must be labeled with the comcode in both alphanumeric and barcode and the serial number (as defined above) in both alphanumeric and barcode.

9C Electronic Data Transfer (EDT) via File Transfer Protocol (FTP)

Data to be supplied electronically (will be replacing the floppy disk specified in section 9A.1. Please continue to provide floppy disks/email data until the ftp process has been proven functional.).

Electronic Data Transfer (EDT) for supplier data is necessary to support the Lucent "Wavestar OLS" project. A long-term solution that utilizes the e-commerce software supported by the Lucent-Merrimack Valley IT organization is the optimal solution. However, in order to facilitate a rapid implementation, we would like to implement the following interim solution utilizing FTP.

Secure FTP accounts have been established for each supplier. The Lucent StarBase development team will create an automated process to poll these accounts for data files. The data files will be transferred to the StarBase server and loaded into the database.

The attached file format is being provided for use in the interim solution. The final implementation of EDT via the DMZ and e-commerce software will be defined at a later date. Please note that once EDT has been verified as functioning successfully, data sheets/floppies will no longer be required to be shipped with each module, but must be available upon request within 24 hours.

Each file sent via FTP can contain the data elements for one or more components.

FTP Site: **ftp.lucent.com**

Login: **ssluftp**
(where: ss = supplier code which is assigned by Merrimack Valley and is equivalent to ss used in section 9B in serial number scheme, lu=Lucent, ftp = file transfer protocol)

Password: **xxxxxxx**
(which is assigned by Merrimack Valley and provided on an individual basis)

File Formats

Two files are required:

- .edt = summary of OA's to be shipped
- .dat = actual data file for each OA

EDT

Create a single file per shipment - filename format **YYYYMMDDHHMMSS.edt** -which will compile all of the Optical Amplifier modules, their serial numbers and associated data file names

There is a subdirectory for each component under the login directory (comcodeWSOA). A file should be sent for each shipment.

File name should be: YYYYMMDDHHMMSS.edt

- YYYY - 4 digit year file is sent
- MM - 2 digit month file is sent
- DD - 2 digit day file is sent
- HH - 2 digit hour file is sent
- MM - 2 digit minute file is sent
- SS - 2 digit second file is sent

NOTE: file extension MUST be 'edt'

The content shall be structured as follows:

comcode,version, serial_number,FNAME,value
comcode,version, serial_number,FNAME,value
:
comcode,version, serial_number,FNAME,value

with:

- **comcode** is the Lucent comcode number of the device.
- **version** is the device version (same as 7th column in Lucent defined serial number scheme).
- **serial number** using the Lucent scheme specified in Section 9B (YYSSMCV12345). The serial number is all UPPER CASE
- **FNAME** is not used for the WSOA and shall be left "FNAME"
- **value** is the file name of the data file in lower case (see .dat file definition below)

DAT

Create a data file for each OA module - filename format **yyssmcv12345.dat** (as defined in section 9B) - containing all of the data defined in Section 9A.2. Data may be transferred only for those Optical Amplifier modules which are actually shipping. The file has to be stored in the same ftp sub-directory as the associated .edt file

Data file name should be: yyssmcv12345.dat

- yy - 2 digit year (00 for year 2000)
- ss - supplier code (assigned by Merrimack Valley Manufacturing).
- m - month of manufacture 1-9, o, n, d (where 1=January, 2=February, ….,letter o = October, n = November, d = December).
- c - part identifier or Code (assigned by Merrimack Valley Mfg)
- v - version a to z (Begin with a, if the component undergoes a change, Merrimack Valley may upgrade this field).
- 12345 - device serial number (extracted from supplier's original serial number).

NOTE: file extension MUST be 'dat' and the file name should be in lower case

Please verify that the file name matches the barcode serial number on the OA Module, except for the fact that the barcode will be uppercase, and the filename will be lower case. [Please note that the floppy is to remain named with 8 characters, while edt is 12 characters]. Please implement a process which validates that the module barcode label information matches the file name transferred via EDT.

Example

Two .dat files were created as described in Section 9A.2: 00ss1ba00001.dat and 00ss1ba00002.dat. An .edt file sent on February 14, 2000 at 12:00 noon containing these WSOA's with comcode 550999999 has the file name:

20000214120000.edt

The file MUST be placed in the appropriate sub-directory under ftp login by component type:

550999999WSOA/20000214120000.edt

The content of this file is as follows:

550999999,A,00SS1BA00001,FNAME,00ss1ba00001.dat
550999999,A,00SS1BA00002,FNAME,00ss1ba00002.dat

The two data files (00ss1ba00001.dat and 00ss1ba00002.dat) which contain all the information that is defined in Section 9A.2 would be stored in the same sub-directory as the 20000214120000.edt file.

Resending Data

Please be aware that if you resend data, the original data will be overwritten. Therefore, anytime you overwrite data (example: Repaired Devices, see SECTION 10), you must send email notification to the Manufacturing Contacts indicating:

- the serial number
- the date the data was overwritten
- the reason for the overwrite

The header/subject line of the email notification shall state "EDT DATA OVERWRITTEN"

9D Accompanied Simulation Tool

OAM vendors shall provide a simulation tool for the particular OAM design. The simulation tool shall represent the nominal performance of their shipped OAM's. Lucent Technologies - Optical Networking Group shall use such software tool to facilitate simulation and design of WaveStar™ OLS 400G.

