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FAB: Optical access networks

Online course specification

Target audience:
Those involved in implementing, installing and maintaining optical access networks.

Course aim:
This online course provides an introduction to the passive components of an optical access network and discusses the practical aspects of installing, testing and maintaining such networks including fibre to the home and fibre to the cabinet installations.

Course level: Introductory
An explanation of PTT course levels is given at the end of this document

Pre-requisites:
An understanding of the basic principles of optical fibre transmission. It is recommended that the PTT course "Optical fibre principles" is studied before attempting this course.

Course structure:
The course consists of the following 8 modules:

1. Course introduction
2. Fibre in the access network
3. Optical cables
4. Cable preparation and installation
5. Fibre management
6. Passive optical networks
7. Optical loss tests
8. Using an OTDR

Module 1: Course introduction

Module aim: To summarise the aims of each module and introduce the navigation and learning facilities provided by the course.

Module 2: Fibre in the access network

Module aim: To describe the various configurations and role of the components of point to point and point to multipoint links in an access network and understand what limits their maximum length.

After completing this module, a trainee will be able to:

- describe the advantages of the use of optical fibre over copper cables.
- describe the various causes of loss in an optical fibre link with reference to the factors that affect the magnitude of those losses.
- describe the role of the various active and passive components of a point to point link.
- explain that full duplex operation can be achieved over a single fibre by use of wavelength division multiplexing.
- describe the advantages of a passive optical network with reference to the role of an optical splitter.

- describe the role of an optical line terminal (OLT), and optical network unit (ONU) and optical network terminal (ONT) and state where in the network these units will be located.
- explain how customers share the bandwidth of the optical fibre running from the splitter to the Optical line terminal.
- compare the structure, components and role of the various PON configurations, FTTH, FTTB, FTTC and FTTdp.
- explain the safety precautions that should be taken when working with optical systems.

Module 3: Optical cables

Module aim: To describe how structure of, and the materials used in, optical cables depends on the environment in which they are to be installed.

After completing this module, a trainee will be able to:

- describe the role of the various protection layers in optical cables.
- describe the effects of water ingress in cables on their optical fibres.
- describe the various methods of preventing the ingress of water into cables.
- explain that certain sheath materials are not suitable for cables installed in enclosed public areas.
- explain that cables with metallic components may need to be avoided in certain situations.
- describe how all-dielectric cables avoid the use of metals by using aramid yarn and/or fibreglass re-enforced plastic strength members.
- state that metallic components of cables should be connected to ground at the termination point.
- describe how cables can be protected against rodent attack.
- compare the structure of cables designed for direct burial, those designed for installation in ducts and those designed to be suspended by poles or pylons.
- describe and compare the structure of ADSS, "figure of 8" and optical ground wire aerial cables.
- describe the advantages of using microducts in an FTTH installation.
- describe the typical structure of drop cables used to connect customers to a FTTH passive optical network comparing those designed for aerial drops and those laid in microducts.
- explain that cables with a small minimum bending radius are necessary for installation with buildings as part of an FTTH installation.

Module 4: Cable preparation and installation

Module aim: To describe the techniques and equipment used to prepare and install optical cables in ducts and on telegraph and utility poles.

After completing this module, a trainee will be able to:

- describe the removal of the protection layers of both internal and external cables in preparation for pulling and termination with reference to the use of specialist tools.
- describe the various ways in which cable ends can be gripped for pulling while minimising the tensile stress on the optical fibres.
- describe how optical fibres are prepared for splicing.
- describe the operation and facilities of modern cleavers and fusion splicers.
- explain the importance of using a swivel and a mechanical fuse when pulling optical cable.
- describe the techniques and equipment for pulling cable into ducts with reference to maintaining a suitable bending radius and limiting the tensile stress on the cable.
- describe the advantages of blowing optical cables into microducts.
- describe the techniques, components and equipment involved in blowing optical fibre cable.
- describe the techniques, components and equipment involved in installing aerial cables with particular reference to necessary safety precautions.

Module 5: Fibre management

Module aim: To understand the role of the various nodes and components of an optical access network providing point to point links to business customers.

After completing this module, a trainee will be able to:

- describe the typical topology of an optical access network with reference to providing redundancy in case of component failure and the ease of implementing new connections.
- describe the role of a distribution node with reference to providing optical connections between optical line terminating equipment and the fibres leading to customers.
- describe the role and typical layout of an optical distribution shelf with reference to the importance of avoiding sharp bends in fibre and protecting exposed fibre and optical splices.
- describe the role and typical layout of a primary flexibility point (PFP) with reference to protecting exposed fibres and optical splices, anchoring the cable to the enclosure and sealing the closure against the ingress of moisture.
- describe the role of a secondary flexibility point (SFP) and the physical differences between an SFP and a PFP.
- describe the role and typical layout of building flexibility points and customer termination points.

