FACTORY ACCEPTANCE TEST PROCEDURE FOR OPTICAL FIBRE (ITU-T G.652D)

APPLICABLE STANDARD
RELEVANT STANDARDS OF
EIA/TIA 455

Sl. No.	Test Name	Test Procedure	Acceptance Criteria
1	Attenuation Coefficient	EIA/TIA 455-78A	≤0.35dB/km (1310nm) ≤0.21dB/km (1550nm)
2	Point Discontinuities of Attenuation	EIA/TIA 455-59	≤0.1 dB
3	Attenuation at Water Peak	EIA/TIA-455-78A	≤0.34dB/km at 1383nm
4	Chromatic Dispersion	EIA/TIA 455 -168A/169A /175A	≤18 ps/(nm·km) at 1550nm
			≤3.5 ps/(nm·km) from 1288 nm to 1339nm
			≤5.3 ps/ (nm·km) from 1271nm to 1360nm
			Zero Dispersion wavelength: 1300nm – 1324nm; Zero Dispersion slope: ≤ 0.092 ps/nm^2.km
5	Core - Clad Concentricity Error	EIA/TIA 455- 176	≤0.5 µm
6	Cladding Diameter	EIA/TIA 455-176	125 ± 0.7 µm
7	Fibre Tensile Proof Testing	EIA/TIA 455-31B	≥1.0%, 1 sec. ≥ 0.69 Gpa (100kpsi)

Note: The test report of the above tests for the fibres are to be carried out by the Fibre Manufacturer and used in the OPGW shall be shown to the inspector during OPGW FAT and shall be submitted along with the OPGW FAT reports.

FACTORY ACCEPTANCE TEST PROCEDURE FOR OPGW CABLES

APPLICABLE STANDARD
IEEE 1138 : 2021 / IEC 60794

Sl. No	Factory Acceptance Test on Manufactured OPGW Cable	Sampling Plan
1	Attenuation Coefficient (1310nm, 1550nm)	10% of offered OPGW drums/Lot and 100% of fibres in selected OPGW Cable drums(Minimum 2 drums).
2	Point Discontinuities of attenuation	10% of offered OPGW drums/Lot and 100% of fibres in selected OPGW Cable drums(Minimum 2 drums).
3	Visual Material verification and dimensional checks as per approved drawings	Quantity Verification: 100% of offered material.
4	Ultimate Tensile Strength	1 Sample from the selected OPGW drums/Lot.
5	Lay Length Measurements	10% of offered OPGW drums/Lot(Minimum 2 drums).

1. **Attenuation Coefficient (1310nm, 1550nm)**
2. **Point Discontinuities of attenuation**

Test Standard : IEC 60793-1-40, EIA/TIA-455-59 & EIA/T1A-455-61 and ITU-T G.652 D

Test Location :

Test Objective : To measure the optical attenuation at wavelengths 1310 nm and 1550 nm & Point discontinuities at both wavelength of 1310 nm and 1550nm.

Test Set-ups:

Prepare the sample under test as per the figure showing below the test setup. The test bench is connected with Optical Time Domain Reflectometer (OTDR) to measure the value of attenuation coefficient and Point discontinuities

Test Procedure:

1. Connect the test sample either to the instrument or to one end of end dead-zone fiber (if used). Connect the other end of the dead-zone fiber (if used) to the instrument.
2. If the accurate locations of point defects are to be recorded, the effective group delay index of the test sample is required. If this value is not known, use FOTP-60 (Method A) to determine it.
3. Enter OTDR parameters such as source wavelength, pulse duration, length range, and signal averaging into the instrument, along with the test sample effective group index. The values of some of these parameters may be present in the instrument.
4. Adjust the instrument to display a backscatter signal from the test sample. It may be advantageous to begin with coarse vertical and horizontal scaling to maximize the length displayed. An example is given in Figure.
5. Examine the OTDR signal along the test sample for point defects. If increased resolution is needed, adjust the graphical display, if possible, to expand the section of interest to larger scale (exercising care to assure that proper reading of the true signal can still be distinguished from the noise points).
6. To determine that a point defect (rather than an attenuation non-uniformity situation) exist observe the area in question using two different pulse durations. If the shape of the loss or gain changes with the pulse duration, the anomaly is a point defect. If the shape does not change, the anomaly shall be considered to be attenuation non-uniformity to be measured by **FOTP-61.**
7. Report any point defect deviations which exceed the values specified in the Detail Specification. Describe the nature of these faults (e.g. apparent loss or gain, reflection, duration, etc.) as required by the Detail Specification.

