INTERNATIONAL STANDARD

ISO 10110-12

Second edition
2007-09-01

AMENDMENT 1
2013-09-15

Optics and photonics — Preparation of drawings for optical elements and systems —

Part 12:
Aspheric surfaces —

AMENDMENT 1

Optique et photonique — Préparation des dessins pour éléments et systèmes optiques —

Partie 12: Surfaces asphériques —

AMENDEMENT 1

Reference number
ISO 10110-12:2007/Amd.1:2013(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The committee responsible for this document is ISO/TC 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards*.

Optics and photonics — Preparation of drawings for optical elements and systems —

Part 12: **Aspheric surfaces**

AMENDMENT 1

Page iv, Foreword

In the list of part titles of ISO 10110, update the part title of Part 8 to read:

— *Surface texture; roughness and waviness*

Page 2, 3.1.2

Number the NOTE to become NOTE 1 and add the following NOTE 2 after NOTE 1:

NOTE 2 In this case, "left" and "right" presume z is increasing from left to right. When the Z-axis is reversed as a result of a reflection (a 180° rotation about the Y-axis), the sign convention for radius and sagitta is also reversed. This is discussed further in 3.3.2.3.

Page 5, 3.3.2.1

Immediately after Equation (12), i.e. before the sentence about Schmidt surface, insert the following new paragraph:

The first order and second order aspheric terms, A_1h and A_2h^2, may be added to Equation (12).

Page 6, 3.3.2.3

Add the following new subclause after 3.3.2.3:

3.3.2.4 Combined surface based on an orthogonal polynomial

A surface of higher order can also be generated by combining a spherical surface [Equation (5)] with a set of orthogonal polynomials of the following type possessing orthonormal derivatives (see Reference [3]).

$$z = f(x, y) + f_1(x, y) \tag{17}$$

$$f_1(x,y) = \frac{\left(\frac{h}{h_0}\right)^2 \left[1 - \left(\frac{h}{h_0}\right)^2\right]}{\sqrt{1 - \left(\frac{h}{R}\right)^2}} \left[A_0 Q_0\left(\frac{h^2}{h_0^2}\right) + A_1 Q_1\left(\frac{h^2}{h_0^2}\right) + \cdots\right] \tag{18}$$

where h_0 marks the upper limit of h. The description z is valid for $0 \le h \le h_0$ only. R is the radius of curvature that intersects the surface at h_0.

For a detailed description of the recursion formulae, see Annex B.

NOTE Another description that combines a conic with a set of orthogonal polynomials, orthogonal in amplitude, is also permitted [see Reference [4], Equations (2) to (3) and (8) to (9)].

Page 14, Annex A

In the table, add a new row for “Sphere”, under “Surfaces rotationally symmetric about *Z*-axis”. For the sake of clarity, the amended table of Annex A is given hereafter in its entirety.

Class	Basic surface	Basic equation $f(x,y)$ =	Power series $f1(x,y)$ = [for toric surfaces, $g1(x)$]
Non-rotationally-symmetric surfaces	Ellipsoid Hyperboloid Paraboloid	$\dfrac{\dfrac{x^2}{R_X}+\dfrac{y^2}{R_Y}}{1+\sqrt{1-(1+\kappa_X)\left(\dfrac{x}{R_X}\right)^2-(1+\kappa_Y)\left(\dfrac{y}{R_Y}\right)^2}}$	$A_4x^4+B_4y^4+A_6x^6+B_6y^6+\ldots$ $\ldots C_3\lvert x\rvert^3+\ldots+D_3\lvert y\rvert^3+\ldots$
$R_X\neq R_Y$ [a] $\kappa_X\neq\kappa_Y$	Cone (a ≠ b)	$c\sqrt{\dfrac{x^2}{a^2}+\dfrac{y^2}{b^2}}$	
$A_{2i}\neq B_{2i}$ $C_{2i\text{-}1}\neq D_{2i\text{-}1}$	Cylinder	$\dfrac{u^2}{R_U\left[1+\sqrt{1-(1+\kappa_U)\left(\dfrac{u}{R_U}\right)^2}\right]}$	$A_4x^4+A_6x^6+\ldots+C_3\lvert x\rvert^3$ for $u=x$ $B_4y^4+B_6y^6+\ldots+D_3\lvert y\rvert^3$ for $u=y$
Surfaces rotationally symmetric about Z axis	Ellipsoid Hyperboloid Paraboloid Sphere	$\dfrac{h^2}{R\left[1+\sqrt{1-(1+\kappa)\left(\dfrac{h}{R}\right)^2}\right]}$	$A_3h^3+A_4h^4+A_5h^5+\ldots$ where $h=\sqrt{x^2+y^2}$
$R_X=R_Y=R$ $\kappa_X=\kappa_Y=\kappa$	Cone ($a=b$)	$\dfrac{c}{a}h$	
$h^2=x^2+y^2$	Plane (Schmidt surface)	0	
	Sphere	$\dfrac{h^2}{R\left[1+\sqrt{1-\dfrac{h^2}{R^2}}\right]}$	$\dfrac{\left(\dfrac{h}{h_0}\right)^2\left[1-\left(\dfrac{h}{h_0}\right)^2\right]}{\sqrt{1-\left(\dfrac{h}{R}\right)^2}}\left[A_0Q_0\left(\dfrac{h^2}{h_0^2}\right)+A_1Q_1\left(\dfrac{h^2}{h_0^2}\right)+\cdots\right]$
Surfaces of revolution; not coincident with coordinate axis	Toric surface	$f(x,y)=R_Y\mp\sqrt{\left[R_Y-g(x)\right]^2-y^2}$ $g(x)=\dfrac{x^2}{R_X\left[1+\sqrt{1-(1+\kappa_X)\left(\dfrac{x}{R_X}\right)^2}\right]}$	$g_1(x)=A_4x^4+A_6x^6+\ldots+C_3\lvert x\rvert^3+C_5\lvert x\rvert^5+\ldots$

