LC Duplex Sealed Plug and Receptacle Singlemode and Multimode Connectors (ODVA Conforming)

1. SCOPE

1.1. Content

This specification, based on IEC 61753-1 Edition 1.0 tests for Category E (Extreme Environment), covers the performance, tests and quality requirements for TE Connectivity (TE) Fiber Optic LC Duplex Sealed Plug and Receptacle Singlemode and Multimode Connectors, Open DeviceNet Vendor Association, Inc. (ODVA conforming).

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).

1.3. Successful qualification testing on the subject product line was completed on 12Feb09. The Qualification Test Report number for this testing is 501-700. This documentation is on file at and available from Engineering Practices and Standards (EPS).

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 Document

501-700: Qualification Test Report (Sealed Industrial LC Duplex Connector System)

2.2. Commercial Standards

- IEC 60529: Degrees of Protection Provided by Enclosures (IP Code)
- IEC 61300: Fibre Optic Interconnecting Devices and Passive Components - Basic Test and Measurement Procedures
- IEC 61754-20: Fibre Optic Connector Interfaces - Part 20: Type LC Connector Family
- TIA/EIA-455-B: Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components

2.3. Reference Documents

- 102-952: Quality Specification (Qualification of Fiber Optic Connectors and Cable Assemblies)
- 408-10079: Instruction Sheet (Sealed Circular LC Connector System -- Plug Kit 1828618-[ ] and Receptacle Kit 1828619-[ ])
- IEC 60068-1: Environmental Testing Part 1: General and Guidance

3. REQUIREMENTS

3.1. Design and Construction

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

3.2. Optical Power Source

Unless otherwise stated in the Qualification Test Report, the optical power source wavelength shall be 1310 ± 30 nm and 1550 ± 30 nm for singlemode, and 850 ± 30 nm and 1300 ± 30 nm for multimode.

3.3. Ratings

Performance	Value				Units
	Singlemode		Multimode		
Attenuation, typical (see Note)	0.08	0.08	0.07	0.04	dB
Return loss, typical (see Note)	55	56	31	32	dB
Operating temperature	-40 to 85				°C
Storage temperature	-40 to 85				°C

NOTE *Typical values represent the median of the sample data for one mated connector pair. See Figure 2 for maximum insertion loss and minimum return loss requirements. Refer to the Qualification Test Report for a list of part numbers used to acquire data.*

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, including end face geometry. LC Connector complies with dimensional requirements of IEC 61754-20. No defects which would affect functionality.	IEC 61300-3-1. Visual, dimensional and functional per applicable quality inspection plan. Measure dimensions D, H1, H2, K, and O as defined in the Fibre Optic Connector Interfaces standard 61754-20. See Note (a).

Figure 2 (continued)