The application can be a Win32 console mode application which can run under Windows NT and Windows 95. The application reads from standard input and writes to standard output. The usual command line I/O re-direction commands (using "<" and ">") will of course allow for the input and output to be directed from/to files, e.g.

```
Filename <amp.in >amp.out
```

There are generally multiple input ports, for instance, a port for the input traffic, and a port for the pump power. The output file will contain the optical powers on the output port (or ports) of the given module.

<u>Input files:</u>
Here is the general structure of the input files (the "typewriter font" represents the input data).

```
EDFA_TYPE = Description
PORT DESCRIPTOR #1
PORT DESCRIPTOR #2
PORT DESCRIPTOR #3
      ...
```

For each input port, the "port descriptor" is as follows

```
RECORD 1: PORT=PORT NAME
RECORD 2: NO. OF 'DISCRETE' CHANNELS, NCH
RECORD 3: Wavelength (nm)    Power (dBm) \
RECORD 4:   ...                          |
RECORD 5:   ...                          | "NCH" records
RECORD 6:   ...                          |
RECORD *: Wavelength (nm)    Power (dBm) /
RECORD *+1: LAM1,LAM2,DLAM = min,max,delta wavelength for
  ASE table
RECORD *+2: ASE power density (mW/nm)
  (full table of ASE follows, one density per line)
```

<u>Output files:</u>
The output file will have a similar format, consisting of a sequential list of port descriptors describing the optical power spectrum on various output ports. The "port descriptor" data provided in the output is identical in format to the data required for "port descriptors" in the input data stream.

Example input file: this example excites the amplifier with 8 channels, with each channel provided with –26.0 dBm input power. The total pump power provided is 19.3 dBm per pump port, i.e. 85 mW per pump port. The "INPUT_PORT" includes a non-null ASE record (but with all ASE densities equal to zero), because it is the port which defines the output ASE grid.

```
EDFA_TYPE=ABCDE
PORT=INPUT_PORT
8
1549.2  -26
1550.8  -26
```

```
1552.4  -26
1554.0  -26
1555.6  -26
1557.2  -26
1558.8  -26
1560.4  -26
1510  1570  1
0.0
. . . (long list of zero values omitted for clarity)

0.0
0.0
PORT=PUMP_PORT
1
980  19.3
```

Example output file: Given the above input, this is the expected output to be generated by the fiber gain application. (For the sake of brevity, most of the output ASE table has been edited out… the line with the three dots represents the missing data.)

```
PORT OUTPUT_PORT
8
     1549.20          4.89
     1550.80          5.34
     1552.40          5.75
     1554.00          6.09
     1555.60          6.29
     1557.20          6.38
     1558.80          6.09
     1560.40          5.44
    1510.000     1570.000        1.000
1.724e-005
. . .
6.645e-003
5.100e-003
```

There is also a need for control variables that will describe the variable attenuator and other variables inside the OAM. In addition to the input and pump ports, the application needs to provide flexibility for a DCM. The application will have to be divided in two parts as to give Lucent the flexibility to provide DCM attenuation, attenuation slope and dispersion data in the same format as the input and output files.

SECTION 10: VENDOR COOPERATION

Component vendors are viewed as strategic partners. Lucent will make every effort to simplify its demands without compromising component quality and Lucent expects full cooperation from its component vendors. Vendors are required to supply all the information requested by *RELQUAL* as soon as possible. Lucent encourages vendor quality initiatives that would enhance the component quality over and above these specifications. Listed below are specific items that Lucent views as important.

- **Field Reliability:** The vendor shall provide requested information to determine the field reliability of the Optical Amplifier Module. This includes population of components and their duration in service as well as quantities returned due to field failures. Failure Mode Analyses (FMA) of field failures must be provided to Lucent upon request.
- **Process Control:** Manufacturing standards should be used to ensure that all processes are in control and standard sources should be used to ensure test equipment calibration before measuring any manufactured lot.

- **Feedback:** The vendor agrees to provide FMA reports, explaining in detail the reasons for the defects, root causes of the problem, the proposed or implemented steps to eliminate defects, the anticipated dates of implementation. A response upon receipt of returned material indicating device disposition is expected within two business days. An initial response of pass/fail status of the indicted components shall be provided no later than 14 days following their receipt. A final report shall be provided no later than 30 days. All communication should (1) reference the Lucent comcode and Device Quality Issue (DQI) number, as well as the vendor part number and serial number and (2) be directed via email to Robert O'Brien, FMA Coordinator, robertobrien@lucent.com, with a copy to the Manufacturing Technical Contact.
- **Repaired Devices**: For units which have been returned for repair:
  - repair the unit
  - retest the unit
  - resend the EDT files and send email to the Manufacturing Technical Contact per Section 9C, Resending Data.

