
SERIES 1400

PROCEDURES FOR TESTING & ACCEPTING OPTICAL FIBRES

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1401 Introduction

- 1 This document has two purposes:
 - To define the optical tests and data required from testing of optical fibres.
 - To define the Virgin Media standard procedure for optically testing and accepting fibre optic cables leased or own build. These tests will normally be carried out by Virgin Media, Virgin Media approved Contractors or third party companies. All parties will use this document as the base for their test procedures and format of deliverables to Virgin Media.

1402 Data to be Delivered

- 1 All Tests must provide the following data for all links:
 - Manufacturers test data for the cable including attenuation/km, CD, PMD as specified in Section 5.4
 - Route identification, including
 - i. cable reference numbers + date of cable installation
 - ii. fiber numbers at each connection point
 - iii. types of connectors
 - iv. number of connectors and location
 - v. connector loss and return loss
 - OTDR test results, as specified in Section 4 and ideally to the format specified in Section 5.
 - Power Loss (as above).
 - PMD (as above)
 - CD (as above)
 - Equipment Information:
 - i. Name of the person(s) who carried out the measurements
 - ii. Date when measurements took place
 - iii. Brand of measurement equipment
 - iv. Type of measurement equipment:
 - v. Serial number of measurement equipment
 - vi. Date and number of the calibration
 - vii. Copy of the calibration certificate

1403 Fibre specifications

- 1 All fibre will meet the specifications as detailed in this clause.

Type and Constitution

- 2 Single mode, complying with the specifications below AND the recommendation ITU-T G 652. The fibers are made of high grade doped silica core surrounded by a silica cladding; they are coated with a dual layer, UV cured acrylate based coating.

Geometrical Properties

Description	Unit	Value
Mode field diameter at 1310 nm	(μm)	$[9 - 10] \pm 10\%$
Cladding diameter	(μm)	125 ± 3
Coating diameter	(μm)	245 ± 10
Mode field non circularity	(%)	≤ 6
Cladding non circularity	(%)	≤ 2
Core/cladding concentricity error	(μm)	≤ 1
Cladding/ coating concentricity error	(μm)	≤ 15

Optical Properties

Description	Unit	Value
Cut-off-wavelength (Cabled Fibre)	(nm)	$\lambda_{cc} \leq 1280$
Attenuation:		
Maximum value between 1285 and 1330 nm	(dB/km)	0.35
Maximum value at 1550 nm	(dB/km)	0.22(new)
	(dB/km)	0.25 (existing)
Maximum value at 1625 nm	(dB/km)	0.23
Attenuation uniformity (local default)	(dB)	≤ 0.1
Chromatic dispersion:		
at 1550 nm	(ps/nm.km)	≤ 18
slope between 1530 and 1565 nm	(ps/nm ² .km)	≤ 0.092
CD between 1280 and 1325 nm	(ps/nm.km)	≤ 3.5
CD between 1565 and 1620 nm	(ps/nm.km)	≤ 18
Polarization Mode Dispersion:	(ps/ $\sqrt{\text{km}}$)	≤ 0.2

Mechanical Properties

Description	Unit	Value
Proof test (minimum duration 1s)	(%)	≤ 1
Macro bend test additional loss at 1550 nm (100 turns on 75 mm diameter mandrel)	(dB)	≤ 0.1

3 Virgin Media Additional Requirements are:

Splice Value < 0.15 dB at 1550 nm*

* In exceptional cases, a splice might be accepted if its splice value is higher than 0.15 dB at 1550nm. In that event, the Splice Attenuation Average must remain < 0.15 dB. For instance, when three (3) re-trials of a splice cannot improve the splice value, it is an exceptional case.

Splice Value =

$$\frac{(Splice\ Attenuation\ from\ A\ to\ B) + (Splice\ Attenuation\ from\ B\ to\ A)}{2}$$

Splice Attenuation Average < 0.1 dB at 1550 nm.

Splice Attenuation Average =

$$\frac{\sum Splice\ values}{Number\ of\ splices\ in\ one(1)\ fibre}$$

Maximum Unitary ODF/S Connector (1 connector + 1 adapter + 1 connector)

Attenuation: 0.5 dB at 1550 nm.

Minimum Connector Return Loss: 40 dB at 1550 nm.

1404 Measurement Tests

- 1 Two (2) types of tests will be required by Virgin Media in order to accept fibre optic cables: OTDR, Power Loss. PMD & CD measurement may be required in some instances, and will be highlighted prior to any works taking place.

Introduction

- 2 For the clarity of this document the two ends of the link will be named:

End-Point A

End-Point B

It must be stated (when providing the results of the optical measurements) which are the A and B End-Points.

These End-Points will generally be the end connectors of the link. These connectors are usually located in the Virgin Media rooms, but in some cases may be located on a third party ODF.