Test Description	Requirement	Procedure
Attenuation (new product).	Singlemode and Multimode: For one mated connector pair: Average attenuation for the group/lot is 0.25 dB. Maximum attenuation is 0.50 dB for > 97% of specimens. Maximum attenuation is 0.75 dB for 100% of specimens. For two mated connector pairs: Average attenuation for the group/lot is 0.50 dB. Maximum attenuation is 1.00 dB for > 97% of specimens. Maximum attenuation is 1.50 dB for 100% of specimens. See Note (b).	IEC 61300-3-4. Launch and receive are both part of the pair under test and are not reference quality. Precondition by cleaning plug and adapter per manufacturer's instructions. Test at 1310 ± 30 nm and 1550 ± 30 nm for singlemode. For singlemode, only the fundamental mode shall propagate at the connector interface and at the detector. Test at 850 ± 30 nm and 1300 ± 30 nm for multimode. Launch cable shall be wrapped in order to maintain Category 1 overfilled launch conditions according to TIA/EIA-526-14A. See paragraph 5.1.
Return loss (new product).	Singlemode: Minimum return loss for any single specimen is 40dB for pigtail specimens (1 mated connector pair). Minimum return loss for any single specimen is 37 dB for jumper specimens (2 mated connector pairs). Multimode: Minimum return loss for any single specimen is 20 dB for pigtail specimens (1 mated connector pair). See Note (b).	IEC 61300-3-6, Branching device or OTDR method. Precondition by cleaning plug and adapter per manufacturer's instructions. Test at 1310 ± 30 nm and 1550 ± 30 nm for singlemode. Test at 850 ± 30 nm and 1300 ± 30 nm for multimode, using the same launch conditions as for attenuation. See paragraph 5.1.
Change in attenuation.	As applicable to each test: Singlemode and Multimode Maximum change in attenuation is 0.2 dB during and after test for pigtail specimens (1 mated connector pair). Maximum change in attenuation is 0.5 dB during and 0.4 dB after test for jumper specimens (2 mated connector pairs).	IEC 61300-3-3 Method 1. Record attenuation before, during and after test as applicable to each test. Unless otherwise specified, measure attenuation at 1310 ± 30 nm and 1550 ± 30 nm for singlemode and at 850 ± 30 nm and 1300 ± 30 nm for multimode. Calculate change in attenuation during test as the difference between the maximum and minimum attenuation values recorded during test (peak-to-peak range). Calculate change in attenuation after test as the difference between the initial reference recorded at the start of each test and the final reading recorded at the end of each test.

Figure 2 (continued)

Test Description	Requirement	Procedure
Dry heat (high temperature endurance).	Singlemode and Multimode: Maximum attenuation for any single specimen is 0.50 dB before, during and after test for pigtail specimens. Maximum attenuation for any single specimen is 1.00 dB before, during and after test for jumper specimens. Maximum change in attenuation for any single specimen is 0.2 dB during and after test for pigtail specimens and 0.5 dB during and 0.4 dB after test for jumper specimens. Minimum return loss for any single specimen is 40 dB for singlemode or 20 dB for multimode before, during and after test for pigtail specimens. Minimum return loss for any single specimen is 37 dB for singlemode before, during and after test for jumper specimens. See Note (b).	IEC 61300-2-18. Maintain specimens undisturbed in the chamber at room ambient (23 ± 5°C and 20 to 70% RH) for 2 hours prior to recording initial attenuation and return loss. A minimum of 3 m [9.8 ft] cable length shall be inside the test chamber ($\geq$ 3 m [9.8 ft] jumper specimen, or $\geq$ 1.5 m [4.9 ft] on each side of the connector for pigtail specimens). Subject specimens to 85 ± 2°C for 96 hours (4 days). Record attenuation and return loss at a minimum interval of 1 hour during test and calculate maximum change in attenuation (peak-to-peak range). At the completion of testing, measure final attenuation and return loss 2 hours after the chamber's return to ambient conditions, with specimens undisturbed in the test chamber. Calculate final change in attenuation after test as the difference between the before and after test readings (change from initial reference at the start of the test). See paragraph 5.2.

Figure 2 (continued)

Test Description	Requirement	Procedure
Cold.	Singlemode and Multimode: Maximum attenuation for any single specimen is 0.50 dB before, during and after test for pigtail specimens. Maximum attenuation for any single specimen is 1.00 dB before, during and after test for jumper specimens. Maximum change in attenuation for any single specimen is 0.2 dB during and after test for pigtail specimens and 0.5 dB during and 0.4 dB after test for jumper specimens. Minimum return loss for any single specimen is 40 dB for singlemode or 20 dB for multimode before, during and after test for pigtail specimens. Minimum return loss for any single specimen is 37 dB for singlemode before, during and after test for jumper specimens. See Note (b).	IEC 6130-2-17. Maintain specimens undisturbed in the chamber at room ambient (23 ± 5°C and 20 to 70% RH) for 2 hours prior to recording initial attenuation and return loss. A minimum of 3 m [9.8 ft] cable length shall be inside the test chamber ($\geq$ 3 m [9.8 ft] jumper specimen, or $\geq$ 1.5 m [4.9 ft] on each side of the connector for pigtail specimens). Subject specimens to -40 ± 2°C for 96 hours (4 days). Attenuation and return loss shall be measured before test, at a maximum interval of 1 hour during test and after test. Maintain specimens undisturbed for 2 hours after the chamber's return to ambient conditions, before measuring final attenuation and return loss. Calculate maximum change in attenuation during test as the peak-to-peak range of attenuation values. Calculate change in attenuation after test as the difference between the before and after test readings. See paragraph 5.2.

