SLOVENSKI STANDARD
SIST EN 4650:2023

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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 au laser UV

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Aerospace series - Wire and cable marking process, UV Laser

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

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

This European Standard was approved by CEN on 2 October 2022.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 4650:2023) 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 document 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 document shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2023, and conflicting national standards shall be withdrawn at the latest by September 2023.

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.

This document supersedes EN 4650:2010.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

The main changes with respect to the previous edition are listed in the following table.

Table 1 — Main changes to previous edition *(1 of 2)*

prEN/EN Number	Edition	Publication Date	Modification	Reason and validation
prEN 4650	P1	2008–08–30	3 – Terms and definitions: Clause updated	Addition of new definitions relating to laser parameters and scanning laser marking
			4 – Requirements: Major revision of the Clause	Expanded and updated, including new detailed requirements for laser scanning marking systems
			5 - Quality assurance provisions: Clause updated	Table 2 updated to reflect changes in Clause 4
			6 - Test methods Clause updated	Addition and updates regarding laser scanning marking systems
			8 – Notes: Clause updated	Updated for scanning laser systems, note added on fungus testing, Table 3 updated with new laser types

Table 1 — Main changes to previous edition *(2 of 2)*

prEN/EN Number	Edition	Publication Date	Modification	Reason and validation
prEN 4650	P1	2008–08–30	Annex A added	Addition of information for dot overlap measurement methods for laser scanning marking and laser beam distribution profiles

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 document is applicable to the marking of aerospace vehicle electrical wires and cables using ultraviolet (UV) lasers.

This document specifies the process requirements for the implementation of UV laser marking of aerospace electrical wires and cables and fibre optic cables 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 document will conform to the requirements of EN 3838.

This document 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.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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*

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

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
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 molded together without common covering, or one insulated conductor with a metallic covering shield or outer conductor

3.1.2
component
for the purposes of this document this shall be an electrical wire or multi-conductor cable or fibre optic cable

3.1.3
contrast
measurement relating to the difference in luminance of the mark and its associated background according to a precise formula

3.1.4
damage
for the purpose of this document, with reference to wire and cable, damage is defined as an 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)

3.1.5
dot overlap
dot overlap for scanning laser systems is defined in relation to the diameter, D, of the laser beam/dot at the surface of the wire, and the distance, d, between the centres of the adjacent dots

Note 1 to entry: the percentage overlap = (1-(d/D)) x 100 %

3.1.6
excimer
gas laser deriving its name from the term “excited dimer”

Note 1 to entry: 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.

3.1.7
fibre optic cable
cable that is designed to transmit light waves between a light transmission source and a receiver

Note 1 to entry: 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.

3.1.8
fluence
energy density, measured in joules per square centimeter (J/cm^2), of a single pulse of the laser beam, which is at the surface of the wire insulation or cable jacket

3.1.9
font
defining shape and style of a character set for printing or marking

3.1.10
gauge
wire size specified for a wire in a wire harness assembly by the wire harness assembly drawing

3.1.11
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 1 to entry: in the case of neodymium (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.

3.1.12
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 1 to entry: a harness may be an open harness or a protected harness.

3.1.13
infrared
IR
electromagnetic radiation in the wavelength range from approximately 700 nm to in excess of 10 000 nm

3.1.14
insulation
outer polymer covering of an electrical wire or multi-conductor cable or fibre optic cable

3.1.15
IR laser
laser that produces a beam of radiation in the IR range

3.1.16
jacket
outer protective covering for a cable

3.1.17
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

3.1.18
laser average power
optical power, measured in Watts (W), delivered by the laser source

3.1.19
laser pulse energy
optical energy, measured in Joules (J) contained in each laser pulse

3.1.20
laser 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 1 to entry: pulse lengths are measured in nanoseconds (ns). 1 ns = 10^{-9} s.