   7.1 Determine the defect location, if required, by placing a cursor at the beginning (or at another point specified by the OTDR manufacturer) of a power rise or drop, this may be difficult to do at a drop. Obtain the distance coordinate via the alphanumeric display.

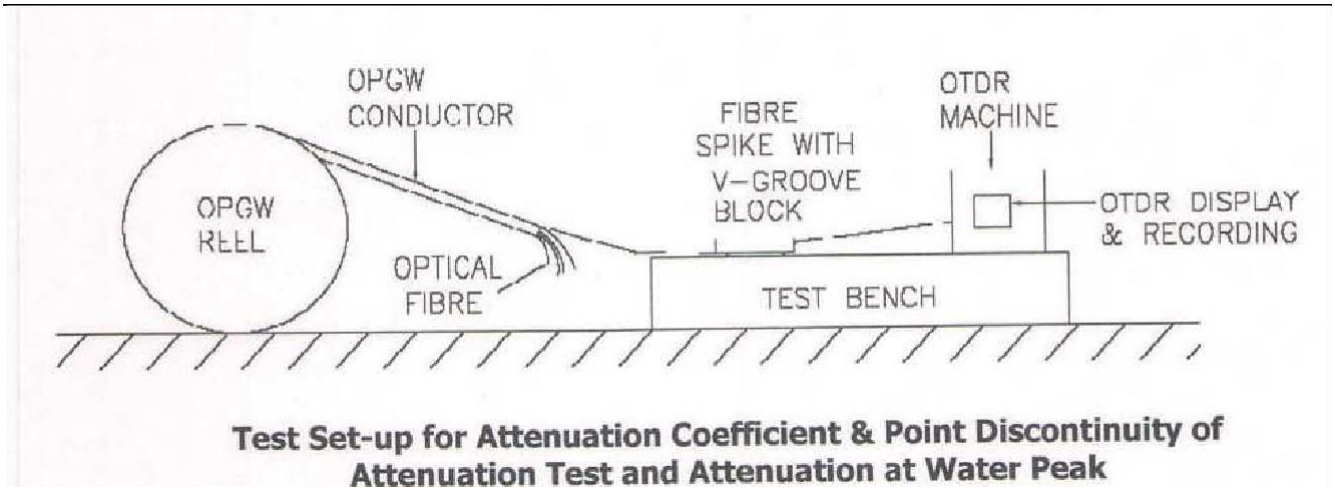
   7.2 Obtain the apparent loss or gain of the defect, if required, by the method described by the OTDR manufacturer .Some instruments required placement of a pair of cursors on each

side of the defect. The two best-fit straight lines (from a two-point or least-squares fit for each) are extrapolated to the defect location .If available, the linear fit method should be chosen. The vertical separation of the lines gives the apparent loss or gain .Note any reflection peak.

7.3 When possible, repeat the test for a single launched into the test sample in the opposite direction. A more accurate loss estimate (and the elimination of apparent gain) is made by averaging

readings taken directionally at the same wavelength .This eliminates the effect of any backscatter different for the fiber sections on both side of the defect.

7.4 Repeat the test at another wavelength.



Test Set-up for Attenuation Coefficient & Point Discontinuity of Attenuation Test and Attenuation at Water Peak

Acceptance Criteria:

For Attenuation

Wavelength	**Attenuation**
1310 nm	< 0.35 dB/Km
1550 nm	<0.21 dB/Km

For Point Discontinuity: Attenuation of fiber shall be uniform throughout its length such that there are no point discontinuity in excess of 0.1dB.

ATTENUATION AND POINT DISCONTINUITY

Ring Mark	Fiber id	At 1310 nm				Ring Mark	At 1550 nm			
		Optical Attenuation	Point Discontinuity	Pass or Fail	Remarks		Optical Attenuation	Point Discontinuity	Pass or Fail	Remarks

Observations, if any:

Test Results:

The attenuation and point discontinuity measured have met/not met the acceptance criteria.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