  Typically, repaired devices shall maintain the initial serial number (in Lucent format). If the device has been updated during the repair, the Version should be upgraded to reflect the most appropriate revision, while the year, month, code and serial number shall remain the same. If the version changes, all labels and data associated with the device must reflect the update.

  For questions, please contact the Manufacturing Technical Contact.
- **Corrective Action:** All necessary corrective action shall be discussed with both the Design and Manufacturing Technical contacts, and implemented as soon as possible.
- **Change Notification:** The vendor will give notice of all changes. The vendor shall provide change documents and seek formal approval from Lucent Technologies (Design and Manufacturing Organizations) before implementing changes into their product.
- **Waivers/Non-conformances/Exceptions:** If a vendor is having difficulty meeting a specified requirement and wishes to request a waiver/nonconformance/exception to be granted, a notice must be provided to both Lucent Technologies' Design and Manufacturing Technical Contacts for approval. The notice must include the Lucent comcode, vendor part number, quantity of devices, expected time frame for delivery of said quantity, description of nonconformance, and corrective action plan. Lucent reserves the right to limit the quantity to be accepted. Periodic status of the corrective actions to be taken shall be communicated via email to both the Design and Manufacturing Technical Contacts until closed.

APPENDIX A – CHANGE HISTORY INFORMATION

ISSUE NUMBER	DATE	DESCRIPTION OF CHANGE(S)
3.0	4-25-2000	**Cover page:** Change History Information. **Section 2A.2:** • New temperature range for heat sink and definition of RT. • Condition 0 added • Tilt for condition 1, 3, 5, 10, 12 = -1.0dB **Section 2A.3:** • Increased limit for gain ripple. • Increased NF for conditions 7 to 9 • Relaxation to monitor ratio variation vs. wavelength **Section 2A.6:** • Increased limit for gain ripple EOL. **Section 2A.7:** • Changes to saturating signal definition. • Updated definition of gain variation **Section 2B:** • Table 2B.1 and Table 2B.3: Limit of Operating OAM heat sink average temperature changed • Table 2B.2 and Table 2B.4: TEC Cooling Capacity: Condition and Limit changed TEC Current, TEC Voltage and TEC Power Dissipation: Condition changed • Note 2: 600 hour temperature limit changed • Note 15: added **Section 2C.1 and 2C.2:** • Requirement for driving VOA to HW limit changed. • Coil inductance added • Allowed change of attenuation increased to +/- 0.1dB for reduced power mode. **Section 2D.4:** • Thermistor set point defined. • Note 2 removed. **Section 3A:** • New drawings Figure 3A-1and Figure 3A-3. • ST connectors replaced by LC connectors. • **Error! Reference source not found.** removed. **Section 4A:** • ST connector section removed **Section 4C:** • Flammability paragraph. **Section 5:** • Environmental Specifications: Opening paragraph **Section 5A:** • Airborne contaminants: First sentence • Cable Retention, first bullet line wordings changed to clarify

		fiber diameter range. **Section 5B:** • First bullet line wordings changed to clarify fiber diameter range. **Section 6A:** • Fourth paragraph, second sentence changed slightly to clarify that Section 7 is in the same document. **Section 9A:** • 9A2.2: Set value for auxiliary heater defined. • 9A2.14: ‘voa_cond0’ added. • 9A2.16 and 9A.2.18: Frequency values adjusted according to Table 2A.10. **Section 9C:** • Section 9C Electronic Data Transfer (EDT) via File Transfer Protocol (FTP) added moved Accompanied Simulation Tool to Section 9D **APPENDIX A:** • Added at the end of the document for maintaining change history information.
3.1	8-22-2000	**Intro:** • Reference list updated **Section 2A.3:** • Table 2A.4: S_a, S_g and S_b level changed • Table 2A.6: Noise Figure (C) condition 6 changed **Section 2B.1:** • Table 2B.2: Note reference changed for Tracking Ratio and Tracking error **Section 2E:** • Section 2E OAM Control Requirements added **Section 3A:** • Sentence added to define the finish of the heat sink • Table 3A.1: Connector type changed for ports D, F, O, M and K • Table 3A.1: Pigtail length changed • Figure 3A-10: ST connector label position added **Section 4A:** • added a more information and reference under “Connector Cleaning” • LC connector optical performance specification change • ST connector optical performance specification added • added titles to the Fungus Resistance and Flammability reference documents **Section 5B:** • side pull loads for 900µm, 250µm and ribbon fiber changed **Section 6A:** • FIT rate table for pump lasers changed

		Section 6B • Supplementary test information added **SECTION 8:** • Updated CDHR information to include letter as an option **Section 9A.2:** • Table 9A.1and Table 9A.2 S_b level changed **Section 9B:** • section re-arraigned **Section 9C** • information on Repaired Devices removed • information on Resending Data added **SECTION 10:** • information on Repaired Devices added
3.2	10-11-00	**Intro:** • Reference list updated **Section 6B—REMOVED** • Additional tests not needed for OAMs; operating vibration testing covered in Telcordia GR-1312.