EESTI STANDARD

EVS-EN 4533-001:2006

Aerospace series - Fibre optic systems - Handbook - Part 001: Termination methods and tools

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EESTI STANDARDIKESKUS

EESTI STANDARDI EESSÕNA	NATIONAL FOREWORD
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Standard on kättesaadav Eesti standardiorganisatsioonist.	The standard is available from Estonian standardisation organisation.

Käsitlusala:	**Scope:**
This Part of EN 4533 examines the termination aspects of fibre optic design for avionic installations. By termination is meant the mechanism used to interface from one component (usually a fibre) to another. This is normally performed by a connector, which aligns the fibre with another component (usually another connector) to a sufficient accuracy to allow continued transmission of an optical signal throughout the operational envelope.	This Part of EN 4533 examines the termination aspects of fibre optic design for avionic installations. By termination is meant the mechanism used to interface from one component (usually a fibre) to another. This is normally performed by a connector, which aligns the fibre with another component (usually another connector) to a sufficient accuracy to allow continued transmission of an optical signal throughout the operational envelope.

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This European Standard was approved by CEN on 28 April 2006.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Foreword

This European Standard (EN 4533-001:2006) has been prepared by the European Association of Aerospace Manufacturers - Standardization (AECMA-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of AECMA, prior to its presentation to CEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2007, and conflicting national standards shall be withdrawn at the latest by January 2007.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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Introduction

a) The handbook

This handbook draws on the work of the Fibre Optic Harness Study, part sponsored by the United Kingdom's Department of Trade and Industry, plus other relevant sources. It aims to provide general guidance for experts and non-experts alike in the area of designing, installing, and supporting multi-mode fibre-optic systems on aircraft. Where appropriate more detailed sources of information are referenced throughout the text.

It is arranged in 4 parts, which reflect key aspects of an optical harness life cycle, namely:

— Part 001: *Termination methods and tools*

— Part 002: *Test and measurement*

— Part 003: *Looming and installation practices*

— Part 004: *Repair, maintenance and inspection*

b) Background

It is widely accepted in the aerospace industry that photonic technology offers a number of significant advantages over conventional electrical hardware. These include massive signal bandwidth capacity, electrical safety, and immunity of passive fibre-optic components to the problems associated with electromagnetic interference (EMI). To date, the latter has been the critical driver for airborne fibre-optic communications systems because of the growing use of non-metallic aerostructures. However, future avionic requirements are driving bandwidth specifications from 10's of Mbits/s into the multi-Gbits/s regime in some cases, i.e. beyond the limits of electrical interconnect technology. The properties of photonic technology can potentially be exploited to advantage in many avionic applications, such as video/sensor multiplexing, flight control signalling, electronic warfare, and entertainment systems, as well as in sensing many of the physical phenomena on-board aircraft.

The basic optical interconnect fabric or `optical harness' is the key enabler for the successful introduction of optical technology onto commercial and military aircraft. Compared to the mature telecommunications applications, an aircraft fibre-optic system needs to operate in a hostile environment (e.g. temperature extremes, humidity, vibrations, and contamination) and accommodate additional physical restrictions imposed by the airframe (e.g. harness attachments, tight bend radii requirements, and bulkhead connections). Until recently, optical harnessing technology and associated practices were insufficiently developed to be applied without large safety margins. In addition, the international standards did not adequately cover many aspects of the life cycle. The lack of accepted standards thus lead to airframe specific hardware and support. These factors collectively carried a significant cost penalty (procurement and through-life costs), that often made an optical harness less competitive than an electrical equivalent.

c) The fibre-optic harness study

The Fibre-Optic Harness Study concentrated on developing techniques, guidelines, and standards associated with the through-life support of current generation fibre-optic harnesses applied in civil and military airframes (fixed and rotary wing). Some aspects of optical system design were also investigated. This programme has been largely successful. Guidelines and standards based primarily on harness study work are beginning to emerge through a number of standards bodies. Because of the aspects covered in the handbook, European prime contractors are in a much better position to utilise and support available fibre optic technology.

1 Scope

1.1 General

This Part of EN 4533 examines the termination aspects of fibre optic design for avionic installations. By termination is meant the mechanism used to interface from one component (usually a fibre) to another. This is normally performed by a connector, which aligns the fibre with another component (usually another connector) to a sufficient accuracy to allow continued transmission of an optical signal throughout the operational envelope.

