SLOVENSKI STANDARD
SIST EN 4650:2010

01-junij-2010

Aeronavtika - Postopek označevanja žic in kablov z UV-laserjem

Aerospace series - Wire and cable marking process, UV Laser

Luft- und Raumfahrt - Leitungs- und Kabelkennzeichnungsverfahren durch UV Laser

Série aérospatiale - Procédé de marquage des fils et câbles par laser UV

Ta slovenski standard je istoveten z: **EN 4650:2010**

ICS:

49.060	Letalska in vesoljska električna oprema in sistemi	Aerospace electric equipment and systems

SIST EN 4650:2010 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 4650

April 2010

ICS 49.060

English Version

Aerospace series - Wire and cable marking process, UV Laser

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COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (EN 4650:2010) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-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 ASD, 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of an identical text or by endorsement, at the latest by October 2010, and conflicting national standards shall be withdrawn at the latest by October 2010.

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Introduction

Ultraviolet (UV) laser wire marking was developed in 1987 to provide a safe, permanent means of marking thin wall insulations; it is now the aerospace industry standard method for marking wire identification codes on to the surface of electrical wires and cables. It provides a simple, convenient, environmentally friendly, cost effective means of marking and identifying wires and jacketed cables. While a few larger airframe manufacturers have developed process standards and specifications for their own use during the introduction of this technology, there has been variability in the issues covered within these specifications and there has been no comprehensive standard process document developed for general use. The intended use of this document is to serve directly as a process standard for use by laser wire marking concerns. It can also serve as a model set of comprehensive requirements for use by organizations who intend to develop in-house laser marking process specifications or serve as a means for evaluating the adequacy and completeness of such specifications by procuring activities.

1 Scope

This standard is applicable to the marking of aerospace vehicle electrical wires and cables using ultraviolet (UV) lasers. This standard specifies the process requirements for the implementation of UV laser marking of aerospace electrical wire and cable and fibre optic cable to achieve an acceptable quality mark using equipment designed for UV laser wire marking of identification codes on aircraft wire and cable subject to EN 3475-100, *Aerospace series — Cables, electrical, aircraft use — Test methods — Part 100: General*. Wiring specified as UV laser markable and which has been marked in accordance with this standard will conform to the requirements of EN 3838.

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 3475-100, *Aerospace series — Cables, electrical, aircraft use — Test methods — Part 100: General*

EN 3475-705, *Aerospace series — Cables, electrical, aircraft use — Test methods — Part 705: Contrast measurement*

EN 3475-706, *Aerospace series — Cables, electrical, aircraft use — Test methods — Part 706: Laser markability*

EN 3838, *Aerospace series — Requirements and tests on user-applied markings on aircraft electrical cables* [1)]

EN ISO 10012, *Measurement management systems — Requirements for measurement processes and measuring equipment (ISO 10012:2003)*

1) Published as ASD Prestandard at the date of publication of this standard.

3 Applicability, terms, definitions, symbols and abbreviations

For the purposes of this document, the following applicability and definitions apply.

3.1 Applicability

This standard is applicable to the marking of airframe electrical wires and cables using ultraviolet (UV) lasers. The laser process practices defined in this standard are mandatory.

3.2 Terms and definitions

3.2.1
cable
electrical cable, unless noted as a fibre optic cable (two or more insulated conductors, solid or stranded, contained in a common covering, or two or more insulated conductors twisted or moulded together without common covering, or one insulated conductor with a metallic covering shield or outer conductor)

3.2.2
component
electrical wire or multi-conductor cable or fibre optic cable

3.2.3
contrast
measurement relating to the difference in luminance of the mark and its associated background according to a precise formula

3.2.4
damage
<wire and cable> unacceptable reduction in the mechanical or electrical properties of the insulation, i.e. specifically a measurable reduction in the performance of the wire or cable that is outside of its defined specification or is otherwise unacceptable

3.2.5
excimer
gas laser deriving its name from the term "excited dimer"

NOTE The laser is energized by means of an electrical discharge in a specialized mixture of rare gases and halogens. Excimer lasers are available operating at a number of discrete wavelengths throughout the UV, the most common of which are 193 nm, 248 nm, 308 nm and 351 nm. The wavelength is dependant only on the gas mix used; 308 nm is commonly used for UV laser wire marking.

3.2.6
fibre optic cable
cable that is designed to transmit light waves between a light transmission source and a receiver

NOTE In signal applications, the transmitter and receiver include devices that are used to convert between optical and electronic pulses. Typical cables include a glass or plastic core, a layer of cladding having a lower refractive index to refract or totally reflect light inward at the core/cladding boundary, a buffer, strength members and jacketing to protect the inner cable from environmental damage.