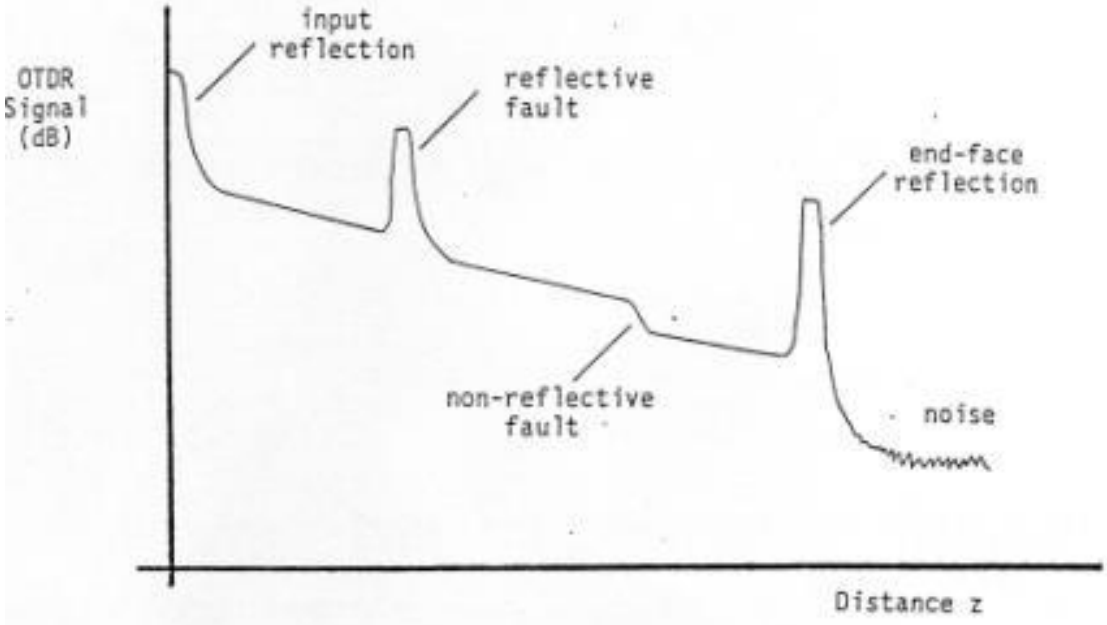


Figure 1. Schematic of an OTDR Trace. Point defects with apparent loss are shown, one reflective and one non-reflective.

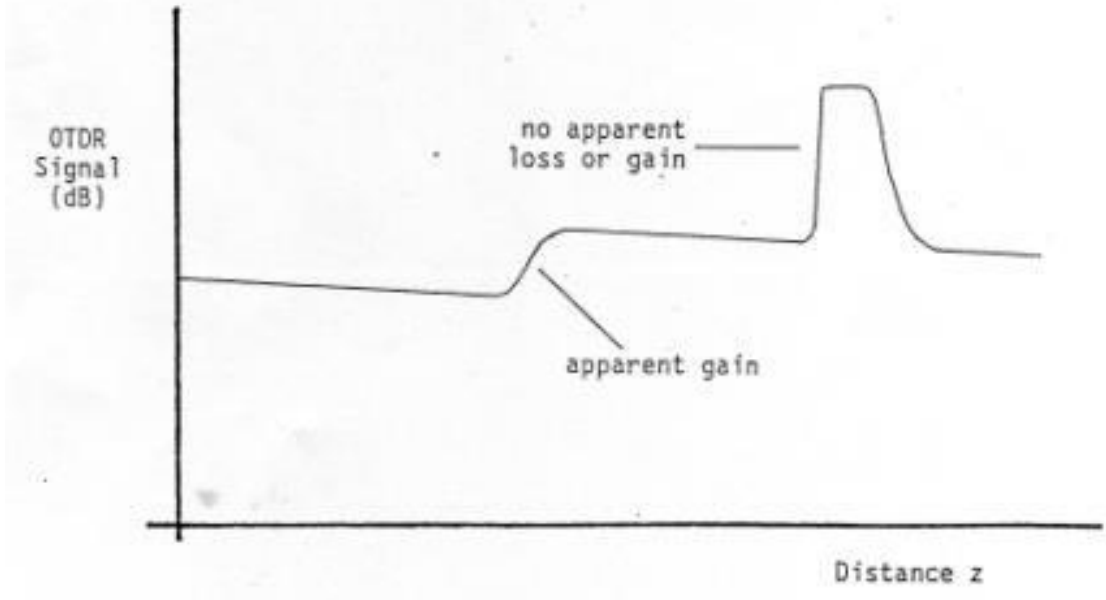


Figure 2. Schematic of an expanded OTDR trace. Two point defects are shown, one with apparent gain, and another with no apparent loss or gain.

3. VISUAL MATERIAL VERIFICATION AND DIMENSION CHECK & GENERAL TESTS

Standard: IEEE-1138:2021, IEC 61089, IEC 61232 & MFR's Technical Specification
Test Location:
Cable Type: OPGW
Reference Document Approved DRS & Drawings of OPGW.

Test Procedure:

1.Physical Verification for the 100% offered quantity of the offered reels/drums shall be carried out.

