FC, SC, ST and D4 Singlemode Fiber Optic Buildout Attenuators

DESIGN OBJECTIVES
The product described in this document has not been fully tested to ensure conformance to the requirements outlined below. Therefore Tyco Electronics makes no representation or warranty, express or implied, that the product will comply with these requirements. Further, Tyco Electronics may change these requirements based on the results of additional testing and evaluation. Contact Tyco Electronics Engineering for further details.

1. SCOPE

1.1. Content

This specification covers the performance, tests and quality requirements for FC, SC, ST and D4 Singlemode Fiber Optic Buildout Attenuators (BOA).

1.2. Qualification

When tests are performed on the subject product line, procedures specified in Figure 2 shall be used. All inspections shall be performed using the applicable inspection plan(s) and product drawing(s).

2. APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the latest edition of the document applies. In the event of conflict between requirements of this specification and the product drawing, the product drawing shall take precedence. In the event of conflict between requirements of this specification and referenced documents, this specification shall take precedence.

2.1. Tyco Electronics Documents

- 101-46: Workmanship Specification
- 501- : Qualification Test Report

2.2. Commercial Standards

- GR-63-CORE: Network Equipment Building System (NEBS) Requirements: Physical Protection
- GR-326-CORE: Generic Requirements for Singlemode Optical Connectors and Jumper Assemblies
- GR-910-CORE: Generic Requirements for Fiber Optic Attenuators
- GR-1221-CORE: Generic Reliability Assurance Requirements for Passive Optical Components
- MIL-STD-883: Microcircuits
- TIA/EIA-455: Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices and Other Fiber Optic Components

3. REQUIREMENTS

3.1. Design and Construction

Product shall be of the design, construction and physical dimensions specified on the applicable product drawing(s).

DESIGN OBJECTIVES 12Feb03

3.2. Optical Power Source

Nominal optical power source wavelengths shall be 1310 and 1550 nm.

3.3. Ratings

Performance	Interface Type and Value			Units
	PC	UPC	APC	
Reflectance	-40	-55	-60	dB
Storage Temperature	-40 to 70			°C
Operating Temperature	-40 to 75			°C
Durability	200			Cycles

Figure 1

3.4. Performance and Test Description

Product is designed to meet the mechanical, environmental and optical transmittance performance requirements specified in Figure 2. Unless otherwise specified, all tests shall be performed at ambient environmental conditions.

3.5. Test Requirements and Procedures Summary

Test Description	Requirement	Procedure
Visual and mechanical inspection.	Meets requirements of product drawing.	TIA/EIA-455-13A. Visual, dimensional and functional per applicable quality inspection plan.
Initial insertion loss (reference).	Insertion loss: ± 0.15 X nominal attenuation value for attenuators ≥ 5 dB. ± 0.75 dB for attenuators < 5 dB.	TIA/EIA-455-171, Method C3. Measure using reference quality leads manufactured per applicable product drawing. Record a single zero reference level reading. Record a single insertion loss measurement in each direction for each attenuator.
Initial reflectance (reference).	Maximum reflectance for any single specimen shall be as stated in Figure 3.	TIA/EIA-455-107. Reflectance shall be measured using a reference quality test lead. Record a single reflectance reading in each direction for each attenuator.

Figure 2 (cont)

DESIGN OBJECTIVES 12Feb03

Test Description	Requirement	Procedure
Controlled operating environment.	GR-910-CORE, Section 4.1.1. Shall meet requirements of Figure 3 before, during, and after test. See Note.	GR-63-CORE, Section 5.1.1. Subject specimens to an ambient temperature of 23°C and 50% RH for a minimum of 24 hours. Decrease the chamber temperature at a rate of 30°C per hour to -5°C, any RH. Maintain -5°C temperature for 16 hours, any RH. Increase chamber temperature at a rate of 5°C per hour to 5°C, any RH. Increase chamber temperature at a rate of 5°C per hour to 28°C. Increase RH to attain a 90% level by the time the target temperature is attained. Maintain 28°C temperature and 90% RH for 96 hours. Increase chamber temperature at a rate of 5°C per hour to 50°C. Decrease RH to attain less than a 32% level by the time the target temperature is attained. Maintain 50°C temperature and less than 32% RH for 12 hours. Maintain 50°C temperature for an additional 4 hours. During these 4 hours, reduce the RH to less than 15%. Decrease chamber temperature at a rate of 5°C per hour to 5°C and maintain RH to less than 15%. Maintain 5°C temperature and less than 15% RH for 3 hours. Increase chamber temperature at a rate of 30°C per hour to 50°C, any RH. Maintain 50°C temperature, any RH, for 3 hours. Decrease chamber temperature at a rate of 30°C per hour to 23°C, any RH. Measure attenuation and reflectance at each temperature plateau, after allowing the specimens to stabilize for a minimum of .5 hour. Final measurements shall be made after stabilizing for 2 hours. See paragraph 5.2.