This Part will explain the need for high integrity terminations, provide an insight into component selection issues and suggests best practice when terminating fibres into connectors for high integrity applications. A detailed review of the termination process can be found in Clause 4 of this part and is organised broadly in line with the sequence of a typical termination procedure.

The vast number of cable constructions and connectors available make defining a single termination instruction that is applicable to all combinations almost impossible. Because of the problems of defining a generic termination instruction, this handbook has concentrated on defining best practice for current to near future applications of fibre optics on aircraft.

This has limited the studies within this part to currently available ‘avionic’ silica fibre cables and adhesive filled butt-coupled type connectors. Many of the principles described however would still be applicable for other termination techniques. Other types of termination are considered further in the repair part of this handbook.

1.2 Need for high integrity terminations

In order to implement a fibre optic based system on an aircraft it is vital to ensure that the constituent elements of the system will continue to operate, to specification, over the life of the system. An important aspect of this requirement is the need for reliable interconnection components. This is often expressed as the need for reliable connectors, but in reality it is the need for a reliable cable to connector termination process. The essence of this requirement is the need to assure reliable light transmission through each optical connector throughout the operational envelope. This needs to be achieved through a robust process that enables a high level of optical performance over the lifetime of the terminations.

Many factors can contribute to an optical connector’s in-service performance, such as basic connector design, choice of optical fibre, cable, operating and maintenance environment etc. However, one of the main factors governing in-service connector performance is the quality of the cable to connector termination.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 4533-002, *Aerospace series – Fibre optic systems – Handbook – Part 002: Test and measurement.*

3 Component selection

3.1 Elements

It is important to recognize that a fibre optic termination, while appearing straightforward, is in fact a complex interaction of the constituent elements such as: fibre coatings, connector design, cable strength member anchorage method, adhesive type and cure regime (where used), material properties and so on. Each of these elements will have an impact on the termination, in terms of reliability, integrity and process complexity.

3.2 Fibre optic cables

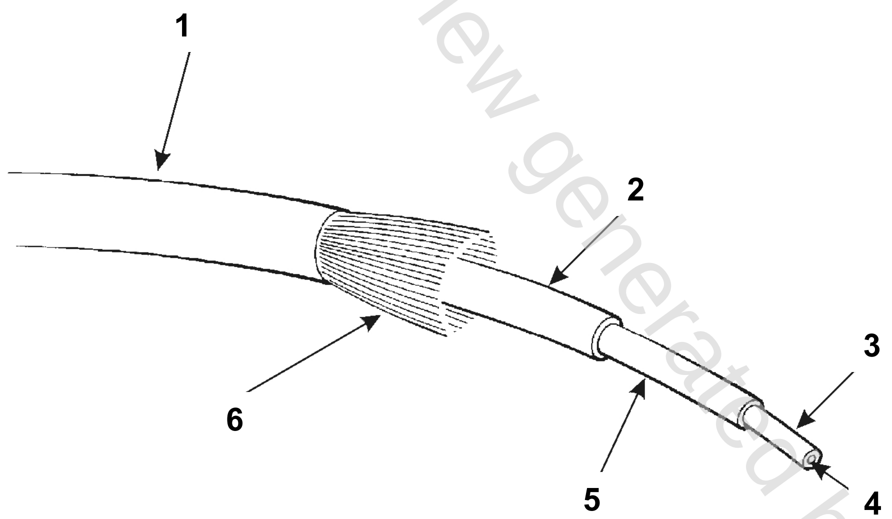
3.2.1 General

One of the main aspects to be addressed is the implication of choosing one cable construction over another.

There are various types of fibre optic cable on the market ranging from loose tube to tight jacket construction, containing a single fibre or an array of many fibres; however, at the time of publication of this handbook the range of options available to aerospace users is somewhat limited. Most of the possible cable types are only suitable for telecommunication applications due to environmental capability limitations, with avionic solutions being generally limited to single fibre, tight jacket constructions.

3.2.2 Cable construction

Although the design of fibre optic cable for use on aircraft is fairly similar from one manufacturer to another there are important differences between cables. The two main areas of difference are fibre coatings and cable strength member materials. Each has its own positive and negative attributes in the context of termination procedures. Avionic fibre optic cables are typically constructed as follows, see Figures 1 and 2.



Key

1 Outer jacket
2 Buffer
3 Cladding
4 Core
5 Primary coating
6 Strength member

Figure 1 — Typical avionic fibre optic cable construction