Figure 2 (continued)

Test Description	Requirement	Procedure
Change of temperature.	Singlemode and Multimode: Maximum attenuation for any single specimen is 0.50 dB before, during and after test for pigtail specimens. Maximum attenuation for any single specimen is 1.00 dB before, during and after test for jumper specimens. Maximum change in attenuation for any single specimen is 0.2 dB during and after test for pigtail specimens and 0.5 dB during and 0.4 dB after test for jumper specimens. Minimum return loss for any single specimen is 40 dB for singlemode or 20 dB for multimode before, during and after test for pigtail specimens. Minimum return loss for any single specimen is 37 dB for singlemode before, during and after test for jumper specimens. See Note (b).	IEC 61300-2-22, Test Nb. Maintain specimens undisturbed in the chamber at room ambient (23 ± 5°C and 20 to 70% RH) for 2 hours prior to recording initial attenuation and return loss. A minimum of 3 m [9.8 ft] cable length shall be inside the test chamber ($\geq$ 3 m [9.8 ft] jumper specimen, or $\geq$ 1.5 m [4.9 ft] on each side of the connector for pigtail specimens). Using a ramp rate of 1°C per minute, subject specimens to 12 cycles between -40 ± 2°C and 85 ± 2°C with 1 hour dwells at each extreme. Attenuation and return loss shall be measured before test, at a maximum interval of 10 minutes throughout the exposure, and after test. Maintain specimens undisturbed for at least 2 hours after the chamber's return to ambient conditions, before measuring final attenuation and return loss. Calculate maximum change in attenuation during test as the peak-to-peak range of attenuation values. Calculate change in attenuation after test as the difference between the before and after test readings. See paragraph 5.2.

Figure 2 (continued)

Test Description	Requirement	Procedure
Composite temperature/humidity cyclic test.	Singlemode and Multimode: Maximum attenuation for any single specimen is 0.50 dB before, during and after test for pigtail specimens. Maximum attenuation for any single specimen is 1.00 dB before, during and after test for jumper specimens. Maximum change in attenuation for any single specimen is 0.2 dB during and after test for pigtail specimens and 0.5 dB during and 0.4 dB after test for jumper specimens. Minimum return loss for any single specimen is 40 dB for singlemode or 20 dB for multimode before, during and after test for pigtail specimens. Minimum return loss for any single specimen is 37 dB for singlemode before, during and after test for jumper specimens. See Note (b).	IEC 61300-2-21 Z/AD profile with exposure to cold. After pre-conditioning, maintain specimens undisturbed in the chamber at room ambient (23 ± 5°C and 20 to 70% RH) for 2 hours prior to recording initial attenuation and return loss. A minimum of 3 m [9.8 ft] cable length shall be inside the test chamber ($\geq$ 3 m [9.8 ft] jumper specimen, or $\geq$ 1.5 m [4.9 ft] on each side of the connector for pigtail specimens). Profile temperature extremes are -10 ± 2°C and 65 ± 2°C, with 93 ± 3% RH at the maximum temperature. Dwell at each temperature extreme for 3 hours. Perform 10 total cycles, with cold shock included in 5 of the first 9 cycles. Attenuation and return loss shall be measured before test, at a maximum interval of 10 minutes during test and after test. Maintain specimens at ambient conditions for a minimum of 24 hours, before measuring final attenuation and return loss. Calculate maximum change in attenuation during test as the peak-to-peak range of attenuation values. Calculate change in attenuation after test as the difference between the before and after test readings. See paragraph 5.2.