DESIGN OBJECTIVES 12Feb03

Figure 2 (cont)

Test Description	Requirement	Procedure
Uncontrolled operating environment.	GR-910-CORE, Section 4.1.2. Shall meet requirements of Figure 3 before, during, and after test. See Note.	GR-910-CORE, Section 5.1.2. Subject specimens to 21 cycles (168 hours) at -40 to 75°C and 0 to 90 ± 5% RH respectively. Measure attenuation and reflectance at each temperature plateau, after allowing the specimens to stabilize for a minimum of .5 hour once a day. See paragraph 5.2.
Low temperature exposure and thermal shock, non-operating environment.	GR-910-CORE, Section 4.1.3. Shall meet requirements of Figure 3 before and after test. See Note.	GR-63-CORE, Section 4.1.1.1. Place specimens into chamber at 25°C, any RH, decrease chamber temperature to -40°C at a rate of 30°C per hour and maintain specimens at -40°C for 72 hours. Remove the specimens from the chamber. Measure change in attenuation and reflectance before the test and after specimens have stabilized at ambient temperature. See paragraph 5.2.
High temperature exposure and thermal shock, non-operating environment.	GR-910-CORE, Section 4.1.3. Shall meet requirements of Figure 3 before and after test. See Note.	GR-63-CORE, Section 4.1.1.2. Place specimens into chamber at 25°C, any RH, increase chamber temperature to 70°C at a rate of 30°C per hour and maintain specimens at 70°C for 72 hours. Remove the specimens from the chamber. Measure change in attenuation and reflectance before the test and after specimens have stabilized at ambient temperature. See paragraph 5.2.
High relative humidity exposure, non-operating environment.	GR-910-CORE, Section 4.1.3. Shall meet requirements of Figure 3 before and after test. See Note.	GR-63-CORE, Section 4.1.1.3. Place specimens into chamber at 25°C, any RH, increase chamber temperature to 40°C at a rate of 30°C per hour. While maintaining the specimens at 40°C, increase the relative humidity to 95% in less than 4 hours and maintain this temperature and RH for 96 hours. Return the chamber to 25°C at a rate of 30°C per hour. Measure attenuation and reflectance before the test and after specimens have stabilized at ambient temperature and humidity. See paragraph 5.2.

Figure 2 (cont)

DESIGN OBJECTIVES 12Feb03

Test Description	Requirement	Procedure
Humidity/condensation cycling.	GR-910-CORE, Section 4.1.4. Shall meet requirements of Figure 3 before, during, and after test. See Note.	GR-910-CORE, Section 5.1.4. Subject specimens to 14 cycles (168 hours), at the temperature humidity profile shown in Figure 8. Measure attenuation and reflectance at each temperature plateau, after allowing the specimens to stabilize for a minimum of .5 hour. Final measurements shall be made after stabilizing for 2 hours. See paragraph 5.2.
Water immersion.	GR-910-CORE, Section 4.1.5. Shall meet requirements of Figure 3 before, during and after test. See Note.	GR-1221-CORE, Section 6.2.10. Subject specimens to water immersion for 168 hours. Water shall be 5.5 ± 0.5 ph and 43 ± 2°C. Measure attenuation and reflectance once per day during test and 24 hours after specimens have been removed from the bath.
Vibration.	GR-910-CORE, Section 4.1.6. Shall meet requirements of Figure 3 before and after test. See Note.	GR-910-C0RE Section 5.1.6. Subject specimens to 10-55-10 Hz traversed in 4 minutes with 1.52 mm [.06 in] maximum total excursion. 2 hours in each of 3 mutually perpendicular planes. Measure attenuation and reflectance before and after testing.
Side pull load.	GR-910-CORE, Section 4.1.9. Shall meet requirements of Figure 3 before, during, and after test. See Note.	GR-910-CORE, Section 5.1.9. Subject specimens to loads specified in Figure 9 applied at a 90 degree angle. Measure change in attenuation and reflectance before, during and after the test.
Cable retention.	GR-910-CORE, Section 4.1.10. Shall meet requirements of Figure 3 before and after test. See Note.	GR-910-CORE, Section 5.1.10. Subject specimens to loads specified in Figure 9 to the secured cable a minimum distance of 10 cm [4 in] from the end of the fiber at a rate of 400 µm [.016 in] per second until the specified load is attained and hold for 1 minute. Measure change in attenuation and reflectance before and after the test.
Durability.	GR-910-CORE, Section 4.1.11. Shall meet requirements of Figure 3 after each re-connection. See Note.	GR-326-CORE, Section 4.4.3.8. Subject specimens to 200 mating and unmating cycles. Measure attenuation and reflectance after each re-connection.

