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TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

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SERIES L: CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Optical fibre identification for the maintenance of optical access networks

Recommendation ITU-T L.85

ITU-T

International Telecommunication Union

Recommendation ITU-T L.85

Optical fibre identification for the maintenance of optical access networks

Summary

Recommendation ITU-T L.85 deals with important considerations with respect to the requirements for an optical fibre identification technique by leaky light waves used for construction and maintenance work in optical access networks.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T L.85	2010-07-29	15

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

CONTENTS

Introduction

The demand for broadband access services has increased throughout the world in the recent years. The number of FTTx subscribers is increasing rapidly, and a large number of optical fibre cables are being installed daily to meet the current demand. During the installation and maintenance of optical fibre communication networks, field engineers must first correctly identify a specific fibre from a bundle of fibres to avoid the incorrect cutting and/or connection of an optical fibre at a worksite. In particular, engineers should distinguish "live" (signal-carrying) and all dark fibres, since service reliability must be maintained. Therefore, it is very important to employ optical tests that distinguish a fibre for identification in an in-service optical fibre cable with no degradation in transmission quality even if the field engineer selects the wrong fibre.

Recommendation ITU-T L.85

Optical fibre identification for the maintenance of optical access networks

1 Scope

This Recommendation:

– describes functional requirements and methods for optical fibre identification for the construction and maintenance of optical access networks;

– deals with an optical fibre identification technique that functions by measuring certain optical characteristics. The optical fibre characteristics should comply with [ITU-T G.652] and [ITU-T G.657], which relate to single-mode optical fibres. It also considers the procedures and requirements for optical fibre identification, including in-service fibre lines, without interfering with optical communication signals in access networks;

– describes the optical fibre identification technology that can be applied to different topologies of optical access networks.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T G.652] Recommendation ITU-T G.652 (2009), *Characteristics of a single-mode optical fibre and cable*.

[ITU-T G.657] Recommendation ITU-T G.657 (2009), *Characteristics of a bending-loss insensitive single-mode optical fibre and cable for the access network*.

[ITU-T G.671] Recommendation ITU-T G.671 (2009), *Transmission characteristics of optical components and subsystems*.

[ITU-T G.987.1] Recommendation ITU-T G.987.1 (2010), *10-Gigabit-capable passive optical networks (XG-PON): General requirements*.

[ITU-T G.Sup39] ITU-T G-series Recommendations – Supplement 39 (2008), *Optical system design and engineering considerations*.

[ITU-T L.25] Recommendation ITU-T L.25 (1996), *Optical fibre cable network maintenance*.

[ITU-T L.40] Recommendation ITU-T L.40 (2000), *Optical fibre outside plant maintenance support, monitoring and testing system*.

[ITU-T L.41] Recommendation ITU-T L.41 (2000), *Maintenance wavelength on fibres carrying signals*.

[ITU-T L.50] Recommendation ITU-T L.50 (2003), *Requirements for passive optical nodes: Optical distribution frames for central office environments*.

[ITU-T L.53] Recommendation ITU-T L.53 (2003), *Optical fibre maintenance criteria for access networks*.

[ITU-T L.66] Recommendation ITU-T L.66 (2007), *Optical fibre cable maintenance criteria for in-service fibre testing in access networks*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 optical distribution frame (ODF) [ITU-T L.50].

3.2 Terms defined in this Recommendation

This Recommendation does not define any terms.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

FTTx Fibre to the x, where "x" indicates the final location on the user side of any one of a variety of optical fibre architectures, e.g., FTTB, FTTC, FTTH, FTTP.

ODF Optical Distribution Frame

PD Photo Detector

5 Conventions

None.

6 Fundamental requirements for optical fibre identification

With a view to realizing the efficient construction and maintenance of optical fibre cable networks, it is very important for field engineers to identify a particular optical fibre among the many fibres in an optical fibre cable or cord at a worksite. Correct optical fibre identification would make it possible to avoid major problems such as the incorrect cutting and/or connection of an optical fibre. Also, when field engineers handle optical fibre lines in existing cables that accommodate "live" (signal carrying) fibres, they should avoid any degradation of communication signals in order to maintain service reliability.