Figure 2 (continued)

Test Description	Requirement	Procedure
Cable retention, axial pull.	Singlemode and Multimode: Maximum attenuation for any single specimen is 0.50 dB before, during and after test. Maximum change in attenuation for any single specimen is 0.2 dB during and after test. Minimum return loss for any single specimen is 40 dB for singlemode or 20 dB for multimode before, during and after test. See Note (b).	IEC 61300-2-4. Fixture specimen so that the load is applied to the fiber/cable retention mechanism and not to the coupling mechanism. Using a 7.6 cm [3 in] mandrel located 25 ± 3 cm [9.8 ± 1.2 in] from the plug, apply a 100 ± 5 N [22.5 ± 1.1 lbf] tensile load to the cable for cables > 2 mm [0.079 in]. Apply load at a rate of 5 N/s [1 lbf/s] at a 0 degree pull angle to the mated specimen and hold for 120 seconds. Measure attenuation and return loss before and after test with the load removed. Record attenuation and return loss at least once during test, after maintaining maximum load for a minimum of 30 seconds.
Cable retention, right angle pull.	Singlemode and Multimode: Maximum attenuation for any single specimen is 0.50 dB before, during and after test. Maximum change in attenuation for any single specimen is 0.2 dB during and after test. Minimum return loss for any single specimen is 40 dB for singlemode or 20 dB for multimode before, during and after test. See Note (b).	IEC 61300-2-7. Using a 7.6 cm [3 in] mandrel located 25 ± 3 cm [9.8 ± 1.2 in] from the plug, apply a 40 ± 2 N [9.0 ± 0.45 lbf] tensile load to the cable. Apply the load at a rate of 5 N/s [1 lbf/s] at a 90 degree pull angle to the mated specimen and hold for 30 seconds. Measure attenuation and return loss before and after test with the load removed. Record attenuation and return loss at least once during test, after maintaining maximum load for a minimum of 10 seconds. Test each specimen once, while mounted in 1 of the following 3 directions: LC connector latch up, latch down or latch to the side. Divide specimen quantity among positions so that all 3 mounting directions are validated.

Figure 2 (continued)

Test Description	Requirement	Procedure
Torsion (twist).	Singlemode and Multimode: Maximum attenuation for any single specimen is 0.50 dB before, during and after test. Maximum change in attenuation for any single specimen is 0.2 dB during and after test. Minimum return loss for any single specimen is 40 dB for singlemode or 20 dB for multimode before, during and after test. See Note (b).	IEC 61300-2-5. Apply a 15 N [3.4 lbf] tensile load to the cable at a point 25 ± 3 cm [9.8 ± 1.2 in] from the plug. Rotate the loaded side ± 180 degrees per cycle for 25 cycles at a maximum twist rate of 30 cycles per minute. Measure attenuation and return loss before and after test with the load removed. Record attenuation and return loss at least once during test, at +180 degrees and -180 degrees extreme positions, and calculate change in attenuation during test. Record final attenuation and return loss after a 5 minute recovery period (after load removal).
Impact.	Singlemode and multimode: Maximum attenuation for any single specimen is 0.50 dB before and after test. Maximum change in attenuation for any single specimen is 0.2 dB after test. Minimum return loss for any single specimen is 40 dB for singlemode or 20 dB for multimode before and after test. See Note (b).	IEC 61300-2-12, Method A. Subject unmated specimens to 8 drops onto a steel plate from a 1.5 m [4.9 ft] height. A protective cover may be used to protect the fiber end faces from getting scratched, but cannot protect the connector. Measure attenuation and return loss before and after the test. Clean specimen before mating for final readings. See paragraph 5.1.
Dust protection.	No observable deposit of dust within the enclosure and connector upon test completion. See Note (b).	IEC 60529, Code IP6X. Part 1 and Part 2 shall each have 4 unique test specimens. Part 1 - Unmated Receptacle with Cap. Tighten the receptacle panel nut to a torque of 2.26 N•m [20 lbf-in] and apply the protective cover to the receptacle. Support the test enclosure within the dust chamber and, with a vacuum pump, create an atmospheric depression not to exceed 2 kPa [0.29 psi]. Based on an air extraction rate of 40 to 80 volumes per hour, circulate 2 kg/m^3 [0.125 lbf/ft^3] of talcum powder, in a suspension, for a 2 hour duration. Part 2 - Mated Receptacle. Mate and lock the plug cable assembly to the receptacle and repeat the test for mated condition.