Figure 2 (cont)

Test Description	Requirement	Procedure
Impact.	GR-910-CORE, Section 4.1.12. Shall meet requirements of Figure 3 before and after test.	GR-1221-CORE, Section 6.2.1. Subject specimens to 8 impact cycles in each of 3 axes dropped from a height of 1.8 m [6 ft] onto a concrete floor. Measure attenuation and reflectance before and after test.
Polarization Dependent Loss (PDL).	Maximum change in attenuation shall be ≤ 0.5 dB or ≤ 0.15A, whichever is larger.	GR-910-CORE, Section 5.2.6. Measure PDL using a fiber coupled Polarization Controller (PC) per Figure 10.
Polarization Mode Dispersion (PMD).	Maximum value of dispersion shall not exceed 0.2 ps for all operating wavelengths.	GR-910-CORE, Section 5.2.7. Measure PMD using the fixed analyzer method or the interferometric method.

NOTE *Shall meet visual requirements, show no physical damage, and shall meet the requirements of additional tests as specified in the Product Qualification and Requalification Test Sequence in Figure 4.*

Figure 2 (end)

Optical Criteria	Digital		
	PC	UPC	APC
Optical Bandpass (nm)	1280-1335 and1525-1575	1260-1360 and 1430-1580	
Change in Attenuation ΔA (dB)	± 0.5 or 0.15A		
Reflectance (dB)	-40	-55	-60

Figure 3

DESIGN OBJECTIVES 12Feb03

3.6. Product Qualification and Requalification Test Sequence

Test or Examination	Test Group (a)					
	1	2	3	4	5	6
	Interface Type					
	SC		FC		ST	D4
	UPC	APC	UPC	APC	UPC	PC
	Test Sequence (b)					
Visual and mechanical inspection	1	1	1	1	1	1
Initial insertion loss (reference)	2	2	2	2	2	2
Initial reflectance (reference)	3	3	3	3	3	3
Controlled operating environment	4	4	4	4	4	4
Uncontrolled operating environment	5	5	5	5	5	5
Low temperature exposure and thermal shock	6	6	6	6	6	6
High temperature exposure and thermal shock	7	7	7	7	7	7
High relative humidity exposure	8	8	8	8	8	8
Humidity/condensation cycling	9	9	9	9	9	9
Water immersion	10	10	10	10	10	10
Vibration	11	11	11	11	11	11
Side pull load	12	12	12	12	12	12
Cable retention	13	13	13	13	13	13
Durability	14	14	14	14	14	14
Impact	15	15	15	15	15	15
Polarization Dependent Loss (PDL)	16	16	16	16	16	16
Polarization Mode Dispersion (PMD)	17	17	17	17	17	17

NOTE *(a) See paragraph 4.1.A.*
(b) Numbers indicate sequence in which tests are performed.

Figure 4

DESIGN OBJECTIVES 12Feb03

4. QUALITY ASSURANCE PROVISIONS

4.1. Reliability Assurance Process

A. Qualification Testing

1. Specimen Selection

Specimens shall be prepared in accordance with applicable Instruction Sheets and shall be selected at random from current production. Each test group shall consist of a minimum of 11 specimens of the interface type indicated in Figure 5.

Test Group	1	2	3	4	5	6
Interface Type	SC-UPC	SC-APC	FC-UPC	FC-APC	ST-UPC	D4-PC
Part Number	209250-X	417021-X	209285-X	209845-X	417399-X	209570-X
Cable Length	10 m [32.8 ft]					
Control Cables Required	1					
Media Type	1 (3 mm)					

Figure 5

2. Test Sequence

Qualification inspection shall be verified by testing specimens as specified in Figure 4.

B. Requalification Testing

If changes significantly affecting form, fit or function are made to the product or manufacturing process, product assurance shall coordinate requalification testing, consisting of all or part of the original testing sequence as determined by development/product, quality and reliability engineering.

C. Reliability

Reliability testing is completed after Qualification testing and includes mechanical/physical tests as well as endurance tests. Figure 6 lists a minimum set of tests that must be performed. This test sequence meets the requirements of GR-910-CORE, section 7.3.2. Performance requirements are according to GR-910, Issue 2, Section 4, “Performance Criteria”.