2. 100% physical verification of sealing of cable ends with end caps, check for provision of spare cable caps for each drum.

3.100% verification of Sealing/Pasting the drum details over the end cap with transparent tape.

4.Verification of drum details properly printed and pasted on each drum suitably as per approved document.

5. Measure the overall diameter at the outside end of the complete OPGW on 10% of offered reels/drums using Caliper/Micrometer of high accuracy.

6. The diameter recorded is the average of two readings, rounded to two decimals of millimeter, taken at right angles to each other at the same location.

7. The verification of the external aspect is made by checking appearance and finish of the completed OPGW. The sequence of the metallic wires/ACS strands and the Aluminium Tubes shall be in accordance with the approved DRS & Drawings.

8. The metallic wires are removed and the diameter of each wire is measured with a micrometer using the same method as referred at point no. 5.

9. The metallic wires are individually examined by eye. All the wires shall be free from imperfections such as fissures, roughness, grooves and inclusions.

10.The Aluminium Tubes are examined by eye. All Aluminium Tubes shall be free from corroding substances, pinholes, cracks, scratches, indentations and other surface imperfections. The inner & outer diameter of each Aluminium Tube is measured with a micrometer using the same method as referred at point no. 5.

Acceptance Criteria:
Acceptance criteria shall be as per Table Test No.5 for the offered OPGW cable.

FAT Procedure for OPGW Cable

Test Results: Visual Verification, Dimensional Checks & other requirements including physical parameters/values of complete OPGW cable, Metallic wires, ACS strands, Aluminium tube and complete optical unit measured/observed have met/not met the acceptance criteria.

Test Summary: The following tests are to be checked and verified under Visual Verification, Dimensional Check Tests and General tests on OPGW Cable.

Table Test-5

Visual Verification, Dimensional & General Tests	Acceptance Criteria
A. Aluminium Clad Steel Strands/Wires:	
1. Appearance	Circular
2. Diameter of each Strand	AS PER APPROVED Cat-1 DRS
3. Elongation at Fracture	AS PER APPROVED Cat-1 DRS
4. No. of ACS Strands	AS PER APPROVED Cat-1 DRS
5. Thickness of Al coating / % IACS	AS PER APPROVED Cat-1 DRS
6. Twist Test (for ACS Strand)	AS PER APPROVED Cat-1 DRS
7. Tensile Strength	AS PER APPROVED Cat-1 DRS
8. Resistance	AS PER APPROVED Cat-1 DRS
B. Complete OPGW Cable:	
1. Appearance	Circular
2. OPGW Cable Construction	AS PER APPROVED Cat-1 DRS
3. Overall cable diameter	AS PER APPROVED Cat-1 DRS
4. Pitch ratio (length (mm)/diameter (mm))	AS PER APPROVED Cat-1 DRS
5. Weight of OPGW Cable	AS PER APPROVED Cat-1 DRS
6. Attenuation Coefficient at 1310nm and 1550nm	AS PER APPROVED Cat-1 DRS
7. Rated Tensile Strength/UTS	AS PER APPROVED Cat-1 DRS
C. General Tests on Optical Unit:	
1. Total no. of fibres, No. of fibres per buffer tube & Color coding of optical fibres in each Tube	AS PER APPROVED Cat-1 DRS
2. No. of Buffer tubes, Color of Buffer tubes, Buffer tube Material	AS PER APPROVED Cat-1 DRS
3. Aluminium tube (Outer and Inner diameter)	AS PER APPROVED Cat-1 DRS
4. Binding Yarn/Tape (Thermal barrier)	AS PER APPROVED Cat-1 DRS
5. Filling Material	AS PER APPROVED Cat-1 DRS
6. Strengthening Member (FRP)	AS PER APPROVED Cat-1 DRS

Note: Elongation at Fracture, Thickness of Al coating; Twist Test will be carried out only once.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

4. ULTIMATE TENSILE STRENGTH TEST

Test Standard	:	IEEE 1138:2021
Test Location	:	
Cable Type	:	OPGW
Objective	:	To verify the actual (ultimate) tensile strength of the OPGW meets or exceeds the UTS of the OPGW.