a If at least one of these inequalities is valid.

Page 15, new Annex B

Add the following annex:

Annex B
(informative)

Description of an orthogonal polynomial

$$Q_{m+1}\left(\frac{h^2}{h_0{}^2}\right)=\frac{P_{m+1}\left(\frac{h^2}{h_0{}^2}\right)-g_m Q_m\left(\frac{h^2}{h_0{}^2}\right)-k_{m-1}Q_{m-1}\left(\frac{h^2}{h_0{}^2}\right)}{l_{m+1}} \tag{B.1}$$

starting with $Q_0\left(\frac{h^2}{h_0{}^2}\right)=1$ and $Q_1\left(\frac{h^2}{h_0{}^2}\right)=\frac{13-16\left(\frac{h^2}{h_0{}^2}\right)}{\sqrt{19}}$

$$P_{m+1}\left(\frac{h^2}{h_0{}^2}\right)=(2-4\frac{h^2}{h_0^2})P_m\left(\frac{h^2}{h_0{}^2}\right)-P_{m-1}\left(\frac{h^2}{h_0{}^2}\right) \tag{B.2}$$

starting with $P_0\left(\frac{h^2}{h_0{}^2}\right)=2$ and $P_1\left(\frac{h^2}{h_0{}^2}\right)=6-8\left(\frac{h^2}{h_0{}^2}\right)$.

The following auxiliary polynomials (B.3), (B.4) and (B.5) have to be solved in the order given here and are valid for $m \geq 2$.

$$k_{m-2}=\frac{-m(m-1)}{2\,l_{m-2}} \tag{B.3}$$

$$g_{m-1}=\frac{-\left(1+g_{m-2}k_{m-2}\right)}{l_{m-1}} \tag{B.4}$$

$$l_m=\left[m(m+1)+3-g_{m-1}^2-k_{m-2}^2\right]^{1/2} \tag{B.5}$$

starting with $g_0=-\frac{1}{2}$, $l_0=2$ and $l_1=\frac{1}{2}\sqrt{19}$.

Based on the recursion the first six Qs are the following:

$$Q_0\left(\frac{h^2}{h_0{}^2}\right)=1$$

$$Q_1\left(\frac{h^2}{h_0{}^2}\right)=\frac{13-16\left(\frac{h^2}{h_0{}^2}\right)}{\sqrt{19}}$$

$$Q_2\left(\frac{h^2}{h_0^2}\right)=\sqrt{\frac{2}{95}}\left[29-4\left(\frac{h^2}{h_0^2}\right)\left(25-19\left(\frac{h^2}{h_0^2}\right)\right)\right]$$

$$Q_3\left(\frac{h^2}{h_0^2}\right)=\sqrt{\frac{2}{2545}}\left\{207-4\left(\frac{h^2}{h_0^2}\right)\left[315-\left(\frac{h^2}{h_0^2}\right)\left(577-320\left(\frac{h^2}{h_0^2}\right)\right)\right]\right\}$$

$$Q_4\left(\frac{h^2}{h_0^2}\right)=\frac{1}{3\sqrt{131831}}\left(7737-16\left(\frac{h^2}{h_0^2}\right)\left\{4653-2\left(\frac{h^2}{h_0^2}\right)\left[7381-8\left(\frac{h^2}{h_0^2}\right)\left(1168-509\left(\frac{h^2}{h_0^2}\right)\right)\right]\right\}\right)$$

$$Q_5\left(\frac{h^2}{h_0^2}\right)=\frac{1}{3\sqrt{6632213}}\left[66657-32\left(\frac{h^2}{h_0^2}\right)\left(28338-\left(\frac{h^2}{h_0^2}\right)\left\{135325-8\left(\frac{h^2}{h_0^2}\right)\left[35884-\left(\frac{h^2}{h_0^2}\right)\left(34661-12432\left(\frac{h^2}{h_0^2}\right)\right)\right]\right\}\right)\right]$$

Page 15, Bibliography

Add the following bibliography references:

[2] Kross, J., Oertmann, F.-W., Schuhmann, R., *On aspherics in optical system*, SPIE Proceedings 656 (1986)

[3] Forbes, G.W., Robust, efficient computational methods for axially symmetric optical aspheres, Opt. Express 18, 19700-19712 (2010)

[4] Forbes, G.W., Shape specification for axially symmetric optical surfaces, Opt. Express 15, 5218-5226 (2007)