In case the fiber to be tested is not terminated at a connector, then a connector will be spliced to the fibers, or a suitable bare end tester may be used, to allow the testing to be performed in the manner described in this document.

OTDR

To measure

- the total attenuation of the link
- any detected events along the line
- the return loss and attenuation of all connectors

Settings

- Wavelength: preferable 1310 nm and 1550 nm (1310nm will only be used for links <40km, 1550nm will be used on all links). 1625nm may be required, but will be identified prior to any works taking place.
- Reflectance threshold (= value above which OTDR will display the event):
-50 dB
- Refractive Index:
If there is only one fiber type in a link: the refractive index provided by the manufacturer will be used.

If the refractive index is not known or the link consists of several fibers: the refractive index will be 1,467.

- Pulse width: two (2) values are used, one (1) for long range measurements, and one (1) for short-range measurements.

Long range measurements aim at measuring the whole link. The minimum pulse width that allows seeing the whole distance of the link should be used, provided that it yields sufficient measurement accuracy (i.e. low noise level). This pulse width will be different for different link distances. The OTDR operator will determine the exact value of the pulse width used at the time. The pulse widths below give only an indication on what is recommended.

0-40 km: pulse width = 2.5 ?s

40-80 km: pulse width = 5 ?s

more than 80 km: pulse width = 10 ?s.

Important note:

In case an event is out of specifications, a measurement with a short pulse width and long averaging time should be performed to examine it in more details. This is to check for example if it resulted from closely spaced events that were merged in one event in the initial measurement. The OTDR operator will determine the exact value of the pulse width used at the time.

Procedure

The OTDR tester must be capable of measuring to distances 50 km greater than the link length.

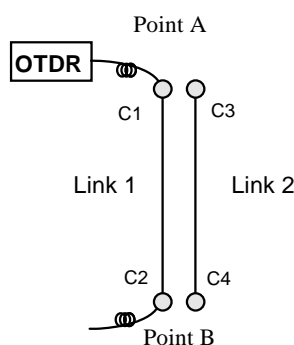
The OTDR test will be carried out in two (2) directions:

- From End-Point A to End-Point B
- From End-Point B to End-Point A

The sections below specify how the testing must take place.

From Point A to Point B

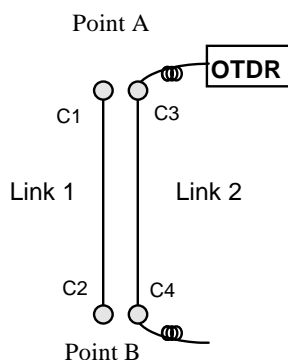
STEP 1:



- The OTDR is connected to connector C1 Point A. Two (2) measurements are made.
- A long range measurement, using a long pulse width, will measure:
the events in link 1
the characteristics of the fibre in link1
- In some cases, several closely spaced connectors are present at the link end. If the above measurement does not allow measuring each connector individually, a short-range measurement (5 to 10 km), using a short pulse width (around 30 ns) will be performed to check each connector.

See Note 1

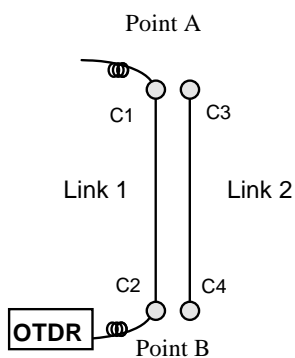
STEP 2:



As above.

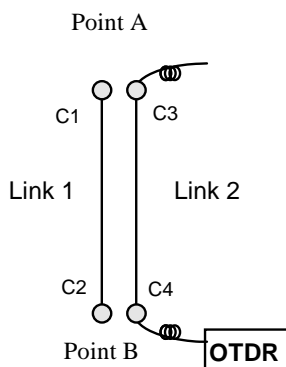
From Point B to Point A

STEP 1:



As above.

STEP 2



As above.

Note 1: The OTDR will have a coil of 2 km attached between the OTDR and the measurement point. The purpose of this coil is to allow the OTDR trace to provide accurate readings from the measurement point onwards.

OTDR Analysis on Site

During the execution of tests on site, the results of OTDR measurements will be compared with the manufacturer's test data and Virgin Media specifications in Paragraph 3.

Where results are out of specifications, the OTDR operator will perform further tests to identify the problem as defined in section 4.2.2. If after further testing the fibre still does not meet the VIRGIN MEDIA specification then remedial actions (such as cleaning connectors, re-performing splices, etc.) will be taken and then further measurements will be performed.

When the OTDR operator deems the fibre acceptable, the final test results in the format as defined in Section 5 will be sent to VIRGIN MEDIA.

Power Loss

To measure

- accurately the total attenuation of the link

Settings

wavelength: 1310nm <40km, 1550 nm for all links

wavelength: 1625 nm for links where requested.