Therefore, the fundamental requirements of an optical fibre identification technique are as follows:

– It must be able to correctly identify a specific fibre from a bundle of fibres by measuring certain optical characteristics.
– It must not damage an optical fibre and thus degrade its reliability.
– It should be capable of being performed without degrading optical communication signals in live fibres.
– It must be capable of identifying a specific fibre even if there is interference from the communication light.

7 Measurement methods and procedures

7.1 Measurement method

The method specified in this Recommendation uses a non-destructive macrobending technique. Figure 1 shows the configuration for optical fibre identification. An identification light is injected into the target fibre from the end of an optical fibre line (e.g., a central office) or is introduced by using optical devices for testing (e.g., an optical coupler). This identification light has a different wavelength from the communication light carrying the data signal. The optical fibre identifier bends the optical fibre, and a photodetector (PD) located at the centre of the bent part detects the modulated identification light leaking from the bent fibre, as shown in Figure 2. This enables the field technician to identify the fibre that is carrying the identification light.

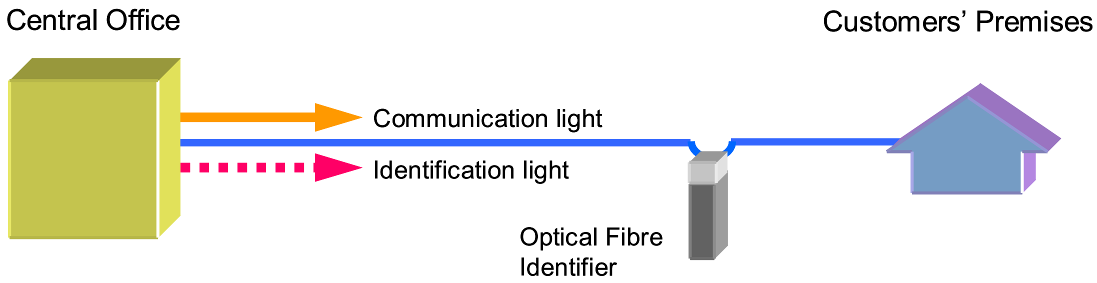

Figure 1 – Configuration for optical fibre identification

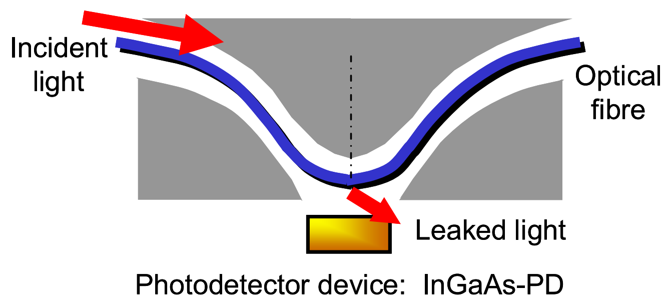

Figure 2 – Typical configuration of bent part of optical fibre identifier

This method applies to different topologies of optical access networks. However, it is difficult to use this method to identify a specific fibre in a point-to-multipoint network (described in [ITU-T L.53]) equipped with external optical splitters. This is because the optical power of the identification light launched from a central office is distributed equally to the branched optical fibres by the optical splitters, so the optical fibre identifier cannot identify a specific fibre. (Optical branching components (wavelength non-selective) are described in detail in [ITU-T G.671].)

If necessary, a specific fibre can be identified in a branched region below the optical splitter by launching the identification light from the far end of the optical fibre line at the worksite.

7.1.1 Identification light source

The identification light is usually input at the end of an optical fibre in a central office or in a user's premises. If the fibre for identification is an in-service line, the communication signal light is carried in the optical fibre and leaked to a PD at the bent part of the optical fibre identifier. By modulating the identification light with a special frequency such as 270 Hz, 1 kHz, 2 kHz, etc., it is possible to separate the communication light and the identification light and to detect the identification light with a high optical power level.

7.1.2 Bend applying part of the optical fibre identifier

The bending loss of an optical fibre generally increases as the wavelength increases. The optical fibre is bent by the bend applying part of the optical fibre identifier to make it possible to detect the leaked identification light with high efficiency. The insertion loss for the communication light should be suppressed to avoid severe deterioration in the BER of transmission systems.