3.2.7
fluence
energy density, measured in joules per square centimetre (J/cm^2), of a single pulse of the laser beam, which is at the surface of the wire insulation or cable jacket

3.2.8
font
defining shape and style of a character set for printing or marking

3.2.9
gauge
wire size specified for a wire in a wire harness assembly by the wire harness assembly drawing

3.2.10
harmonic generation
use of non-linear optical processes to change the wavelength of a laser, enabling the output of an infrared laser to be converted to shorter wavelengths

NOTE In the case of Nd lasers this results in a frequency doubled output at 532 nm in the green and a frequency tripled output at 355 nm in the UV, which is used for wire marking.

3.2.11
harness
assembly of any number of wires, electrical/optical cables and/or groups and their terminations which is designed and fabricated so as to allow for installation and removal as a unit

NOTE A harness may be an open harness or a protected harness.

3.2.12
infrared
IR
electromagnetic radiation in the wavelength range from approximately 700 nm to in excess of 10 000 nm

3.2.13
insulation
outer polymer covering of an electrical wire or multi-conductor cable or fibre optic cable

3.2.14
IR laser
laser that produces a beam of radiation in the IR range

3.2.15
jacket
outer protective covering for a cable

3.2.16
laser
laser is an acronym for Light Amplification by the Stimulated Emission of Radiation. Lasers are a source of intense monochromatic light in the ultraviolet, visible or infrared region of the spectrum. The "active" or lasing medium may be a solid, liquid or gas. The laser beam is generated by energizing the active medium using an external power source, which is most commonly electrical or optical

3.2.17
legibility
properties of a mark that enable it to be easily and correctly read

3.2.18
luminance
quantitative measurement of the visible light reflected from a surface, in this case the wire or cable insulation

3.2.19
mark
meaningful alphanumeric or machine readable mark applied to the surface of a wire or cable jacket

3.2.20
markability
ability of a wire construction to be marked to provide legible identification marks of a specified contrast when marked in accordance with this standard

3.2.21
neodymium
Nd
elemental metal that forms the active laser material in the most common type of solid state laser

NOTE The neodymium is held in an optically transparent solid "host" material, and is energized by optical input, either from a flash lamp or from the optical output from a diode laser. The host material does not play a direct role, but can slightly influence the laser wavelength. Typical host materials are specialized crystal materials, such as Yttrium Aluminium Garnet (YAG), Yttrium Lithium Fluoride (YLF) and Yttrium Vanadate (YVO_4). These lasers are commonly referred to as Nd:YAG, Nd:YLF and Nd:YVO_4 respectively. The primary wavelength of Nd solid state lasers is in the infrared (IR) at a wavelength of approximately 1 064 nm. The IR output of such lasers can be conveniently reduced to lower wavelengths suitable for wire marking by use of harmonic generation.

3.2.22
pulse length
time interval between the laser energy crossing half the maximum energy on the rising and the falling edges of the pulse; referred to as FWHM – full width half maximum

NOTE Pulse lengths are measured in nanoseconds (ns). 1 ns = 10^{-9} s.

3.2.23
purchaser
activity that can issue a purchase order or contract

3.2.24
quality conformance
tests performed on production samples at a specified frequency to ensure that the requirements of this standard are met

3.2.25
quality conformance inspection
process that includes measurements, non-destructive tests, analysis, and associated data that will provide verification that a particular individual component continually conforms to the requirements defined in the standard

3.2.26
supplier
original equipment manufacturer (OEM) or a value added manufacturer which has design and production control of the processes used to produce the final product in accordance with the standard

3.2.27
ultraviolet
UV
electromagnetic radiation in the wavelength range from approximately 200 nm to 400 nm

3.2.28
UV laser
laser that produces a beam of radiation in the UV range

3.2.29
verification inspection
process that demonstrates that a product is capable of fully conforming to all the requirements defined in a standard

NOTE Verification Inspection includes definition of the measurements, tests, analysis, and associated data that provides consistent rationale for acceptance of a particular supplier's design as meeting the standard requirements typically prior to acquisition by the Purchaser.

3.2.30
wavelength
λ
distance between repeating units of a wave pattern, e.g. the distance between the crest of one wave and the crest of an adjacent wave

NOTE 1 Laser wavelength is typically measured in nanometres (nm).

NOTE 2 $\lambda = c/f$

where

c is the velocity of light;

f is the frequency.

3.2.31
wire
single metallic conductor of solid, stranded or tinsel construction, designed to carry current in an electric circuit, but not having a metallic covering, sheath or shield

NOTE For the purpose of this specification, "wire" refers to "insulated electric wire".

3.2.32
wire code
wire circuit identification number or code assigned to a specific wire in a wire harness assembly and marked on the insulation surface

3.3 Symbols and abbreviations

nm : nanometre, 10^{-9} m;

ns : nanosecond 10^{-9} s;

ETFE : ethylenetetrafluoroethylene;

PFA : perfluoroalkoxy fluoropolymer;

PTFE : polytetrafluoroethylene;

PVDF : polyvinylidene difluoride / polyvinylidene fluoride.