Test	Standard	Conditions	Sampling	Group
Mechanical Shock	EIA/TIA-455-2A	1.8 meters, 5 cycles	11	1
Vibration	EIA/TIA-455-11A	20 G, 10 to 2,000 Hz	11	1
Thermal Shock	EIA/TIA-455-71	ΔT=100°C, 20 cycles	11	1
High Temperature Aging (Dry)	MIL-STD-883-D, Method 1005	85°C, <40% RH, 5000 hours	22	2
High Temperature Storage (Damp)	EIA/TIA-455-5A	75°C, 90% RH, 2000 hours	22	3
Temperature Cycling	EIA/TIA-455-3A, or MIL-STD-883D, Method 1010	-40 to 75°C, 500 cycles	11	4

Figure 6

DESIGN OBJECTIVES 12Feb03

D. Reliability Monitoring

Reliability monitoring shall be initiated on completion of a Reliability Test Program as outlined in paragraph 4.1.C. above. The purpose is to verify that the manufacturing process continues to be capable of producing product that meets the established reliability objectives.

Product should be sampled from normal production according to specified sampling plans and intervals. An effective activation energy of 0.6 eV shall be used in applicable reliability calculations for damp heat failure data as specified by GR-910, Issue 2, Section 7.3.2.

Test	Standard	Conditions	Sampling	Interval
High Temperature Storage (Damp)	EIA/TIA-455-5A	75°C, 90% RH, 2000 hours	3 pieces per part number	Monthly

Figure 7

4.2. Acceptance

Acceptance is based on verification that the product meets requirements of Figure 2. Failures attributed to equipment, test setup or operator deficiencies shall not disqualify the product. When product failure occurs, corrective action shall be taken and specimens resubmitted for qualification. Testing to confirm corrective action is required before resubmittal.

4.3. Quality Conformance Inspection

The applicable quality inspection plan will specify the sampling acceptable quality level to be used. Dimensional and functional requirements shall be in accordance with the applicable product drawing and this specification.

5. SPECIAL INSTRUCTIONS

5.1. Cleaning

If at any time, a connector specimen is uncoupled during qualification testing, the optical interfaces shall be cleaned in accordance with section 4.5. of Workmanship Specification 101-46 prior to any subsequent optical measurements. Additional cleaning techniques deemed necessary by Product Engineering shall be described in the Test Report. If, after cleaning the connector as prescribed, loss performance exceeds the specified limit, or, if the operator suspects the presence of debris at the optical interface, perform the cleaning procedure a second time. If the resultant optical reading still exceeds the specification, clean the interface a third time and accept that reading.

5.2. Control Cables

Control cables shall be subjected to climatic environmental tests. Transmittance shall be recorded each time a specimen transmittance is made. Changes in control cable power of less than 0.05 dB may be neglected in the test specimen power and loss calculations. If control cable power changes by more than 0.05 dB during the duration of the test or sequence of tests, change in control cable power shall be included in power and loss calculations per TIA/EIA-455-20A.

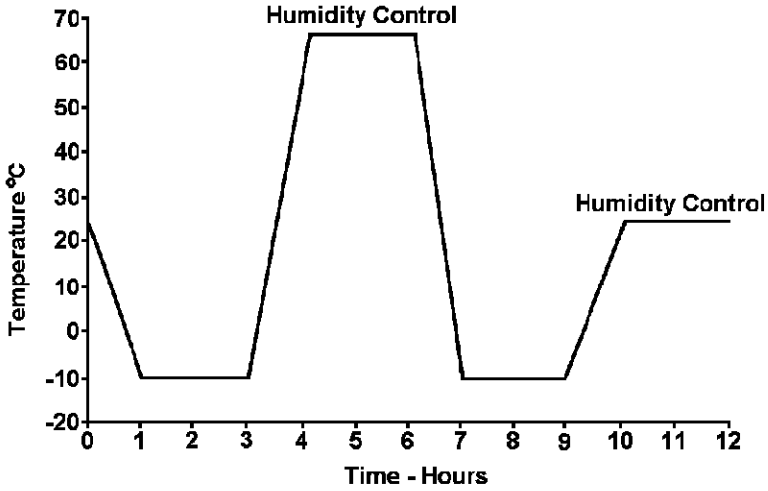

Figure 8
Humidity/condensation Cycling Profile

Media Type	Side Pull Tensile Load	Cable Retention Load
Type I: reinforced cable (2 mm diameter min)	1.25 kg [2.75 lb]	2.0 kg [4.4 lb]
Type II: 900 µm loose buffered	0.25 kg [0.55 lb]	0.7 kg [1.54 lb]
Type III: 250 µm coated or tight buffered	0.25 kg [0.55 lb]	0.5 kg [1.1 lb]

Figure 9
Loading

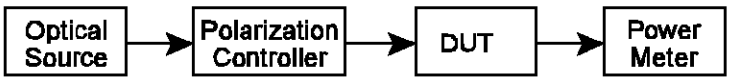

Figure 10
PDL Configuration

DESIGN OBJECTIVES 12Feb03