Also, to take into account the working efficiency when handling optical fibres in an optical enclosure, an optical cabinet, or an optical distribution frame (ODF) in which many optical fibres are accommodated, it is preferable for the head of the bend applying part of the optical fibre identifier to be compact and thin.

If bend insensitive fibres (e.g., [ITU-T G.657]) are used, the radius of the bend applying part should be designed appropriately and additional experience is required.

7.2 Applicability of optical fibre identification techniques

Typical applicable areas of optical fibre identification techniques are central offices, indoor areas and outdoor areas. The characteristics of optical fibre and fibre-ribbon in applicable areas should comply with [ITU-T G.652] and [ITU-T G.657].

8 Requirements for in-service fibre line identification

The category of working stages for optical fibre identification is described in [ITU-T L.25] and [ITU-T L.40]. An optical fibre identification function is needed for both "preventative maintenance" and "post-installation pre-service or post-fault maintenance". During construction work, there are no "active" fibres among the bundled fibres in the optical fibre cables. Therefore, optical fibre identification can be performed without regard to wavelength. However, in-service fibre line identification is necessary during service construction and maintenance work, because there are both "live" and "dark" (no signal) fibres in the same optical fibre cables. The requirements for optical fibre identification for in-service fibre lines are described below.

8.1 Design of bending radius of the optical fibre identifier

As described in clause 7.1.2, the bending loss increases when the optical fibre identifier is used in service installation or maintenance work, such as the replacement and repair of optical fibre cables. It is necessary to design the bending radius of the bent part of the optical identifier to minimize the effect on the transmission system. There are trade-offs between the measurement dynamic range and the bending loss with optical fibre identification. Therefore, the bending radius of the bend applying part should be designed taking both the measurement dynamic range and the bending loss of the optical fibres into account.

8.2 Test light wavelength

When the fibre is not in service, acceptable wavelengths in terms of fibre reliability can be used for the test light. When the optical fibre is carrying communication signals or its status is unknown, the identification test light wavelength must not be a wavelength that is used for communication signals so as to avoid any interference with the test light. The maintenance wavelength for in-service testing is defined by [ITU-T L.41]. There are several recommended maintenance wavelength bands depending on the operating wavelength range that is used by a given transmission system. The operating wavelength range in terms of spectral bands is described in [ITU-T G.Sup39] and [ITU-T G.987.1]. When the communication wavelength band extends to the L-band, an ultra long wavelength (U-band) of 1650 nm is used for maintenance testing.

8.3 Requirement for in-service monitoring and identification equipment

[ITU-T L.66] defines several requirements for in-service monitoring such as the wavelength bandwidth and optical power level of the test light, and the characteristics of the test light cut-off filter and measurement equipment.

8.4 Monitoring optical power level of the communication light

A communication light in an optical fibre line can be detected by using the optical fibre identifier. A communication link can be confirmed by monitoring the optical power level of a communication light. In every case, the bending loss should be considered in order to minimize any effect on the communication signals. This function is not necessarily required for the optical fibre identification equipment, because the detection of a communication light does not identify a fibre for identification. Moreover, this function requires cautious use, because the determination of a "live" or "dark" fibre by monitoring the optical power level of a communication light is not fail-safe.

Appendix I

Japanese experience – Optical fibre identification technology in Japan

(This appendix does not form an integral part of this Recommendation)

I.1 Introduction

The optical access network is expanding rapidly in today's broadband communication society. In Japan, the number of FTTH users had exceeded 16 million by the end of September 2009, and a large number of optical fibre cables are still being installed daily. Therefore, the smooth operation and maintenance of the equipment used in this network is becoming even more important. Also, service reliability is increasingly important because optical access networks are expected to assume a lifeline role. During the installation and maintenance of optical fibre communications networks, field technicians must first correctly identify a specific fibre from a bundle of fibres in order to avoid the incorrect cutting and/or connection of an optical fibre at a worksite. An optical fibre identifier is widely used as a convenient tool with which to identify a fibre for the construction and maintenance of optical cable networks. The optical fibre identifier functions are based on the non-destructive macro-bending method. With this method, optical fibres are identified by detecting an identification signal that leaks from a bent fibre.