Test Set-up:

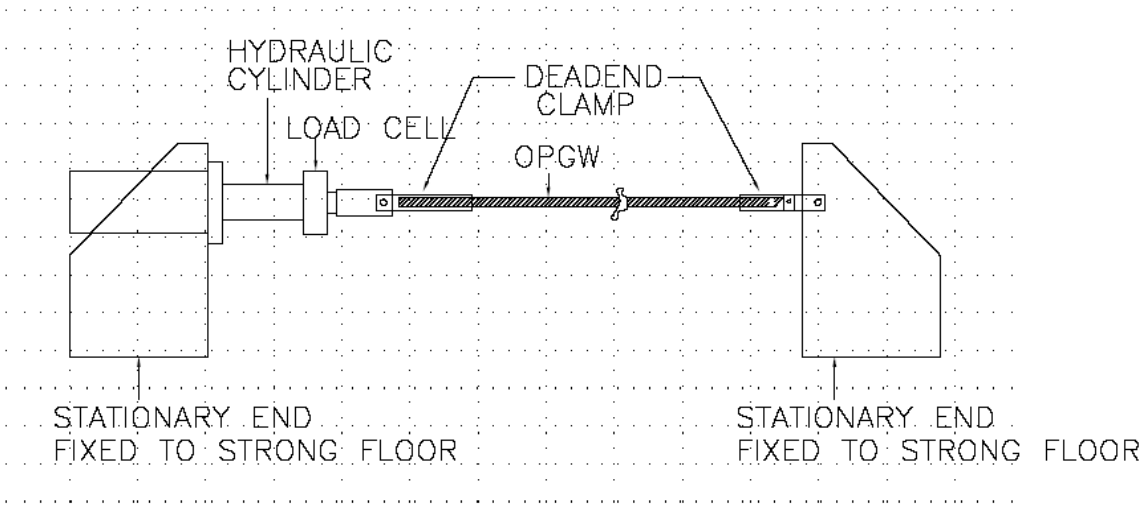
The OPGW sample shall be installed in a suitable tensile test machine. The length of the cable between the loading points of the tensile machine to be minimum 10m. Pre-tension at 2% UTS a suitable transducer such as a load cell or dynamometer shall be used to measure the tension in the cable as per figure.

Test Procedure:

1. A tension is applied to the OPGW conductor until failure of the conductor occurs. The sample Cable length is 10 mtrs minimum between the dead end clamps. Pre-tension the sample to 2% UTS of OPGW.

2. The load shall be applied at a uniform rate such that the time to reach UTS of the cable is at least 5 minutes and then hold for one(1) minute at 100% UTS. Record the continue plot/graph for applied force vs elongation/displacement/time. The observations of UTS test should meet or exceed the 100% UTS of the OPGW mentioned in DRS.

3. The ultimate tensile strength of the cable shall be defined as the maximum load the cable can withstand before failure. Individual strand failures do not necessarily constitute cable failure. However, no outer layer strands shall fail below 100% of the cable UTS. This is to ensure that the outer strands will not unravel below the maximum design loading conditions.



Acceptance Criteria:
The OPGW should with stand not less than 100% of the UTS without failure of any outer strands or any component of OPGW for a period of at least one minute holdup at 100% UTS.

Observations, if any:

Test Results:
The OPGW withstood/did not with stand not less than 100% of the ultimate tensile strength without failure of any outer strands or any components of OPGW for a period of at least one minute holdup at 100% UTS.

Tested by:
(Sign with date)

Witnessed by:
(Sign with date)

5. LAY LENGTH MEASUREMENT

Test Standard : TEC/GR/TX/OFC-021/01/SEP-11

Test Location :

Cable Type : OPGW

Test Set-up: See figure- 3.
Lay length measurement shall be made on a Straight length of OPGW cable while under tension load.

Test Procedure:
1.Measurements are taken at stranding operations between the closing die and capstan reel.
2.Take a piece of paper (onion skin quality) which is a length greater than three times the maximum lay length specified for the OPGW under measurement.
3.Lay the paper over the OPGW and run a lead pencil over the length of the paper to obtain strand
marks on the tracing paper.
4.The lay length is determined by measuring the strand marks for N strands of the OPGW cable
(N number of strands in layer).
5.Repeat for total of three measurements and average the measurements to determine lay length.

Acceptance Criteria:

Cable Type	Lay Length
OPGW	10 to 16 * OPGW outside Diameter

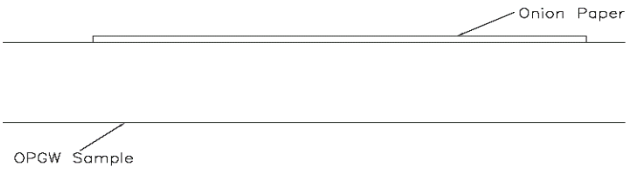


Figure 3 – TEST SET–UP for Lay Length Measurement Test

Test Results:
The lay length measurement for OPGW cable shall be between 10 to 16 times OPGW outside diameter.

Tested by:
(Sign with date)

Witness by:
(Sign with date)