Procedure

The power loss measurement consists of six (6) different steps that are detailed below:

1. Reference power before measurement (not on site)
2. Reference power variation control before measurement (on site)
3. Measurement from End-Point A to End-Point B
4. Measurement From End-Point B to End-Point A
5. Reference power variation control after measurement (on site)
6. Reference power after measurement (not on site).

Not all these steps can be performed if only one set of power loss equipment is available on site. It is therefore recommended to use at least two (2) power receivers.

It is not important for the power loss measurement in which direction it is measured so it does not matter which is End-Point A or B.

The sections below detail the steps.

Reference Power Before Measurement (not on site)

A reference power measurement is required so that the loss of the patchcords and connectors that will be used for the measurement are included in the calibration of the test equipment.

This measurement is performed before and after the main fiber measurement.

Reference Power Variation Control Before Measurement (on site)

As optical equipment is very sensitive to the environmental conditions, the equipment behavior can vary while the optical measurements are performed. Many optical transmitters require a warm-up time to achieve a stable output power.

In order to check the stability of the test equipment, this Reference Power Variation Control must take place on site, before and after the measurements.

Measurement from End-Point A to End-Point B

This measurement determines the loss of the link in the direction $A \Rightarrow B$. The result of this measurement should immediately be compared with the OTDR attenuation result.

However, the loss of one connector (i.e. 0,5 dB) must be added to the attenuation measured, since it was included in the calibration.

Reference Power Variation Control After Measurement (on site)

Once all the fibres have been measured in both directions, the power variation of the test equipment has to be measured again as specified above.

If the difference between this measurement and the measurement of section 4.3.4 is higher than 0.2 dB, the measurements will be carried out again.

Reference Power After Measurement (not on site)

Once all the fibers have been measured in both directions, the reference power of the test equipment has to be measured again as specified above.

If the difference between this measure and the initial one is higher than 0.4 dB, Virgin Media will be informed of the difference measured. Virgin Media will make a decision on whether the measurements are acceptable or not.

PMD

To measure

- accurately the polarization mode dispersion of the link using a interferometric technique

Settings

- This test has to be performed on fibres that are not active (the information will be given by Virgin Media or can be tested with a live fiber identifier).
- A source and interferometer are used at opposite ends.
- Set both units at the same wavelength (1550 nm).
- First measurement has to be repeated to ensure the measurement equipment is stable (for example from cold).

Procedure

The PMD measurements will be carried out for all fibres in one direction only with on one side the power source and on the other side the PMD analyzer.

After measurement, the PMD analyzer will give following results per link:

- Total PMD value in ps
- PMD value in ps/ $\sqrt{\text{km}}$

Note: It is not necessary to repeat these measurements in the opposite directions.

1405 Presentation of Results

The results must arrive at Virgin Media within maximum 5 calendar days after completion of the measurements. All data files will be sent to Virgin Media via e-mail within 5 days following the measurements. In certain circumstances, as described in Series 1110, results may be required on a next day basis.

Any measurement report should always state the following:

- Name of the person who carried out the measurements
- The brand, type and serial numbers of the equipment that were used, the date and number of the calibration - certificate
- A unique nomenclature of each fiber that has been measured

The following results will be delivered to Virgin Media:

OTDR

The OTDR results will be delivered as follows:

- OTDR trace of each link (including the two (2) connectors) :
- From End-Point A to End-Point B
- From End-Point B to End-Point A
- Table of events of each link including:
 - event type
 - attenuation
 - return loss (if any)
 - km where it is located

pulse width used

- From End-Point A to End-Point B
- From End-Point B to End-Point A
- Average value
- A comparison of the events seen on the OTDR and the physical implementation of the cable (ODFs, splice boxes). This will allow to see if there is any problem in the cable installation.
- An explanation of all events that are out of specifications.
- Diskette containing the traces and tables described above in the BELLCORE GR-196-CORE Issue 1 OTDR Data Standard.
- Electronic Copies of all results.

Power Loss

The power loss results will be delivered as follows:

- Calibration results:
 - Reference Power
 - Reference Power variation (before and after measurement)
- Attenuation in dB between the connectors located in VIRGIN MEDIA equipment room.

PMD

The PMD results will be delivered as follows:

- PMD for each link expressed in picoseconds per square root of kilometer (ps/ $\sqrt{\text{km}}$)

Manufacturer's Test Results

The fibre manufacturer results should be delivered to VIRGIN MEDIA. They should include the following Optical Properties:

- Attenuation:
 - Maximum value between 1285 and 1330 nm
 - Maximum value at 1550 nm
 - Maximum value at 1625 nm, if available
 - Attenuation uniformity (local default)
- Chromatic dispersion:
 - between 1285 and 1330 nm
 - at 1550 nm
- Polarization Mode Dispersion

1406 Abbreviations

ODF	Optical Distribution Frame
OTDR	Optical Time Domain Reflectometer
PMD	Polarization Mode Dispersion
CD	Chromatic Dispersion