I.2 Configuration

Figure I.1 shows the configuration of an optical fibre identification at a worksite. Optical fibres are normally identified by using a test light source and an optical fibre identifier shown in Figure I.1. At the central office, the identification test light is injected into the target fibre via an optical coupler for testing. This test light wavelength is 1650 ± 5 nm that is in accordance with [ITU-T L.66]. The test light wavelength is different from the wavelengths of the communication light carrying the data signal. An optical filter is equipped at either end of the optical fibre line. The filter allows a communication light to pass but not the test light. The optical fibre identifier is based on non-destructive macrobending. The equipment consists of a bender part and a photo-detector. The optical fibre identifier bends an optical fibre and the photodetector placed at the centre of the bent part detects the 270-Hz modulated identification light leaking from the bent fibre. This enables the field technician to identify which fibre is carrying the identification light. Also, this method can identify fibres while they are in use, so there is no need to interrupt service to the user.

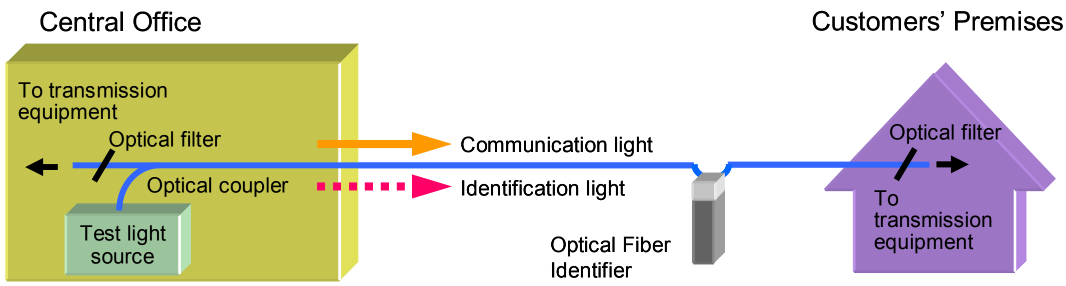

Figure I.1 – Configuration of optical fibre identification

I.3 Procedure for optical fibre identification

Fibre identification with a fibre identifier based on the macro-bending method is carried out with the following process. An identification light of 1650 nm modulated at a certain frequency (e.g., 270 Hz) is launched into a fibre by using an optical coupler for testing in the central office. This modulation prevents the identifier from detecting undesired light from an external light source. At the worksite, the field technicians bend a fibre by clamping it with the fibre identifier. The optical fibre identifier selectively detects the modulated identification light leaked from the bent fibre. Therefore, we can identify a specific fibre from bundle of fibres by judging the presence of the leaked identification light.

I.4 Design of the optical fibre identifier

When a field technician bends a fibre carrying a communication signal, the bending loss might cause the deterioration of the communication light. If this bending loss is too large it will interrupt the service. On the other hand, when too little bending is applied, there is insufficient leaked light for detection at the photo-detector and the fibre cannot be identified. In order to reduce the bending loss with a certain detection sensitivity, it is necessary to optimize the amount of bending applied to the fibre. The insertion loss of the optical fibre identifier for the communication light should be suppressed to less than 2 dB to avoid the deterioration of the transmission quality.

I.5 Applicable area of optical fibre identification techniques

Table I.1 shows the applicable area of the optical fibre identification technique in Japan. This technique works well for optical fibres using communication wavelengths of 1310 nm, 1550 nm and the long-wavelength band (L-band) described in [ITU-T G.Sup39].

Table I.1 – Applicable area of the optical fibre identification technique

Area	Type of optical fibre line
Central office	Optical fibre cord (ϕ 1.1, 1.7 and 2.0 mm)
Outdoors	Fibre-ribbon, optical fibre (ϕ 0.25 and 0.5 mm), optical drop cable
Indoors	Optical fibre cord (ϕ 1.5 mm), optical indoor cable

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