Figure 2 (continued)

Test Description	Requirement	Procedure
Temporary water immersion.	No accumulated ingress of water within the enclosure and connector, which could reach live parts. See Note (b).	IEC 60529, Code IPX7. Parts 1, 2 and 3 shall each have 4 test specimens. Specimens may be reused. Part 1 - Unmated Receptacle with Cap. Tighten the receptacle panel nut to a torque of 2.26 N•m [20 lbf-in] and apply the protective cover to the receptacle. Immerse the enclosure, such that the lowest point is located at a 1000 mm [39.37 in] water depth, for a 30 minute duration. Part 2 - Mated Receptacle. Mate and lock the plug cable assembly to the receptacle and repeat the test for mated condition. Part 3 - Unmated Plug with Cap. Apply the protective cap to the plug and repeat the test for a capped plug.

NOTE

(a) Dimensions not measured on actual test specimens are covered by First Article approval, which includes verification of product drawings per the dimensions specified in IEC 61754-20.

(b) Shall meet the visual requirements, show no physical damage, and shall meet the requirements of additional tests as specified in the Product Qualification Test Sequence in Figure 3.

Figure 2 (end)

3.6. Product Qualification Test Sequence

After visual and mechanical inspection, specimens shall first be tested for initial attenuation and return loss on new product, after which the remaining tests may be performed in any order. The groups and sequencing shown below is the suggested test plan.

Test or Examination	Test Groups (a)							
	1	2	3	4	5	6	7	8
	Test Sequence (b)							
Visual and mechanical inspection	1	1	1	1	1	1	1	1
Attenuation	2	2	2	2	2			2
Return loss	3	3	3	3	5			3
Cold	4							
Change of temperature	5							
Dry heat (high temperature endurance)		4						
Composite temperature-humidity cyclic test		5						
Torsion (twist)			4					
Impact			5					
Cable retention, axial pull				4				
Cable retention, right angle pull					4			
Dust protection						2		
Temporary water immersion							2	

NOTE

(a) Numbers indicate sequence in which tests are performed.
(b) See paragraph 4.1.A.
(c) A specimen consists of a mated duplex connector pair, except where noted in Figure 2 (such as capped specimens for sealing tests).

Figure 3

4. QUALITY ASSURANCE PROVISIONS

4.1. Qualification Testing

A. Specimen Selection

Specimens shall be prepared in accordance with the applicable Instruction Sheets and shall be selected at random from current production. Specimen shall be defined as a Sealed Industrial LC mated with a duplex LC connector.

B. Specimen Quantity

Specimen quantity shall be a minimum of 8 for each individual test, with the exception of multiple-part sealing tests (dust and water immersion) which shall have a minimum of 4 specimens for each sample configuration (mated, capped). See Figure 3.

C. Test Sequence

Qualification inspection shall be verified by testing specimens as specified in Figure 3.

4.2. 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.

4.3. 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.

4.4. 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 according to the applicable Instruction Sheet 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 should be included in power and loss calculations per TIA/EIA-455-20A.