Module 6: Passive optical networks

Module aim: To describe the role of the various passive and active components of a passive optical network delivering FTTH, FTTB and FTTC services.

After completing this module, a trainee will be able to:

- describe the role of an optical splitter in a passive optical network (PON).
- describe the role of an OLT and optical distribution shelf in the access node of a PON.
- describe the physical structure of a PON in terms of feeder cable, distribution cables, drop cables, primary fibre concentration point (FCP) and secondary FCP.
- explain that the PFCP should be close as possible to the served customers.
- describe and compare typical applications and advantages of FTTC, FTTB and FTTC services.
- describe the role of the passive and active components delivering an FTTH service in a single occupancy building.
- describe how a multiple dwelling unit (MDU) can be provided with a FTTB service that utilises existing wiring in the building.
- describe the role of the in-building components of a system providing an FTTH service to units in an MDU.
- describe the role and limitations of protection systems in a PON.
- describe the structure and role of the components of a system providing fibre to the cabinet (FTTC) services with reference to the role of an OTU / DSLAM, tie cable, electrical splitters and VDSL modem.
- describe the benefits and role of the components of a fibre to the distribution point service.

Module 7: Optical loss tests

Module aim: To describe the use of optical loss test sets and dual port power meters to check that optical links and passive optical networks meets their power budget requirements.

After completing this module, a trainee will be able to:

- state that a power budget calculation can be used to determine the maximum length of a link or to check that a link of a given length can provide an adequate performance.

- describe the relevance of the variables in a power budget calculation including launched power, receiver sensitivity, link loss and system margin.
- explain that loss measurements should be made at each wavelength used by the operational link or PON connection.
- explain that bidirectional loss measurements are necessary giving reasons.
- describe the purpose of testing with reference to pre-installation, verification, and characterisation testing, and fault-finding.
- describe the roles and typical facilities of an optical loss test set (OLTS).
- describe the tasks necessary to prepare for an OLTS test.
- explain the particular characteristics necessary for an optical power meter designed to measure the optical signal transmitted by PON equipment.

Module 8: Using an OTDR

Module aim: To describe the principles, characteristics and use of an Optical Time Domain Reflectometer.

After completing this module, a trainee will be able to:

- state typical applications of an OTDR measurement.
- describe how backscattered and reflected energy is used by an OTDR to locate and measure the loss of optical connections on a link and measure fibre loss.
- describe the significance of the OTDR characteristics dynamic range, resolution and deadzone and explain the factors that affect the value of those characteristics.
- describe the factors that affect the choice of pulse width, range and acquisition time in an OTDR test.
- give the reasons why an OTDR test may be repeated at different wavelengths.
- describe how the position of a splice, demountable connection, macrobend and fibre end can be identified on an OTDR trace.
- describe the facilities of a modern OTDR including automatic selection of test parameters and automatic identification of events on a fibre trace.
- describe the particular issues that affect the identification of events on an OTDR test on a passive optical network with reference to splitter loss and the direction of the test.

Course access requirements:
To access the course, a computer running a browser such as Google Chrome, Safari etc is required. The computer should have Internet access. A screen resolution of at least 1024x768 is necessary.

Learning facilities:
This online course employs interactive simulations, hypertext links to an online glossary and multiple-choice question sessions to fully involve the trainee in the learning experience. Each module provides revision links to previously studied, relevant topics. A record of progress and level of achievement is recorded for each trainee. Once studied as a structured, assessed course, the content can be browsed for revision or reference.

PTT course levels:
PTT online courses are categorised by one of three levels according to the depth of treatment they provide:

1. **Introductory:**

   PTT Introductory courses are designed for those with no previous experience or knowledge of telecommunications. These courses provide an overview of telecommunications or discuss the fundamentals of electronic communications. The study of general science at secondary (high) school is a typical pre-requisite for PTT Introductory courses.
   PTT Introductory courses are suitable for those joining the telecommunications sector particularly those in an apprenticeship programme.

2. **Intermediate:**

   PTT Intermediate courses are designed for technicians and engineers requiring an understanding of a certain aspect of telecommunications. Those planning to study an Intermediate course should have an understanding of the basic principles of electronic communications.
   The depth of treatment provided by Intermediate courses is typically equivalent to level 3 of a UK national vocational qualification (NVQ). PTT Intermediate courses can be used to support the attainment of a Communications Technology NVQ at level 3.

3. **Advanced:**

   PTT Advanced courses are designed for those who require an in-depth treatment of a certain aspect of telecommunications. Such courses are suitable for system designers as well as those who will be responsible for the maintenance of the system described in the course.
   Those planning to study a PTT Advanced course should have a background in telecommunications, and an understanding of telecommunications fundamentals and the principles of the type of telecommunications system described in the course.

PTT
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